Pharmacological Aspects of Nursing Care

Sixth Edition

Barry S. Reiss, B.S., M.S., Ph.D.
Mary E. Evans, B.S.Ed., M.S.N., Ph.D., R.N., F.A.A.N.
Revised by
Bonita E. Broyles, R.N., B.S.N., Ed.D.

Delmar / Thomson Learning

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CONTENTS

section 4 Agents Used to Treat Gastrointestinal Disorders

section 5 Agents Affecting the Central Nervous System

LIST OF TABLES (TEXT)

LIST OF TABLES (APPENDICES)

PREFACE

introduction

This new full-color edition of *Pharmacological Aspects of Nursing Care* presents vital information on more than 1,100 pharmacologic agents. In the most comprehensive edition to date, this text remains easy to understand, well-organized, and logical in its discussion of nursing responsibilities related to pharmacology—making it a vital text for all nursing students. The use of full color will stimulate the reader and make this sometimes difficult to understand content an exciting learning experience.

The nurse's role in the assessment, diagnosis, planning, implementation, and evaluation of clients receiving drug therapies is a vital and growing function of nursing. Additionally, the role of educating clients about their drug therapies is a critical component in obtaining the client's cooperation in the therapies.

To function therapeutically and successfully in these roles, the nurse must understand:

- the fundamental principles of drug action,
- the principles and methods of drug administration,
- the accurate calculating of drug dosages,
- the special considerations of drug therapy for pediatric and geriatric clients,
- the application of specific drugs in the treatment of health alterations,
- normal and adverse responses by the client to drug therapy, and
- the appropriate nursing interventions to achieve the desired goals of drug therapy.

In addition, the nurse must be able to assess a client's response to a drug therapy to provide feedback about its effectiveness. To ensure that these client goals are met, the framework of the nursing process is used to guide the learner in this new edition.

organization of text

The text begins with an introduction to drugs and drug therapies, including a brief history of pharmacology, sources of drugs and dosage forms, drug legislation, principles of drug action, pharmacokinetic factors in drug therapy, and drug interactions and incompatibilities. A discussion follows of the principles and methods of drug administration, with emphasis on the implications for nursing care. A review of dosage calculations is included. Specific drug therapy considerations for pediatric clients and geriatric clients are presented in separate chapters to highlight the special concerns for these groups of clients.

The remainder of the text is organized according to the major drug classifications, identified either by their clinical use or by the body system they affect. For each classification of drugs discussed in the text, the underlying pharmacological principles of drug action and the specific uses in clinical practice are explained. This is followed by "Applying the Nursing Process," which contains assessment, pertinent nursing diagnoses, planning/goals, implementation, and evaluation.

features and benefits

- New Activity Software CD-ROM is packaged free with every book! The activity software contains over 500 questions in a game format that enables students to study and test their knowledge in an interactive and stimulating learning environment.

- Nursing care considerations are discussed in the section *Applying the Nursing Process* that help the nurse focus on her role.
- Highlighted *Key Nursing Implications* provide a ready reference for students to focus their attention on the most important principles of drug therapy and their relationship to clinical nursing practice.
- For easy reference, nursing implications, drug routes of administration, drug dosages, and adverse effects are summarized in extensive drug tables in each drug classification chapter.
- Numerous *Nursing Care Plans* apply the nursing process to specific drug therapies for common health problems. The plans give students the opportunity to study the dynamics of the nursing process in typical clinical situations.
- *Home Care/Client Teaching* sections are included for nurses providing care to clients before discharge from acute care facilities, health clinics, and physicians' offices and once the client has returned home.

revised content

- Information on 115 new drugs is added to this edition.
- New full-color illustrations have been added.
- All nursing diagnoses and terminology in the Nursing Care Plans are updated to the 2001–2002 NANDA guidelines, *Nursing Diagnoses: Definitions & Classification*.
- The *Applying the Nursing Process* section within each chapter is expanded to include nursing diagnoses, planning/goals, and evaluation for each drug classification.
- *Nursing Care Plans* and *Case Studies* have been revised to provide diversity of client population and present currently used drugs.
- Home Care Hints have been expanded to include a focus on Client Teaching.
- Suggested Activities are revised to present more challenging *Critical Thinking Exercises*.
- Each chapter lists publications consistent with chapter content, including Internet sites and current nursing periodicals.
- The "five rights" of medications have been updated and expanded to include "Right Documentation" and "Right to Refuse."
- Pharmacokinetic differences in pediatric clients and geriatric clients have been expanded.
- Drug tables throughout the text are updated for new drugs, trade names, dosages, routes, adverse effects, and nursing implications.
- Expanded content on the autonomic nervous system
- Recommended dietary allowances (2000) can be found in Chapter 33
- Chapter 39, "Drugs Used in the Treatment of Cancer," has been expanded to include the newest agents and protocols of drug treatment.
- Herbal and drug interactions are included, where appropriate.
- Pediatric and geriatric dosages and nursing implications have been added for many drug classifications.
- Tables have been added for drug classifications, such as antivirals, to reflect current focuses of drug research.

new content for this edition includes

- a list of Internet sites added to Chapter 1
- the FDA Medical Products Reporting Program
- herbals/botanical medicine
- over-the-needle venipuncture

- methcillin-resistant *staphlococcus aureus* (MRSA), oxicillin-resistant *staphlococcus aureus* (ORSA), and vancomycin-resistant *enerococcus* (VRE)
- fourth-generation cephalosporin
- antiviral drug interactions
- pain management in end-of-life care
- drug products used for PCA analgesia
- sympathomimetics (adrenergics), sympatholytics (adrenergic blockers), parasympathomimetics (cholinergics), and parasympatholytics (anticholinergics)
- catechol-o-methyltransferase inhibitors
- leukotriene receptor antagonists
- prostaglandin-inhibiting agents to treat glaucoma
- discussion on myocardial infarction in Chapter 29
- glycoprotein IIb/IIIa inhibitors
- combination potassium-sparing and hydrochlorothiazide diuretics
- cardiovascular risk factors
- hypertension risk groups
- Joint National Committee for Prevention, Detection, Evaluation, and Treatment of Hypertension Guidelines
- magnesium, copper, chromium, and selenium added to Chapter 33
- removal of agents from the market by the FDA
- impotence
- biologic response modifiers
- adjuvant agents to antineoplastics
- antineoplastic agents' potential for causing nausea/vomiting
- topoisomerase 1 inhibitors
- examples of combination chemotherapeutic regimens
- antiparasitic agents
- diabetic foot ulcers

instructor support materials

Instructor's Manual, Computerized Test Bank, and PowerPoint slides on CD-ROM! The available IM and CTB instructor tools have been revised to accompany the sixth edition of *Pharmacological Aspects of Nursing Care*, and new PowerPoint slides have been added for classroom instruction.

Instructor's Manual includes chapter outlines to assist instructors in planning class lectures and activities. Answers are also included to the case study questions from the text chapters.

Computerized Test Bank consists of over 1,000 questions. These include true/false, multiple-choice, matching, short answer, and essay questions. This software allows the user to create tests in less than 5 minutes, with the ability to print them in a variety of layouts and even add the instructor's ***own*** questions. It also has electronic "take-home testing" (put test on disk), Internet-based testing capabilities, and allows the user to insert multimedia (video, audio) into the electronic tests.

PowerPoint slides include over 50 pieces of artwork from the text for classroom reference.

about the author

Dr. Broyles began in nursing in 1968 working as a student nursing assistant while pursuing her Bachelor of Science degree in Nursing from Ohio State University in Columbus, OH. She was graduated with her B.S.N. in 1970 and spent the next 13 years staffing and teaching in obstetrics and gynecology. From 1972 to 1976, she taught in the Associate Degree Nursing Education

program at Columbus Technical Institute (which is now Columbus State). During this same period, she and her husband had two sons—Michael Richard and Jeffrey Allen Brown. During her 5-year position as Patient Teaching and Discharge Planning Coordinator for Obstetrics at Mt. Carmel Medical Center in Columbus (1976–1981), Dr. Broyles published her first professional work. At this juncture, she decided to expand both her intellect and nursing skills into the medical-surgical arena of nursing, in which she has staffed and taught nursing since 1981. She moved with her husband, Roger Broyles, to North Carolina in 1985. She is currently working at Piedmont Community College in Roxboro, NC, and has been teaching in the nursing education department since 1986. She is the course coordinator for Maternal-Child Nursing (teaching the pediatric nursing component of the course), Adult Nursing II, and Pharmacology. She is involved in both levels of nursing education in the Associate Degree Nursing Program, with special emphasis on second-level nursing courses. She received her Master of Arts in Educational Media from North Carolina Central University in 1988 and her Doctorate of Education from LaSalle University in 1996. Her dissertation research covered critical thinking in Associate Degree Nursing Students and was the largest study published on this topic.

acknowledgments

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The author wishes to thank Barry S. Reiss and Mary E. Evans for such a wonderful manuscript to revise. The author has used this text in her nursing classes since its first edition. This text was originally designed as a student-friendly pharmacology text and the author has attempted to build on that and the professional style of Dr. Reiss and Dr. Evans.

Finally, the author wishes to thank the reviewers for their wonderful comments and suggestions, many of which were used in this sixth edition. Having been a book reviewer for 5 years, the author appreciates the time and effort of the reviewers as they shared their expertise to help make this edition such a success.

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SECTION 1

Introduction to Drugs and Drug Administration

MAJOR NURSING DIAGNOSES

- Ineffective Health Maintenance
- Noncompliance Related to Drug Regimens
- Deficient Knowledge (Illness and Its Treatment)
- Risk for Poisoning
- Risk for Injury
- Risk for Imbalanced Nutrition

1 Drugs/Agents and Factors Affecting Their Action

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the scope of the science of pharmacology
- Identify drug sources and provide an example of each
- Identify the properties of each of the following dosage forms:
  tablets • capsules • troches • suppositories • solutions • suspensions • emulsions • semisolid dosage forms (ointments, creams, and gels) • transdermal patches • parenterals (ampules, vials, prefilled syringes)
- Compare the significance of the chemical name, generic name, and brand name of a drug
- Discuss the meaning of each part of a "product insert" and a "patient package insert (PPI)"
- Identify the component parts of a written prescription order
- Identify the meaning of common abbreviations used in prescription orders
- Identify the significance of each controlled substance schedule as defined in the Controlled Substances Act of 1970 (Title II of the Comprehensive Drug Abuse Prevention and Controlled Substances Act of 1970)
- Describe Canadian drug legislation
- Briefly describe the review process employed by the FDA in evaluating the safety and effectiveness of nonprescription drug products
- Identify the significance of each of the four phases involved in the clinical testing of a new drug
- Describe the FDA Medical Products Reporting Program
- Describe the role of the nurse in the clinical testing of a new drug
- Identify the unique characteristics of each of the following drug information sources:
  AHFS Drug Information • *Physicians' Desk Reference* • *Drug Facts and Comparisons* • *Handbook of Nonprescription Drugs*
- Discuss the significance of the following terms in the measurement of drug concentrations in the body:
  minimum effective concentration (MEC) • minimum toxic concentration (MTC) • plateau or steady-rate concentration • peak concentration • trough concentration
- Discuss the significance of the term "bioequivalent" as it pertains to a drug product
- Compare the actions of agonist, partial agonist, and specific antagonist drugs
- Differentiate among each of the following adverse drug reactions:
  side effect • toxic effect • allergic reaction • idiosyncratic reaction • teratogenic effect

- Describe the importance of each of the following factors in the passage of a drug through the body:
  stomach acidity • the solubility of drug in fat • drug-protein binding • microsomal enzymes • tubular secretion • glomerular filtration
- Explain the relationship between the plasma concentration of a drug and its "drug half-life"
- Describe the role of each of the following factors in determining a subject's pharmacological response to a drug:
  age • sex • body weight • body surface area • basal metabolic rate • disease states • genetic factors • placebo effect • time of administration • tolerance
- Explain the significance of drug interactions, as well as physical and chemical incompatibilities of drugs in client care

A drug can be broadly described as any chemical substance that affects living systems by changing their structure or function. Pharmacology is the science concerned with the history, sources, and physical and chemical properties of drugs, as well as the ways in which drugs affect living systems. Because of the complex nature of this science, various subdivisions of pharmacology have evolved.

Pharmacology

- Study of history, sources, and physical and chemical properties of drugs
- Also includes how drugs affect living systems

Pharmacodynamics

- Study of the biochemical and physiological effects of drugs
- Study of drugs' mechanisms of action

Pharmacokinetics

- Study of the absorption, distribution, biotransformation (metabolism), and excretion of drugs
- Each of these factors is related to the concentration of the drug and/or its chemical by-products in various body sites as well as the time required for these drug concentrations to develop and/or change.

Pharmacotherapeutics

- Study of how drugs may best be used in the treatment of illnesses
- Study of which drug would be most or least appropriate to use for a specific disease, what dose would be required, etc.

Pharmacognosy

- Study of drugs derived from herbal and other natural sources
- By studying the compositions of natural substances and how the body reacts to them, one gains better knowledge for developing synthetic versions.

Toxicology

- Study of poisons and poisonings
- As almost all drugs are capable of being toxic under some circumstances, this deals with the toxic effects of substances on the living organism.

HISTORY

The treatment and prevention of disease is as old as the history of man since it has always been considered as important to survival as the need for food and shelter. In early civilizations, disease was viewed with great superstition. Prevention and

treatment of illness were, therefore, often directed to driving away evil spirits and invoking magical powers. To enhance the mystical treatment of disease, primitive cultures began to experiment with the plants that grew around them. This led to the discovery of the first medicinal agents, some of which (**alcohol**, **opium**, etc.) are still used today. Even agents used as poisons to coat the tips of arrows and spears of ancient warriors (e.g., **curare**) are still used medicinally.

Ancient Egypt is often credited as being the cradle of pharmacology. Egyptian medical sources, such as the Ebers Papyrus, which were written over 3,000 years ago, listed over seven hundred different remedies used to treat specific ailments. These were probably the earliest documents devoted entirely to medicine. Hippocrates, in the fourth century BC, declared in Greece that knowledge about health and disease could only come through the study of natural laws. This resulted in the first systematic dissections of the human body done to study the functions of specific organs.

In the first century, Dioscorides prepared *De Materica Medica*, which scientifically described six hundred different plants and classified them, for the first time, by substance rather than by the disease they were intended to treat. This work remained the main source of pharmaceutical knowledge until the sixteenth century. At that time, Paracelsus, a Swiss scientist, first advocated the use of single drugs, rather than mixtures or potions, as a means of treating diseases. He believed that the dosage of single drugs could be regulated more precisely than that of complex mixtures and recognized the dangers of giving too much or too little medicine to a specific client. He wrote, "all things are poisons, for there is nothing without poisonous qualities. It is only the dose which makes a thing a poison." For his contributions Paracelsus is often considered to be the father of pharmacology.

It was not until the seventeenth century that the English physiologist William Harvey first began to explain how drugs exert their beneficial or harmful effects. He first demonstrated the circulation of blood in the body and introduced a new way of administering drugs—*intravenously*. In the two hundred years that followed Harvey's work, drug products of greater purity gradually evolved. Using these purified drugs two French physiologists, Francois Magendie and Claude Bernard, in the nineteenth century, demonstrated that certain drugs work at specific sites of action within the body.

Lister and Semmelweis first introduced the use of antiseptics to prevent infection during surgery. With Ehrlich's discovery of antibiotics and Banting and Best's discovery of **insulin**, the golden age of pharmacology was ushered in. This culminated in the development of literally thousands of drugs during the twentieth century. Collectively, these drugs have altered the practice of medicine and saved millions of human lives.

SOURCES OF DRUGS

Drugs may be derived from a number of different sources. Some are derived from natural sources. For example, insulin can be extracted from the pancreas of animals, **attapulgite suspension** (e.g., **Kaopectate**) is derived from natural clays, while some bulk-forming laxatives (e.g., **Metamucil**), cardiac drugs (e.g., **digitoxin**) and cancer chemotherapeutic agents (e.g., **vincristine**) are derived from plants.

Some drugs are produced semisynthetically. For example, many antimicrobial agents are prepared by chemically modifying substances that are available from a natural source. Likewise, some human insulin products are prepared by chemically modifying animal insulin so it has precisely the same chemical structure as human insulin.

The vast majority of drugs currently in use are entirely prepared by synthetic means; i.e., they are formed by chemical reactions in a laboratory (e.g., **Synthroid**). Such agents are synthesized after determination of how the chemical structure of a compound relates to its pharmacological properties. Because synthetic drugs are produced in the laboratory, it is often possible to create compounds that have greater purity than those which are naturally derived.

The most exciting advances in the development of new drugs have been in the area of biotechnology. Biotechnology involves the manipulation of proteins to permit the large-scale industrial production of complex natural substances (e.g., hormones) or genetically altered biological substances. It is a science that uses discoveries derived from molecular biology, recombinant DNA technology, genetic engineering, immunology, and pharmacology.

In pharmacology, the greatest potential for applying biotechnology is in gene splicing. This involves the genetic manipulation of nonpathogenic, rapidly growing bacteria, such as *E. coli*, to enable them to manufacture complex biological compounds that would be extremely difficult or

costly to prepare by conventional means. The process of gene splicing involves the inoculation of such *E. coli* organisms with plasmids. Plasmids are circular DNA molecules that carry a few genes the bacterium can perpetuate and duplicate in addition to its own chromosomes (Figure 1–1).

Currently, hundreds of different biotechnology products are in various stages of development (i.e., are in Phase I, II, or III of testing). Products already approved include human insulin, human tissue plasminogen activator, human growth hormone, and hepatitis B vaccine. The first decade of the new millenium promises to be a time when the introduction of biotechnology products will be common and their benefits to humans almost too great to measure.

DRUG USES

Drugs may be helpful to both the healthy and the sick. Drugs have six major uses.

- The most common drug use is symptomatic treatment. Many drugs are used to relieve disease symptoms (e.g., **aspirin** to relieve fever and headache).

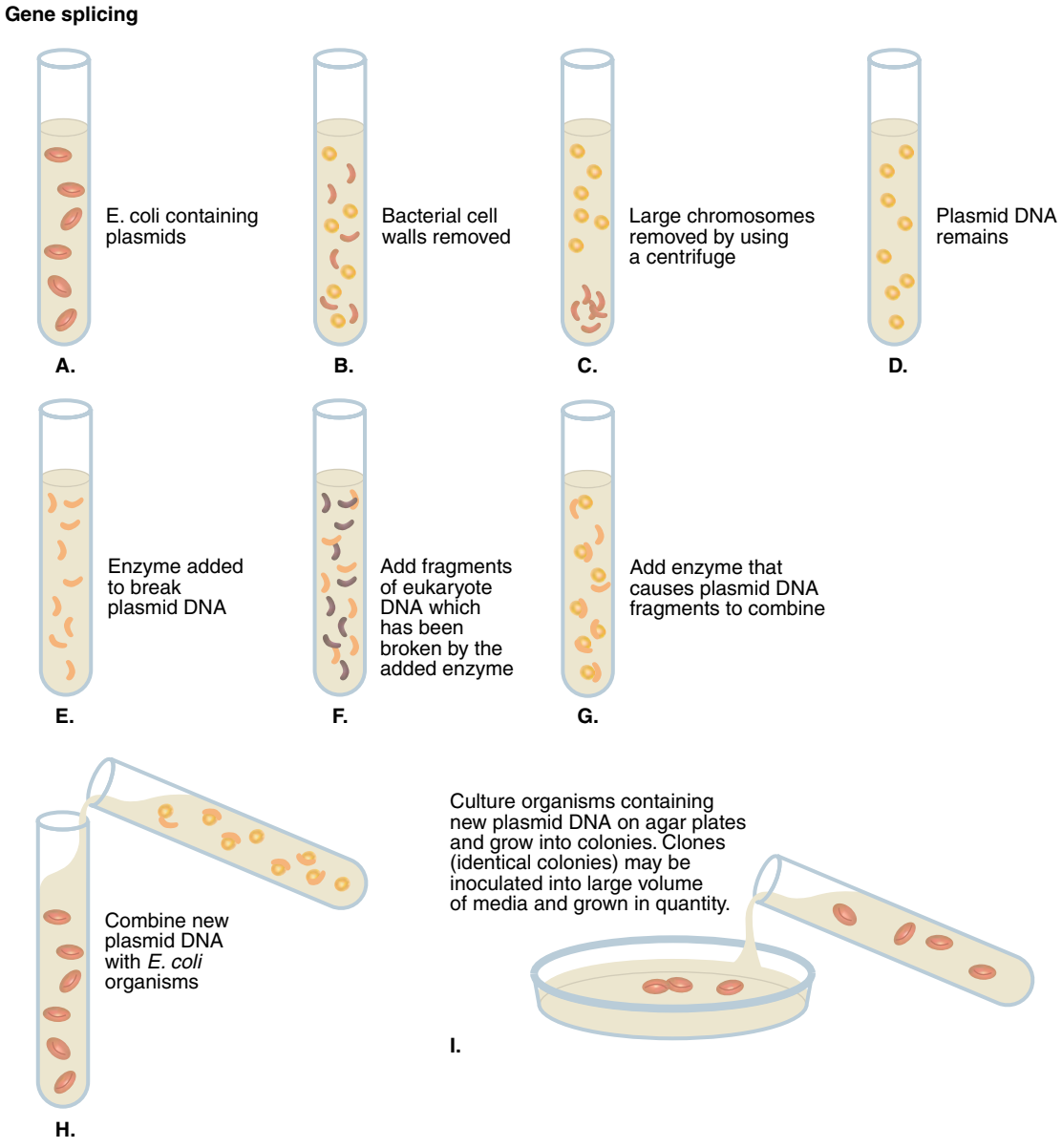

Figure 1–1 Gene Splicing

- Preventive drugs help the body avoid disease (e.g., hepatitis vaccine for serum hepatitis B).
- Diagnostic drugs (e.g., radiopaque dyes) help the physician determine whether a disease is present.
- Curative drugs (e.g., antibiotics) eliminate the disease.
- Health maintenance drugs (e.g., insulin) help keep the body functioning normally.
- Contraceptive drugs (e.g., oral contraceptives) prevent pregnancy.

DOSAGE FORMS

Drugs are capable of being transported into the human body in a variety of ways. Rarely are they administered in their pure chemical form, but rather in a formulation designed to maximize the stability and usefulness of the medication. Such formulations or dosage forms may be simple solutions of the drug in water and some may be more complex combinations. Some of the most common dosage forms are in the next sections.

Tablets

The tablet is the most popular dosage form and usually the easiest to administer. Almost all tablets now used in the United States are "compressed" tablets. They have been formed by compressing a mixture of pure drug(s) with inactive components that serve to add bulk, shape, weight, and/or other properties to the tablet. Compressed tablets are usually manufactured commercially since costly equipment is required to form them.

Most tablets contain a disintegrating agent in their formulation. Usually this is cornstarch. The disintegrating agent swells when it comes into contact with fluid in the stomach and causes the tablet to break apart into smaller particles, which dissolve rapidly and release the active drug. Many tablets are scored to facilitate convenient division into halves or even quarters (Figure 1–2A). Unscored tablets are difficult to break evenly. Some are coated with a substance which prevents the tablet from dissolving in the stomach but permits it to dissolve in the small intestine. Such tablets are *enteric-coated* (ec) and are designed to carry drugs that could irritate the stomach or be chemically destroyed by the acid environment of the stomach. Since the coating of enteric-coated tablets is designed to dissolve in a neutral or alkaline pH environment, it is important to avoid administering such dosage forms with antacids, milk, or other alkaline substances, as these may cause the coating to dissolve in the stomach rather than in the small intestine. Enteric-coated tablets should never be crushed or chewed.

Timed or Sustained-Release Tablets. Many different technologies exist for permitting drugs to be released from tablets in a controlled fashion. For example, some tablets (e.g., Slow-K®) have crystals of potassium chloride embedded in a wax matrix. When these tablets come in contact with gastric fluid, the fluid causes small amounts of the dissolved drug to leak through the channels in the wax matrix and promotes gradual release of the drug over several hours. This helps reduce the irritating effect of the drug on the GI lining. Controlled release of **potassium chloride** and other drugs is also accomplished by preparing tablet products that contain a microencapsulated drug, i.e., small drug particles coated with a polymer coating. When the tablet disintegrates, the microencapsulated drug particles are released. Depending on the thickness of the polymer coating, the particles release the drug over varying periods. *Osmotic* pumps have also been employed in providing a controlled release feature from some tablets. Osmotic pumps are polymer-coated tablets that allow water to enter into the tablet from the gastric fluid. As the drug dissolves within the tablet, it forms an osmotic gradient that forces drug solution out of a laser-drilled hole on the tablet surface. This mechanism permits a slow and steady drug release over a number of hours.

Some tablets contain different layers or have cores that separate different drugs that might be

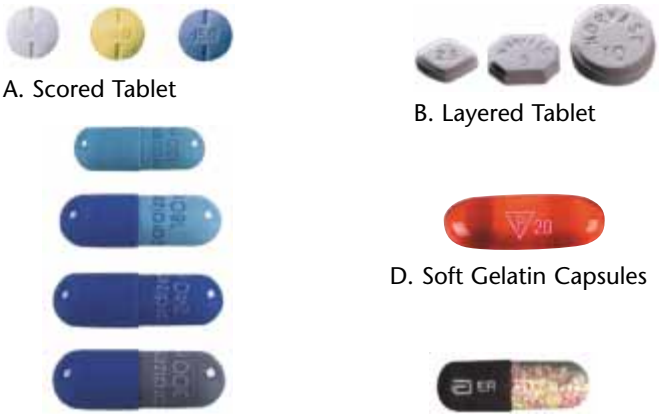

Figure 1–2 Solid Dosage Forms. *(From* Physicians Drug Reference *(2001). Montvale, NJ: Medical Economics. Courtesy of Medical Economics.)*

incompatible with one another. These layers may separate different doses of the same drug that are to be released at different times during the passage of the tablet through the gastrointestinal tract (Figure 1–2B).

While most tablets are intended to be swallowed whole by the client, some are meant to be chewed prior to being swallowed. Chewing provides a localized drug effect in the mouth, as well as better distribution of the drug in the stomach. Other tablets are to be dissolved under the tongue (*sublingually*) (SL) or in the inner lining of the cheeks (*buccally*) (BC). This permits the drug to directly enter the circulation without first passing into the stomach.

Capsules

A capsule is a dosage form in which a drug is enclosed in either a hard or soft soluble shell, usually made of gelatin. When the capsule is administered orally, the shell generally dissolves in the stomach within 10 to 20 minutes, releasing its contents. Hard gelatin capsules (e.g., **Temazepam**) consist of two parts that slide together to enclose the powdered medicinal contents (Figure 1–2C). They may be commercially manufactured or they may be prepared by the pharmacist to contain a precise medicinal formulation. If necessary, they may be opened by the nurse for administration in food, liquids, or tube feedings. To discourage tampering, some capsules are now manufactured to make it impossible to separate the two parts of the capsule without destroying its integrity.

Soft gelatin capsules (e.g., **Colace**) are usually designed to encapsulate medicinal liquids (Figure 1–2D). They are only prepared by commercial manufacturers and are completely sealed. Some capsule products contain small drug-impregnated beads designed to release drug(s) at different rates while they pass through the gastrointestinal tract, thereby producing a sustained-release action (Figure 1–2E).

Troches

Troches, or lozenges, are solid dosage forms that are generally disc shaped and should be dissolved slowly in the mouth. They are often designed to release medication that exerts an antiseptic or anesthetic effect on the tissues of the oral cavity or throat (e.g., **zinc** lozenges).

Suppositories

A *suppository* is a dosage form that is to be inserted into one of the external body orifices, usually the rectum, vagina, or urethra. Once inserted, it either dissolves slowly in the body fluids or melts at body temperature to release the medicinal content. Such medications may exert a localized effect on the tissue or they may enter the bloodstream and act throughout the body.

The most popular vehicle, or base, for suppositories is cocoa butter, a by-product of the chocolate industry. Cocoa butter is a waxy solid at room and refrigerator temperatures, but melts at body temperature. This is a desirable characteristic for a suppository base.

Solutions

A solution is a clear liquid preparation that contains one or more solvents, usually water, and one or more dissolved components, or solutes. When used orally, solutions are often flavored and colored to make them more appealing to the client. Solutions offer the advantage of easy administration, particularly for pediatric and geriatric clients, as well as the ability to infinitely vary the dose administered.

Syrups are sweetened solutions that are often used to mask the unpleasant taste of certain drugs. Syrups are also given for their soothing effect. Sugar-free syrups are available for diabetics. *Elixirs* are also solutions, but contain a solvent mixture of alcohol and water as well as other components. They are often employed as vehicles in order to dissolve drugs that do not dissolve in water alone. *Tinctures* are solutions that contain alcohol as the primary solvent but which may contain some water as well. Because tinctures are available for internal and external use, they should be stored separately from other liquid medication. *Careful label checks should be made before administering them.*

Solutions are used in a wide variety of medicinal applications. Most are given orally, but some are administered by other routes. Solutions used for injection (*parenteral* administration) or in the eye (ophthalmic use) must be sterile and should be nonirritating to body tissues. When administered intravenously, the solution must also be free of solid particulate matter.

A *douche* solution is one intended to be used in cleansing a body part or cavity, usually the vagina. It is often prepared by diluting a liquid concentrate

or soluble powder with water to make a solution of an appropriate strength.

Unless they are prepared and stored carefully, most solutions are subject to contamination by bacteria, molds or other microorganisms, as well as by dust. If they are not kept in tightly capped containers, the solvent of most solutions will evaporate, leaving behind a more concentrated drug solution.

Suspensions

Suspensions are liquid dosage forms that contain solid drug particles that are suspended in a suitable liquid medium. Most suspensions are administered orally although some are applied to the skin as lotions or liniments or administered by injection. **Note:** Suspensions should never be administered intravenously. Magmas are suspensions which contain relatively large drug particles (e.g., **milk of magnesia**). All suspensions must be shaken thoroughly immediately prior to administration in order to assure dosage uniformity each time the product is used.

Emulsions

Emulsions are dispersions of fine droplets of an oil in water or water in oil. Those which contain an oil dispersed in water are primarily used orally. By dispersing a medicinal oil (e.g., **castor oil** or **mineral oil**) in water that contains flavoring agents, the objectionable taste and/or odor of the oil can be masked. Some sterile emulsions containing vegetable oils dispersed in water are used intravenously as an injectable nutrient source.

Emulsions containing water droplets dispersed in oil are used primarily for topical application to the skin. The oily vehicle may provide a useful protective action for damaged skin while the water droplets may carry dissolved medicinal agents to the application site. Emulsions must be shaken thoroughly just prior to their use since the oil and water phases, as well as solids which may be suspended in some emulsion products, may tend to separate upon standing.

Topical Dosage Forms

Semisolids. Many different semisolid dosage forms are utilized to apply drugs onto the skin surface. Most are employed in the treatment of dermatological disorders. Some may be greasy and insoluble in water (e.g., petrolatum and most ointments), while others (e.g., creams and gels) usually are not greasy and are easily washed from the skin with water. Selection of the appropriate base to use for topically applied drugs is based upon such factors as:

- the desired rate of drug release from the base
- whether to retain or remove moisture at the site of drug application
- how stable the drug(s) is (are) in the base

The student is referred to Chapter 40 for a more detailed discussion of dermatological products.

Topical Patches. Within the last few years, several dosage forms have been developed that permit topical drugs to pass through the skin and into the bloodstream where they exert systemic effects. **Nitroglycerin**, a drug used primarily in the treatment of *angina pectoris*, is available in an ointment dosage form which releases the drug gradually through the skin and into the bloodstream. A number of drugs, e.g., nitroglycerin, **estrogen**, **clonidine**, **fentanyl**, **scopolamine**, and **nicotine** are available in patchlike devices known as transdermal therapeutic systems (Figure 1–3). Most of these consist of a reservoir that contains the drug, a water-resistant surface covering, a thin membrane which lies between the drug and the skin, and an adhesive area which permits the secure application of the system to the skin. Once applied, the drug slowly passes from the reservoir through the membrane into the skin. The drug then is absorbed into blood vessels within the skin and is carried to other parts of the body. The student is referred to Chapter 29 for a more detailed discussion of the use of nitroglycerin ointment and transdermal therapeutic systems.

Figure 1–3 Client removing protective outer layer of a transdermal therapeutic system (Transderm Nitro®) application.

Implants

Drugs may be administered for extended periods of time, sometimes as long as five years, by administering them in small flexible capsules made of a Silastic polymer. These capsules are surgically implanted subdermally, often in the upper arm region. When the action of the drug is to be discontinued or when new implants need to be inserted, the old implants are surgically removed. An example of such a system is Norplant, a product that releases contraceptive doses of **progestin** for up to a 5-year period.

Parenteral Products

Several different ways are used to package sterile solutions or suspensions intended for use as an injection. *Ampules* are sterile, sealed, glass or plastic containers containing a single liquid dose. *Vials* are either single- or multiple-dose glass or plastic containers that are sealed with a rubber diaphragm. Prefilled syringes containing a single dose also are available.

DRUG NAMES

By the time a drug becomes available for commercial distribution in the United States, it already has several names. During its earliest stages of development, the first name which is likely to be applied is the *chemical name*. This is a systematically derived name which identifies the chemical structure of the drug. Since the chemical name is often quite complex, a *code designation* is sometimes chosen for the drug during this early period of its development. This merely represents a temporary name, which is generally discarded once a drug becomes commercially available. Investigational drugs, those that are not yet commercially available but are undergoing experimental study, are often labeled only with this code designation.

Once a drug is to be marketed, a relatively simple *generic*, or *nonproprietary name*, is assigned to the drug by the U.S. Adopted Names (USAN) Council. This name is meant to be easier to pronounce and remember than the chemical name. Yet it reflects some important pharmacological or chemical characteristic of the drug. Attention is also given to selecting a name unlikely to be confused with the names of other drugs.

When a drug appears to be ready for commercial distribution, it may be assigned a *brand* (or *trade*) *name*. This name, which is usually followed with

KEY NURSING IMPLICATIONS 1–1

General Guidelines for Drug Administration

1. Enteric-coated tablets should not be administered with antacids, milk, or other alkaline substances because enteric-coated agents require the acid environment of the stomach to be effective.
2. Enteric-coated tablets should not be crushed before administration because crushing will alter absorption.
3. For appropriate absorption, some tablets are to be chewed or dissolved under the tongue (sl-sublingual) or in the inner lining of the cheek (bc-buccal), rather than being swallowed whole.
4. Suspensions and emulsions must be shaken thoroughly immediately before use because the separation that occurs after standing for a short period will alter the dosage if used in the separated form.
5. Suspensions are never administered intravenously.
6. Solutions administered parenterally or in the eye must be sterile to prevent causing infection, and those administered intravenously must be sterile and free of particulate matter that could serve as an *embolus*.
7. Proper storage of solutions is very important to prevent contamination and evaporation.
8. The skin integrity should be assessed for rashes or open areas before applying topical medications, as these conditions will alter the absorption time of the medication.
9. Transdermal therapeutic systems or patches permit drugs to pass through the skin into the bloodstream. Therefore, the nurse must be very careful when applying them to prevent self-medication.
10. A previous transdermal patch should be removed before the next dosage patch is applied.
11. Proper disposal of transdermal patches is important, so children do not apply used patches to themselves and so that house pets will not chew them.

From DeLaune & Ladner (1998)

the superscript ®, is registered by the U.S. Patent Office, is approved by the U.S. Food and Drug Administration (FDA), and is permitted to be used only by the company which has registered the drug. The brand, or trade, name is usually short and one that is easy to recall. It often does not refer to the drug alone but to the entire formulation in which the drug is contained. When a drug is manufactured by different companies, each company must market the drug under its own trade, or brand, name. An example of some of the names currently used for a single drug are listed below:
Chemical Name: 7-chloro-2-methylamino-5-phenyl-3H- 1,4- benzodiazepine 4-oxide hydrochloride
Nonproprietary, or *Generic*, *Name:* **chlordiazepoxide hydrochloride**
Brand Name: **Librium**

Once a manufacturer's patent for a drug has expired (usually 17 years from the date it was first registered), other companies are free to market the drug under their own trademarked name or under the generic name of the drug. Considerable controversy has raged regarding the therapeutic equivalence, or *bioequivalence*, of products containing the same dose of a specific drug but in a different formulation. This debate has been further intensified by the recognition that vast price differences may exist between competing brand name products, as well as those sold under the drug's generic name. In some instances, different products containing identical drugs and drug doses have been shown to produce significantly different pharmacological responses, even in the same client. In other cases, no significant difference in response is noted when such competing products are administered. It has become evident, therefore, that no generalization can be made regarding the therapeutic effectiveness of competing drug products containing the same dose of a drug. Careful assessment must be made of the client's response when the source of a client's drug product is changed, in order to immediately recognize any variation that may occur.

CLASSIFICATION OF DRUGS

Up to the beginning of the twentieth century, no federal controls existed for the protection of consumers who used drugs. After a number of catastrophic incidents in which deaths resulted from the use of adulterated drugs, the first federal statute controlling the manufacture of drugs was passed—the Food and Drug Act of 1906. It required that all drugs marketed in the United States meet minimal standards of strength, purity, and quality. The act also established the U.S. Pharmacopoeia (USP) and the National Formulary (NF) as the official legal standards for drugs in the United States.

In 1938 the Federal Food, Drug and Cosmetic Act added the requirement that a drug be shown to be safe before it could be distributed in interstate commerce. An amendment to this act, known as the Durham-Humphrey Amendment, was enacted in 1952. It required that certain drugs be classified as *legend drugs*, i.e., that they be labeled with the legend "Caution—Federal law prohibits dispensing without prescription." It also specified that all other drugs approved for use be considered nonprescription drugs. These could be sold directly to the consumer without the need for a prescription.

In 1962, this act was again amended by the Kefauver-Harris Amendment. It added the requirement that both prescription and nonprescription drugs be shown to be effective as well as safe. This was followed in 1970 by the Comprehensive Drug Abuse Prevention and Control Act (also known as the Controlled Substance Act), which further classified drugs according to their potential for causing abuse. It also regulated the manufacture and distribution of drugs considered capable of causing dependence.

As a result of these federal statutes all drugs may be classified into one of four categories:

- prescription or legend drugs
- nonprescription or over-the-counter (OTC) drugs
- investigational drugs
- illicit, or "street," drugs

Prescription Drugs

Prescription drugs are those that have on their labels the prescription legend described previously. Before such drugs can be marketed in the United States, the manufacturer must file a New Drug Application (NDA) with the U.S. Food and Drug Administration (FDA). This action must include a detailed description of the drug, its toxicity, and the results of all experimental clinical trials of the drug in clients. Only if the FDA determines that the drug has been proven to be safe and effective and that the claims made for the drug by the manufacturer are supported by scientific data, is the drug approved for general distribution.

Drugs introduced after the 1962 Kefauver-Harris Amendment were subjected to particularly close scrutiny and were rated systematically by experts assembled by the FDA. This rating process was part of a project known as the Drug Efficacy Study Implementation (DESI). Drugs that were designated as being "ineffective" were removed from the market, while those classified as being "possibly effective" or "probably effective" required reformulation or retesting to remain on the market. All newly introduced products must be shown to be effective prior to marketing.

Prescription drugs may be prescribed by physicians, dentists, veterinarians, or other legally authorized health practitioners as part of their specific practice; that is, physicians may only prescribe drugs intended for human use, veterinarians only for animal use, etc. The usual method employed in transmitting the prescriber's wishes to the pharmacist who will compound and/or dispense the medication is the prescription order.

Prescription Forms. The prescription is an order for medication (or other forms of therapy) which specifies precisely the name of the drug and the dosage regimen to be used by the client for whom it is written (Figure 1–4). Most prescriptions are written on printed forms, which may be imprinted with the prescriber's name and address, as well as other information required by the laws of different states. In addition, prescriptions usually contain the component parts:

- descriptive client information (e.g., name, address, age, or birth date)
- the date on which the prescription was written by the prescriber
- the R_X symbol
- name and dosage strength of the prescribed medication
- dispensing instructions for the pharmacist (e.g., "Dispense 100 tablets" or "Compound 40 capsules")
- directions for the client, or signa (often abbreviated sig. or Sig.), which the pharmacist will place on the prescription label
- refill and/or specialized labeling instructions (e.g., "Refill 5 times" or "Do not label")
- the prescriber's signature, address, and telephone number

It should be noted that by convention some parts of the prescription order may be written in Latin. More commonly, abbreviations are used for these terms. Detailed lists are in Chapter 2, which deals with drug administration, and in Chapter 4.

Medication orders intended for hospital or other institutional inpatients are generally written by the prescriber on a form known as the "Physician's Order Sheet." The design of this form may vary widely from institution to institution or even within the same institution (Figure 1–5). Usually when the prescriber writes an order on such a form, one or more duplicate copies are simultaneously made. These may be sent to the pharmacy, the client records department, and/or to other areas of the institution.

Storage of Medications. All personnel responsible for the storage of medication must be aware of the necessity for keeping them in secure areas away from the general flow of traffic in the institution. In addition, proper control of the environment is essential. Most medications may be safely stored at normal room temperature. Some, however, require refrigeration or must even be kept frozen to maintain their potency. Every effort must be made to assess the storage requirements of each medication stored at the nursing station and to discard medications that have been improperly stored for even brief periods. Most medications have an expiration date printed on their label. This indicates the length of time the preparation will remain stable *when stored under recommended conditions*. When the date is shown

Name Jane Doeseckle Age 36

Address 15 Celtic Ave. , Exam City, NY Date 7/ 5 / xx

This prescription will be filled generically unless physician signs on line stating "Dispense as written".

℞ Polymox 500 mg.
Disp. #30
Sig: 1 t.i.d

Refill x3

F. Giacobbe

Dispense as Written
Frank Giacobbe, M.D.
DEA # AG7241893

Substitution Permissible
120 Madison Road Center, NY
Ph. No. 432-2341

Figure 1–4 This prescription has been completed and signed by the physician.

as a month and year (e.g., June 2004), expiration refers to the last day of the month indicated. Beyond the expiration date, the manufacturer cannot guarantee full drug potency or stability and the product should be discarded. **Note:** Medications that are stored for even brief periods at temperature extremes (e.g., in a hot automobile during summer months) may dramatically lose their potency, regardless of the expiration date on the label.

A number of medications are classified as *controlled substances*. These are agents that have

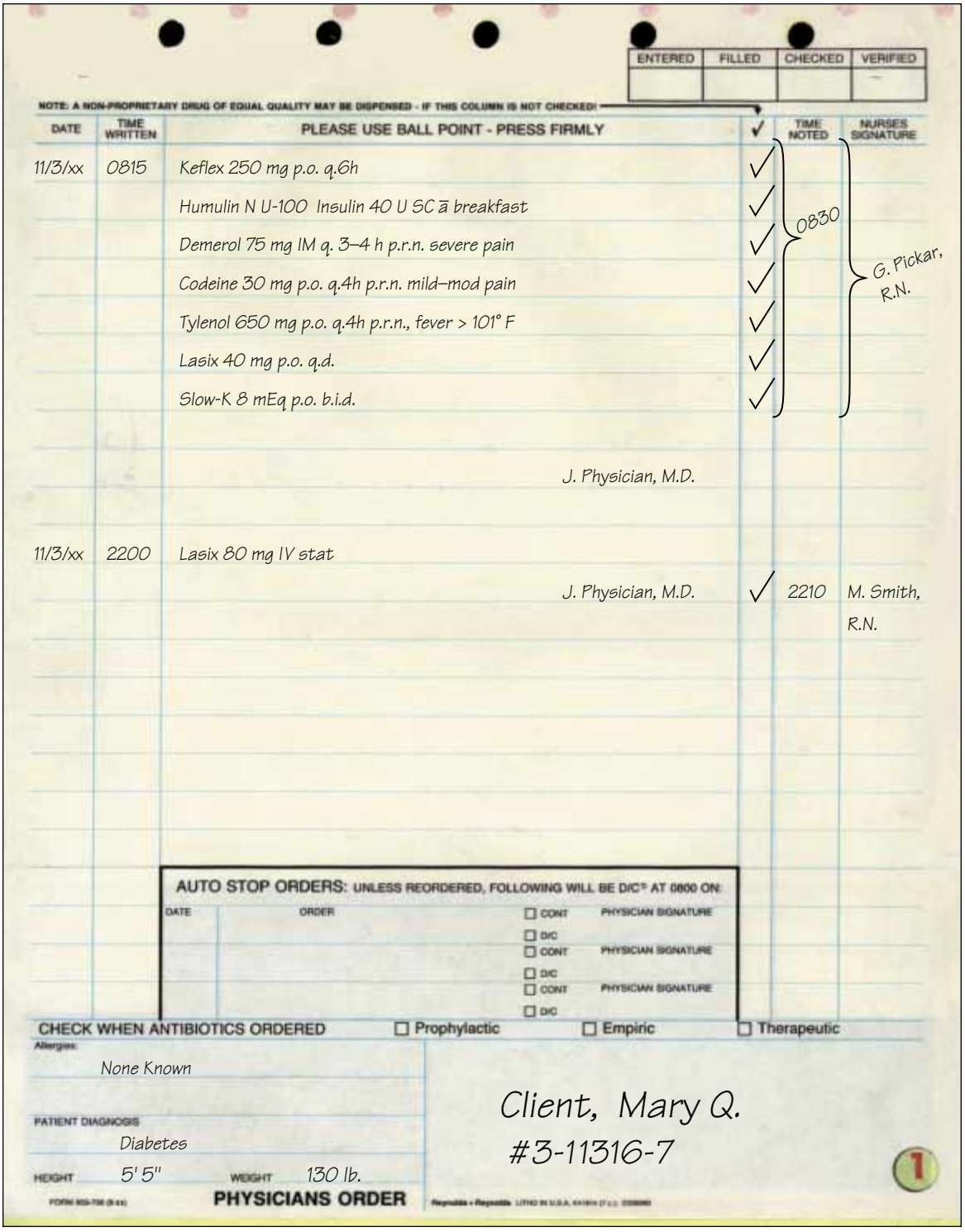

Figure 1–5 Physician's Order

been identified by various governmental bodies as having the ability to cause physical and/or psychological dependence. Controlled substances are classified in five different categories, or schedules, under the Controlled Substances Act of 1970. Table 1–1 describes the characteristics of each schedule.

The prescribing, dispensing, manufacturing, administration, and storage of controlled substances are subject to considerably greater governmental control than the use of conventional prescription drugs. Procedures to be followed in virtually every step from the manufacture to the administration of these agents are precisely defined by law. In handling such agents, the nurse has both special legal and ethical responsibilities. The legal responsibilities include the maintenance of secure storage conditions for these drugs. This often includes the use of double-locked storage cabinets as well as keeping accurate records of the disposition of all doses of controlled substances received and/or used during each shift.

In most institutions, orders for controlled substances must be renewed every 48 hours for the order to remain valid. The nurse has the responsibility for carefully assessing the progress of clients receiving controlled substances in order to determine the development of physical and/or psychological dependency or the possible abuse of the medication.

TABLE 1–1

Controlled Substances Schedules

SCHEDULE I
Drugs in Schedule I have a high potential for abuse and no accepted medical use in the United States, e.g., heroin, LSD.

SCHEDULE II
Drugs in Schedule II also have a high potential for abuse, but do have a currently accepted medical use in the United States. It has been determined that abuse of a drug included in this schedule may lead to a severe psychological or physical dependence, e.g., meperidine, morphine, cocaine, oxycodone, Ritalin.

SCHEDULE III
Schedule III drugs have accepted medical uses in the United States, but they have a lower potential for abuse than drugs in Schedules I and II, e.g., Tylenol with codeine, hydrocodone.

SCHEDULE IV
These drugs have a low potential for abuse relative to Schedule III drugs. Abuse of Schedule IV drugs may lead to limited physical or psychological dependence as compared to Schedule III drugs, e.g., Librium, Valium.

SCHEDULE V
Schedule V drugs have the lowest abuse potential of the controlled substances. They consist of preparations containing limited quantities of certain narcotic drugs generally used for antitussive and antidiarrheal properties, e.g., Lomotil, Robitussin A–C.

Source: Controlled Substances Act of 1970, Title II of Comprehensive Drug Abuse Prevention and Controlled Substances Act of 1970.

Nonprescription Drugs

Drugs that may be legally acquired by the client without a prescription order are known as nonprescription, or OTC drugs. Such agents are considered to be relatively safe for the layperson to use when taken according to directions provided by the manufacturer and when given to treat conditions for which they are intended. In 1972, after years of relatively little control of drugs sold without a prescription, the FDA began reviewing each class of OTC drugs (i.e., antacids, laxatives, etc.) to establish the safety and efficacy of the ingredients. This was accomplished by the appointment of expert panels by the FDA. Each of these panels was to review a specific category of OTC drug products. Upon completing this review, the panel was to designate each ingredient used in the products as being in one of three categories. Agents placed in Category I were those recognized as being safe and effective for the therapeutic uses claimed for them. Those in Category II were not recognized as being safe and effective, while those in Category III were agents for which additional data were required to establish safety and/or *efficacy*. Based upon the recommendations made by these panels, many OTC products have been removed from the market or have been reformulated to gain acceptance. As a result of the FDA's review of OTC products and their ingredients, many ingredients previously available only by prescription can now be sold as OTC products. These include many ingredients used to treat colds and allergies, certain strengths of **hydrocortisone** topical products, **ibuprofen** and **naproxen** in certain strengths, some topical antifungal products, drugs used to reduce acid secretion in the stomach, and some fluoride dental rinse products. It is

likely that more products will have their status changed from prescription to OTC in the next several years.

Even though a prescription order is not required for their purchase, OTC medications are capable of producing considerable toxicity, if they are not used in accordance with their labeled directions and/or if they are used in combination with other OTC drugs or prescription drugs the client may be using. Many OTC drugs should not be used in the presence of certain medical conditions. It is essential, therefore, that the nurse make every attempt to assist the client in identifying health problems that can be safely treated with OTC medication and in selecting safe and effective products. The pharmacist is an excellent resource for information concerning the appropriate use of OTC medication. The client should be encouraged to communicate with a pharmacist about any OTC drug needs.

Once the client begins self-medication with an OTC product, it is essential that continuous evaluation of the response to the medication be made to identify the development of any adverse effects. This includes adverse effects resulting from interaction with prescription drugs. It is equally important to avoid the masking of symptoms (e.g., cough, pain, or fever) that could be the result of a serious underlying disorder.

Investigational Drugs

In order to fulfill the requirements of the FDA, a manufacturer who wishes to market a new drug must perform a wide array of animal studies and carry out clinical testing of the drug in human subjects. To accomplish this, the manufacturer must file a "Notice of Claimed Investigational Exemption for a New Drug" (IND) with the FDA. This is a complex form, which must include:

- all known information regarding the chemical, biological, pharmacological, and toxicological properties of the new agent
- precise details of how the drug is manufactured and how it must be stored to preserve its stability
- the name and qualifications of each investigator who will participate in the clinical trial
- a signed statement from each investigator indicating awareness of the nature of the drug to be studied, as well as assurances that the investigator or an appointed agent will adequately supervise every aspect of the study and that the drug will be administered only to volunteers or clients who have been fully informed of the nature of the study and from whom an informed written consent has been obtained. Consent forms must be read and signed by clients and witnesses (Figure 1–6).
- *protocols* that clearly define how the drug is to be administered to experimental subjects (i.e., in what doses, by what route, for how long, etc.). Protocols include what specific observations or determinations will be made during the trial.

Clinical studies performed on human subjects prior to the marketing of a drug are usually divided into four phases. Phase I is devoted to the evaluation of the drug in normal human volunteers to determine if the drug is toxic and how it is metabolized and excreted. Phase II involves a more detailed evaluation of the drug in normal subjects, and initial trials in relatively small numbers of subjects who have the disease state for which the drug is intended to be used. The next phase, Phase III, consists of broad clinical trials designed to evaluate the usefulness of the drug in treating the disease for which it is claimed to be effective. Phase IV involves postmarketing surveillance of the drug product's activity. During this phase, prescribers are encouraged to submit to the manufacturer and/or the FDA experience reports based on their clinical use of the product. This permits the detection of problems with the use of the product that would only be evident on widespread use in many diverse clients.

The nurse is generally most involved in Phase III of the clinical trial and may be responsible for administering investigational drugs to clients. In doing so, it is essential that the clinical protocol to be followed be readily available for inspection and that the proper method of drug administration and client evaluation be understood completely before initiating therapy. In some states, only persons identified in the clinical protocol as investigators may administer the medication and/or obtain informed consent from a subject. The nurse should, therefore, be familiar with the laws defining the extent to which a nurse may participate in the testing of investigational drugs.

The personal response of the subject in whom an investigational drug is being used may vary considerably. Some clients may have unrealistic expectations of a drug's usefulness, perhaps believing that it must be better than existing forms of

Memorial Hospital
Hometown, New York
PERMISSION FOR CLINICAL INVESTIGATION

Patient Form

1. I hereby authorize Dr. _____and/or such assistants as may be selected him/her to conduct studies upon_____for the following:
   _____
   _____

2. I further authorize Dr. _____ and/or such assistants as may be selected by him/her, to perform certain procedures in connection with the diagnosis and treatment of my condition including the following extraordinary procedures: _____
   _____
   _____

3. I have (have not) been made aware of certain risks, possible consequences and discomfort associated with these extraordinary procedures which are: _____
   _____
   _____

4. I understand that no guarantee or assurance has been made as to the results that may obtained although I have (have not) been advised of the possibility that certain benefits may be expected such as: _____
   _____

5. I have (have not) had explained to me alternative procedures that may be advantageous and they include the following: _____
   _____

6. I have (have not) received an offer to answer any inquires concerning the procedures involved _____

7. I have (have not) had explained to me all medical terminology in connection with this study
   _____

8. I understand that it is in the intent of the principal investigator to maintain the confidentiality of records identifying subjects in this study. The Food and Drug Administration, however, may possibly inspect the records to monitor compliance with published federal regulations.

9. I understand that I may withdraw this consent and discontinue participation in this study at any time, without prejudice to my care, by informing Dr. _____ of my desire to withdraw. _____ Yes, I understand _____ No, I do not understand

10. I understand that Department of Health and Human Services regulations require the Memorial Hospital to inform me of any provisions to provide for medical treatment for any physical injury which may occur as a result of this study. In the connection, I understand that the Memorial Hospital does not have a formal pan or program to provide for the cost of medical treatment or compensation for any physical injury which occurs as a result of this study and for which they do not have legal liability. However, in the unlikely event that I am Injured as a result of my participation, I understand that I should promptly inform
    Dr. _____
    SIGNED _____
    RELATIONSHIP _____
    ADDRESS _____
    _____
    DATED _____

PERMISSION FOR CLINICAL INVESTIGATION
Witness Form

I, the undersigned, hereby acknowledge that I was present during the explanation of the above consent for clinical investigation given by Dr. _____to
_____
during which the nature, purpose, risks, complications and consequences thereof were fully set forth and all questions answered and I was present while _____signed the above consent.

Dated_____

_____
(witness)

_____
(address)

_____

Figure 1–6 Example of forms that must be signed before a client participates in a clinical investigation. The upper form is read and signed by the client, the lower by the witness. A member of the study staff fills in the blanks before submitting the form for clients and witnesses to sign.

therapy because it is "new." Others may participate in a trial with some reluctance, because they believe that they are being used as a "guinea pig." Understanding these feelings and assisting the client to deal with them are important for all those involved in the clinical study. Only subjects who have signed informed consent forms should receive investigational drugs. They should fully understand the potential hazards associated with the intended therapy. In addition, as volunteers, subjects who are part of the study may withdraw from a program at any time.

The student is referred to Chapter 39 for a discussion of nursing actions related to the clinical use of investigational drugs.

The FDA Medical Products Reporting Program

The FDA Medical Products Reporting Program (MedWatch) is an Internet site for health professionals and consumers to voluntarily report "adverse events and product problems with medications (drugs and biologics, except vaccines), medical devices (including *in vitro* diagnostics), special nutritional products (dietary supplements, infant formulas, medical foods) and other FDA-regulated medical products" (Food and Drug Administration, 1994). The Internet site *http://www.fda.gov/medwatch* provides MedWatch FDA form 3500 with instructions for completing form and submitting it to the FDA. The FDA MedWatch program can also be contacted through their toll-free telephone number (800-FDA-1088). MedWatch was established to provide a comprehensive product problem reporting system.

The Drug Product Problem Reporting Program (DPPR) established in 1971 by the USP was the primary reporting system for identifying and improving defective and potentially unsafe drug products; however, it ceased to operate in August, 2000. At the time of the DPPR's inception, it was the only nationally operated program focused on surveillance of medical products, providing the FDA with information about drug products that could endanger the public health. The USP continues to operate the USP Medication Errors Reporting Program and MedMARx® as a part of the SP Practitioners' Reporting Network.

Illicit Drugs

Illicit agents, or "street" drugs, are those which are used and/or distributed illegally. They may be: (1) drugs which are not legal for sale under any circumstances in the United States (e.g., **heroin**) or (2) drugs which may be sold legally under certain circumstances (e.g., with a prescription order) but which have been manufactured illegally or diverted or stolen from normal channels of distribution. Illicit drugs usually are used for nonmedical purposes, generally to alter mood or feeling.

The student is referred to Chapter 41 for a detailed discussion of illicit drugs and substance abuse.

CANADIAN DRUG LEGISLATION

In Canada the Health Protection Branch of the Department of Health and Welfare is responsible for monitoring the potency, purity, and safety of Canadian drug products. This is done through the administration and enforcement of two federal acts.

The Food and Drug Act includes legislation about prescription, nonprescription, and controlled drugs. Examples of controlled drugs include barbiturates and amphetamines, which must be carefully monitored to prevent indiscriminate use. Controlled drugs are potentially addicting and subject to more stringent controls than ordinary prescription drugs.

The Narcotic Control Act governs the manufacture and distribution of narcotics, e.g., morphine, codeine, meperidine. As with controlled drugs, these drugs also require a prescription, because dependency is a potential outcome from narcotic use. In addition, automatic stop order policies are in place in most agencies. The nurse must become familiar with these policies and know when he/she can be in legal possession of a narcotic. *Narcotics* and controlled drugs are stored under double-lock and key. Records are maintained to ensure accountability for every dose administered.

DRUG INFORMATION RESOURCES

The nurse, as well as other health professionals who may prescribe, dispense, or administer medication, requires reliable and current drug information. Such a need is heightened when one considers the constant dynamic changes in pharmacology. Dozens of new drug products are released every year. Although textbooks of pharmacology may be useful as sources of information regarding basic pharmacological principles, they quickly become outdated and do not always meet the varied needs of the working health practitioner.

In an institution, the most readily available source of drug information may be the institution's drug formulary. This is a continually revised compilation of drugs and drug products available for use in an institution. The formulary serves to provide prescribers within the institution with a selection of useful and economical drugs from which to choose. It also limits the number of duplicative drug products that must be stocked. For example, a formulary may only list one oral product for the treatment of cough, even though dozens may be available commercially.

The *AHFS Drug Information* (2001), published by the American Society of Hospital Pharmacists, is a reference that is sometimes available at a nursing station. This publication, which is published annually and updated quarterly, lists a variety of information about almost all drugs in current use in the United States.

The *Physicians' Desk Reference* (2001) or PDR, as it is often called, is an annual publication primarily intended for use by prescribers. It contains several types of drug information, each of which is identified by color-coded pages. Drugs are listed by generic and brand names, as well as by manufacturer. A product information section contains virtually the same information provided with the original drug package. The PDR also contains a useful product identification section of color photographs of more than 1000 commercially available tablets, capsules, and other dosage forms. This section makes the PDR perhaps the best source for identifying unknown drug products by their appearance. The usefulness of this publication is somewhat limited, since many drugs, drug products, and nursing data with implications are not included.

The *American Drug Index* (2000) is a work published annually that lists basic drug information, i.e., generic and brand names, manufacturers, uses, dosages, and dosage form availability. It provides little pharmacological information.

Facts and Comparisons (2001) is a highly useful reference available in an annual bound version, as well as in looseleaf and computer versions. The looseleaf form is updated monthly. *Facts and Comparisons* lists a variety of information including the actions, indications, interactions, warnings, contraindications, precautions, adverse reactions, dosage, and important prescribing and client information for each drug. Information about related drugs is presented in a tabular form, permitting easy comparisons to be made of the content and relative cost of competing products.

The *Handbook of Nonprescription Drugs*, published by the American Pharmaceutical Association, is perhaps the most valuable resource for information regarding nonprescription medication. Each of its chapters is devoted to a discussion of a different class of nonprescription drugs and includes a review of the diseases treatable by self-medication, as well as the content of competing nonprescription products used for the treatment of the same conditions.

Drug Interactions is a guide to drug–drug interactions, herbal–drug interactions, and the effects of drugs on clinical laboratory tests. Information on the mechanism, if known, of each listed drug interaction, its clinical significance and how it may best be managed is presented.

While the preceding references are the most popular, there are many others which may be of use to the nurse. These include nursing journals, textbooks, periodicals, and other reference sources, as well as the product information which may accompany the drug package.

With the rapid explosion of scientific literature related to drug action has come the need for rapid retrieval of this drug information. This has been accomplished by the development of several computer services which permit the user to identify journal articles on a given drug-related topic from literally hundreds of different journals. Once the appropriate articles have been identified, hard copies or summaries of the actual articles can be accessed directly without the need for maintaining a large journal library. Systems that use such data retrieval techniques are frequently available in hospital pharmacies or in health profession school libraries.

The pharmacist is often the best resource for drug information both in the institution and in the community. In addition to a background of education and experience, the pharmacist has access to the most complete and current library of drug information literature available.

THE PRODUCT INSERT

A product insert is a detailed description of a drug product that is required to be included in the package of all legend drug products sold in the United States. The contents of the product insert

DOSAGE AND ADMINISTRATION

Kefzol may be administered intramuscularly or intravenously after reconstitution. Total daily dosages are the same for either route of administration.

Intramuscular Administration—Reconstitute as directed by Table 3 with 0.9% Sodium Chloride Injection, Sterile Water for Injection, or Bacteriostatic Water for Injection. Shake well until dissolved. Kefzol should be injected into a large muscle mass. Pain on injection is infrequent with Kefzol.

TABLE 3. DILUTION TABLE

Vial Size	Diluent to Be Added	Approximate Available Volume	Approximate Average Concentration
250 mg	2 mL	2 mL	125 mg/mL
500 mg	2 mL	2.2 mL	225 mg/mL
1 g*	2.5 mL	3 mL	330 mg/mL

*The 1-g vial should be reconstituted only with Sterile Water for Injection or Bacteriostatic Water for Injection.

Intravenous Administration—Kefzol may be administered by intravenous injection or by continuous or intermittent infusion.

Intermittent intravenous infusion: Kefzol can be administered along with primary intravenous fluid management programs in a volume control set or in a separate, secondary IV bottle. Reconstituted 500 mg or 1 g of Kefzol may be diluted in 50 to 100 mL of 1 of the following intravenous solutions: 0.9% Sodium Chloride Injection, 5% or 10% Dextrose Injection, 5% Dextrose in Lactated Ringer's Injection, 5% Dextrose and 0.9% Sodium Chloride Injection (also may be used with 5% Dextrose and 0.45% or 0.2% Sodium Chloride Injection), Lactated Ringer's Injection, 5% or 10% Invert Sugar in Sterile Water for Injection, Ringer's Injection, Normosol®-M in D5-W, Ionosol® B with Dextrose 5%, or Plasma-Lyte® with 5% Dextrose.

ADD-Vantage Vials of Kefzol are to be reconstituted *only* with 0.9% Sodium Chloride Injection or 5% Dextrose Injection in the 50-mL or 100-mL Flexible Diluent Containers.

Intravenous injection (Administer solution directly into vein or through tubing): Dilute the reconstituted 500 mg or 1 g of Kefzol in a minimum of 10 mL of Sterile Water for Injection. Inject solution slowly over 3 to 5 minutes. Do not inject in less than 3 minutes. (NOTE: ADD-VANTAGE VIALS ARE NOT TO BE USED IN THIS MANNER.)

Dosage—The usual adult dosages are given in Table 4.

TABLE 4. USUAL ADULT DOSAGE

Type of Infection	Dose	Frequency
Pneumococcal pneumonia	500 mg	q12h
Mild infections caused by susceptible gram-positive cocci	250 to 500 mg	q8h
Acute uncomplicated urinary tract infections	1 g	q12h
Moderate to severe infections	500 mg to 1 g	q6 to 8h
Severe, life-threatening infections (eg, endocarditis, and septicemia)*	1 g to 1.5 g	q6h

*In rare instances, doses up to 12 g of cefazolin per day have been used.

Figure 1–7 Kefzol label with portion of the accompanying package insert.

must be approved by the FDA before the drug can be marketed. The insert must be periodically updated to represent the current information available about the drug. Most product inserts contain similar information about the drug product (Figure 1–7). The following is a description of the meaning of the categories that are often part of the Product Insert:

Brand Name. This is the name, approved by the Federal government, which the manufacturer may exclusively use to call the product. It is always followed by the superscript ® symbol.

Generic Name. This is the name, approved by the Federal government, which is commonly used to describe the active drug(s) in the product. The name may be used by anyone.

Description. This section describes the physical and chemical properties of the active drug in the product. It may include information about the appearance of the drug, its solubility, chemical formula and structure, and melting point. Inactive ingredients may also be listed in this section.

Clinical Pharmacology. This describes the mechanism of action of the active drug in the human body.

Indications and Usage. The indication is a description of the illnesses for which the drug is approved for use. The usage describes how and for how long the drug is generally used.

Contraindications. This describes the situations when the drug product should not be used, e.g., if the client is hypersensitive to any components in the product.

Warnings. These are situations in which there is a threat of imminent and serious danger if the

BOX 1–1
Internet Drug References

Active Drug Information Finder. *http://www.activedruginformationfinder.com*

British National Formulary. *http://bnf.vhn.net*

Corey Nahman-Drug Database, Full Product Disclosures, Drug Monographs, Package Inserts. *http://www.coreynahman.com/druginfopage*

Drug Database-by Trade Name. *http://pharminfo.com/drugdb_mnu.html*

Drug Information Database* *http://www.infodrug.com*

Drugs Information. *http://www.drugsexpert.com*

DrugTrain.com. *http://www.drugtrain.com*

Food and Drug Administration (FDA)—Consumer Drug Information *http://www.fda.gov.cder.consumerinfo*

Food and Drug Administration (FDA)—How to Report Adverse Reactions. *http://www.fda.gov/opacom/backgrounders/problem*

Medication Directory. *http://cbshealthwatch.aol.com*

Mediconsult.com: Drug Info. *http://www.mediconsult.com*

Nurse's PDR Resource Center. *http://www.NursesPDR.com*

PlanetRx—An Online Pharmacy and Drugstore. AOL Keyword: PlanetRx

RxUSA Certified Pharmacy. *http://www.rxusa.com*

The Drug Safety Problem. *http://www.thomasjmoore.com*

University of Florida College of Pharmacy Website. *http://www.cop.ufl.edu*

U.S. Pharmacopedia. *http://www.usp.org*

VideoPharmacist. *http://www.videopharmacist.com*

What's New in Drugs. *http://www.drugref.com*

Other sites for specific drugs will be included in the respective chapters' references.

*Easy to use, provides color pictures of medications.

drug product is used, e.g., during pregnancy or in the presence of renal disease.

Precautions. These are suggested steps that should be taken to use the drug product safely, e.g., doing frequent renal function testing while the client is using the drug product. This section also generally includes a statement of the Pregnancy Category in which the drug has been placed, e.g., Pregnancy Category X.

Overdosage. This section lists the dangers, if any, of using excessive quantities of the drug product. It may also provide a recommendation of possible ways to treat toxic effects caused by the drug.

Dosage and Administration. This is a listing of the dosage and administration techniques recommended for the use of the drug product. It may indicate whether or not the product should be administered with meals.

How Supplied. This lists the dosage forms, strengths, and package sizes of the drug product that are available from the manufacturer. It may also list the codes used on each form of the product and a statement of how the drug product should be stored, e.g., in a refrigerator.

In addition to the above information, the Product Insert will also generally have the name and address of the manufacturer and distributor of the product as well as a date. The date is very important because it indicates when the Product Insert was published. Because the information in the Product Insert may change, the nurse should make every effort to refer to the most current Product Insert for information about the drug product.

PRINCIPLES OF DRUG ACTION

Drugs are capable of exerting a wide variety of effects in the human body. All drug action can, however, be described in terms of several fundamental pharmacological principles.

- Drugs do not create new cellular functions but rather alter existing ones. For example, an antibiotic slows the growth and/or reproduction of microbial organisms, while many laxative agents simply increase the rate of peristaltic movement of the lower gastrointestinal tract. Drug action is, therefore, generally described in relative terms, i.e., relative to the physiological state which existed when the drug was administered.

- Drugs may interact with the body in several different ways. Some act by altering the chemical composition of a body fluid. For example, antacids are designed to alter the acidity of the stomach contents. Certain laxatives such as milk of magnesia raise the concentration of dissolved substances in the gastrointestinal tract, thereby osmotically attracting fluid into the gut. Other drugs accumulate in certain tissues because of their affinity for a tissue component. For example, gaseous general anesthetics have an affinity for the lipid portion of nerve cell membranes and may, therefore, accumulate in fatty cells and depress nerve function throughout the body.

  The most common way in which drugs exert their action is by forming a chemical bond with specific receptors within the body. Such binding will usually only occur if the drug and its receptor have a compatible chemical shape. Such an interaction between a drug and a receptor is often compared to the relationship between a lock and a key (Figure 1–8).
- Different drugs whose molecules precisely fit into a given receptor (e.g., most **penicillins**) can be expected to elicit a comparable drug response; those which do not perfectly fit the receptor shape may produce only a weak response or no response at all. In general, the better the fit with its receptor, the stronger the drug's affinity will be for the receptor and the lower will be the dose required to produce a pharmacological response. For example, many hormone receptors within the human body are highly specific. They will respond only to chemical compounds having a precise chemical structure. Hormone responses may often be elicited, therefore, by the presence of only minute concentrations of an appropriate hormone since it has a strong affinity for the receptor.
- Drugs which interact with a receptor to produce a response are known as *agonists*. Those drugs which have no specific pharmacological action of their own but interact with a receptor to inhibit or prevent the action of an agonist are known as *specific or pure antagonists*. Agonist–antagonist drugs exert some agonist as well as some antagonist action; that is, they interact with a receptor to elicit some pharmacological response but may concurrently antagonize the action of other agonists (usually of higher potency) which interact with the same receptor. For example, the depression of the central nervous system caused by certain *narcotic agonists* such as **morphine** may be completely reversed or blocked if the client is given the specific *narcotic antagonist* **naloxone** (**Narcan**). However, if the agonist–antagonist **pentazocine** (**Talwin**) is administered instead, the depressant action of the morphine will be considerably reduced, but some narcotic action caused by the agonist activity of the pentazocine will also be evident.

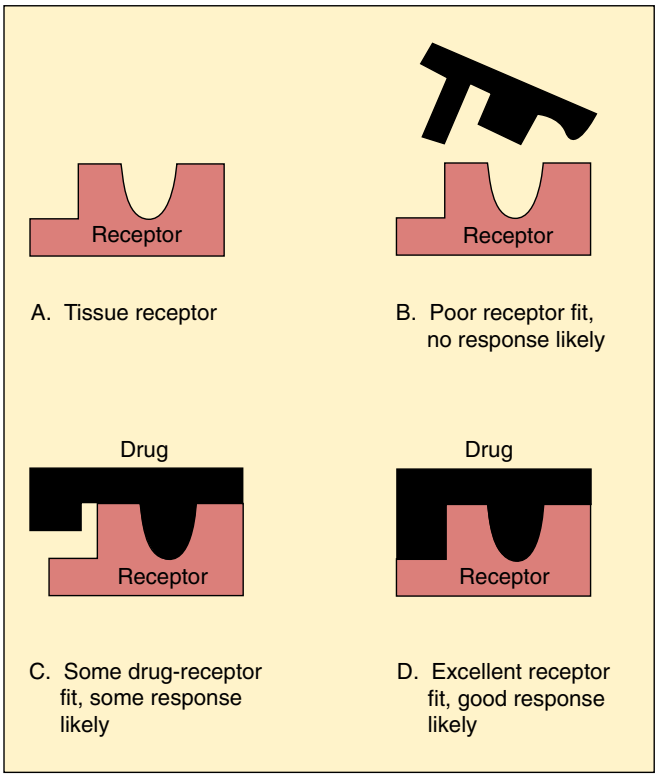

Figure 1–8 Drug-receptor interaction. Binding with specific receptors occurs only when the drug and its receptors have a compatible chemical shape.

ADVERSE DRUG EFFECTS

In addition to the intended effects that a drug produces, it is also capable of producing undesired or adverse effects. These may be classified according to whether or not they are related to the pharmacological effects of the drug. Those which result

from the pharmacological effects of the drug are most common and are often referred to as *side effects*. They result because of the lack of specificity of action exhibited by most drugs; that is, the drugs act not only on tissues with which they are intended to interact but also with other tissues of the body which may be capable of responding to the presence of the drug. For example, antihistamines are drugs which are meant to counteract the symptoms associated with *allergic reactions*. Many of these antihistaminic agents also depress the central nervous system (CNS) and therefore produce side effects such as drowsiness, dizziness, and/or weakness. Likewise, many antibiotics which are administered orally may disrupt the normal bacterial content of the gastrointestinal tract and produce side effects such as gastrointestinal distress and diarrhea. Since side effects are generally predictable, they can usually be identified rapidly and appropriately managed.

Drug *toxicity* is also a predictable adverse drug effect which is related to the dose of drug administered. Virtually all drugs are capable of producing *toxic effects*. The dosage range between the therapeutic dose of a drug and its toxic dose is a measure of the drug's safety. The term "therapeutic index" is sometimes used to describe the safety of a drug and is expressed in the form of a ratio:

$$\text{Therapeutic Index (TI)} = \frac{LD_{50}}{ED_{50}}$$

where LD_{50} is the lethal dose of a drug (the dose that will kill 50% of animals tested) and ED_{50} is the effective dose (the dose that produces a specific therapeutic effect in 50% of animals tested). The greater the therapeutic index, the safer a drug is likely to be.

Unpredictable *adverse drug effects* such as allergic reactions and *idiosyncratic reactions* are seen less frequently than predictable ones. They may be considerably more serious. Allergic or hypersensitivity reactions to drugs are not the result of the drug's primary pharmacological action(s) but rather a response of the client's immunological system to the presence of the drug. Such reactions are relatively uncommon. However, when they do occur, they often appear with only low levels of the drug in the body and produce a response which is unlike the normal pharmacological response expected. For example, in clients allergic to penicillin, minute doses of penicillin may result in the development of a dermatological reaction (hives, rash, etc.) or, in some cases, in a severe allergic response (*anaphylaxis*), which may include breathing difficulty and/or circulatory collapse.

Allergic reactions do not occur unless the client has been previously exposed to the agent or a chemically related compound. Such previous exposure or sensitization to the agent may take place without the knowledge of the client. For example, sensitization with some antibiotic agents may result from ingesting meat that contains a residue of antibiotic administered to the animal prior to slaughter. Sensitization of persons preparing and administering antibiotics may also occur through careless handling of the drug and contamination of the surrounding environment. An allergic reaction may occur immediately after exposure of the sensitized individual to the offending agent (as in anaphylaxis) or it may be delayed for hours or even days. Allergic reactions can vary from mild

KEY NURSING IMPLICATIONS 1–2

Adverse Drug Effects

1. Negative side effects and adverse effects are those resulting from the normal pharmacological effects of a drug, e.g., drowsiness caused by antihistamine use. Side effects may be also positive.
2. Toxic effects are those related to the dosage administered. All drugs are capable of producing toxic effects.
3. Allergic reactions are not a result of the pharmacological effects of the drug, but rather a response of the client's immunological system to the presence of the drug. Prior sensitization to the drug is generally required.
4. Idiosyncratic reactions are the result of abnormal reactivity to a drug caused by genetic differences between the client and nonreacting individuals.
5. A teratogenic drug is one that will cause a congenital defect in an infant whose mother took the drug while pregnant.
6. Drug tolerance occurs when the client requires a higher dose or more frequent administration to produce the desired drug effect.

skin rashes, hives, and itching to difficulty breathing (*dyspnea*) to anaphylactic shock.

When an allergic reaction occurs, the medication should be discontinued immediately, the supervisor notified, and appropriate treatment, such as the administration of **epinephrine** and antihistamines, initiated.

An idiosyncratic drug reaction, unlike an allergic reaction, may occur when the client is first exposed to the drug. It is defined as an abnormal reactivity to a drug, caused by a genetic difference between the reactive client and nonreactive individuals. The abnormal response may range from an extreme reaction to a minute concentration of the drug to complete resistance of a client to even high doses of the drug.

A *teratogenic* drug is one that will cause a congenital defect in an infant whose mother took the drug while pregnant. Drug-induced teratogenesis is most likely to occur during the first trimester of pregnancy, a time of active and rapid formation or development of new organs in the fetus. Although most susceptible to teratogenic activity during the first trimester, structural and functional teratogenesis can be induced by drugs later in pregnancy and even postnatally through lactation or use of infant formula products deficient in one or more essential nutrients. Adverse drug reactions resulting in teratogenesis can best be avoided by using special caution in administering drugs to women of child-bearing age.

Some drugs, such as narcotics, barbiturates, and antianxiety drugs, produce *drug tolerance* and *dependence* after repeated doses. Drug tolerance means that a client develops a resistance to the effects of a drug. It is characterized by the need for an increased dose or frequency of drug administration. Drug tolerance is a symptom of *physical drug dependence*. Physical drug dependence exists when the body becomes so accustomed to a drug that the body cannot function normally unless the drug is present. When the drug is discontinued, withdrawal signs and symptoms such as tremors, nausea, vomiting, sweating, and convulsions may occur. *Psychological drug dependence* occurs when the drug is the center of a person's thoughts, emotions, and activities. Physical effects are not present when the drug is withdrawn. Clients should be monitored closely for drug dependence. Automatic stop order policies help prevent unwarranted drug dependency. If drug dependency is suspected, the drug dose is gradually decreased or a different drug is prescribed.

PHARMACOKINETIC FACTORS IN DRUG THERAPY

As was described earlier in this chapter, pharmacokinetics is the study of the liberation, absorption, distribution, biotransformation, and excretion of drugs. It also includes the study of the relationship of each of these factors to the concentration of a drug and/or its chemical by-products in various body sites and over various periods of time.

Liberation

When a solid drug is administered enterally (through the gastrointestinal system) orally, it must first dissolve in gastric or intestinal fluids before it can be absorbed into the bloodstream. Administering fluids with the solid dose will generally increase the rate at which a drug dissolves and the speed with which it is absorbed. The rate of absorption may vary, even in tablet or capsule formulations containing the drug. The term *bioavailability* is used to describe the absorption efficiency of a particular drug formulation. When the administration of two products containing the same drug results in the same degree of *bioavailability* the products are said to be bioequivalent.

Absorption

Absorption is the process by which a drug passes from its site of administration into the fluids of the body that will carry it to its site(s) of action. Absorption is the first step in the passage of a drug through the body, unless it is introduced directly into the bloodstream by intravenous administration.

Many factors influence the gastric absorption of drugs. For example, the presence of food may interfere with the dissolution and absorption of certain drugs, as well as delay the transit time of a drug from the stomach to the small intestine. This may be important, as most drugs are absorbed primarily in the small intestine. In addition, the acidity of the stomach may influence drug absorption. Stomach acidity may vary at different times of the day, in clients of different ages, or because of the nature of a recently ingested meal. Some drugs, because of their chemical properties or instability, are not capable of being absorbed efficiently from the gastrointestinal tract. In order to

exert a systemic effect, such drugs may need to be administered parenterally.

Drugs may be administered and absorbed through tissues which lie under the tongue (*sublingual* administration), on the surface of the tongue (translingual administration), or in the inner lining of the cheeks (buccal, or transmucosal administration). These routes may be appropriate for the administration of some drugs, to protect them from chemical decomposition which might occur in the stomach or the liver (the first-pass effect) if the drug were given orally. Nitroglycerin, a drug used in treating the cardiovascular condition *angina pectoris*, is an example of a drug which may be administered by these routes. If given orally, nitroglycerin is absorbed and transported to the liver. There it may be destroyed before it can reach its site of action, the coronary arteries. However, when the drug is administered sublingually, translingually, or by the transmucosal route, it is absorbed into blood vessels, which carry it directly to the heart. This permits a pharmacological response to occur before the drug is destroyed in the liver.

When drugs are administered by injection (i.e., parenterally) other than by the intravenous route, they may also undergo an absorption process before reaching the body fluids which will transport them to their site of action. For example, when a drug is administered under the skin (i.e., subcutaneously), its absorption into the circulatory system is slower than if it were injected into a muscle. This is because muscles are better supplied with blood vessels than subcutaneous tissue. Absorption of drugs from either subcutaneous or intramuscular injection sites may be increased by application of heat and/or massage to the area. These actions will increase blood flow to the site. Absorption of drugs from such injection sites may be reduced by the application of cold packs or compresses to the area and/or by the injection of a *vasoconstrictor* drug such as epinephrine into the site. This local injection may be desirable to limit the action of a drug to a particular region of the body (e.g., when administering regional anesthetic drugs). Some drugs intended for subcutaneous or intramuscular injection may be formulated as a suspension of a poorly soluble form of the drug in water or an oily vehicle. Such dosage forms, often referred to as *depot* injections, are intended to provide sustained drug action by permitting the drug to be absorbed slowly from its site of injection.

Rectal absorption of drugs after administration of a medicated enema or suppository tends to be unpredictable. This route is therefore generally reserved for instances in which the use of more reliable routes of administration is not feasible, for example in cases of severe nausea and vomiting or when a localized drug action is desired in the rectum or lower colon.

Distribution

Drug distribution is the process by which a drug is carried from its site of absorption to its site of action. When a drug enters the bloodstream, it is carried most rapidly to those organs having an extensive blood supply, such as the heart, liver, kidneys, and brain. Areas with less extensive blood supply, like muscle, skin, and fat, receive the drug more slowly.

The physical and chemical characteristics of a drug usually determine precisely how the drug will be distributed. Those drugs which are highly soluble in fatty tissue (e.g., some general anesthetics) may accumulate rapidly in fat. In some cases, fat may act as a reservoir for such drugs, slowly releasing the drug back into the bloodstream, thereby prolonging its effect and delaying its elimination.

A number of drugs are capable of being bound to plasma proteins, particularly albumin (Figure 1–9). While in this bound state, the drug is incapable of eliciting a pharmacological effect. In most cases, however, an equilibrium is established between the concentration of bound and unbound drug. This permits bound drug to be released from its binding sites when plasma concentrations of unbound drug diminish. When two drugs are administered that are both capable of being protein bound, they may compete for the same binding sites. Displacement of one bound drug by another may increase the observed pharmacological response to the displaced drug since more

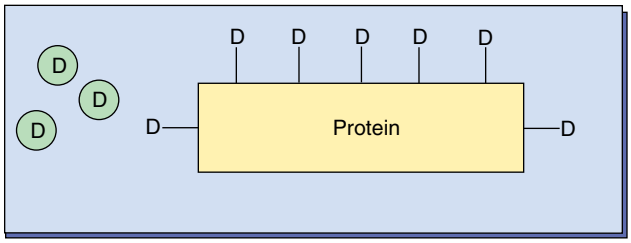

Figure 1–9 Drug molecules that are bound to protein (D) are pharmacologically inactive, while those that are unbound Ⓓ are active.

may be circulating in the blood in the active, unbound state. An example of this drug interaction occurs when aspirin and **warfarin** (an oral anticoagulant) are used together. The aspirin displaces the warfarin from its binding sites, resulting in an increased anticoagulant effect and greater chance of hemorrhage. For this reason, close client monitoring is essential in clients using two drugs capable of competing for binding sites in order to identify the emergence of an enhanced or diminished drug response.

Biotransformation (Metabolism)

In order to be eliminated from the body by way of the kidneys, a compound must be fairly soluble in water. Since many drugs are not very water soluble, they must first undergo drug metabolism or biotransformation to convert them to a more water soluble form. Biotransformation is also useful since it may permit the body to inactivate a potent drug before it accumulates and produces toxic effects.

Most biotransformation reactions occur in the liver and are performed by the reaction of liver enzymes with the drug. These drug-metabolizing enzymes, often referred to as *microsomal enzymes*, originate in the smooth endoplasmic reticulum of the liver. The reaction products that are produced when drugs are acted upon by these enzymes are known as metabolites. When a metabolite is capable of exerting a pharmacological action of its own, it is referred to as an active metabolite. An inactive metabolite has no pharmacological activity.

Some drugs (e.g., **phenobarbital**) are capable of stimulating or inducing the release of microsomal enzymes from the liver in a quantity greater than would normally be secreted. Such drugs are known as microsomal enzyme inducers. When a client receives a drug which is normally metabolized by microsomal enzymes and begins using a microsomal enzyme-inducing drug, the first drug may undergo more rapid biotransformation than would normally be expected. This action may reduce the client's response to the drug. In some cases a microsomal enzyme-inducing drug may also be metabolized by microsomal enzymes. This phenomenon has been employed to explain why the dosage of certain drugs must be continually increased to elicit the same pharmacological response.

Under certain circumstances, the liver's ability to metabolize drugs may be impaired. For example, premature infants and neonates may have immature livers which do not yet secrete adequate levels of microsomal enzymes. The capacity of the liver to metabolize drugs may also decline with increasing age or in the presence of hepatic damage (e.g., that caused by chronic alcohol ingestion). This is due to the diminished production of metabolizing enzymes. If doses of drugs normally metabolized by the liver are not reduced in situations where the liver's capacity to metabolize drugs is impaired, the drugs may accumulate in the body and produce toxicity.

Elimination

Drugs and their metabolites may be eliminated from the body in several different ways. Although the most important route of drug excretion is the kidney, some agents may be eliminated in the feces, exhaled via the respiratory tract, in breast milk, saliva, and/or sweat.

The excretion of drugs and metabolites by the kidney may be accomplished by two different mechanisms. The most common is the filtration of the agent through the *glomerulus* into the renal tubule (Figure 1–10). In many cases, the drug which has entered the tubule in this manner may

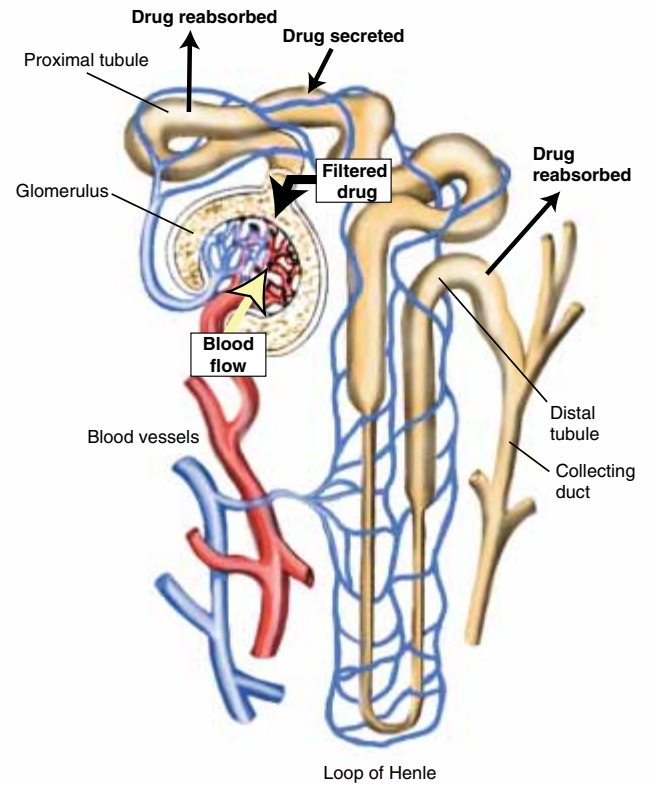

Figure 1–10 Renal excretion of drugs. Note sites where drugs are secreted and reabsorbed.

be partially reabsorbed through the wall of the tubule back into the bloodstream, thereby delaying its complete elimination from the body. Some drugs (e.g., penicillin) may be eliminated by being secreted directly through the walls of the tubule, i.e., by tubular secretion. This is generally a more rapid process than glomerular filtration and results in the rapid elimination of such drugs. Attempts have been made to prolong the action of certain drugs eliminated by tubular secretion by developing drugs which would block the tubular secretion process. One such drug, **probenecid** (**Benemid**), an antigout drug, is sometimes administered with penicillins or other tubular-secreted drugs to prolong their action in the body.

The pH of the urine may affect the rate of drug excretion by changing the chemical form of a drug to one which can be more readily excreted or to one which can be reabsorbed back into the circulatory system. Drugs which are weak acids, e.g., barbiturates, penicillins, and other drugs that are available as sodium or potassium salts, tend to be better excreted if the urine is less acid, as this will increase the proportion of drug which is in the ionized, water soluble form. Weak bases, e.g., morphine, **atropine**, and other drugs that are available as sulfate, hydrochloride, or nitrate salts, are better excreted if the urine is more acidic.

The efficiency with which drugs and/or metabolites are excreted by the kidneys often diminishes in persons of advancing age. This may necessitate a reduction in dose and/or fewer drug administrations in elderly clients to prevent the accumulation of toxic concentrations of drugs or active metabolites. This may also be the case in clients with renal impairment caused by disease (e.g., nephritis) or by the administration of *nephrotoxic* drugs (e.g., aminoglycoside antibiotics).

Measuring Drug Action

The action of drugs may be described mathematically in a number of different ways. One of the most common is by the use of the expression "drug half-life" or "elimination half-life." This may be defined as the time interval required for elimination processes to reduce the concentration of a drug in the body to one-half of what it was at the beginning of the time interval. For example, if the elimination half-life of a drug was 4 hours the following would be observed:

amount of drug in the body initially	=	100%
amount remaining after 4 hours	=	50%
amount remaining after 8 hours	=	25%
amount remaining after 12 hours	=	12.5%
amount remaining after 16 hours	=	6.25%

Note that as each 4-hour interval (one half-life) elapses, the drug concentration in the body is further reduced by 50% of what it was at the beginning of the interval. This process would continue until the entire dose of the drug was eliminated.

Another means of describing drug action is by the use of a graphic depiction of the plasma concentration of the drug versus time (Figure 1–11). On this graph, the zero point on the "time" axis represents the time at which the drug is first administered. With an orally administered dose, the drug concentration in the plasma increases from a zero level as the drug is absorbed into the plasma from the gastrointestinal tract. This rise continues until the elimination rate of the drug is equivalent to its rate of absorption. This point is known as the *peak plasma level* of the drug, that is, the highest plasma level achieved by the administration of a single dose of the drug. The time elapsed from the time of administration to the time that the peak plasma level is reached is known as the "time to peak" and is important in making clinical judgments about the use of a drug. From the peak plasma level the concentration declines since the amount of drug being eliminated exceeds the amount being absorbed.

When a drug is administered by rapid intravenous (*bolus*) injection, the plasma level versus

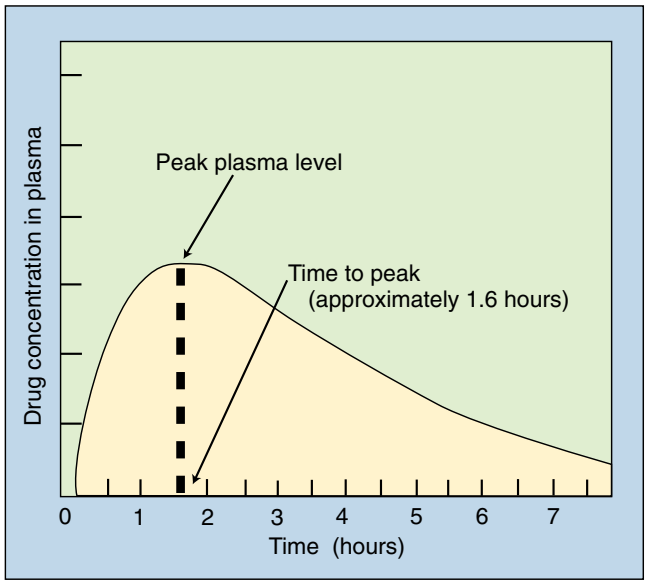

Figure 1–11 Plot of drug concentration in plasma versus time after a single oral administration of a drug.

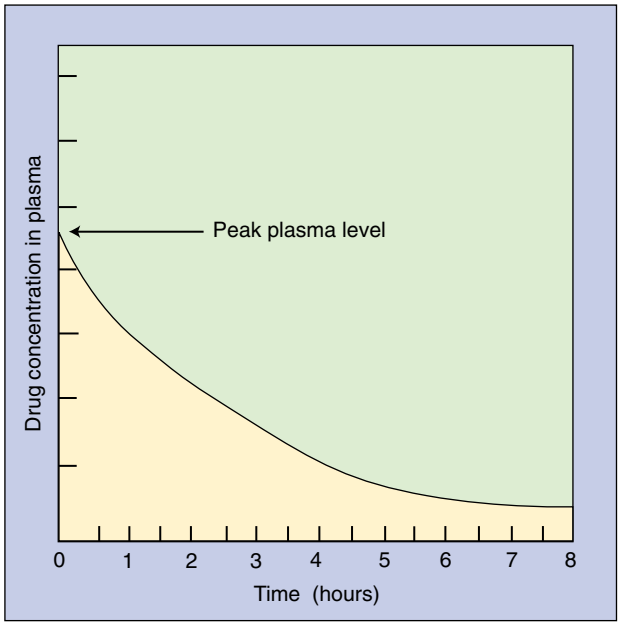

Figure 1–12 Plot of drug concentration in plasma versus time after a single intravenous (bolus) administration.

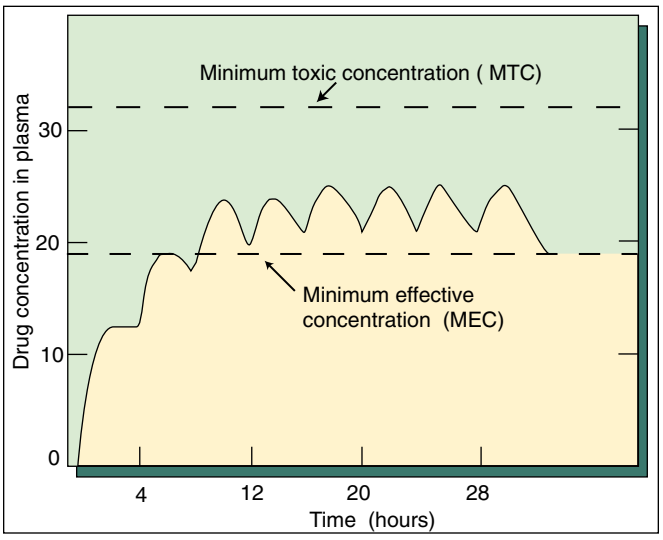

Figure 1–13 Plot of drug concentration in plasma versus time after multiple oral administrations.

time plot (Figure 1–12) is somewhat different from that observed with oral drug administration since the drug is introduced directly into the bloodstream without requiring the absorption step. In this case the peak drug level is achieved immediately at the time of administration, time zero. Only a decline of plasma concentration is observed, reflecting the elimination of the drug.

When most drugs are prescribed, an attempt is made to choose a dose and dosage interval which will permit the plasma level of the drug to remain above the minimal level required to elicit a pharmacological response, that is, the minimal effective concentration (MEC). Yet it must remain below the plasma level at which toxic effects of the drug are observed, the minimum toxic concentration (MTC). The plasma level versus time plot of a drug administered orally at 4-hour intervals in order to keep the plasma concentration of the drug between the MEC and MTC is illustrated (Figure 1–13). Note that with the first administrations the MEC may not be reached. In situations requiring rapid achievement of therapeutic plasma levels of a drug, a high initial or "loading" dose of a drug may be administered to produce effective plasma levels of the drug quickly.

Often a number of administrations of a drug may be required before a plateau or steady-state concentration of the drug is achieved in the plasma. For most drugs it has been observed that about 4–5 elimination half-lives must elapse before this concentration plateau is reached. This level will remain fairly constant as long as the dose of the drug or its frequency of administration is not altered.

MONITORING DRUG THERAPY

Drugs should only be administered to achieve a therapeutic objective, e.g., the relief of pain or control of blood sugar levels. Once this objective is defined, the appropriate drug and dosage regimen are chosen for the client. Some means of monitoring therapy must then be utilized to assess the degree to which the therapeutic goal has been achieved and to detect the development of any adverse effects.

Traditionally, drug therapy has been monitored by observing the client for the development of desired therapeutic (e.g., lowering of blood pressure) and/or undesired toxic (e.g., ringing of the ears) effects. Although this technique may be useful in some situations, it may frequently be inaccurate and potentially dangerous; for example, in assessing a client receiving a drug which is meant to control seizures, monitoring may be difficult, since the client may only experience seizures on an infrequent basis without the drug.

An alternative or adjunct to observation is to measure a biochemical change which reflects the drug's activity. For example, a client receiving the anticoagulant drug warfarin may have therapy mon-

itored by measuring prothrombin time rather than by observing the absence of further clot formation.

A valuable approach in monitoring therapy with some drugs is to measure plasma concentration of the drug in the client at a time when the drug concentration in the body is greatest (the peak concentration) or lowest (the *trough level*). This is particularly useful if there is a clear relationship between the drug's plasma concentration and its therapeutic activity or toxicity, e.g., with the use of **gentamicin**, **digoxin**, **theophylline**, or **phenytoin**. It is also useful in clinical situations where a therapeutic endpoint is difficult to assess, e.g., the control of seizures. In such cases, the objective of drug therapy may be to achieve and maintain a specific drug concentration in the plasma which falls between the minimum effective concentration (MEC) and minimum toxic concentration (MTC) of the drug.

In order to interpret plasma concentration data properly, several types of information must be available:

- A history of the drug's use in the client must be obtained. Such a history should include the doses and dosage regimen employed,since this information will be useful in determining whether or not a "steady-state" or stable concentration of the drug exists in the client.
- The time of sampling, i.e., when the blood sample is taken from the client, is important information to record, since the plasma concentration of a drug may vary considerably within the time interval between two consecutive administrations of the drug.
- The client's age, weight, and use of other medication are also important, since these factors may impact on the action of the drug being monitored.
- Knowledge of the client's renal and hepatic clearance as well as cardiovascular function is required since these factors will affect the drug's action, concentration, and duration of effect.

KEY NURSING IMPLICATIONS 1–3

Information Needed When Measuring Plasma Concentration of a Drug

1. prior history of the drug's use in the client
2. time of sampling
3. client's age and weight
4. use of other medication
5. status of client's renal, hepatic, and cardiovascular function

INDIVIDUAL VARIATION OF PHARMACOLOGICAL RESPONSE

While an understanding of the fundamental scientific principles discussed thus far is essential in understanding how drugs exert their effects, it should be noted that considerable variation may occur in the response of any two individuals to the same drug and dosage regimen. Such variable responses are often difficult to predict, thereby necessitating close monitoring of all clients receiving potent medications. The following are some of the factors which have been shown to contribute to individual variation of drug response:

- *age*—Those clients who are at age extremes, i.e., the very young and very old, often exhibit great variations in drug absorption, distribution, biotransformation, and elimination.
- *gender*—Males and females have different body compositions. The proportion of fat to lean body mass, etc., may influence the action as well as the distribution of drugs through the body.
- *body weight*—Increased body weight may necessitate the use of higher drug doses, since the dose required to reach equivalent levels of a drug in body tissues and fluids may be greater.
- *body surface area*—Body surface area (BSA) has been shown to be a useful measure of what dose of a drug would be appropriate to use for a specific client. It is generally determined by the use of a nomogram, a chart which permits estimation of BSA from height and weight data (Figure 1–14).
- *basal metabolic rate*—Clients with a high basal metabolic rate (BMR) may metabolize and/or eliminate drugs more rapidly than those with a normal metabolic rate.
- *disease states*—Underlying disease states may affect an individual's response to a drug by modifying factors such as absorption, distribution, biotransformation, and excretion.
- *genetic factors*—Individual variation in response to the effects of drugs may occur because of genetic differences between two individuals. For example, some clients may metabolize certain drugs more slowly because of a genetically induced enzyme deficiency.

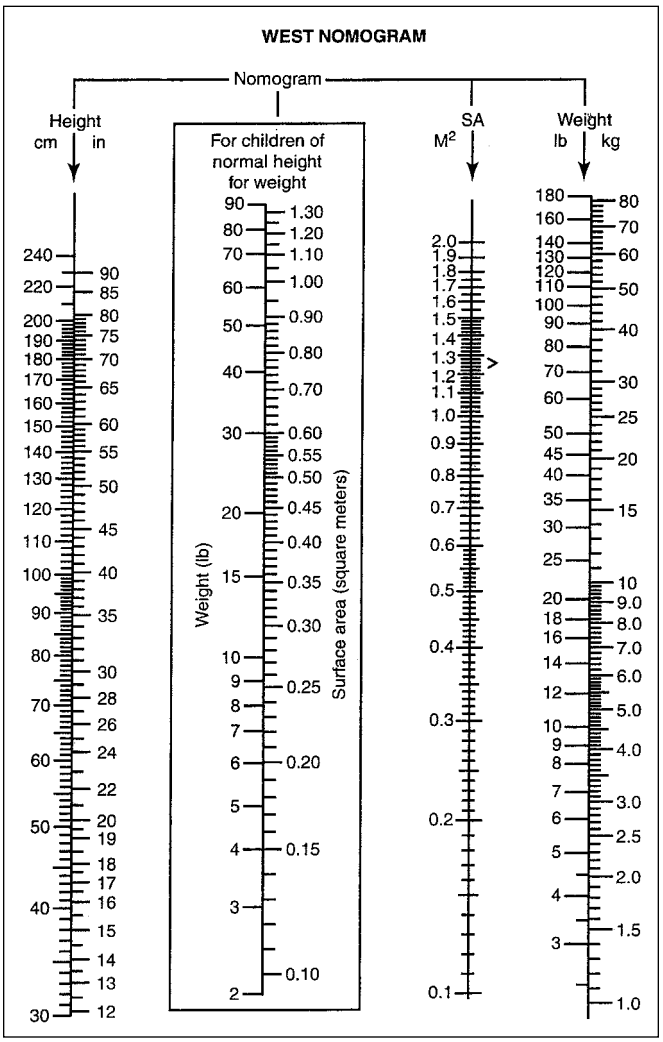

Figure 1–14 Use of Nomogram. In the example, a child who weighs 15 kilograms and is about 92 centimeters in height has a body surface area of 0.60 square meters. *(From* Nelson Textbook of Pediatrics *(16th ed.), by R. E. Behrman, R. M. Kleigman and A. M. Arvin, 2000, Philadelphia: Saunders. Copyright 2000 by Saunders. Reprinted with permission.)*

- *placebo effect*—By definition, a *placebo* is a dosage form which contains no pharmacologically active ingredient. A *placebo effect* is one elicited by the administration of virtually any drug, whether it is pharmacologically active or inert. The effect results from a variety of factors, including the relationship of the client with those providing treatment, belief in the ultimate success of their therapy, and the client's cultural and ethnic background, as well as many other factors. In treating subjective symptoms such as pain or anxiety, the placebo response may be as important as the actual pharmacological actions produced by potent drugs. It is essential, therefore, that the placebo effect be explored and utilized whenever possible in providing treatment.
- *time of administration*—The time of day or month that a drug is administered has been shown to affect the pharmacological response of clients to specific drugs. For example, corticosteroids often are more effective if given in the morning than at night, while the use of certain modes of cancer therapy in females may be more effective during certain parts of the menstrual cycle.
- *tolerance*—Considerable variation exists in the ability of different clients to become tolerant to the effects of certain drugs, particularly narcotic analgesics (e.g., **codeine**) and other central nervous system depressants. This may account for the dramatic differences in the dosage of a particular drug required to elicit a given level of pharmacological response in clients.
- *environmental factors*—Exposure to very hot or cold environmental temperatures may influence an individual's response to drug therapy.
- *idiosyncratic responses*—This subject was discussed earlier.

DRUG INTERACTIONS

A drug interaction occurs when the pharmacological effects of one drug are potentiated or diminished by another drug. If the administration of two or more drugs produces a pharmacological response which is greater than that which would be expected by the individual effects of each drug together, the drugs are said to be acting *synergistically*. If one drug diminishes the action of another, it is said to act antagonistically.

Drug interactions may be desirable or undesirable. For example, the use of a central nervous system stimulant such as **caffeine** with an antihistamine that may cause drowsiness as one of its side effects may be a useful drug interaction; the caffeine acts only to counteract the unwanted side effect of the antihistamine without altering its intended pharmacological action. The use of an antacid with the antibiotic **tetracycline** would be likely to result in an undesirable drug interaction, however, since the antacid may form a chemical complex with the tetracycline,

thereby rendering it incapable of being absorbed into the bloodstream.

Drug interactions may occur at any step in the passage of a drug through the body—during its liberation, absorption, distribution, biotransformation, or excretion. Interactions may also take place at the receptor site of a drug by interfering with the ability of the drug to combine with the receptor to produce a pharmacological effect. In most cases, however, drug interactions simply involve the overlapping of similar pharmacological effects (e.g., central nervous system depression) to produce an excessive drug response (potentiation) or the opposite pharmacological activity (e.g., the use of a drug intended to constrict the pupil of the eye with one which dilates the pupil).

Drugs may also interact with foods, laboratory test substances, and environmental pollutants. The body of knowledge involving the interaction of drugs with other drugs or substances has grown rapidly. Many reference sources dealing with drug interactions have been published. The student is referred to the listings at the end of this chapter for readings dealing with drug interactions.

The student is also referred to Appendix 5, which summarizes many of the most clinically significant drug interactions. In addition, throughout this text, references are made to those drug interactions that may be appropriate to each chapter.

PHYSICAL AND CHEMICAL INCOMPATIBILITIES

Since all drugs are chemical compounds, they are all capable of reacting chemically with other substances. This often becomes most evident when two or more drugs are combined in preparing solutions for parenteral administration. In some cases (but not always), when an incompatibility exists, some change in appearance of the mixture provides outward evidence that an unwanted chemical reaction is occurring or has occurred. It may appear as precipitate formation, color change, or gas evolution. **Note:** Under no circumstances should such a mixture be administered to the client until the safety of the administration can be assured. Generally, the mixture is discarded.

Before combining two drug solutions, every attempt must be made to ascertain the stability and safety of the mixture. This can best be accomplished by consulting with the pharmacist and/or by referring to a compatibility chart.

HERBALS/BOTANICAL MEDICINE

Herbals

Herbal medicine has been used since prehistoric times and is used today by up to 80% of the world's population. It involves the use of natural plant substances to prevent and treat disease. The latter part of the 1990s and into the twenty-first century has seen an increased use of herbal supplements by people believing these substances can prevent and cure disease. Historically, herbal medicine has been associated with the Chinese and frequently is used in conjunction with acupuncture (Sinclair, 1998). Currently, herbals are sold in nutrition stores, major drug chains, as well as discount retail stores wherever vitamins are sold.

In a study done at the Harvard School of Medicine, Brigham and Women's Hospital in Boston (Sinclair, 1998), researchers concluded that "alternative medicine use is common in the preoperative period." They found 22% of presurgical clients reported the use of herbal remedies with 51% using vitamins (Tsen, 2000). Women and clients aged 40–60 years old were the most likely to use herbals. Among the most commonly used herbals included echinacea, gingko biloba, St. John's wort, garlic, and ginseng.

Of primary concern to health care professionals is that herbals are not regulated by the FDA and, thus, their safety and efficacy has not been reliably established. The FDA does, however, have an Office of Special Nutritionals in its Center for Food Safety and Applied Nutrition that places adverse herbal product effects reported to the FDA in its database. The Internet site for this information is *http://vm.cfsan.fda.gov*. Many scientific studies have focused on herbal medicine, and the results are available on numerous Internet sites devoted to alternative medicine. WebMD (*www.webmd.com*) presents herbal information at its site. The Alternative Medicine Foundation (*www.herbmed.org*) provides information concerning more than 120 herbs, from achillea to zizyphus, including human clinical studies, traditional and folk use, adverse effects, and contraindications

for the use of herbals. All information cited in this section can be referenced through this web site.

The Herb Research Foundation (*www.herbs.org*) is a nonprofit research and education organization founded and "dedicated to improving world health through the informed use of herbs." Its web site focuses on media outreach and education programs around the world.

Herbal treatment claims range from the treatment and prevention of heart disease to adjuncts to cancer prevention and therapy. Some of the herbs and their uses are familiar to many people, such as aloe vera, garlic, gingko, and echinacea.

Aloe vera's most common use is in the treatment of superficial skin burns. Aloe vera is a common ingredient in numerous hand lotions. In addition, aloe vera plants are familiar sights in homes.

Garlic (allium sliva) and ginseng are consistently among the biggest selling herbal supplements. Garlic is said to possess antimicrobial, antithrombitic, antitumor, antilipidemic, antiarthritic, and hypoglycemic qualities (Herbal Companion to AHFS DI, 2001). In studies as current as the year 2000, including a study at the University of Kuwait, the use of garlic and onions in the treatment and prevention of cardiovascular disease and cancer is "an area of considerable investigation and interest" (www.herbmed.org).

Astrogalus (locoweed), according to researchers in 1998 who reviewed Chinese medicine (Sinclair, 1998), showed immunopotentiating effects. They also reported their review indicated astrogalus as a potential adjunct for cancer therapy (www.herbmed.org).

One of the most popular herbals today is ginkgo. It has been advertised as a prevention and treatment for dementia. Studies have reported that use of ginkgo caused from moderate to no effect on clients with mild to severe dementia. It also claims to help treat depression. In addition, it has been studied relative to claims that it can treat sexual dysfunction. It has been shown to alter blood coagulation because of its platelet-activating antagonist qualities. Studies focusing on the adverse effects of ginkgo have shown an association between subarachnoid hemorrhage and bilateral subdural hematomas and the long-term use of ginkgo biloba.

Echinacea was the subject of numerous studies in the year 2000. One such study indicated its positive effect when used with garlic to prevent and treat the flu. Other articles have stated that the use of echinacea for atherosclerosis treatment "lacks clinical validation" (www.herbmed.org).

Nursing Implications

Because of the increased use of herbal medicine in our society, nurses need to be sure to address this matter during the assessment of all clients. Two important facts health care professionals need to remember are: (1) herbals are not regulated by the FDA and (2) herbals, like drugs, are chemicals and, consequently, chemically have an influence on the body. Nurses need to be familiar with herbals in common use, and should ask clients if they use herbals, what herbals they use and how often, and assess the clients' knowledge of why they are taking these supplements. The nurse also needs to assess the clients for the presence of potential adverse effects associated with the use of specific herbals. Reporting the information received to the physician is an important nursing action, as herbals can influence the pharmacotherapeutics of medical treatment.

CRITICAL THINKING EXERCISES

1. Identify the significance of each of the following as they pertain to the use of drugs in the United States:
   - Food and Drug Act of 1906
   - Federal Food, Drug and Cosmetic Act of 1938
   - Durham-Humphrey Amendment of 1952
   - the Controlled Substance Act of 1970
2. Describe the significance of the term "bioequivalent" as it applies to a comparison of two drugs.
3. Define the term "pharmacotherapeutics" and give an example of a drug and its use.
4. Discuss the history of the prevention and treatment of disease as it applies to pharmacology.
5. Contact a state and/or local substance abuse agency to determine what materials are available for secondary school students.
6. Contact a hospital pharmacist to determine which drugs are routinely monitored using plasma drug levels and how the data is used to establish client dosages.
7. Visit a pharmacy and determine the costs of 25 brand-name products and compare them to the costs of generic equivalents of thatdrug.
8. Discuss why brand-name drugs are more expensive than generic products, including

such factors as the costs incurred in the investigational process, pharmaceutical company profits, etc.

DRUG INFORMATION SOURCES

AHFS Drug Information. Published by American Society of Hospital Pharmacists, 4630 Montgomery Ave., Washington, DC 20014

Physicians' Desk Reference. Published by Medical Economics Company, 680 Kinderkamack Rd., Oradell, NJ 07649

The American Drug Index. Edited by Norman F. Billups. Published by Lippincott/Harper Company, Keystone Industrial Park, Scranton, PA 18512

The Modern Drug Encyclopedia and Therapeutic Index. Edited by Gonzales and Lewis. Published by Yorke Medical Books, 666 Fifth Avenue, New York, NY 10103

Facts and Comparisons. Published by Facts and Comparisons Division, J.B. Lippincott Co., 111 West Port Plaza, St. Louis, MO 63141

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U.S. Department of Justice: Drug Enforcement Administration: Controlled Substance Act: www.usdoj.gov/dea/briefingbook/page9

2 Principles and Methods of Drug Administration

OBJECTIVES

After studying this chapter, the student will be able to:

- Relate the five steps of the nursing process to the administration of medications
- List the "seven rights" of medication administration
- Discuss the importance of the right documentation
- Identify client's rights regarding medication
- Define abbreviations commonly used in medication administration
- State the procedure for preparing drugs for parenteral administration from a multiple-dose vial
- List the steps in withdrawing drugs from an ampule
- List three types of clients for whom the usual procedure of oral medication administration must be modified
- Describe the procedure for administration of medications by way of a nasogastric tube
- Select an appropriate injection site for administration of parenteral medications, being aware of developmental factors that could influence site selection
- Select an appropriate needle and syringe for various types of parenteral injections
- List sequentially the procedure to be used for intramuscular, subcutaneous, and intradermal injections
- List the steps for administering ear drops
- Discuss nursing actions related to the administration of medications for the treatment of gynecological health problems
- Apply the steps of the nursing process in client teaching
- Discuss a nursing process approach to fostering compliance with medication regimens

Administering medications, supervising medication self-administration, and assisting other health personnel with the administration of medications are common functions of the nurse. These functions require a variety of skills.

Knowing the actions, both intended and unwanted, of drugs taken by clients under the nurse's care is essential, even when the nurse is not personally responsible for administering the drugs. Maintaining competency in medication adminis-

tration requires continual updating of the nurse's knowledge about therapeutic agents and methods of drug administration.

THE NURSING PROCESS AND MEDICATION ADMINISTRATION

All nursing care activities are governed by the nursing process. This process is the method by which the individual needs of clients are determined and measures are taken to meet these needs. The nursing process has five steps. The first step is *assessment*, in which the nurse gathers information used in identifying the client's nursing needs. Data are systematically collected and analyzed, using interviews, observations, laboratory reports, and other sources. The second step uses the data to state one or more *nursing diagnoses*. Carpenito (1999c) defines nursing diagnosis as "a statement that describes the human response (health state or actual/potential altered interaction pattern) of an individual or group which the nurse can legally identify and for which the nurse can order the definitive interventions to maintain the health state or to reduce, eliminate or prevent alterations." (Carpenito 1999c, p. 5) Once problem areas have been identified and information is available regarding the individual, the third step, *planning*, can occur. Planning is accomplished by one nurse or a group of health care staff, plus the client and significant others. The purposes are to establish priorities for the diagnosed problems, determine appropriate interventions, and set expected client outcomes. During the fourth step, *implementation*, the nurse or caregiver carries out the plan of care. The final step is *evaluation*, in which the nurse determines the outcome(s) of providing care. The nursing process is, of course, dynamic. Once it is initiated, the nurse is constantly engaged in assessing, diagnosing, planning, implementing, and evaluating the care provided. For additional information about the nursing process, the student is referred to the specialty texts at the end of this chapter.

In administering medications, the nursing process focuses on five interrelated functions:

1. Assessment
2. Nursing diagnosis
3. Planning
4. Implementation
5. Evaluation

Assessment

Assessment supplies the basis for many nursing actions related to drug therapy. It involves collecting and examining data about the client. Comprehensive assessment is initiated on first contact with the client and is conducted in a more focused manner with each subsequent contact. For example, assessment involves taking a medication history during the initial contact with the client. Assessment also includes acquiring baseline data such as height and weight, which may be useful in prescribing medications and in evaluating the effects of drug therapy. Assessment is also required in determining readiness for learning about drug therapy and in learning what the client already knows about his/her illness and its treatment. In addition, the nurse is responsible for assessing whether a drug is in the proper form for administration to a client. For instance, if a medication is ordered by mouth and the physician orders a tablet, but the nurse knows that the client is only able to swallow liquids, the nurse should check to see if the medication comes in either elixir or suspension form. If it does, the nurse should speak with the physician and the pharmacist about changing the order and supplying the liquid form.

Nurses are responsible for observing and recording the therapeutic and adverse effects of drug therapy. Although many types of untoward reactions can occur in response to drug therapy, it is particularly important for a nurse to know the factors that may place a client at risk for developing a hypersensitivity reaction and to observe (assess) the client for indications of such a response. Risk factors may include a previous allergic response to drugs, a family history of allergy, and current receipt of parenteral medications. Assessment of the client for *anaphylaxis* includes observing for nausea, vomiting, *pruritus*, report of substernal tightness, and dyspnea. These signs and symptoms are followed by *hypotension*, *bronchospasm*, *urticaria*, diffuse *erythema,* and *laryngeal edema*. The development of anaphylaxis signals that emergency assistance is needed.

Finally, nurses frequently assess the client's need for medication. Examples of this type of assessment include checking the client's pulse before administering drugs intended to slow the heart and improve its efficiency, checking blood pressure before administering an antihypertensive, and determining the need for medication ordered on a PRN, or as needed, basis.

Nursing Diagnosis

Diagnosis involves analyzing collected data and stating one or more diagnoses. In this text, the diagnoses identified may be either nursing diagnoses or collaborative problems. Nursing diagnoses are those problems for which nurses can legally prescribe interventions independently according to the nurse practice act of the state where they are working. Collaborative problems, according to Carpenito (1999b, p. 7), are problems defined as "physiologic complications" that nurses manage using "both physician-prescribed interventions and nursing-prescribed interventions to minimize the complications of the events." Because drugs are generally prescribed by physicians and because drugs alter body functioning, collaborative problems are commonly identified by nurses who administer and monitor medications. In caring for clients receiving drug therapy, diagnoses could include alteration in physiological functioning, such as decreased cardiac output related to the development of ineffective heart action, deficient knowledge regarding the illness or its treatment, and alteration in comfort level, such as acute pain. Statement of the diagnosis assists in identifying appropriate interventions, for example, administration of pain medication, preparation of a teaching plan, and specification of client outcomes, such as pain relief or correct performance of self-administered medication.

Planning

Planning includes setting priorities and determining nursing interventions. For medications, planning includes such activities as discussing the client's medication needs or responses with the physician and determining an appropriate schedule for administration of a drug. Setting client care goals is another important planning activity. Nurses also formulate instructional objectives and design client education programs to assist individuals in the self-administration of drugs.

Implementation

Implementation is the actual administration of the medication and/or the initiation of a medication schedule or client education program. In some cases, the nurse may not be performing the actual task, for example administering the medication, but is responsible for supervising the person who is implementing the plan. Implementation includes recording nursing interventions and observations about the person's response to the interventions.

Evaluation

Evaluation is the comparison of actual client outcomes with expected outcomes. It includes assessing the effectiveness of the medication in alleviating signs and symptoms of illness, determining adverse effects that result from the use of the drug, and determining the client's ability to self-administer medication. Clients' understanding of their illness and its treatment, including drug therapy, and their compliance with therapy are also evaluated. Modification of the nursing care plan is initiated based on the evaluation. If the nurse discovers, for example, that the client has not been compliant with the medication treatment program, an assessment is made of the reasons for noncompliance and the planning process begins again.

Client and family participation in the nursing process is critical. Compliance with therapeutic regimens frequently requires the client to learn and integrate new behaviors and to alter lifestyles in significant ways. To gain the client's cooperation with the treatment program, nurses should avoid imposing their will on the client, but should work with the client to establish a therapeutic alliance. Clients who perceive their input into and vested interest in their therapeutic regimen are more likely to maintain their treatment programs than those who feel that the program has been forced upon them.

In this text, where it is especially important, a step in the nursing process—for example, assessment—may be highlighted in regard to the nursing care of a client receiving a particular drug. When no particular step in the nursing process is mentioned, it is assumed that the nurse is systematically using the nursing process in carrying out medication functions, as well as other nursing care functions.

ADMINISTERING MEDICATIONS

Assessment

Before any medication is administered to the client, it is important for the nurse to conduct a thorough assessment of the client. One major focus of this assessment is taking a medication history. The client should be asked for the names of

KEY NURSING IMPLICATIONS 2–1

Assessment

1. Take a medication history.
2. Assess the client's understanding about illness, including past experience.
3. Conduct a physical assessment.
4. Obtain information about social networks and resources.

all medications they are currently taking, both prescription drugs and over-the-counter (OTC) drugs, as well as herbals and alcohol. Also, they are asked for home remedies they might be using to treat indigestion or nervousness or to induce sleep. The frequency of administration and dosage for each medication is recorded. When making a home visit, it is useful to have the client gather these medications and review the use of each with the nurse. This frequently provides an opportunity to discuss drug–drug interactions, the importance of discarding expired medications, and other issues related to safety in using medications.

Clients are also asked about adverse drug effects or allergic or hypersensitivity effects they have experienced as a result of taking medication. (See Chapter 1 for a discussion of these adverse drug effects.) They are asked about a history of allergic responses, in general, and about family history of allergy or untoward responses to medication or anesthetics. This may alert the nurse to individuals who are at risk for problems such as *malignant hyperthermia*.

It is useful to ask the client or caregiver (if the client is unable to respond because of developmental stage or incapacity due to illness) what they believe to be the causes of the illness. Their knowledge of the illness and past experience with illness and its treatment may be useful information in planning interventions during this period of illness. Special attention should be paid to a client's cultural understanding of illness and its treatment.

Physical assessment of the client is important and provides baseline information on height (or length in infants), weight, blood pressure, temperature, pulse, and respiration. It also provides information about general health and nutrition and about physical conditions, such as muscle atrophy, that will influence decisions regarding medication administration. Assessment is also made of sensory integrity, as this information is essential in planning care. The nurse especially notes hearing and vision aids used by the person.

Finally, it is useful to obtain basic information about an individual's social networks and resources for self-care. These factors influence whether individuals will have prescriptions filled and will comply with the treatment program.

Nursing Diagnosis

A number of nursing diagnoses may be useful in guiding planning and implementation. These may include:

- Ineffective health maintenance
- Risk for injury
- Noncompliance related to drug regimens
- Deficient knowledge (illness and its treatment)
- Ineffective management of the therapeutic regimen

The student is referred to texts on nursing diagnosis for more specific information about the identification and specification of relevant diagnoses.

Planning

Once the assessment has been completed and the nursing diagnoses made, the nurse engages in identifying the desired outcomes of nursing intervention and in planning appropriate nursing actions to achieve these outcomes. It may be useful for the nurse to consider several factors that may affect drug therapy. For example, it is important to identify why the client needs a drug. It may be helpful to identify the client responses that will indicate a therapeutic response has been achieved. This will assist the nurse in evaluating desired outcomes.

KEY NURSING IMPLICATIONS 2–2

Diagnosis and Planning

1. State relevant nursing diagnoses.
2. Identify desired outcomes of nursing intervention.
3. Focus on:
   - why the drug is needed.
   - how the drug will be administered.
   - common indications of adverse effects.
   - other nursing measures that will enhance the likelihood of achieving desired outcomes.

A second focal area is on drug administration. This area includes exploration of issues such as preparation of the drug for administration and special nursing measures to be used before, during, or after administration to ensure safety and enhance effectiveness of the medication.

Another focal area is identifying common adverse drug effects. This presumes knowledge of the drug to be administered, special issues about the method of administration, and knowledge about the client.

Finally, the nurse considers other nursing measures that may enhance the effectiveness of the medication regimen. These nursing measures include creating an environment conducive to rest and sleep, developing and implementing a teaching plan, providing emotional support, and using massage and positioning, plus many other activities designed to improve physical and mental well-being.

Implementation: Preparing to Administer Medications

In preparing to administer medications, it is important for the nurse to ensure cleanliness of all materials used. The nurse's hands, the work surface, and all supplies must be clean. In addition, the nurse checks to see that necessary supplies needed for administration are on hand. Medications should be prepared in an area with good lighting and a minimal number of distractions.

Once these preliminary steps are completed, the next task is to verify the order for the medication to be administered. This order must include the date, time, drug name, dosage, route, frequency and duration or length of administration, and required signature by the prescriber (Ignatavicius, 2000). The medication order must always be written, except in some emergency situations. In the event of an emergency, a written order must be obtained as soon as the emergency has been controlled. If a prescriber is on the nursing unit and gives a verbal order for medication, the nurse requests that it be written on the appropriate order sheet. If the prescriber orders a drug over the telephone, a licensed nurse must take down the information. On the next visit to the nursing unit, the prescriber must sign the written record of the verbal order. Medication orders frequently contain abbreviations. Table 2–1 presents abbreviations commonly used in administration of medications.

Once the order has been examined for its completeness, the nurse prepares to administer the medication. A general guide to use in medication administration is to check yourself against the "classic" seven rights: the right medication in the right amount to the right client at the right time in the right route. In addition to the "classic" five rights, two other rights have been receiving increased attention. The first of these is the right documentation. Whenever nursing interventions are implemented, correct and timely documentation is required. When administering medications, the nurse notes the date, time, name of the medication, dosage, and route of administration on the client's medication record. Depending on the procedure, the nurse may also record specific information about the site of administration and the person's response to the administration procedure. The nurse initials the medication record and/or signs the client's chart following this documentation.

Clients have rights also. In the seventh right, clients have the right to refuse medication. Refusals

KEY NURSING IMPLICATIONS 2–3

Implementation: Preparing Drugs for Administration

1. Ensure cleanliness of your hands, work area, and supplies.
2. Ensure availability of supplies.
3. Ensure adequate lighting.
4. Decrease environmental distractions.

KEY NURSING IMPLICATIONS 2–4

Remember the Rights of Medication Administration

1. The Right Drug
2. In the Right Dose
3. To the Right Client
4. At the Right Time
5. By the Right Route
6. Right Documentation
7. Client Right to Refuse

TABLE 2–1

Abbreviations Commonly Found in Drug Orders

ABBREVIATION	ENGLISH MEANING	ABBREVIATION	ENGLISH MEANING
aa.	of each	o.d.	every day or once a day
ad lib	freely, as desired	o.u., O.U.	both eyes
a.c.	before meals	p	after
b.i.d., B.I.D.	twice a day	p.c.	after meals
c	with	p.o.	by mouth
caps.	capsule(s)	p.r.n., PRN	as the occasion arises, when needed or requested
cc	cubic centimeter		
dl, dL	deciliter	q	every
elix.	elixir	q.d.	once a day
ext.	extract	q.h.	every hour
g	gram	q2h	every two hours
gr	grain	q4h	every four hours
gtt	drop(s)	q6h	every 6 hours
h	hour	q8h	every 8 hours
H.S., h.s.	at bedtime or hour of sleep	q12h	every 12 hours
ID	intradermal	q.s.	a sufficient quantity
IM	intramuscularly	q.i.d., Q.I.D.	four times a day
inj.	by injection	q.o.d.	every other day
I.U.	International Units	s	without
IV or I.V.	intravenously	S.C., s.c. or sub q	subcutaneously
IVPB	intravenous piggyback	S.L.	sublingually
kg	kilogram	sol.	solution
kvo	keep vein open	ss	one-half
L	liter	stat	immediately
mcq	micrograms	susp.	suspension
mEq	milliequivalents	tab.	tablet
mg	milligram	t.i.d., T.I.D.	three times a day
ml, mL	milliliter	TPN	total parenteral nutrition
NGT	nasogastric tube	tr.	tincture
O.D.	in the right eye	tsp.	teaspoon
O.S.	in the left eye	u	unit

Note: Some prescribers write the abbreviations without using periods.

must be documented in the client's record, with the date, time, and reason for refusal, if known. Clients also have the right to know the names of the medications they are taking. They have the right to information about the reason the medication has been ordered and the likely therapeutic effects, side effects, and common adverse effects. Because health care facilities differ in regard to procedures for ensuring these client rights, the student should check with the instructor or agency policy and procedure manuals regarding these rights.

Right Drug. After checking the order, the nurse selects the right medication. When using a non-unit dose system, the label on the container should be read three times: when taking the container from its location, when removing the medication from the container, and when returning

KEY NURSING IMPLICATIONS 2–5

The Right Drug

1. Carefully check the order.
2. Check the medication against the order.
3. Do not administer a medication someone else has prepared.
4. If using a unit dose system, do not open the unit packaging until you are at the client's bedside.

the container to its storage place. For unit dose administration, the three checks should be carried out. These are checking the medication (1) when removing it from its location in the drawer, bin, or refrigerator; (2) when comparing it to the client's medication administration record; and (3) before administering it to the client. Use special care when administering drugs whose name sounds like another drug. Never use medication from a container that is unlabeled or whose label is illegible or defaced.

When a unit dose system is in use, be certain to keep the dose packaged until immediately before it is administered. Always read a unit dose package three times. Encouraging the client to read and open the unit dose package provides an opportunity for educating the client about the medication.

If you are responsible for preparing multiple doses of a drug to be used at other times, for example a multiple-dose vial of an antibiotic, be certain that the name, strength of the solution, date of preparation, and your initials appear on the container. Also, be certain the medication is stored properly. Never administer a medication someone else has prepared, except if withdrawing a dose from a multiple-dose vial described and labeled as detailed. Before administering the medication, check the dose against the client's medication administration record (MAR). Finally, for safety, never leave medications unattended.

Whenever there is uncertainty about the order, first check the original order from which the current copy was transcribed. Also check with someone in authority, for example the instructor, head nurse, or prescriber.

Safe administration of the right medication requires that the nurse become familiar with basic information about the drug, including its action, contraindications for use, usual dosage, and side effects. To accomplish this, current reference books should be available on the nursing unit.

Right Dose. Determining the correct amount of a drug is sometimes difficult because three measurement systems are used in ordering medications. The nurse must be familiar with household measures, the apothecary system, and the metric system and must be able to convert from one system to another. Table 2–2 lists approximate equivalents useful in converting from one system to another.

To prepare the right amount of medication, the nurse must have developed skills in using measuring devices such as medication cups, droppers, and syringes. When preparing a liquid medication for oral administration, shake all suspensions and emulsions to ensure proper distribution of the ingredients. Examine the measuring device. Most have measurements for the three systems: for

TABLE 2–2

Some Commonly Used Approximate Weight and Measure Equivalents

METRIC WEIGHTS		
1 kilogram (kg)	=	1000 grams (g)
1 gram (g)	=	1000 milligrams (mg)
1 milligram (mg)	=	1000 micrograms (mcg)
1 microgram (mcg)	=	1000 nanograms (ng)
METRIC VOLUME		
1 liter (L)	=	1000 milliliters (mL)
LIQUID EQUIVALENTS		
Metric to Apothecary		
30 mL	=	1 fluid ounce (ʒ)
250 mL	=	8+ fluid ounces
500 mL	=	1+ pint
1000 mL	=	1+ quart
Household Measures with Approximate Equivalents		
1 teaspoon (tsp)	=	5 milliliters (mL)
1 tablespoon (tbsp)	=	15 milliliters (mL) = ½ fluid ounce
Apothecary		
60 minims (m)	=	1 fluid dram (ʒ) = 4 milliliters (mL)
1 fluid ounce (ʒ)	=	30 milliliters (mL)
1 milliliter	=	16 minims (m)
4 milliliters	=	1 fluid dram (ʒ)
OTHER EQUIVALENTS		
1 kilogram (kg)	=	2.2 pounds (lb)
4 grams (g)	=	60 grains (gr)
1 gram (g)	=	15 grains (gr)
0.3 gram (g)	=	5 grains (gr)
60 milligrams (mg)	=	1 grain (gr)
30 milligrams (mg)	=	1/2 grain (gr)

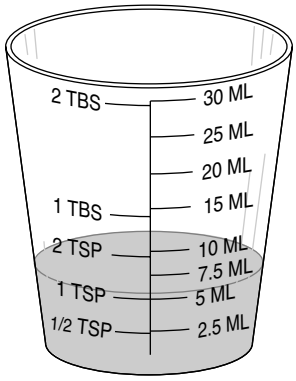


Figure 2–1 Always measure the volume of a liquid medication at the lowest point of the meniscus. This medication cup contains 5 mL of liquid.

KEY NURSING IMPLICATIONS 2–6

The Right Dose

1. Be familiar with the various measurement systems and the conversions from one system to another.
2. Always use the appropriate measuring device and read it correctly (e.g., measure liquids for oral administration at the meniscus).
3. Shake all suspensions and emulsions.
4. When measuring drops of medication with a dropper, always hold the dropper vertically and close to the medication cup.
5. When removing a drug from a multiple-dose vial, inject an amount of air equal to the amount of fluid to be withdrawn.
6. Do not attempt to divide unscored tablets and do not administer tablets which have been broken unevenly along the scoring.

example, a metric measure (mL) for milliliters; an apothecary measure (oz) for ounces; and a household measure (tsp and tbsp) for teaspoon and tablespoon, respectively. Select the proper measurement system (Pickar, 1999). Place the measuring device on a flat surface. Hold the medication container and pour away from the label to avoid soiling it. Raise the measuring device to eye level. Read the measurement at the lowest point of the meniscus, or curve, the liquid makes in the measuring glass (Figure 2–1). Wipe excess liquid off the bottle before replacing the cap (DeLaune, 1998).

Some medications are measured with a dropper. To ensure the proper amount of medication, the dropper must be held vertically. The bulb is squeezed and then slowly released, drawing medication up into the dropper until the proper dosage, as marked on the dropper, is reached. **Note:** Always use the dropper that comes with the medication. Do not interchange droppers; there is a variation in capacity from one dropper to another. When only a few drops of an oral medication are ordered, a dropper is used to draw up the medication. Holding the filled dropper over the medication cup, the bulb is squeezed slowly until the proper number of drops is counted. Except for elixirs and tinctures, oral medications measured by dropper may be mixed with a small amount of water in the medication cup to permit the administration of the full dose. Elixirs and tinctures should not be diluted, as this may cause precipitation of the drug.

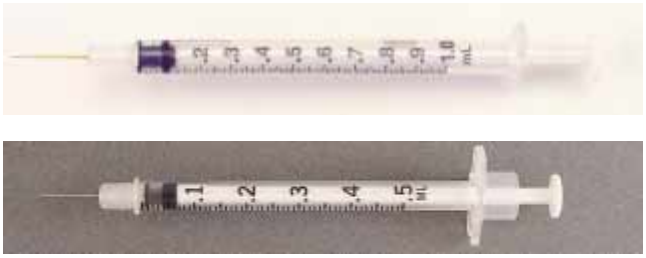
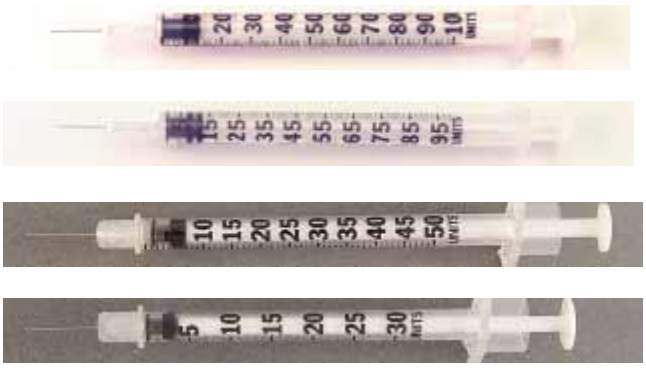
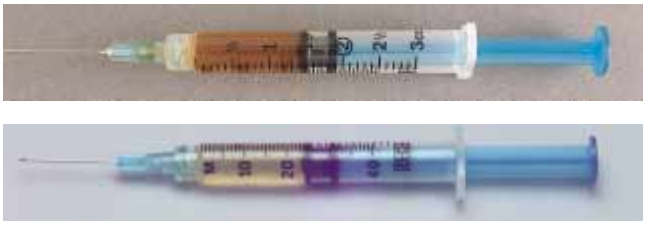
Administering the correct amount of injectable medications depends upon selection of the appropriate strength solution and the correct type of syringe. Syringes are generally available in different sizes, ranging from those which hold 0.3 mL to those holding 50 mL. In addition, there are three types of syringes in common use: tuberculin syringes, **insulin** syringes designed for various strengths of insulin, and general purpose syringes. Table 2–3 provides information about the sizes, calibration units, and common uses for each of these three types of syringes.

When preparing to administer an injectable medication, first determine the exact volume of the drug to be administered. Then select the right type and size of syringe and needle. When removing the drug from a multiple-dose vial, prepare the stopper on the vial by wiping with an alcohol sponge; inject an amount of air into the vial equal to the volume of fluid to be removed and withdraw the required amount of liquid. If there are air bubbles in the syringe, these must be removed by holding the syringe with the needle toward the ceiling and tapping the syringe with your finger to move the bubbles toward the hub. They should be expelled by gently pushing on the plunger. An appropriate volume of fluid should be replaced, and the needle recapped. (See Figure 2–2 for the parts of a needle and syringe.)

When the medication is in a glass ampule, first flick the top of the ampule with your finger to be sure all the medication is in the larger bottom portion. Then wrap the neck of the ampule with a dry

TABLE 2–3

Types of Syringes in Common Use

SYRINGE	SIZE	SCALE	GENERAL USES	
tuberculin (TB)	1 mL	0.01mL	Intradermal injections Allergy injections Injectable medications for infants and young children Heparin injections Other situations requiring precise measurement of a small volume of medication (less than 1 mL)	
insulin	0.3 mL 0.5 mL 1 mL	units	Administration of insulin of a specified strength	
general purpose	2–50 mL	mL	For use in administering 0.5–50 mL of medication; for example, the administration of antibiotics and pain medication	

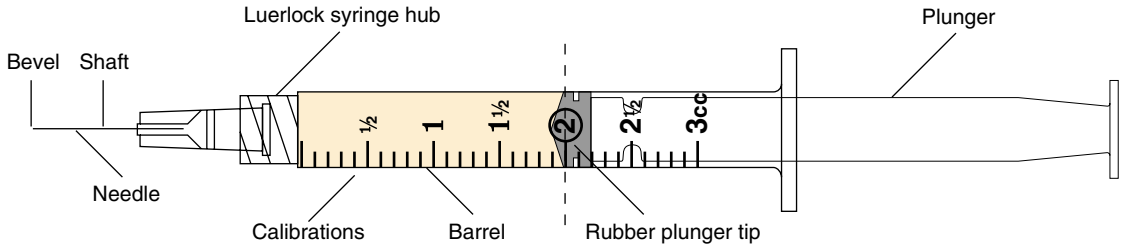


Figure 2–2 Parts of the needle and syringe

gauze pad and snap off the top. Recently, a device to open ampules has been marketed. The nurse inserts the ampule into the device and squeezes the opener while turning the ampule. A blade inside the device cuts the neck of the ampule. To remove the medication, the ampule is held steady on a flat surface between the first two fingers of the hand not used for manipulating the syringe. A filter needle or straw is used for withdrawing the medication to avoid drawing glass particles into the syringe. Measure the correct dose and remove air bubbles in the manner previously described.

It is sometimes necessary for the nurse to divide a tablet to administer the correct dose of a drug. For example, a medication order for an antianxiety agent reads **meprobamate** (**Equanil**) 200 mg P.O. at 9 AM and 400 mg H.S. The pharmacist supplies scored tablets containing 400 mg each. For the morning dose, the nurse will have to divide the tablet in order to administer 200 mg of meprobamate (Saxton, 1998). To do this, the nurse breaks the tablet at the score line with a pill cutter. Only tablets which break evenly along the scoring should be given, because those which have broken unevenly may contain too high or too low a dosage of the medication. Never attempt to break unscored tablets, as this may result in the administration of inaccurate dosages. Consult with the pharmacist whenever there are questions about the dosage to be administered when it varies from the dosage supplied.

Right Client. Once the medication has been properly prepared, the next step is to identify the right client. Although techniques suggested for identifying the right client might seem unnecessary to the student assigned to administer medications to only one client, it is important to understand and practice the principles to avoid errors when administering medications to several clients. Nurses, therefore, should make it a habit to employ proper identification procedures regardless of the number of clients involved.

In general, take every opportunity to be certain that you are administering the medication to the right client. If the client is in bed, check the name tag on the bed. Always check the client's wrist identification band. If the client is physically and mentally able, ask him/her to state his/her name.

Figure 2–3 Check a client's identification band before administration of medication.

If a parent is present and the child is too young to tell you his/her name, ask the parent the name of the child. Explaining that you wish to make certain of the person's identity before administration will usually encourage hesitant persons to give you this information. Finally, address the person by name, stating that you have medications for him/her. If the client questions the appearance, dosage, or method of administering the medication, always recheck the order and the medication itself before administering the dose. Another important factor to assess in determining if this is the right client is asking the client about drug allergies. If the client is allergic to the particular medication ordered or any ingredient in the medication or its class, the nurse should report this to the physician for possible changes in the client's medication order (Figure 2–3).

Right Time. The prescriber's order will specify the number of times a day the medication is to be given. It may also state the exact hours of administration or give general guidelines such as directions to administer with meals or before meals. If no exact time is given, drug administration is frequently planned according to a standard agency administration schedule. Medication administration schedules are based on knowledge of the desired effect of the drug, the characteristics of the drug itself, possible interactions with other drugs, and the client's daily schedule.

The schedule established for drug administration is important, and the nurse adheres to the schedule. A routine schedule helps to prevent administration of doses too close together or too

KEY NURSING IMPLICATIONS 2–7

The Right Client

1. Check the tag on the client's bed.
2. Check the client's identification band.
3. Ask the client to state his/her name.
4. Ask parents to tell you the name of their child.
5. Address the person by name before administering the medication.
6. Always double check orders that the client questions.

KEY NURSING IMPLICATIONS 2–8

The Right Time

1. To achieve maximum therapeutic effectiveness, medications are scheduled to be administered at specific times.
2. The nurse should adhere, as closely as possible, to the scheduled time(s) of administration.

far apart and is important in maintaining a relatively constant blood level of drugs that are given several times a day. As a general rule, the nurse should always be certain that a medication is administered within ½ hour of the time it is ordered to be given.

Right Route. The right route includes the correct route of administration, and administration in such a way that the client is able to take the entire dose of the drug and receive maximal benefit from it. The physician will usually specify the route by which the medication should be administered. If none is specified, the oral route is often intended, but for safety the nurse should check with the prescribing physician. However, any questions about the medication order should be discussed with the prescriber before administration of the first dose.

KEY NURSING IMPLICATIONS 2–9

The Right Route

1. Be sure you know the prescribed route by which a medication is to be administered.
2. If no route is specified in the physician's order, the prescribing physician should be questioned about the intended route.
3. Always gain the client's cooperation before attempting to administer a dose of medication.
4. Consider the client's developmental level during administration of medications.
5. The nurse must know what vehicles may be used with various drugs.
6. To achieve maximum effectiveness and client well-being, it is important to plan the order in which medications are administered.

Drugs may be administered in a variety of ways. Not all drugs may be administered by all of the possible methods. Many drugs, however, are available in several forms, permitting administration by more than one route. The method by which a drug is administered affects such factors as the absorption, speed of onset, dose, and side effects. Table 2–4 lists the most common routes by which drugs are administered. Although nurses may not be responsible for administration by all of these routes, they need to be familiar with the terminology. Nurses assist physicians in administration of drugs by some of these routes, e.g., *intra-articular*.

When assisting a physician in administering a medication, the nurse ensures that the seven rights of administration are followed. The extra care taken by the nurse to ensure that the seven rights are adhered to may help to prevent mistakes, which can occur particularly when other staff members performing administration procedures are not as familiar with the client's history and condition as the nurse is. The nurse retains responsibility for the drugs he/she prepares for administration. If the nurse has concerns about the safety of administering a particular drug to a particular client or about the route of administration, the physician should be asked to prepare and

TABLE 2–4

Common Routes of Drug Administration

PRIMARILY FOR LOCAL EFFECTS
topical application—to mucous membranes or skin
intra-articular—within the cavity of a joint
intracardiac—into a chamber of the heart
intradermal or intracutaneous—into the dermal layer of the skin
intrathecal—into the spinal fluid
inhalation—into the respiratory tract

PRIMARILY FOR SYSTEMIC EFFECTS
By the gastrointestinal tract:
buccal or transmucosal—in the cheek
oral—by mouth
sublingual—under the tongue
rectal—in the rectum

By injection:
intramuscular—into a skeletal muscle
intraosseous—into the bone marrow
intratracheal—into the trachea
intravenous—into a vein
subcutaneous—into the subcutaneous tissue

administer the medication, as well as to record the procedure on the client's record. It is also important to provide information and support for the client during procedures that may be uncomfortable, such as *intrathecal* administration of medications. Always be certain to record the procedure and the client's ability to tolerate the procedure on the client's record.

Administering a drug so that the client is able to take the entire dose and receive maximal benefit from it includes several nursing activities:

1. The nurse must gain the client's cooperation. Explanation about the administration procedure should be given and the client's ability to understand must be considered.
2. Special administration techniques may be required because of the client's developmental level. These are discussed in Chapters 5 and 6.
3. Some medications are administered in such small amounts or have such an unpleasant taste that they must be diluted or mixed in another vehicle, such as juice, in order for the client to take the entire dose. It is important for the nurse to know with which liquids specific drugs may be mixed without significantly altering the properties or actions of the drug. Consult with a pharmacist if questions arise about drug-vehicle compatibility.
4. If several drugs are to be administered at the same time, the order in which the nurse administers these drugs may be important. For example, it may be difficult for the client to turn for an injection. In this situation, oral medications should be administered first, followed by the injection and positioning of the client for maximum comfort. Also, some drugs have a local soothing effect on mucous membranes of the mouth or throat. Such drugs should be administered following other oral medications and should be followed by little or no water. As a general guide, when administering oral medications, the sequence used would be: (1) drugs that require special assessments, such as those for which an apical pulse or blood pressure assessment is required; (2) other tablets and capsules; (3) liquid preparations except for syrups intended for local soothing or anesthetic actions; (4) sublingual preparations; and (5) antacids and liquid preparations intended for local soothing or anesthetic actions which are given with instructions not to eat or drink fluids for 20 to 30 minutes.

Right Documentation. The right documentation includes the drug, the dosage administered, the time administered, the route and site if given parenterally, and the client's response. Most facilities have an MAR for documenting this information; however, if the client is being medicated at home, this information may be documented on the client's anecdotal note (Figure 2–4.)

In addition, with medications administered *PRN* (as needed) such as pain medication or medications for acute anxiety or agitation, the nurse must document in the nurse's notes the client's pain level (as identified by the client) or the behavior observed indicating the need to medicate the client for anxiety or agitation. The nurse must also document the effectiveness of medication administered within 30 minutes to one hour for oral medications, 20 minutes for intramuscular medications, and 10–15 minutes for intravenous bolus medications.

The right documentation is not only a legal requirement, but also a safety responsibility of the nurse. It is the primary method used to communicate medication administration from one nurse to the next nurse caring for a specific client. The basic principle of documentation is "if it isn't documented, it wasn't done." Consequently, if the nurse does not document that a particular medication was given, a second dose may be administered by another nurse, causing the client to experience adverse reactions, even life-threatening responses. For instance, if a client is to receive insulin at 3:00 PM (1500 in military time) according to the physician's order and the nurse does not document that the medication was administered, the nurse on the next shift may assume the 3:00 PM insulin was not given and administer the dose at 3:45 PM, thus causing the client to

KEY NURSING IMPLICATIONS 2–10

The Right Documentation

1. Be sure to document the medication and time administered on appropriate facility document.
2. Document site location after administering intradermal, subcutaneous, or intramuscular injection.
3. Document if client refuses medication, client's reason, and reporting of refusal to physician.

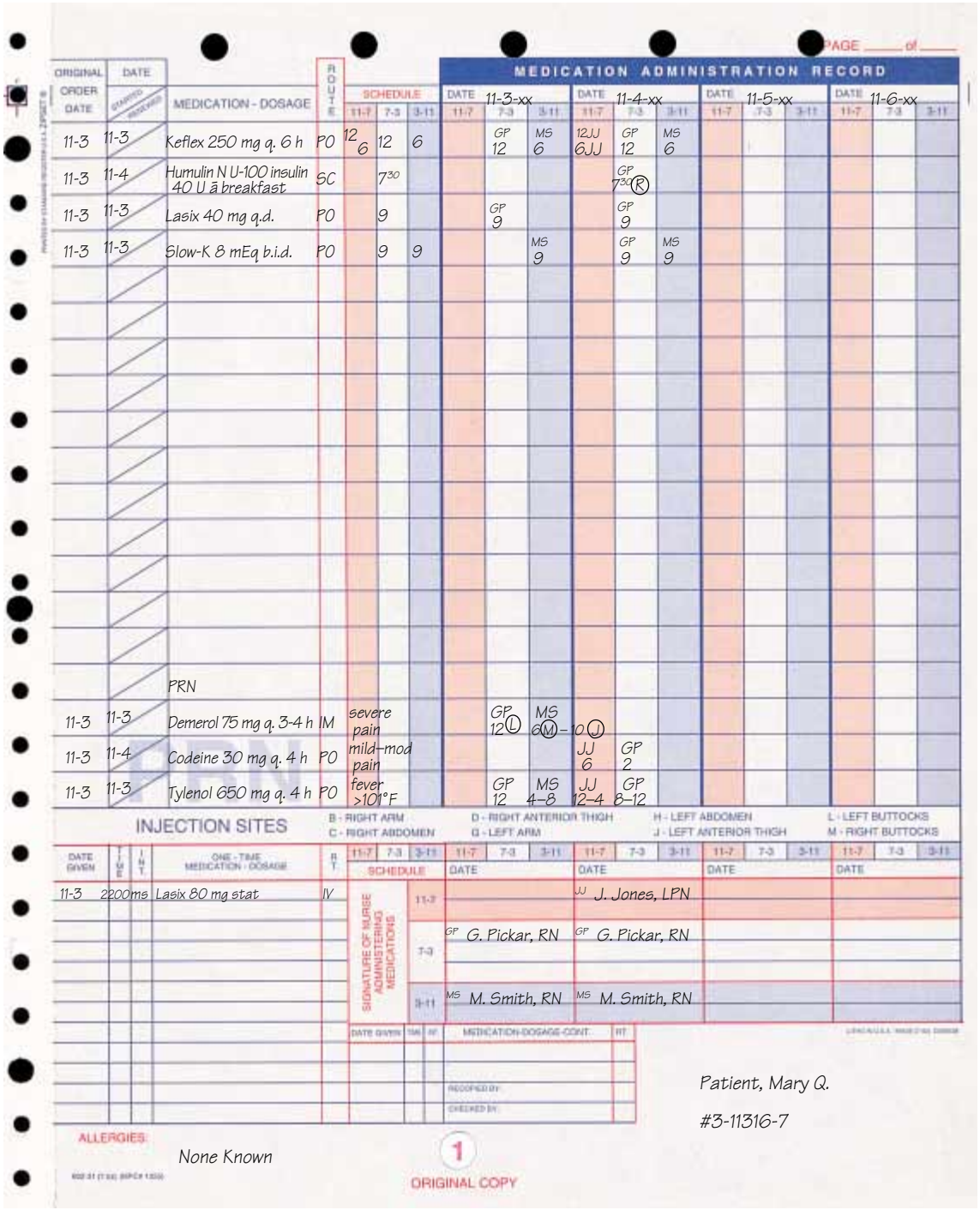


Figure 2–4 Medication Adminstration Order

experience a potentially life-threatening hypoglycemic reaction.

Documentation is also the primary evidence for insurance companies as to whether a claim is paid or not. The client may receive medication, which if not documented, the facility has no evidence to submit to the insurance company for reimbursement. An inappropriate and illegal practice (but unfortunately one that does occur) is for the nurse in an acute care facility to "borrow" a medication from client "A" to give to client "B" with the intent of replacing the borrowed medication to client A's medication bin when client B's medication is sent from the facility pharmacy. Any

number of circumstances can and do occur where the borrowed medication is not replaced. As a result, client A is charged for taking the medication and client B is not.

Right to Refuse. The client has the right to refuse to have a medication administered. Without the client's permission (or the permission of the legal guardian in the case of a pediatric client or a client unable to give permission who has a legal guardian), the nurse providing any treatment, including administering medications, is potentially at risk for legal complications. Because the nurse is the health care professional who most often is the one administering the medications, addressing client refusals is an important nursing function.

Most refusals by clients are the result of the client's knowledge deficit about what the medication is and what it does. When a client refuses to take a medication, the nurse's first action should be to assess the client's reason for the refusal. Addressing the client's lack of understanding of the medication will usually result in the client's compliance. A proactive nursing approach is to always inform all clients about their medications before attempting to administer them.

Some client refusals result from the health care professionals' lack of knowledge of a client's allergy to the medication that the physician was unaware of when the medication was prescribed. The physician should immediately be notified about the client's refusal and the presence of the client's allergy. The physician will then reassess the medication order.

Other refusals are due to the client experiencing adverse effects of the medication. For example, a client receiving a laxative or stool softener for constipation begins to have loose or diarrhea stools and refuses the next dose of the medication. This is a legitimate reason for not administering the medication and contacting the physician for an order change.

Some refusals are the result of the client's feeling powerless either because of being in an acute care facility or because of the health alteration that precipitated the need for the medication. Again, this information can be retrieved from the nurse's assessment done as a result of the client's refusal.

KEY NURSING IMPLICATIONS 2–11

The Client's Right to Refuse

1. Be sure to assess client's reason for refusing medication.
2. If knowledge deficit underlies client's reason for refusal, provide appropriate explanation for why medication is ordered, what medication does, and the importance of medication for treatment of client's health alteration.
3. Document if client refuses medication, client's reason, and reporting of refusal to physician.

Implementation: Oral Administration of Medications

Several principles and methods concerning the administration of oral medications have already been discussed. Table 2–5 gives some general guidelines to be used in the administration of oral medications. Other chapters contain further guidelines to follow in administering medications to children (Chapter 5) or elderly persons (Chapter 6). In addition, there are some special considerations, which need to be discussed in greater detail. As a general principle, the nurse's hands must not touch tablets or capsules as they are being transferred from the container holding multiple doses to the medication cup. The correct dose is either poured directly into the cup or into the cap of the bottle containing the medication, and then transferred to the cup.

KEY NURSING IMPLICATIONS 2–12

Oral Administration of Medications

1. Do not touch tablets or capsules as you transfer them from container to medication cup.
2. Do not disrupt the structure of enteric-coated, sustained-action, encapsulated beads, or wax-matrix medications and sublingual or buccal products.
3. Check the placement and patency of a nasogastric tube before administering any medication through it.
4. Medications should never be added to a nasogastric feeding unit, unless specifically ordered.

TABLE 2–5

Administration of Oral Medications

GUIDELINES

1. Wash your hands.
2. Check the written medication order for completeness. It should include the client's name, date, drug name, dosage, route, frequency, and duration of therapy. Verify the medication order by comparing the physician's order with the reference that is used when preparing and administering the drug.
3. Check to see if there are any special circumstances surrounding the administration of the dose to the client. For example, a nasogastric tube may be attached to suction or the client may be permitted nothing by mouth (NPO). Check with the prescriber to determine if the medication should be administered by another route. When the client is on NPO, withhold the dose and chart the reason for not giving it. When the client is once again permitted food and fluids, e.g., following a diagnostic test, medications scheduled for once a day may be administered. For drugs to be administered several times a day, return to the daily schedule.
4. Check for a history of drug allergies.
5. Be certain that you know the expected action, safe dosage range, special instructions for administration, and adverse effects associated with the drug ordered. Also, assess the client's total drug profile for possible drug interactions.
6. Prepare the dosage as ordered. Remember not to crush or tamper with sustained-action, sublingual, enteric-coated, and buccal dosage forms. Scored tablets may be broken along score marks, if necessary. If dosage strengths or forms other than those available on the nursing unit are required for the client, contact the pharmacist.
7. Do not touch tablets or capsules with your hands.
8. Unit dosage packages should not be opened until the nurse is ready to administer the dose to the client. As part of an educational program, the client may be encouraged to open the package to gain familiarity with the medication and labeling.
9. Check the label on medications three times before administering any drug.
10. Never prepare a dosage of medication which is discolored, has precipitated, is contaminated, or is outdated.
11. Identify the client by using the procedures discussed in the text. If the client expresses any doubt about the medication, always recheck the order, drug label, and dosage on the container.
12. Perform any assessments that must be done before administering the drug; for example, take an apical heart rate before administering a cardiac glycoside.
13. Elevate the head of the bed to aid the client in swallowing the medication.
14. Stay with the client as he/she swallows the medication. Provide necessary assistance, e.g., positioning and/or obtaining fluids to aid in swallowing. Instruct the client not to chew any tablets or capsules except those which are to be chewed.
15. If the client refuses the medication, determine why. Report the refusal and the reason given to the head nurse. Note it on the client's chart. Do not leave medications at the bedside.
16. If the client vomits within 20 to 30 minutes of taking the medication the physician must be promptly notified. Also note the details on the client's chart. Save vomitus for inspection, if possible. Do not readminister the medication without a physician's order.
17. If the dosage is to be administered sublingually, instruct the client to place the tablet under the tongue and not to swallow or chew the tablet. Buccal tablets are placed between the gum and the cheek, preferably next to an upper molar. The client should also be advised not to disturb the tablet by chewing or drinking while the tablet is being absorbed.
18. If the fluid intake and output are being monitored, record the amount of fluid taken with the drug on the client's intake sheet.
19. Following administration, be certain the client is comfortable. Provide appropriate instructions to the client regarding the medication. Then immediately record the procedure. This should include the name of the drug, dosage, route, special factors related to oral administration (e.g., nasogastric tube clamped following administration), time of administration, and your name or initials. Record indications of the effectiveness of the medication (e.g., decrease in body temperature following aspirin administration).

A special area of concern is the oral administration of medications to clients who are not able to swallow tablets and capsules. Some of the reasons for this inability include: age (young children and elderly persons have particular difficulty), swallowing anxiety, nervousness, anatomical obstructions, or having a *nasogastric* or *gastrostomy* tube in place. Occasionally it may be necessary for a nurse to reduce tablets to a powder by using a mortar and pestle or a pill crusher or to empty capsules and administer the powdered contents mixed with juice or applesauce. This technique works well and can be used in most cases. Nurses should not disrupt the integrity of any product which is enteric-coated or which is prepared as a sustained-action form. Nor should products containing encapsulated beads or a wax matrix be disrupted. Also, sublingual or buccal products must not be reduced to powder. To do so would interfere with the absorption, metabolism, and therapeutic effectiveness of the drug. In addition, the drug may irritate the upper gastrointestinal tract if given in powdered form. Other considerations must be remembered whenever oral dosage forms are disrupted. All crushed tablets should be used as soon as possible. The client should be told that the medication has been mixed with the food or liquid. This is important to avoid mistrust that might compromise the nurse-client relationship. Also, because medications in powder form may stick to the esophagus, the client should be instructed to take fluid before and after swallowing the medication. Some sustained release (SR) preparations, for example those with time-release beads, can be sprinkled onto or mixed with foods such as applesauce. The beads should not be chewed but swallowed whole. Whenever there is a question regarding alteration of an oral medication, the nurse should contact the pharmacist for advice. The pharmacist should also be contacted to see if a solid medication is available in a liquid form that could be substituted safely.

Some clients with nasogastric or gastric tubes will have orders for medications to be given through the tube. Liquid preparations of the drug may be used when available. In other cases, the nurse will have to reduce the tablet to as fine a powder as possible, using a mortar and pestle. Soft gelatin capsules may have a pinhole pricked in one end and the liquid squeezed out into a plastic medicine container or cup. Again, sustained-action and time-release dosage forms must not be pulverized. Most capsules that contain a powder may be emptied of their contents. The resulting powder from capsules or pulverized tablets is mixed with a small amount of fluid, usually 20–30 mL of warm water or normal saline, and taken to the client's bedside. As a general rule, avoid mixing drugs with enteral formula. **Note:** Do not administer bulk-forming laxatives, such as **psyllium**, through a nasogastric tube as obstruction of the tube is likely to occur. After preparing the medication for administration and identifying the client, elevate the client's head 30–45° to avoid aspiration during and following administration of the medication (Miller, 2000).

Before administering the medication, the nurse must check the placement of the nasogastric tube to be certain that medication administered through it will reach the stomach.

Two techniques can be used to determine the proper placement of the nasogastric tube:

- Aspirate a small amount of gastric contents.
- Place a stethoscope diaphragm on the abdomen over the stomach just below the xiphoid process. Use a syringe to slowly insert a small amount (10–12 mL) of air into the tube while listening with the stethoscope for the entry of air into the stomach.

The patency of the tube is also checked, particularly when the tube has not been connected to a suction device. Patency can be checked by aspirating a small amount of gastric contents and by flushing the tube with a small amount of normal saline (about 20–30 mL). Always return fluid removed from the stomach to maintain electrolyte balance.

After placement and patency have been established, flush the tube with approximately 30 mL of warm water (20 mL for children). The previously prepared medication can be administered through a syringe barrel (without the plunger) connected to the tubing (Figure 2–5). Hold the barrel of the syringe approximately 6 inches higher than the client's nose and allow the medication to flow into the stomach by gravity. If it is hard to get the medication flowing, gently insert the plunger or bulb into the syringe. When the medication begins to flow, remove the plunger or bulb and allow the medication to flow in by gravity. Between each medication, flush the tube with 5–30 mL of warm water to clear the tubing and prevent clogging. The administration of medication is followed by a small amount of fluid, 20–25 mL for children and 30–50 mL for adults, and the tube is clamped for about 20–30 minutes. Clamping is necessary; otherwise the medication which had just been

Figure 2–5 The medication, mixed with a small amount of sterile water or normal saline, is allowed to run into the nasogastric tube by gravity.

administered would be withdrawn from the stomach by the suction apparatus and tubing. The client's head should remain elevated for 20–30 minutes following instillation of the medication.

Implementation: Parenteral Administration of Medications

The word parenteral means administered by a route other than the intestinal tract. In common usage, however, parenteral means administered by injection. The most common ways in which drugs are administered by injection are: *intradermally*, *intramuscularly*, *subcutaneously,* and intravenously. Drugs can also be administered intrathecally into the *subarachnoid space* of the spinal column; *intra-articularly* into a joint cavity; *intralesionally,*\ or directly into a lesion; *intracardiac* into the cardiac muscle; or *intra-arterially*. These less common ways of administering medications require the use of special procedures and equipment. They are generally performed by a physician.

An important part of administering drugs by injection is selecting the appropriate equipment. Table 2–6 contains some guidelines for selecting the appropriate size needle for various types of injections. The Tubex® system uses a sterile cartridge-needle unit intended for one-time use (Figure 2–6). Many manufacturers are introducing injection systems with built-in safeguards against accidental needle sticks (Figure 2–7). The nurse

TABLE 2–6

Selection of Needles for Injection

TYPE OF INJECTION	SUGGESTED NEEDLE GAUGE (G)	SUGGESTED NEEDLE LENGTH	NURSING IMPLICATIONS
intradermal	26 or 27 G	¼" or ⅜"	Used for diagnostic purposes and to determine sensitivity to injectable medications. Most frequent site of injection is the inner aspect of the forearm.
subcutaneous	25 to 28 G	½" to ⅝" ⅞" in obese people	Used most frequently for administration of insulin and heparin. Can be used for administration of fluids by clysis, when 22 G, 1½" needles are preferred.
intramuscular	21–23 G	1" to 1½"	Longer needles are preferred for irritating medications. Larger gauge needles (20 G) are preferred for viscous injectable products, e.g., those in an oil vehicle.
intravenous	18–24 G 16 G	various lengths depending on the type of equipment preferred (½"–1½")	Used for blood tests and administration of most fluids and electrolyte solutions. Used for blood transfusions.
intracardiac	26 G	4"	For emergency use only by physician

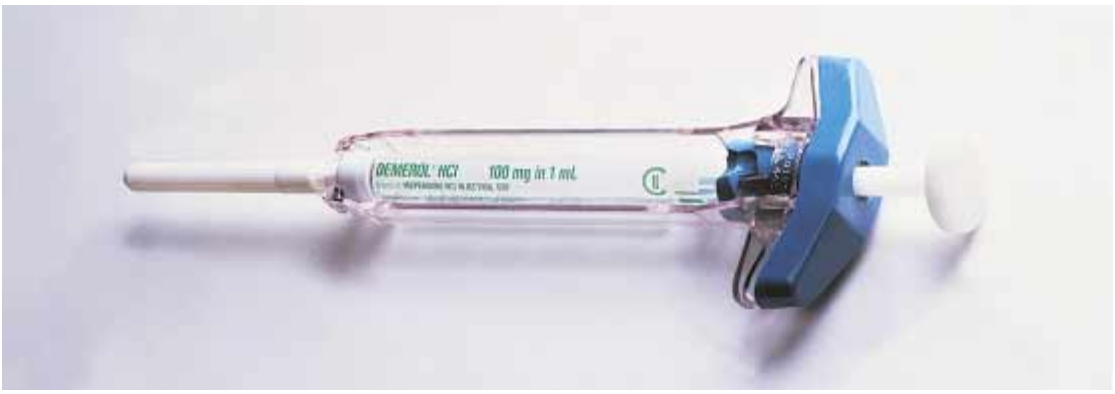


Figure 2–6 Closed injection system: Tubex® injector.

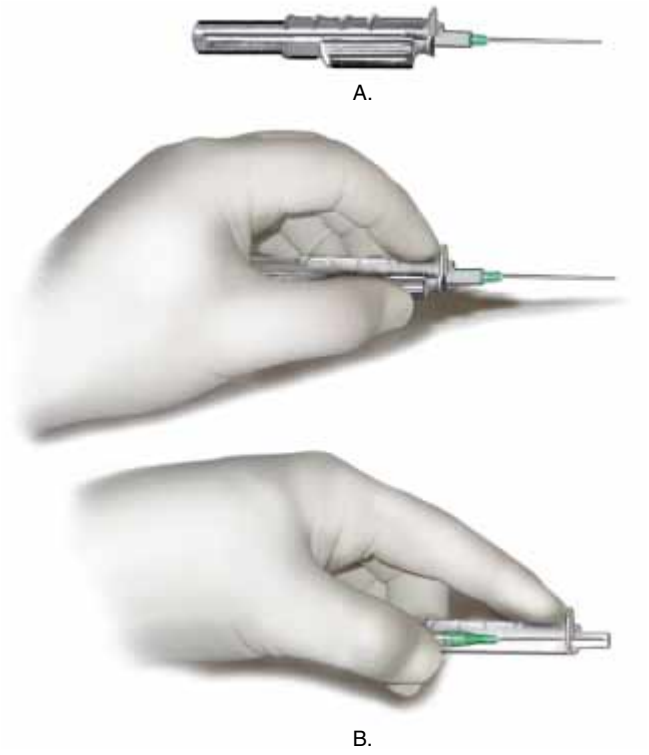


Figure 2–7 This IV catheter safety system (A) is designed to prevent accidental needle sticks. In (B), the top illustration shows a finger placed on the flange of the protective sheath. In the bottom illustration, the protective sheath has been pushed down over the needle.

must examine the manufacturer's instructions for each product to successfully use the product.

Safely Administering Parenteral Medications

Nurses always have been concerned about controlling the spread of infection. To prevent infection, nurses wash their hands before and after performing procedures. They ensure and maintain the sterility of the equipment used for procedures, and they prepare the client's skin to diminish the likelihood of infection when administering injections. In recent years, it has become more important to pay special attention to safety precautions when engaging in nursing procedures that are intrusive, require contact with body fluids, and breach the body's defense systems (Sennett, 1999). The reasons for this special attention include the development and spread of serious illnesses that are not adequately controlled by drug therapy (e.g., serum hepatitis B and *acquired immunodeficiency syndrome* [AIDS]), the number of clients with compromised immune mechanisms (e.g., those with AIDS, those who have received drugs that suppress the immune system, or those who have received total body irradiation), and the toxic nature of some drugs used in treating illnesses (e.g., cancer chemotherapeutic agents). For these reasons, the Centers for Disease Control and Prevention (CDC) has developed universal precautions to be used during the routine care of *all* clients. The following measures are indicated whenever parenteral medications are administered and in other procedures where the nurse is at risk of infection:

1. Always thoroughly wash hands before and after performing procedures, after contact with body fluids, and between clients. Gloves never replace handwashing.
2. Wear gloves whenever coming into contact with body fluids, for example, whenever performing any injection of medication and when discontinuing an intravenous infusion. Gloves must be used consistently, not only with clients having known communicable diseases.
3. Always carefully dispose of used gloves, needles, and syringes according to the facility's procedures/policies. Never recap a needle after giving an injection.

4. If accidentally exposed to body fluids, for example, by needle stick through gloves or being splashed in the eye, always seek immediate treatment. Document the incident.
5. Carefully follow the facility's procedures for the care of clients with known communicable diseases and ensure that other personnel and visitors adhere to the procedures regarding client contact.

Intramuscular Administration

The intramuscular route is preferred with medications which are irritating or painful, because pain is minimized when large muscles are used for injection. The procedure for giving an intramuscular injection is detailed in Figure 2–8. Instructions for using the Z-track method of intramuscular injection are given in Chapter 32. The application of EMLA (eutectic mixture of local anesthetics—**lidocaine** 2.5%, **prilocaine** 2.5%) cream to the proposed injection site one to two hours before the procedure will provide up to 0.5 mm of local anesthesia. EMLA is used more frequently in children (Chapter 5), but should be available for adults as well. The muscles most frequently used as injection sites are the deltoid in the upper arm; the gluteus medius, minimis, and maximus in the buttocks; and the vastus lateralis of the thigh. *The deltoid site is reserved for small quantities, 1 mL or less of clear, nonirritating solutions*. This injection site is located on the lateral side of the humerus, from two to three finger-widths below the acromion process and above the deltoid groove in adults and one finger-width below the acromion process and above the deltoid groove in children (Figure 2–9).

When locating an injection site, it is always important to identify anatomical landmarks and to inspect the tissue for its suitability (e.g., suffi-

1. Wash your hands.
2. Check the order and prepare the medication.
3. Identify the client and explain the procedure.
4. Position the client for maximal comfort, privacy, and exposure of the injection site.
5. Put on disposable gloves.
6. Identify the anatomical landmarks by inspection and palpation.
7. Identify the injection site.
8. Clean the injection site with an antiseptic, using a circular motion working from the site outward. Place the swab between the fingers of the hand that is holding the skin taut.
9. Remove the protective needle cap.
10. Holding the syringe firmly and perpendicularly to the skin, thrust the needle into the muscle. Do not insert the needle up to the hub, but leave ⅛–¼ inch to allow identification in case the needle should break (a rare occurrence).
11. Holding the syringe with the left hand, aspirate by pulling back on the plunger with the right hand. If blood appears in the syringe, remove the needle, discard the medication and equipment, and begin the procedure from step 1.
12. If no blood appears in the syringe, slowly introduce the medication. This allows time for distention of a space within the muscle to accommodate the fluid and prevents the forcing of the medication back up the needle tract into the subcutaneous tissue. (Another way to ensure that medication does not leak out of the injection site is to draw an air bubble of 0.3 mL into the syringe after the correct volume of medication has been obtained. When the medication is injected, the bubble follows the medication, clearing the needle and helping to prevent seepage of medication into the needle tract and subcutaneous tissue.)
13. Smoothly and quickly withdraw the needle. Immediately place pressure over the puncture site with a new swab. Unless contraindicated, massage the injection site to facilitate absorption of the medication.
14. Position the client comfortably.
15. Dispose of the needle and syringe properly in sharps container and remove gloves.
16. Chart the date, time, route and site of injection, and the name and the dosage of the medication.

Figure 2–8 Procedure for intramuscular injection. A 90° angle is used for all intramuscular injections given in the deltoid muscle, quadriceps, or gluteus muscles.

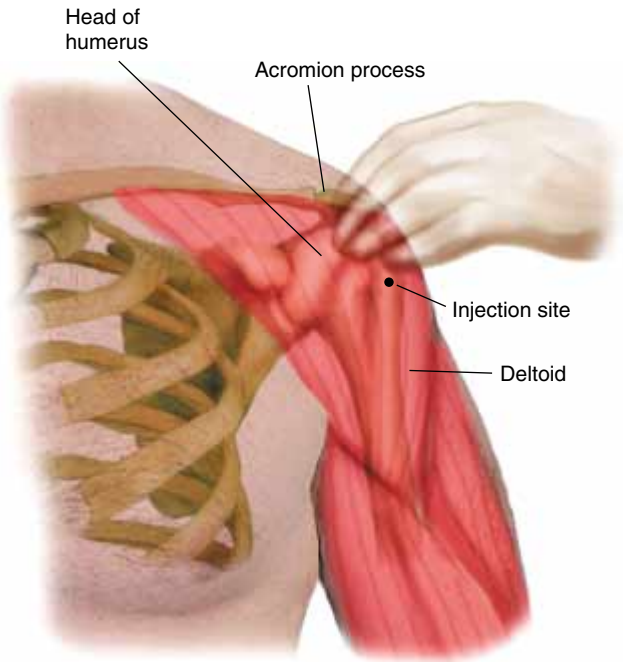


Figure 2–9 The deltoid injection site is located on the lateral side of the humerus from two to three finger-widths below the aromion process in adults and one finger–width below the acromion process in children.

cient muscle mass and adequate circulation and free of infection, tissue breakdown, scars, or skin imperfections). It is also important to avoid frequent use of the same injection site. Rotation of the site is important whenever clients are receiving frequent subcutaneous or intramuscular injections. Drug absorption is enhanced, tissue integrity is preserved, and client discomfort may be minimized when sites are rotated. To ensure site rotation by nursing staff, the nurse records the injection site that has been used in the client's record. A diagram or chart can be made to record the injection sites used in certain clients, such as those requiring parenteral antibiotics several times each day for a week or more.

In adults and older children, the gluteal muscles are the preferred site for intramuscular injections because of the size of the muscle mass. There are two injection sites that may be used: the dorsogluteal and the ventrogluteal. **Note:** The dorsogluteal site is not used in infants or in children who have not been walking, since this muscle is not well developed at that early stage. To give an injection using the dorsogluteal site, the client is requested to lie prone with the toes pointing inward to relax the buttocks. The client is requested to face away from the nurse so as not to observe the procedure. The arms are placed apart and flexed toward the head. The injection site is identified by palpating the posterior superior iliac spine and the greater trochanter of the femur. An imaginary line is drawn between these landmarks. This line parallels the sciatic nerve. An injection site is selected above and lateral to this line (Figure 2–10). The area below the imaginary line is never used as an injection site, as the sciatic nerve could be damaged. Detailed instructions for administering an intramuscular injection are given in Figure 2–8.

The second and often preferred injection site in the gluteal area is the ventrogluteal, using the gluteus medius and minimus muscles. To use this site, the client is requested to lie on the side. To locate

KEY NURSING IMPLICATIONS 2–13

Intramuscular Administration of Medications

1. Always identify anatomical landmarks. Check tissue for its suitability before making a final site selection.
2. Injection sites should be rotated.
3. The deltoid site may be used for 1 mL or less of clear, nonirritating solutions.
4. Do not use the dorsogluteal or ventrogluteal sites in infants or in children who have not been walking for at least 1 year.
5. The vastus lateralis site is the best choice for children under 3 years.
6. Children should have EMLA applied 1–2 hours prior to IM injection (see Chapter 5).

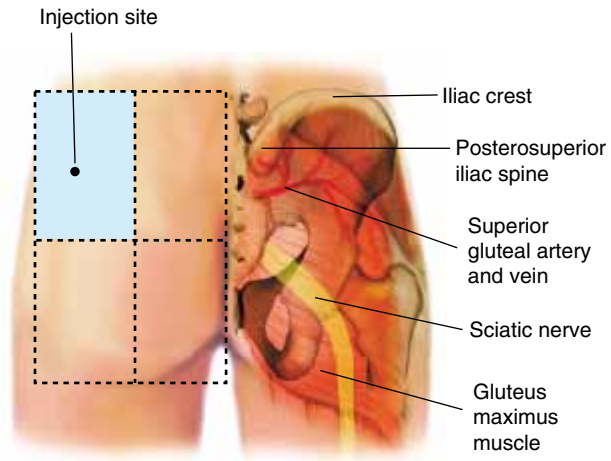


Figure 2–10 When using the dorsogluteal site, injection is made into the gluteus maximus muscle.

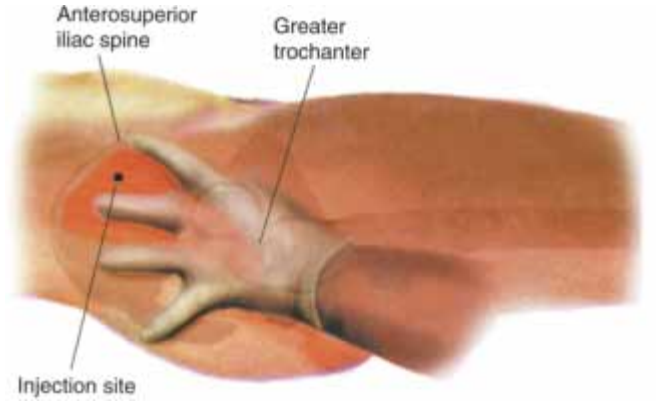


Figure 2–11 The ventrogluteal injection site on the right hip is located by cupping the greater trochanter with the palm of your left hand and by pointing the left index finger toward the anterior superior iliac spine. Point the middle finger toward the crest of the ilium. Spread your index and middle fingers to form a V. The injection site is located deep in the V, no higher than the first (proximal) knuckle.

the injection site on the right hip, place the palm of the left hand, if you are right-handed, on the greater trochanter of the client's right femur (Figure 2–11). Point the left index finger toward the anterior superior iliac spine. Spread the other fingers to form a V between the index and middle fingers. The injection is given in the lower part of the V formed between the fingers. To locate the injection site on the left hip, point the left middle finger toward the anterior iliac crest, and spread the index finger to form a V. **Note:** Do not use this site in children who have not been walking for a year as these muscles are not well developed.

The site for injection in the lateral thigh is the vastus lateralis muscle. This site may be used for both adults and children. It is the site selected for children of 3 years and younger. The vastus lateralis muscle is well developed in early life and has the additional advantage of containing few major blood vessels and nerves. To locate a safe injection site:

1. Divide the thigh into three equal parts between the greater trochanter and the knee.
2. Use the middle third part.
3. Divide the anterior thigh in half and the lateral thigh in half.

The injection site(s) can be anywhere within the rectangle formed by these lines (Figure 2–12). When giving an injection into this area, the client is asked to *lie on the back in the supine position*. The needle, inserted to a depth of 1 inch in adults,

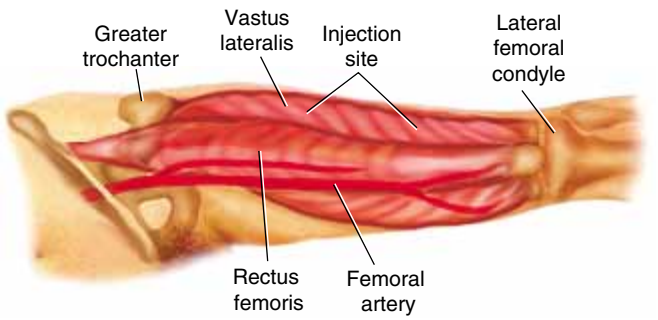


Figure 2–12 Location of the vastus lateralis injection site in adults. See Figure 5–4 for location of this site in a young child.

is parallel to or angled slightly toward the anterior aspect of the thigh.

Subcutaneous Administration

Subcutaneous injections are used more frequently than intramuscular injections. This is the preferred method for some drugs, such as insulin. These injections are given in areas with abundant subcutaneous tissue such as the middle lateral aspect of the upper arm, the abdomen on either side of the umbilicus, the buttocks, and the middle and outer area of the thigh. (See Figure 2–13 for a discussion of the procedure for administering a subcutaneous injection and Figure 2–14 for a diagram of the commonly used sites.) Subcutaneous injections may be given at either a 45° or 90° angle. When using a ⅝-inch needle, a 45° angle is generally used, except when administering heparin or insulin. Heparin is administered with a ½-inch or ⅝-inch needle at a 90° angle and administered in abdominal subcutaneous sites (see Chapter 30 for the administration procedure). Insulin injections are generally administered with a ½- or ⅝-inch needle at a 90° angle, since this has

KEY NURSING IMPLICATIONS 2–14

Subcutaneous Administration of Medications

1. Insulin and heparin injections are generally administered at a 90° angle.
2. Drugs other than insulin and heparin are administered at a 45° angle.
3. Some SC medications may be administered continuously (see Chapter 36) (Osbenour, 1998).

1. Wash your hands.
2. Check the order and prepare the medication.
3. Identify the client and explain the procedure.
4. Position the client for maximal comfort, privacy, and exposure of the injection site.
5. Put on disposable gloves.
6. Identify the anatomical landmarks by inspection and palpation.
7. Identify the injection site. In an ideal site you should be able to pinch at least 1 inch (2.5 cm) of subcutaneous tissue between the thumb and forefinger.
8. Cleanse the injection site with an antiseptic using a circular motion working from the site outward. Allow the site to dry. Place the swab between the fingers of the hand not holding the syringe.
9. Remove the protective needle cap.
10. Grasp the skin firmly between the thumb and forefinger to elevate the subcutaneous tissue.
11. Holding the syringe firmly and at a 45° angle to the skin, thrust the needle into the tissue. **Note:** A 90° angle is used when administering insulin or heparin.
12. Once the needle is inserted, release your grasp on the client's tissue.
13. Holding the syringe with the left hand, aspirate by pulling back on the plunger with the right hand. If blood appears in the syringe, remove the needle and discard the medication and equipment. Begin the procedure from step 1. Do not aspirate when administering heparin.
14. If no blood appears in the syringe, slowly introduce the medication. This allows time for distention of a space within the tissue to accommodate the fluid and prevents the forcing of the medication back up the needle tract.
15. When the syringe is empty, smoothly and quickly withdraw the needle and use a new swab to immediately place pressure over the puncture site. Unless contraindicated, as in heparin administration, massage the injection site to facilitate absorption of the medication.
16. Safely discard the needle and syringe according to agency policy.
17. Remove gloves.
18. Wash your hands.
19. Chart the date, time, route, and site of injection, and the name and the dosage of the medication.

Figure 2–13 A 45° angle is used for subcutaneous injections. A 90° angle is used for insulin and heparin injections.

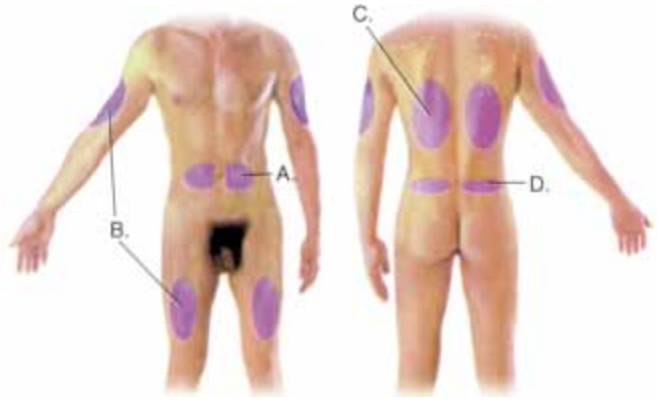


Figure 2–14 These are the most commonly used subcutaneous injection sites.

been shown to decrease the occurrence of local complications of long-term insulin therapy (see Chapter 36). When administering a subcutaneous injection to an obese person, the nurse selects a ⅝-inch needle for a 90° and a ⅞-inch needle for a 45° angle injection.

Intradermal Injections

An injection technique occasionally used by nurses is the intradermal administration of medications or diagnostic agents. This route is commonly used to administer diagnostic *antigens*. The preferred injection site is the inner aspect of the central forearm, but other relatively hairless and thinly *keratinized* areas, such as the upper chest and shoulder blades, can be used (Figure 2–15). The procedure for administration of an intradermal injection is described in Figure 2–16.

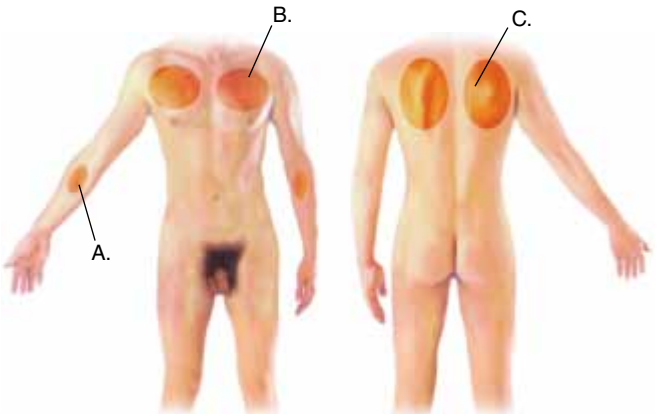
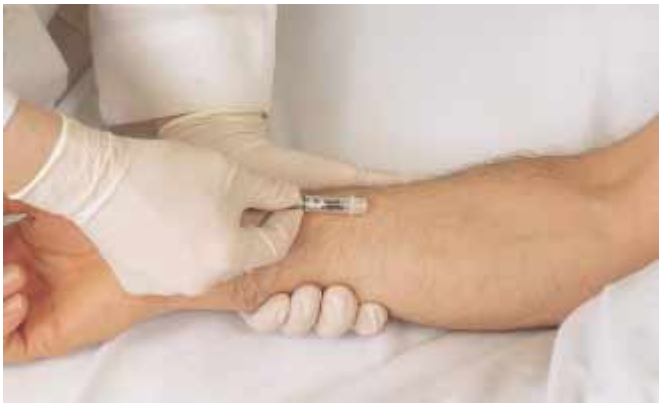
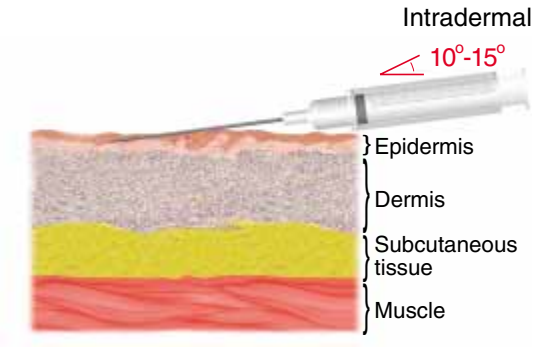


Figure 2–15 These are the most commonly used intradermal injection sites.





INTRADERMAL INJECTION

1. Wash your hands.
2. Assemble the needle equipment (1 mL tuberculin syringe with a 26 G, ⅝-inch needle, acetone, alcohol swabs).
3. Locate the antecubital space. Select a site one (young children) to several (adults) finger-widths distal to this landmark. Select a site without skin blemishes and with little hair.
4. Put on gloves.
5. Cleanse the site with an alcohol swab, using a circular motion and working from the area of the site outward. DO NOT use iodine solution to cleanse the skin as residual iodine may interfere with interpreting the results of the skin test. Allow the skin to dry thoroughly.
6. Holding the client's forearm in one hand, stretch the skin taut.
7. Position the syringe, with the bevel of the needle pointing upward, so that the needle is almost flat against the client's skin.
8. Insert the needle through the epidermis so that the point of the needle is visible through the skin. The needle should be advanced until it is approximately ⅛ inch (3 mm) below the skin's surface.
9. Gradually inject the medication. When you have completed the injection, leave the needle in place for a few moments and watch for the development of a small blister (wheal).
10. When the wheal appears, withdraw the needle and apply gentle pressure. Never massage the area or apply pressure to the site as this may interfere with the test results.
11. When an intradermal injection is given for diagnostic purposes, e.g., to determine sensitivity to an allergen, a control wheal is also made. The solution injected is the same fluid without the allergen, and the wheal is made on the opposite arm.
12. Remove gloves and dispose of equipment properly.
13. Wash your hands.
14. Chart the name of the medication, the amount given, the time and location of the test and control sites. Always observe the client for local (redness, itching) and systemic reactions (anaphylaxis).
15. Clients are advised not to rub or scratch the area.

Figure 2–16 Intradermal injections are made at a 15° angle.

Instillation of Ear Drops

Nurses administer ear drops and are responsible for teaching clients and their families about this procedure. Steps involved in administering ear drops to children and adults are discussed in Figure 2–17.

Administration by Insertion and Irrigation

Vaginal Medications. Special techniques are required to administer medications to women with *gynecological* health problems. These procedures involve the use of vaginal suppositories, creams, jellies, or ointments and the administration of medicated douches. Most medications intended for vaginal use come with special applicators. In the case of vaginal creams or jellies, these applicators involve a barrel and a plunger (Figure 2–18). The barrel screws onto the tube containing the medication. When the tube is squeezed, the medication fills the applicator. The applicator is detached and the tube is recapped. The medication is then ready for administration. Vaginal suppositories also frequently come with a similar type of applicator. The plunger is withdrawn slightly and the unwrapped suppository is placed in the barrel (Figure 2–19).

Before administering these medications, the nurse identifies the client, explains the procedure to be performed, and provides privacy. The client

ADMINISTRATION OF EAR DROPS

1. Assemble the necessary equipment. Wash your hands.
2. Warm the medication to body temperature by holding it in your hands for several minutes or placing the unopened container into a dish with a small amount of warm water 98.6°–109.4°F (37°–43°C). **Note:** Do not immerse the medication container in the water, and do not place in water if the label will be affected in any way.
3. Clean the outer ear carefully and thoroughly with cotton.
4. Ask the client to lie on one side, with the ear to be treated facing upward.
5. In children under 3 years, pull the pinna back and down and—without touching the dropper to the ear—place the prescribed number of drops into the ear canal. The drops may be milked down into the ear canal by placing gentle pressure on the tragus. In children and adults who may move unexpectedly, it is safer for the nurse to place the heel of the hand holding the dropper on the cheekbone.
6. In persons over 3 years of age, pull the cartilaginous part of the pinna back and up; without touching the dropper to the ear, place the prescribed number of drops into the ear canal.
7. Advise the client to remain in the same position for about 5 minutes following administration.
8. When the client sits upright, allow the remaining medication to flow out the ear canal. Cleanse the external ear with dry cotton balls.
9. Chart the date, time, name and dosage of medication given, the ear treated, the time of administration, and observations about the ear and/or the client's tolerance of the procedure.

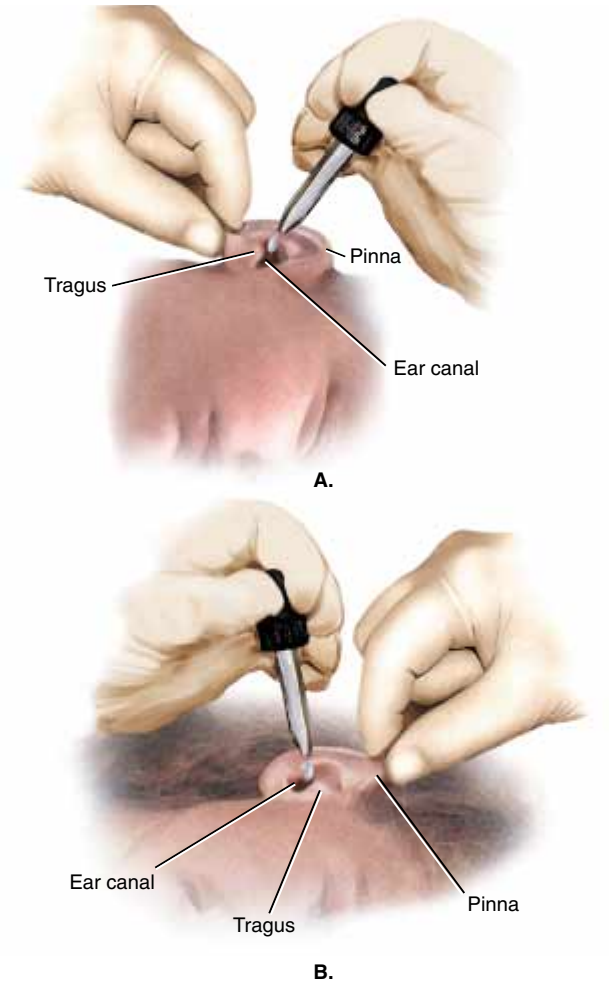


Figure 2–17 A. In young children, the pinna should be pulled down and back. B. To administer ear drops to adults, pull the pinna up and back.

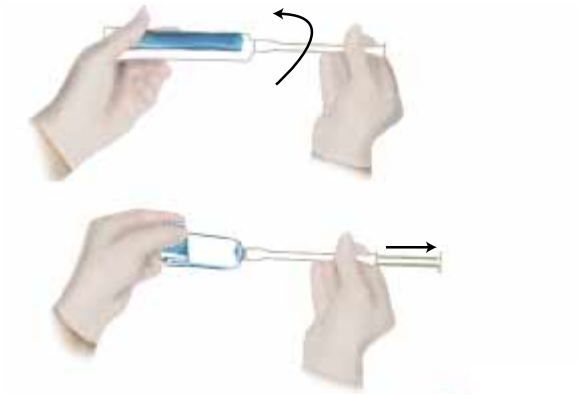
is asked to void before the procedure to prevent having to go to the bathroom shortly after receiving the medication. Some clients will be more comfortable administering these types of medications to themselves. In this case, the nurse explains that the medication should be inserted while the client is lying down, and demonstrates the applicator/plunger while explaining how to use it ("insert the applicator into the vagina and depress the plunger"). The client is left to perform the procedure with the nurse within call. After administration of the medication, the applicator is thoroughly cleansed and placed by the client's bedside for future use, unless a disposable unit has been used.

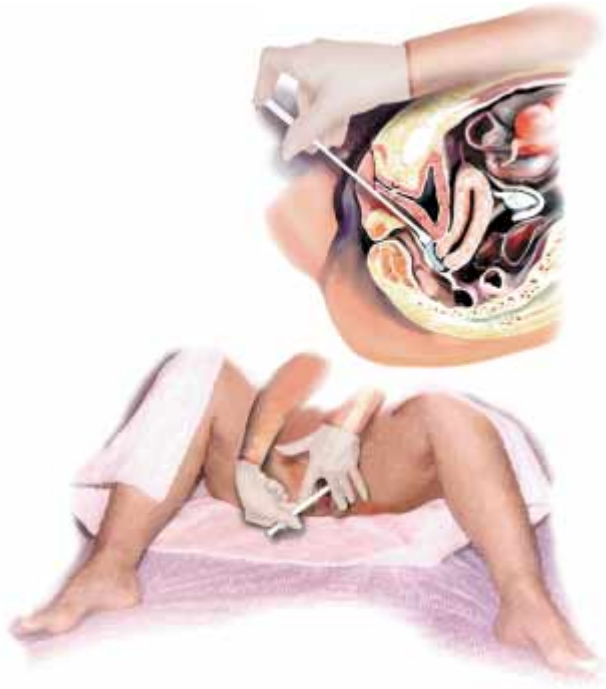
Ambulation will cause some of the medication to drain from the vagina. For optimal effectiveness, the client should remain lying down for at least 20 minutes. For this reason, a vaginal medication ordered for daily administration is usually administered at bedtime. Also, women should be advised that these medications can stain their clothing. To prevent staining, a sanitary pad

KEY NURSING IMPLICATIONS 2–15

Vaginal Administration of Drugs

1. The client may be permitted to self-administer these medications following instruction in the method of administration.
2. Instruct the client to remain lying down for at least 20 minutes after insertion of vaginal creams, ointments, jellies, tablets, or suppositories.
3. A sanitary pad or panty liner may be worn to avoid staining of clothing.





ADMINISTRATION OF VAGINAL CREAMS

1. Assemble the equipment.
2. Wash your hands and put on gloves
3. Insert the plunger all the way into the barrel.
4. Remove the cap from the tube containing the medication and attach the barrel to the tube.
5. From the bottom of the tube, squeeze the medication upward into the barrel. Fold the empty tube upon itself to empty the tube efficiently.
6. When the barrel is full, disconnect it from the tube and recap the tube.
7. Identify the client.
8. For administration, the client should be lying on her back. Unless otherwise contraindicated by the physical or emotional condition of the client, the nurse can instruct the client in self-administration. If the nurse is to administer the vaginal cream, disposable gloves are to be put on now.
9. Insert the barrel of the applicator into the vagina as far as it will comfortably go.
10. Holding the applicator steady, depress the plunger.
11. Instruct the client to remain recumbent for at least 20 minutes.
12. Withdraw the applicator. Provide the client with sanitary pad or panty liner to prevent staining. Disassemble and clean its parts in warm soapy water. Rinse and dry the parts.
13. Nurse removes gloves and washes hands.
14. Chart the date, time, name and dosage of the medication given, the time of the administration, and your initials.

Figure 2–18 The client should be in a recumbent position for the administration of vaginal creams.

or panty liner may be used for several hours following the administration of vaginal medications.

Medicated douches, also called vaginal irrigations, are occasionally ordered to promote comfort and remove secretions. Douche solutions should be warm, about 40°C (104°F). Douches can be administered with the client lying in bed on a bedpan with her knees flexed, or lying in an empty bathtub with her knees flexed. The nurse must wear gloves during this procedure. The nozzle of the administration set is carefully introduced into the vagina when the fluid begins to flow either by gravity or by compression of the administration reservoir. The nozzle is gently moved from side to side and forwards and backwards to ensure thorough irrigation of all vaginal areas.

Following the douche, assist the client to dry herself or provide supplies for her to do so. Because some fluid may continue to drain from the vagina for a short time after the douche, a sanitary pad or panty liner is used to prevent accidents. Chart the procedure, listing the time, solution used, pertinent observations, and the client's response to the douche.

Rectal Suppositories. Rectal administration of medications is used when other routes are not appropriate for the medication being administered. The nurse must remember how uncomfortable (physically and psychosocially) this may be to the client and ensure adequate explanation and privacy. The actual procedure is easy and involves lubricating the tip of the unwrapped suppository and inserting it a short distance into the rectum. A disposable plastic glove is used. Following insertion, the buttocks are squeezed together for a short time until expulsion reflex subsides, and the client is instructed not to try to forcefully expel the suppository. Finally, the anal area is cleaned of any excess lubricant, using toilet tissue. Remove the glove, wash your hands, and chart the procedure.

ADMINISTRATION OF VAGINAL TABLETS OR SUPPOSITORIES

1. Assemble the equipment.
2. Wash your hands and put on gloves.
3. Place the plunger into the barrel.
4. Remove the protective foil wrapping from the vaginal tablet or suppository.
5. To load the applicator, pull out the plunger until it stops and place vaginal medication into the barrel.
6. Identify the client.
7. For administration, the client should be lying on her back. Unless otherwise contraindicated by the physical and emotional condition of the client, the nurse can instruct the client in self-administration of the medication.
8. If the nurse is to administer the vaginal tablets or suppositories, disposable gloves are put on now.
9. Using either hand, the client or nurse grasps the barrel of the applicator with the thumb and middle finger. The applicator end with medication is then inserted as deeply into the vagina as it will go comfortably.
10. Holding the applicator steady the plunger is depressed, depositing the medication in the vagina.
11. Instruct the client to remain recumbent for at least 20 minutes. Provide the client with a sanitary pad or panty liner to prevent staining.
12. The applicator is withdrawn and the plunger removed from the barrel for cleaning. Both sections of the applicator should be washed in warm soapy water, rinsed, and dried.
13. Nurse removes gloves and washes hands.
14. Chart the date, time, name and dosage of the medication given, the time of administration, assessments such as vaginal discharge, and your initials.

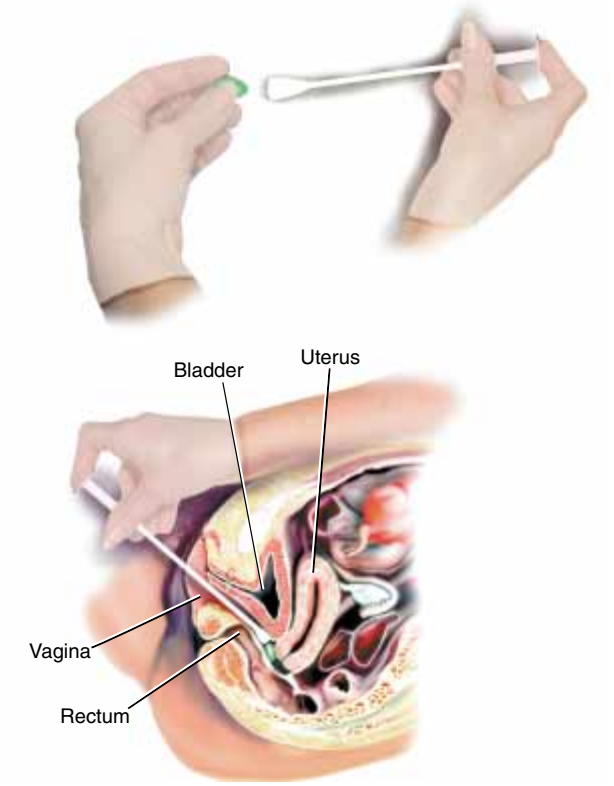


Figure 2–19 Administration of vaginal tablets or suppositories

Intervention: Other Drug Administration Techniques

Several methods of drug administration have been reviewed: oral, parenteral, instillation, insertion, and irrigation. There are other techniques used by nurses in carrying out drug therapy, such as topical application and inhalation. Discussion of various types of administration is found in later chapters as they relate to specific drug groups, for example:

- epidural analgesia (Chapter 10)
- rectal suppositories (Chapter 16)
- nasal drops and nasal sprays (Chapter 23)
- inhalations (Chapter 25)
- eyedrops and eye ointments (Chapters 26 and 27)
- transdermal patches (Chapter 29)
- topical administration for treatment of skin disorders (Chapter 40)
- insulin pumps (Chapter 36)
- pumps for the administration of cancer chemotherapy (Chapter 39)

NURSING PROCESS IN CLIENT TEACHING

Client teaching is an important nursing function. The primary purpose of teaching is to enable the client to engage in self-care activities. During the acute phase of an illness, the client may be overwhelmed by the threat to existence and by the strange environment. Under these circumstances, clients often defer to knowledgeable health personnel and allow them to do many things that they would do for themselves, if they were able. Part of the recovery process involves encouraging and instructing the client and/or family in self-care activities. Client teaching can help the client regain a sense of control.

In teaching clients and/or families about their medication and related treatment plan, the nurse should remember:

- For teaching to be effective, the client must indicate a readiness to learn.
- Teaching must be geared to the client's level of understanding. This is dependent on the

KEY NURSING IMPLICATIONS 2–16

Client Teaching

1. Client teaching is an important nursing function which enables the client to engage in self-care.
2. To be effective, teaching must take account of the client's readiness to learn, unique characteristics, and life situation.
3. Teaching makes use of the nursing process.
4. Clients should possess general knowledge of their illness and its treatment, the name and dosage of their medication, the administration schedule, the importance of taking the medication as scheduled, common side effects, major adverse effects and what to do about them, whom to call for help, and when and where to obtain their prescription and related supplies.

client's age, physical condition, memory, and other personal factors. (See Chapters 5 and 6 for hints about teaching children and the elderly.)

- Teaching must take account of the client's reading level, language, cultural values, and religious beliefs.
- Physical factors such as hearing and vision affect the methods of instruction and the general approach to the client.
- Teaching is most effective when several senses are involved and when the client has an opportunity to practice skills.
- Reinforcement and reward are important aspects of the teaching-learning process.
- Several brief teaching periods may be more effective than one longer period.

Teaching, like other nursing activities, makes use of the nursing process. A planned program of client teaching includes:

1. ***assessing*** the client's learning needs, motivations, strengths, and factors which might influence the client's willingness or ability to learn.
2. ***formulating a nursing diagnosis***. Such diagnoses might include deficient knowledge, ineffective management of therapeutic regimen, or sensory-perceptual alterations affecting learning.
3. ***developing a teaching plan***, including the objectives of client teaching. It is also important to identify the criteria for a successful outcome and to determine who will be involved in the teaching, approaches and tools to be used, and the sequencing of instruction.
4. ***implementing*** the teaching plan, making use of appropriate teaching techniques and aids. Teaching may be carried out individually or in groups. Medication education groups have been used successfully, for example, in teaching clients with mental health problems about their medication.
5. ***evaluating*** the client's response and recording it on the client's clinical record. Evaluation is based on comparison of the teaching objectives and outcome criteria with the client's actual knowledge and/or behavior. Knowledge may be assessed by verbal feedback or written quizzes. Skills are evaluated by having the client actually perform the skill while the nurse observes.

Whenever possible, the nurse should provide instruction to someone else close to the client, as well as to the client. This other person can provide support and reinforcement in self-care and is also able to assume care of the client if the client becomes unable.

The following are important points to teach the client about a medication program:

- a general knowledge of the health problem and its treatment, including how the drug is expected to affect the problem
- the name and dosage of the medication
- the schedule for administration
- the importance of taking the medication as ordered
- the consequences of not taking the medication
- the major adverse effects that could result from taking the medication and what to do if they occur
- how to handle minor side effects
- whom to call and when to call for advice
- when and where to get the prescription filled and to obtain other supplies or services

Additional aspects of client teaching are discussed in following chapters.

FOSTERING COMPLIANCE AND COOPERATION WITH MEDICATION REGIMENS

A client is said to be compliant with a prescribed drug regimen when all doses of the medication are taken correctly for the prescribed length of therapy. The nurse and other health professionals can

promote compliant behavior by encouraging the clients to be cooperative with the use of their medication. The term cooperation, rather than compliance, is used throughout this text since it conveys a more positive approach to improving client care.

Drug therapy of the institutionalized client is generally closely supervised. Therefore, it is not subject to a significant degree of uncooperative behavior. In sharp contrast, the treatment of ambulatory clients is frequently associated with poor client cooperation with prescribed medication regimens. Investigators who have studied this problem have estimated a noncooperation rate ranging from 17% to 90%. The result of this misuse of medications is often a failure to respond to therapy. When the prescriber is not aware of the uncooperative behavior and the client shows no apparent improvement, the result may be questioning of the original diagnosis, increasing the dose of the drug originally prescribed, or prescribing an entirely different drug.

Clients may fail to cooperate for various reasons. Some of these include:

- inadequate understanding of the illness, the intended action of the prescribed medication, or the instructions for its use
- dissatisfaction with the prescriber
- dissatisfaction with the diagnosis
- the cost of the medication
- inconvenience; for example, having to take the prescribed medication several times a day
- the number of medications; generally, it is more likely that uncooperative behavior will occur if several medications are being taken
- the development of adverse effects upon using the medication
- forgetfulness
- stigma or not wishing to be viewed as ill

Recognition of the reasons for lack of cooperation can assist the health practitioner in preventing its occurrence and help assure the optimal use of the prescribed medication.

A number of measures can be taken to increase the likelihood of greater cooperation.

- Provide more effective client education by first determining the client's level of understanding and then providing appropriate instruction, which can include steps to improve the client's comprehension of the disease process, the intended purpose of the prescribed medication, and appropriate scheduling of administrations to better coincide with the client's normal routine.

KEY NURSING IMPLICATIONS 2–17

Cooperation

1. Ideally, cooperation with treatment means that all medication doses are taken correctly for the prescribed length of therapy.
2. Some reasons for lack of cooperation include: inadequate understanding of the illness, cost of medication, the development of adverse effects, and forgetfulness.
3. A number of measures can be taken to foster the likelihood of cooperation. These include educational programs, memory aids, and alterations in the number and doses of medication.
4. The nursing process is an important means of promoting cooperation.

- Use devices such as medication calendars which help clients keep track of their medication consumption so that any administration error can be quickly detected and rectified (Figure 2–20).
- Make attempts to reduce the number of medications and doses to be taken. For example, some medications may be available in a prolonged-action dosage form, which permits taking single rather than multiple daily doses.
- Reinforce administration instructions each time the client returns to the prescriber or to the pharmacy.

The promotion of client cooperation is clearly a challenge for all health practitioners, but one which must be aggressively addressed, if drug therapy for ambulatory clients is to be justified and effective.

NURSING PROCESS APPROACH TO IMPROVING COOPERATION

As previously noted, many clients do not cooperate with their drug therapy. Nurses can be helpful to clients taking medications by assessing the degree of cooperation, determining the reasons for lack of cooperation, and planning strategies for improving cooperation with the client.

Initially, in efforts to improve cooperation, the focus is on assessment. Is the client taking the correct dosage in the correct manner at the times prescribed for the length of time prescribed? In determining the degree of cooperation, it is important for the nurse to be nonjudgmental and

DRUG NAME COLOR/SHAPE	DIRECTIONS & CAUTIONS	SUN	MON	TUES	WED	THUR	FRI	SAT
Librium green & black capsule	3 times a day Do not drink alcohol	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5
Prednisone small tablet	3 times a day Do not stop suddenly	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5	8 12 5
Hydrodiuril yellow tablet	Once a day in morning Keep in air-tight container	8	8	8	8	8	8	8

(A)

DRUG NAME COLOR/SHAPE	DIRECTIONS & CAUTIONS	SUN	MON	TUES	WED	THUR	FRI	SAT
Librium green & black capsule	3 times a day Do not drink alcohol	~~8~~ ~~12~~ ~~5~~	~~8~~ ~~12~~ ~~5~~	~~8~~ 12 ~~5~~	8 12 5	8 12 5	8 12 5	8 12 5
Prednisone small tablet	3 times a day Do not stop suddenly	~~8~~ ~~12~~ ~~5~~	~~8~~ ~~12~~ ~~5~~	~~8~~ 12 ~~5~~	8 12 5	8 12 5	8 12 5	8 12 5
Hydrodiuril yellow tablet	Once a day in morning Keep in air-tight container	~~8~~	~~8~~	~~8~~	8	8	8	8

(B)

Figure 2–20 Clients are instructed to mark the medications calendar whenever they take a dose of the drug. This identifies errors and omissions, if they occur. (B) illustrates that the 12 PM dose has been missed.

to explore the factors related to lack of cooperation. It is useful to initiate discussions about cooperation with general questions regarding the client's treatment (e.g., "Have you found that the treatment that your doctor has prescribed has made any difference in your symptoms?"). The nurse then asks more specific questions such as, "What difficulties related to your medication

treatment do you have?" If it appears that the client has problems with cooperation, the nurse assesses the reasons for these problems by focusing on common reasons for lack of cooperation, including an assessment of the factors listed. These data are then used to formulate a nursing diagnosis, such as ineffective management of therapeutic regimen related to experiencing unpleasant side effects or to deficient knowledge about the illness and the intended effects of treatment.

Once the nursing diagnosis has been made, the nurse and client discuss the goals for the treatment program and the intervention strategies that can lead to meeting these goals. A number of general measures to foster cooperation have been noted. Specific measures to improve cooperation must be individualized for each client and are, of course, logical outcomes of assessment, diagnosis, and planning. Evaluation of nursing interventions then can be directed toward assessing the degree of cooperation and the achievement of therapeutic goals such as prevention, alleviation, or cure of illness and its symptoms.

HOME CARE / CLIENT TEACHING

1. The nurse should ask to see all of the prescription and OTC medications used by the client.
2. The nurse should assess the sensory and cognitive status of the client. This assessment should include the client's ability to read prescription labels and use of corrective lenses for reading vision, noting whether the client actually wears the corrective lenses. Also, the nurse should assess the client's understanding of the medications he/she is taking. Does the client understand what each medication is prescribed for? Does the client understanding the dosing according to the prescriber's orders?
3. The nurse should assess the support system the client has in the home. Do other members of the household understand the medication regimen and take part in assuring that the regimen is followed?
4. An assessment should also include factors that might inhibit the client from filling prescriptions, for instance, transportation, insurance, and other financial considerations.
5. Once the listed assessments have been completed and addressed, a medication record listing the names and dosages and frequency of use should be prepared. At each visit the nurse should note any changes in the use of these medications, question the client about side effects and adverse effects, and assess the therapeutic effectiveness of the medications.

CASE STUDY

George Baker, 76, had major abdominal surgery several days ago. He now has a nasogastric tube in place and is receiving fluids intravenously.

Mr. Baker has a history of cardiac disease, and his physician has ordered that **digoxin elixir** 0.5 mg be administered through the nasogastric tube once a day. In addition, he is ordered to receive 600,000 units of **Wycillin** (**procaine penicillin G**) IM once a day. As you are preparing to administer his medications, Mr. Baker asks for pain medication. The Kardex shows that he has an order for **meperidine** (**Demerol**) 75 mg IM q4h PRN.

Questions for Discussion

1. What do the following abbreviations used in Mr. Baker's orders mean?
   mg h
   IM PRN
2. What seven rights of medication administration govern the preparation and administration of these medications?
3. Describe the procedure for administering the digoxin elixir through the nasogastric tube.
4. Describe the procedure and nursing considerations for the administration of the procaine penicillin G.

CASE STUDY

Charles Denver, 50, visits the physician complaining of a recurrence of his urinary tract infection. Ten days ago Mr. Denver was seen by Dr. Gregory and received a prescription for an antibiotic. He now complains of urinary frequency and burning and is requesting a prescription for a different antibiotic. The nurse makes an initial assessment of the situation and finds that Mr. Denver took the antibiotic for only five days.

Questions for Discussion

Select the lettered item that best answers the question or completes the sentence.

1. The nurse's first action should be to:
   a. chide Mr. Denver for his lack of cooperation
   b. immediately usher the client in to see the physician
   c. send the client home to complete the course of therapy
   d. assess why Mr. Denver stopped taking the medication
2. Factor(s) related to uncooperative behavior that the nurse will want to assess include:
   a. inadequate understanding of the illness
   b. the development of adverse effects, if any
   c. inconvenience of the schedule of administration
   d. all of the above
3. If the nursing diagnosis is ineffective management of therapeutic regimen related to deficient knowledge, the nurse will:
   a. send the client home with a booklet on antibiotic therapy
   b. design a brief instructional program to remedy the knowledge deficiency
   c. inform the physician of the deficient knowledge
   d. tell the client that he should pay closer attention when the doctor talks to him
4. Evaluation of the instructional program intervention will focus on:
   a. the client promising to complete the course of therapy
   b. counting the capsules remaining in the medication container when the client next visits the physician
   c. having the client explain to the nurse the reasons why treatment must be continued for the length of time prescribed
   d. verifying the absence of infection at the end of the proposed period of treatment

CRITICAL THINKING EXERCISES

1. Measure the volume of liquid contained in 5 to 10 different teaspoons. Compare each with the teaspoon measurement on a medication cup. Note the amount of error, if any, between the volume in a teaspoon and the volume in the medicine cup's measure for teaspoon. List the problems that could arise if the physician instructs a parent to administer one teaspoonful of a drug preparation to a young child.
2. Using a medicine dropper, measure how many drops of vegetable oil and how many drops of alcohol are necessary to make 1 mL. Discuss the implications that such a difference has for medication administration.
3. Using aseptic technique, practice withdrawing 2 mL of sterile water from a multiple-dose vial. Have someone else check your measurements.
4. Divide a scored tablet into halves. Then divide an unscored tablet into halves. What implications does the ease and evenness of tablet division have for drug administration?
5. Grind an aspirin tablet into a form suitable for administration through a nasogastric tube or for mixing with juice or applesauce.

6. Design a plan for a homebound visually impaired geriatric client to allow him/her to be able to safely take three drugs. The client has been given specific instructions for each drug.
7. Prepare a report to share in class discussing appropriate nursing actions using each of the following scenarios:
   a. What if the client vomits after taking by-mouth medications?
   b. What if the client does not take the medication, which is found later in the client's bed or trash can?
   c. What if the client is in the bathroom when the nurse arrives to administer the client's medication?
   d. What if the client refuses to take the medication ordered because it "upsets my stomach"?

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3 Nursing Clients Receiving Drugs Intravenously

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the nursing considerations in caring for a client receiving an intravenous infusion
- List in a stepwise manner the procedure for venipuncture
- Describe the procedure involved in administering a drug intravenously through a special administration chamber
- Describe the procedure involved in administering a drug intravenously by bolus injection through a primary intravenous setup
- Describe the administration of a drug intravenously by IV push through a maintenance port or a heparin lock
- Discuss the use of electronic infusion devices to monitor intravenous therapy
- List the complications of intravenous therapy
- Apply the appropriate nursing interventions for clients experiencing complications of intravenous therapy
- Calculate the rate of flow of intravenous infusions

Intravenous injection may be used for diagnostic or therapeutic purposes. Clients receiving drugs intravenously may be found in hospitals and other inpatient settings, in outpatient clinics, and in their homes. Nurses are frequently responsible for initiating intravenous therapy, for monitoring therapy, and for administering drugs intravenously in all of these settings.

INTRAVENOUS ADMINISTRATION

In an introductory text it is not possible to present all the possible information about intravenous therapy which the nurse will ever need. Basic procedures related to administering intravenous medications are discussed. For more detailed information, the student is referred to specialty texts, such as those listed at the end of this chapter.

The equipment that is used to administer drugs intravenously, particularly by infusion, changes continuously, and needleless systems are now available in many facilities. The student should become familiar with the manufacturer's directions for using equipment and must be familiar with the agency's policies and procedures regarding the administration and maintenance of intravenous therapy.

Intervention

When performing an intravenous puncture, whether to obtain blood or to administer fluid and electrolyte solutions, medications, or blood products, it is particularly important to provide an explanation to the client and to gain cooperation. Although most people are anxious when receiving injections, they seem to be particularly anxious about intravenous injections. It is also important to select the appropriate equipment. The gauge of the needle is determined by the nature of the therapy, viscosity of the medication, and the size and condition of the vein selected for injection. Over-the-needle catheters or *cannulae* are used for short- and long-term therapy and, for safety reasons, for much of the intravenous therapy administered to children. If long-term or continuous therapy is being initiated, the veins of the lower forearm are the preferred areas of injection in older children and adults. If a single injection is to be given, the large veins of the *antecubital* space are most frequently selected.

In most instances the nurse performs the initial *venipuncture*, or insertion of a needle into a vein. The peripheral veins for intravenous therapy are illustrated (Figure 3–1). The two most commonly used peripheral IV devices are the butterfly and the angiocatheter (Figure 3–2). The procedure for performing venipuncture is detailed in Figure 3–3. There are several methods of securing the needle or catheter once the venipuncture is complete (Figure 3–4). In many instances, the nurse will be administering medication through an already established intravenous line. The procedures for administering drugs through an established line are discussed and illustrated later in this chapter. Nursing students may also be requested to assist physicians or registered nurses who are administering drugs intravenously. **Note:** Students are advised always to seek supervision before performing a procedure related to the administration of fluids and/or drugs intravenously.

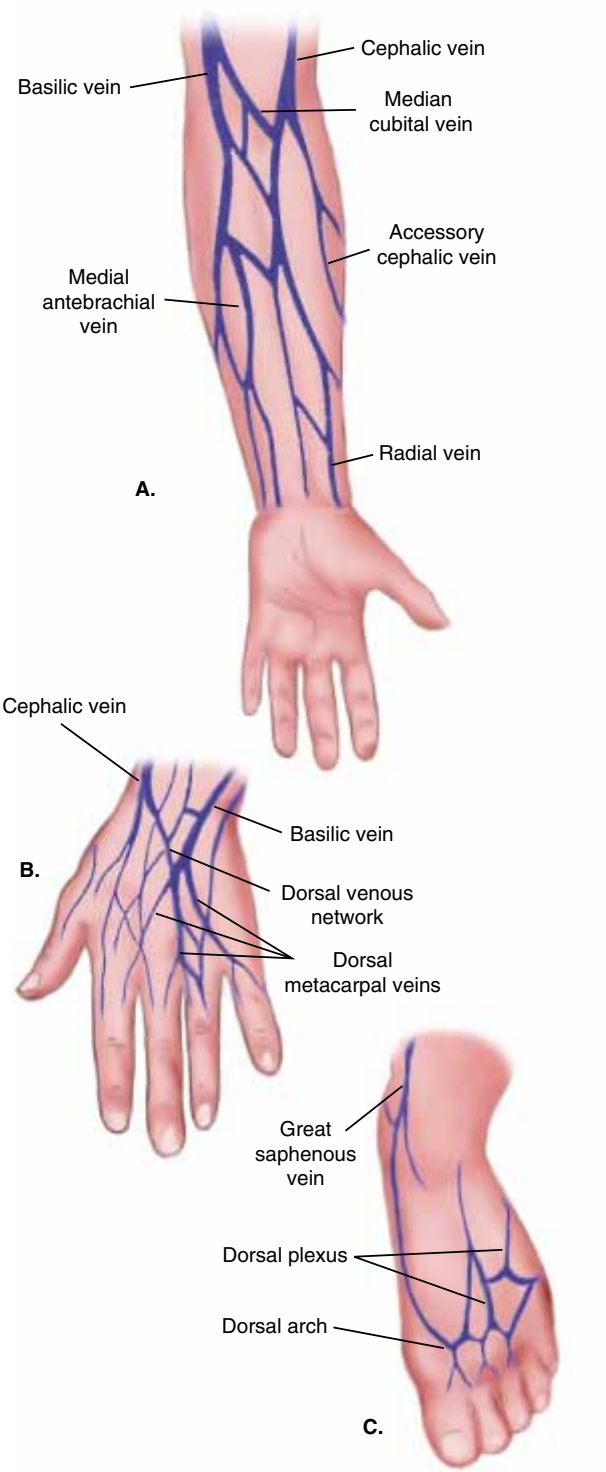


Figure 3–1 Peripheral veins used in intravenous therapy. (A) Arm and forearm; (B) Dorsum of the hand; (C) Dorsal Plexus of the foot.

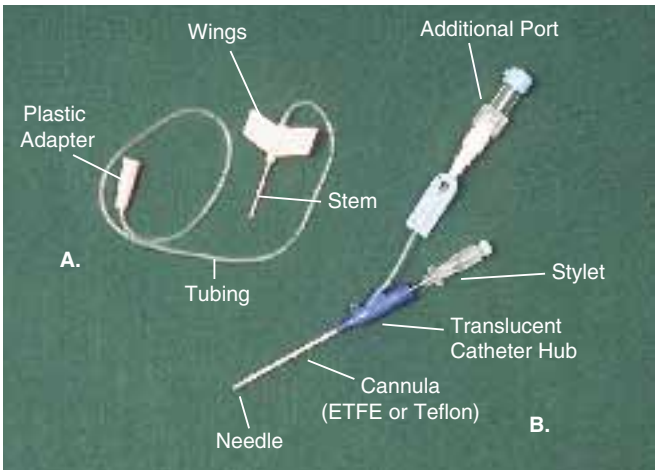
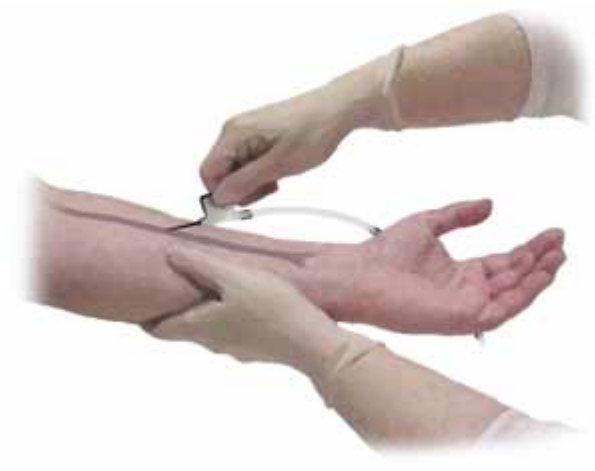


Figure 3–2 Peripheral IV devices. (A) Butterfly; (B) Angiocatheter.



1. Explain the procedure, gain the client's cooperation and examine the client for an appropriate injection site. (**Note:** The veins of the hands and forearms are most often used in older children and adults, while the veins of the scalp may be used in infants.)
2. Wash your hands.
3. Assemble the equipment you will need. This includes antiseptic, needle or catheter, tourniquet, tape, and medication or infusion solution containing the medication. It may also include scissors to clip hairy areas, tape, and gauze or a transparent dressing if a permanent intravenous line is to be established.
4. A wing-tip butterfly (see illustration) or over-the-needle catheter (angiocatheter) will be used for the venipuncture if the infusion is to run of a period of hours. The nurse should prime the tubing and needles with fluid to displace the air. Recap the needle or angiocatheter to maintain its sterility.
5. If the venipuncture will be done on an adult client, the nurse applies a tourniquet in a slipknot just above the client's elbow or about 6 inches above the site selected. The nurse then examines the forearm to locate a healthy vein of sufficient size conveniently located for the procedure being undertaken. **Note:** The tourniquet should be applied with sufficient tension to impede the venous flow without obstructing the arterial flow. The nurse should be able to detect a radial pulse with the tourniquet in place.
6. If the tourniquet fails to raise an appropriate vein, several techniques can be used. First, the nurse can request that the client open and close his/her fist repeatedly. The nurse may be able to identify a suitable vein while the fist is closed. The nurse can also tap the vein lightly or request the client to lower the body part below the level of the heart. If these procedures fail to raise a suitable vein, the nurse may remove the tourniquet and wrap the forearm in warm wet towels for 10 to 15 minutes. After heat has been maintained for this period and the vein engorged, the tourniquet can be reapplied just before removing the warm pack, and a vein can be selected.
7. Put on disposable gloves. It is helpful to cut any necessary tape before putting on gloves.
8. Once a vein has been selected, the injection site is prepared with an antiseptic solution. Using friction, clean the area with antiseptic (e.g., tincture of iodine 1% if the client is not allergic to iodine) in a circular motion beginning with the intended puncture site and working outward for about 2 inches. (**Note:** The antiseptic solution should be at room temperature, as a cold antiseptic may cause the vein to constrict.)
9. When the site has been thoroughly cleansed, allow the antiseptic to dry thoroughly before proceeding further.
10. Stabilize the chosen vein by placing the thumb of your nondominant hand on the tissues just *below* the site. Gently stretch the skin downward.
11. Remove the needle protector and hold the needle facing the blood flow and with the bevel of the needle facing upward. **Note:** With the over-the-needle catheter, the needle has the catheter over it, with the bevel of the needle extending beyond the catheter. With the wing-tip butterfly, pinch the wings together tightly. With the over-the-needle catheter, grasp the flash-back chamber tightly.
12. The nurse then approaches the vein at a 30° angle directly over the vein (direct method) and in one motion pierces the skin with the needle and advances it into the vein. **Note:** Another technique is called the indirect method and involves approaching the vein at a 45° angle approximately ½ inch below and slightly to one side of where the vein wall is to be penetrated. The needle angle is then decreased until the needle is nearly level with the skin and the needle is advanced into the vein.
13. If the needle is situated in the vein, the nurse will observe backflow of blood into the tubing with the wing-tip butterfly or into the back-flash chamber with the angiocatheter. The administration set tubing is then connected to either the wing-tip tubing or the angiocatheter hub and the tourniquet is removed from the client's arm. If using an angiocatheter, the needle and catheter are advanced and then the needle is removed from inside the catheter.
14. The nurse then opens the clamp on the administration set to allow flow of fluid while checking for free flow. If the fluid flows freely, the rate of infusion is slowed by partially closing the clamp.
15. The needle or hub of the catheter is then secured with tape. There are several ways to secure the needle or catheter (Figure 3–4). An easy method is to place one strip of tape over each wing (or flanges of the angiocatheter) keeping the tape parallel to the needle (catheter) and placing another strip of tape immediately on top of the wings (or flanges) or just below them. The tape will form the letter H.
16. The wing-tip needle's administration tubing is then looped on top of the last piece of tape and secured there with more tape. If using an angiocatheter, the administration set tubing attached to the catheter hub is looped and secured with tape. This prevents undue strain on the attachment to prevent the tubing from becoming detached from the catheter hub. **Note:** Some facilities have special procedures for preventing infection and

(*continues*)

Figure 3–3 Venipuncture using the direct approach in preparing to administer an intravenous infusion.

protecting the site. The student should check the procedure in the clinical setting.

17. The nurse then regulates the flow of fluid by opening and closing the clamp until the proper rate of flow has been established.
18. The nurse places another piece of tape on a flat surface and writes the date and time, the type of needle, and his/her initials. This piece of tape is placed to the side of the taped dressing.
19. Remove gloves.
20. Wash your hands.
21. The procedure is charted in the client's record. The notation should include the date and time, the location and type of needle, the fluid to be infused (including any additives), the rate of flow, relevant observations about the client's condition, the appearance of the site, the number of attempts required to access the vein, and the nurse's initials.

Special Note: All containers of fluids to be infused intravenously must be properly labeled. The information which should be recorded on a label to be attached to the container includes: the client's name and room number, the dosage of additives, drip rate, the date and time the container is hung, the number of the container if multiple containers of fluid are to be infused (e.g., 1, 2, or 3), and the nurse's initials. The nurse must always check the expiration date on the label. It is also recommended that the tubing be labeled to ensure that it will be changed every 72 hours. Check the agency's policy and procedure manual for specific information. The date and time the tubing was changed and the nurse's initials are written on a label or tag attached to the administration set.

Figure 3–3 (*continued*)

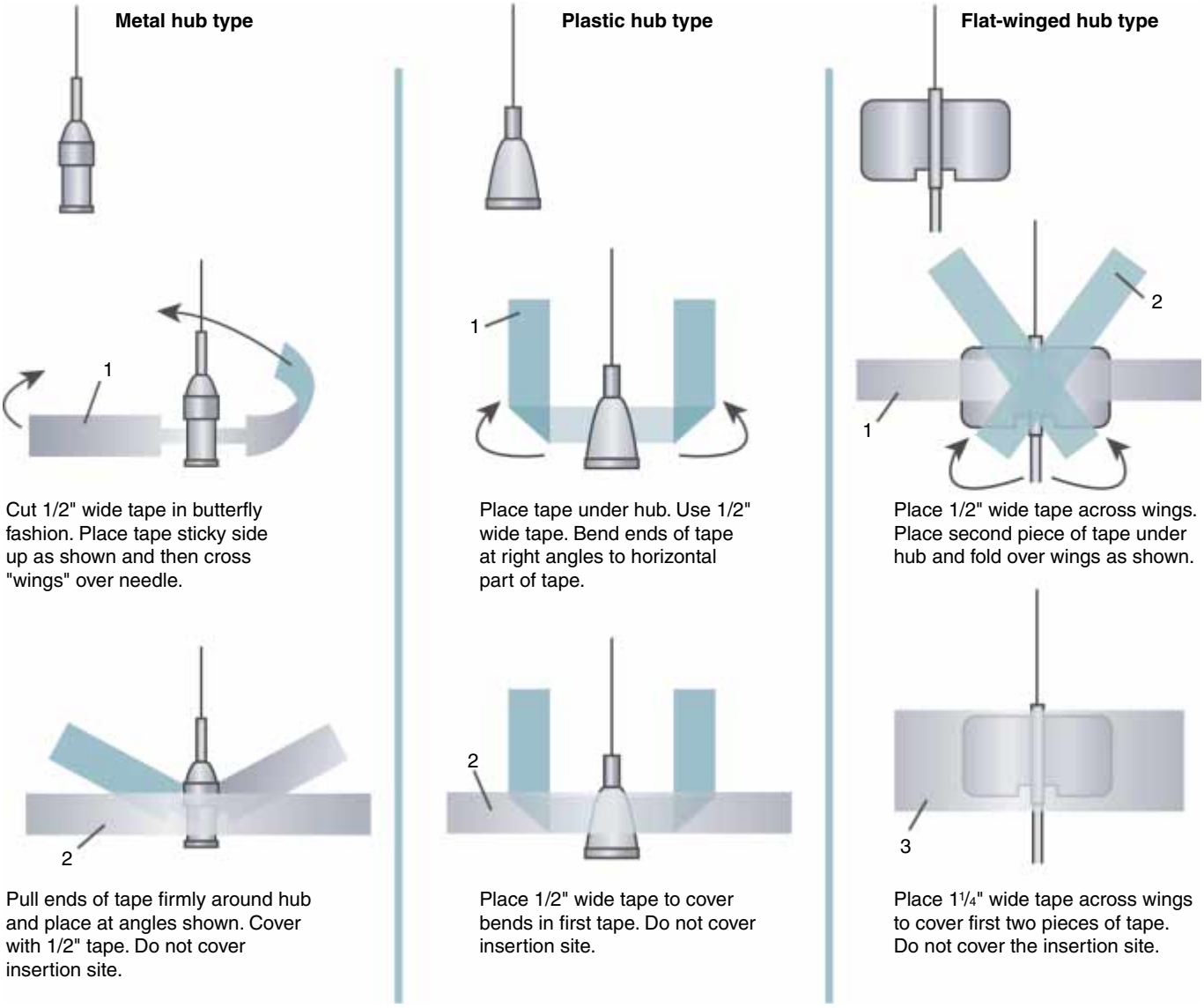


Figure 3–4 Suggested methods for securing intravenous needle. *(Adapted from Steele, J. "Taping Procedure for Securing Over-the-Needle Cannulas."* Practical IV Therapy. *Springhouse Corporation, 1988, p. 38)*

Whatever procedure is used, strict aseptic technique is required to prevent serious and sometimes fatal infections. It is important, also, to observe the client carefully during the administration procedure. Because the drug is rapidly distributed throughout the body in relatively concentrated doses, untoward effects may be seen during the administration procedure or shortly after. Remember that it is important to ensure that all tubing used in administration setups is primed before use to prevent air embolism (Figure 3–5). To do this, all clamps on the tubing must be closed. Using aseptic technique, insert the administration pack into the container of fluid to be administered. (Most administration packs specify the procedure for this operation on the package containing the kit.) Then invert the fluid container. Gently squeeze the drip chamber until it is half full. Remove the protective cap from the end of the administration pack and hold the end of the tubing over a sink, paper cup, or other receptacle. **Note:** Be careful to preserve the sterility of the cap and end of the tubing. Then unclamp the tubing and allow fluid to run through the tubing until all air bubbles have been expelled. Finally, clamp the tubing to stop the flow and replace the protective cap over the end of the tubing.

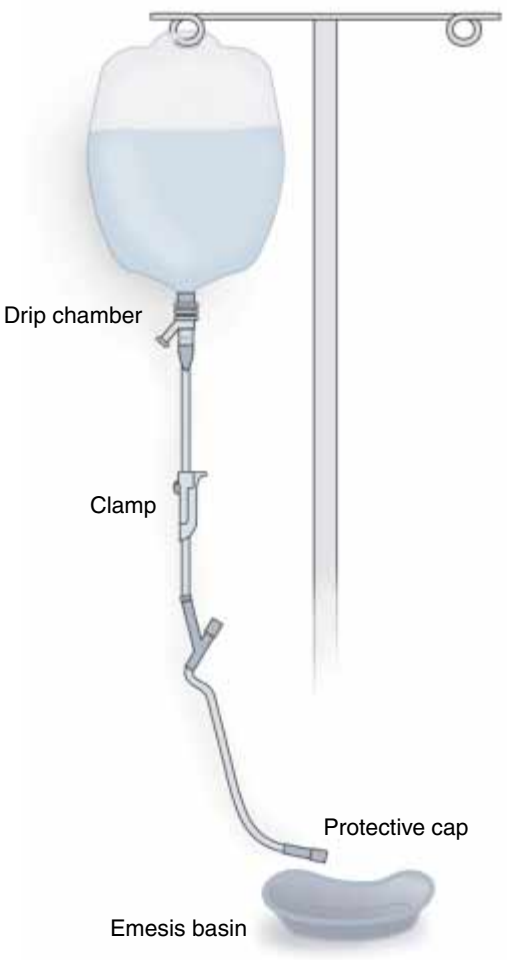


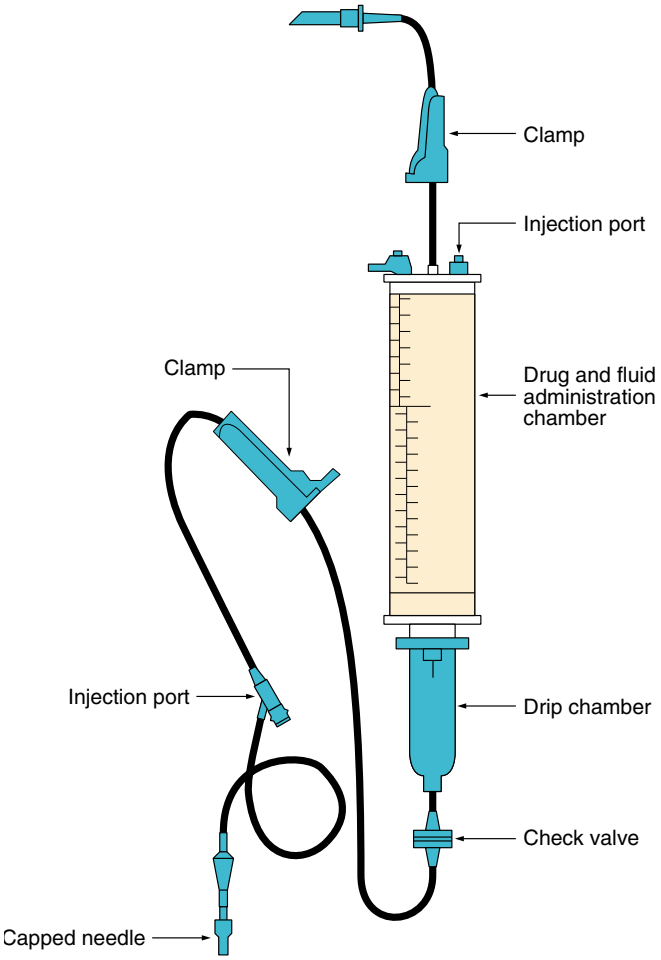
Figure 3–5 Priming the intravenous infusion equipment. To prepare the administration set for the infusion, close all clamps, fill half of the drip chamber, remove the protective cap, release the clamps, and allow the solution to clear all air from the tubing. Be certain that all air has been removed from the tubing. Then reclamp the tubing and replace the cap.

Remember to chart all intravenous medications that have been administered. If the physician administers the drug, note it on the client's record. Also chart the name of the drug, dosage, time, and site of administration. If you are responsible for subsequent drug administration by the piggyback route, note and chart the drug, the time the infusion started, the rate of flow, and time the infusion ended. Also enter the amount of fluid infused on the intake and output record.

Several special procedures may be used in administering drugs intravenously. Among them are introducing the medication through a special administration chamber (Figure 3–6), use of a controlled release infusion system (CRIS) connected to the line between the fluid container and the administration set, and administration by piggyback. The usual method of administering intravenous medications by piggyback is given in Figure 3–7. **Note:** If the primary's tubing does not contain a back-check valve, the primary must be turned off while the piggyback is infusing.

An alternate procedure involves hanging the piggyback container higher than the primary container so that the piggyback will empty first. The primary then begins to empty (Figure 3–7B). To use this procedure, follow steps 1 through 7 as outlined. Then hang the piggyback container higher than the primary one. Special extension hooks from which to hang the primary container are available. This hook ensures that the piggyback setup is higher and will empty first. Once the containers are in place, DO NOT clamp the primary tubing. Just open the clamp on the piggyback set and establish the correct rate of flow. Monitor the flow of the piggyback set and discontinue it when completed. Chart the procedure as discussed in step 13 of Figure 3–7.

At times, the nurse may also administer a medication by intravenous bolus or intravenous push.



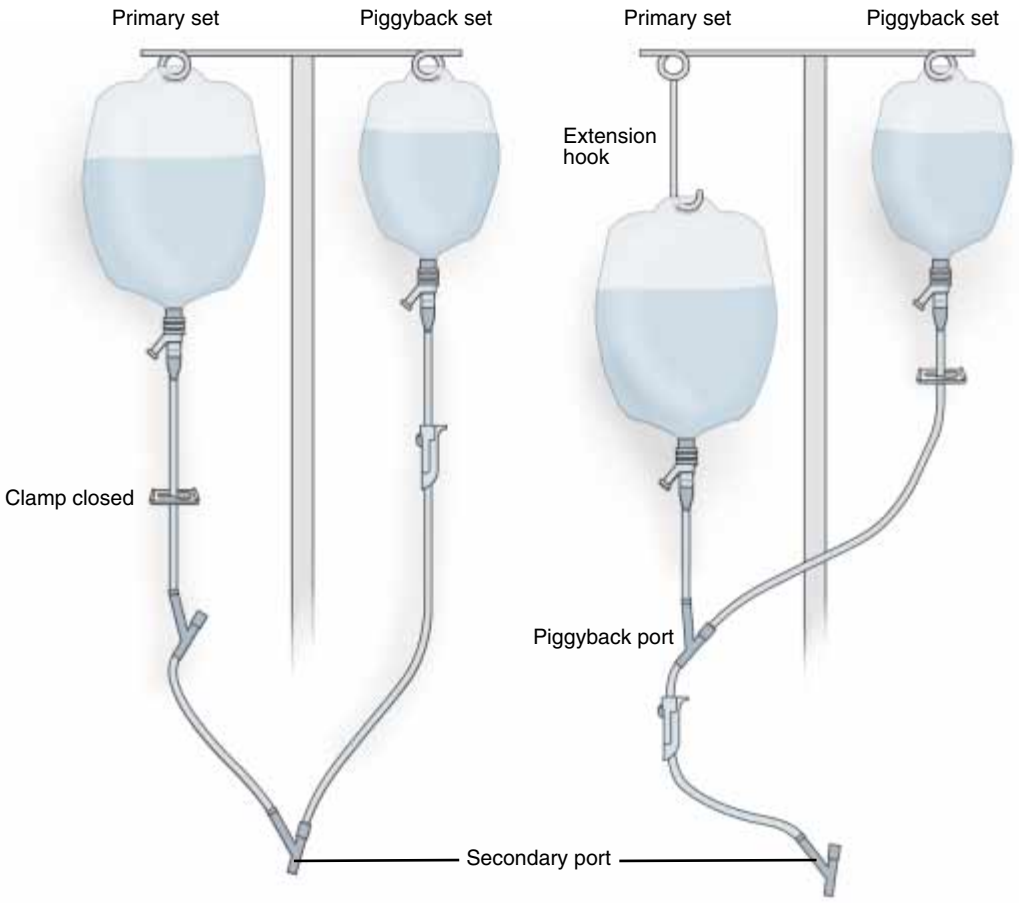
ADMINISTRATION THROUGH A SPECIAL ADMINISTRATION CHAMBER
(e.g., Soluset or Buretrol)

1. Wash your hands.
2. Follow the manufacturer's directions for priming the setup. After priming the setup, clamp the administration tubing below the drip chamber.
3. Allow 10–15 mL of the fluid being administered intravenously to flow into the drug administration chamber.
4. Close the clamp between the bag and administration chamber.
5. Cleanse the injection site on the administration chamber with alcohol.
6. Inject the medication to be administered into the chamber.
7. Open the clamp between the bag and drug administration chamber and add the appropriate amount of fluid to the administration chamber.
8. Clamp the tubing above the administration chamber.
9. Gently agitate the drug administration chamber to mix the fluids.
10. Open the clamp below the chamber.
11. Establish the flow rate appropriate to permit administration of the required amount of medication within the specified time period.
12. Once the medication has been administered, open the clamp above the administration chamber to resume administration of the fluid as ordered.
13. Chart the procedure including the date, time, medication, dosage, amount of fluid infused, and client's reaction to the procedure.

Figure 3–6 A volume control set with a special administration chamber will permit the administration of precise amounts of intravenous fluids.

This may be done either through a primary intravenous setup or through *intravenous access device* (*IVAD*) or intermittent therapy setup. Guidelines for this mode of drug administration are provided in Figures 3–8 and 3–9. **Note:** Always check to see that the medications given through IVADs or infusion ports are compatible with the fluid already in the tubing. Flushing of the existing fluid may be required before a second medication is introduced. Two major factors affecting the rate of administration of IV bolus medication are the purpose for which the drug is prescribed and the adverse effects related to the rate or route of administration. In general, drugs prepared for bolus administration are reconstituted to be given at the rate of 1 mL per minute. This rate is considered standard if no specific rate of administration has been ordered. The student is referred to the agency's policy manual for specific information about the procedure and rate for administering medications IV by bolus.

The nurse must also be familiar with filters that may be used in administering intravenous fluids. The purpose of a filter is to remove particulate matter, thereby decreasing the risk of contamination. Filters are used most often when administering total parenteral nutrition or solutions using drugs from vials or ampules. Some filters are built into the administration set, while others must be attached. Because a number of types of filters are

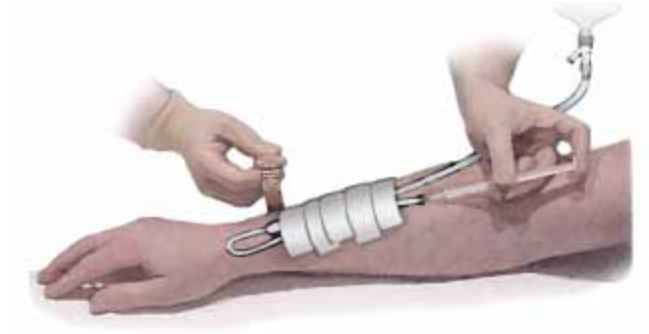


ADMINISTRATION BY PIGGYBACK

1. Wash your hands.
2. Check the order and prepare the medication to be administered in the required amount of fluid or obtain the medication already prepared. If the medication is refrigerated, remove it from the refrigerator 20 to 30 minutes prior to administration. If the Add-Vantage system is being used, dilute the medication and mix it well immediately before administration.
3. Identify the client.
4. Connect the bag containing the medication to an intravenous administration pack.
5. Place a needle, usually 20G, on the end of the tubing designed for it.
6. Invert the bottle and run a small amount of the fluid through the tubing to remove the air.
7. Take the administration setup to the bedside and invert the bottle next to the primary intravenous administration setup.
8. Cleanse the needle injection site on the primary set with an antiseptic solution and insert the needle, being careful not to puncture the tubing of the primary setup.
9. Tape the needle securely in place.
10. Clamp the primary set tubing.
11. Open the clamp on the piggyback set and establish the correct rate of flow.
12. Check the flow frequently so that the primary set tubing can be unclamped to reestablish its flow once the piggyback setup has emptied.
13. Complete the charting of the information related to the drug administration including the drug, its dosage, amount of fluid, administration time, and the client's response to the procedure. Be certain to chart the amount of fluid infused on the intake and output record.

Figure 3–7 In the (A) setup, the tubing to the primary set is clamped to allow the piggyback unit to empty first. The tubing on the primary setup is unclamped once the piggyback unit empties. In the (B) setup, the primary bottle is hung on an extension hook to allow the piggyback unit to empty first. The primary unit then begins to empty.

available, the nurse must read the manufacturer's directions regarding the use of a filter. Figure 3–10 shows the nurse attaching one type of filter. To attach this filter, the nurse—using aseptic technique—removes the protective caps from the administration set and the filter. The administration set's male adapter is then fitted snugly into the filter's female adapter. The male–female con-



ADMINISTRATION BY IV PUSH OR BOLUS THROUGH A PRIMARY INTRAVENOUS SETUP

1. Wash your hands.
2. Put on gloves.
3. Select a syringe several milliliters larger than required for the drug. This allows room for dilution of the drug with venous blood.
4. Check the order and prepare the appropriate medication using guidelines from IV drug infusion reference.
5. Identify the client.
6. Close the primary setup tubing behind the point of injection.
7. Cleanse the injection port on the administration tubing with an antiseptic solution.
8. Hold the sides of the injection port with your free hand and puncture the site.
9. Draw back on the plunger to check for blood backflow to make sure the IV needle is placed in vein.
10. Administer the drug slowly over a period of time (usually 1–7 minutes).
11. Periodically aspirate to establish the location of the needle or catheter in the vein.
12. Observe the client carefully for untoward reactions.
13. When administration is completed, withdraw the needle and open the tubing, checking to ensure the flow rate.
14. Run fluid rapidly through the IV line for about a minute. This will help to dilute the medication.
15. Readjust the proper rate of flow.
16. Dispose of equipment safely according to agency procedure, using sharps container for the needle.
17. Remove gloves.
18. Wash your hands.
19. Chart the procedure including the time, name and dosage of the drug, and the client's response to the administration.

Figure 3–8 Drugs given by intravenous push or bolus are administered slowly over a period of 1–7 minutes.

ADMINISTRATION BY IV PUSH THROUGH AN IVAD OR SALINE LOCK

1. Wash your hands.
2. Check the order.
3. Put on gloves.
4. Identify the client.
5. Disinfect the injection port with an antiseptic solution.
6. Flush the administration setup with sterile normal saline or a dilute heparin solution, if this is indicated by hospital procedure. (See Chapter 30 for a more detailed discussion of flushing the setup.)
7. Firmly attach the syringe containing the drug to the setup.
8. Aspirate gently to establish the patency and placement of the needle in the vein.
9. Slowly administer the medication.
10. Remove the syringe used for medication administration, and flush the setup with sterile fluid. The type and amount of fluid are usually specified in the physician's order or in a hospital procedure manual.
11. Dispose of equipment safely according to agency procedure.
12. Remove your gloves.
13. Wash your hands.
14. Chart the procedure including the date, time, name and dosage of the drug, procedure used to care for the saline lock, and the client's response to the administration.

Figure 3–9 Use of an intermittent therapy setup permits intravenous administration of medication without the discomfort associated with ongoing infusion or multiple needle punctures.

nection is held downward while the nurse opens the clamp to allow solution to prime the line. As the solution is running, the nurse taps the filter, working from the bottom to the top to dislodge air bubbles that may be trapped in the filter's membrane. Finally, all clamps are closed and the protective cap is replaced. The nurse is then ready for the venipuncture procedure.

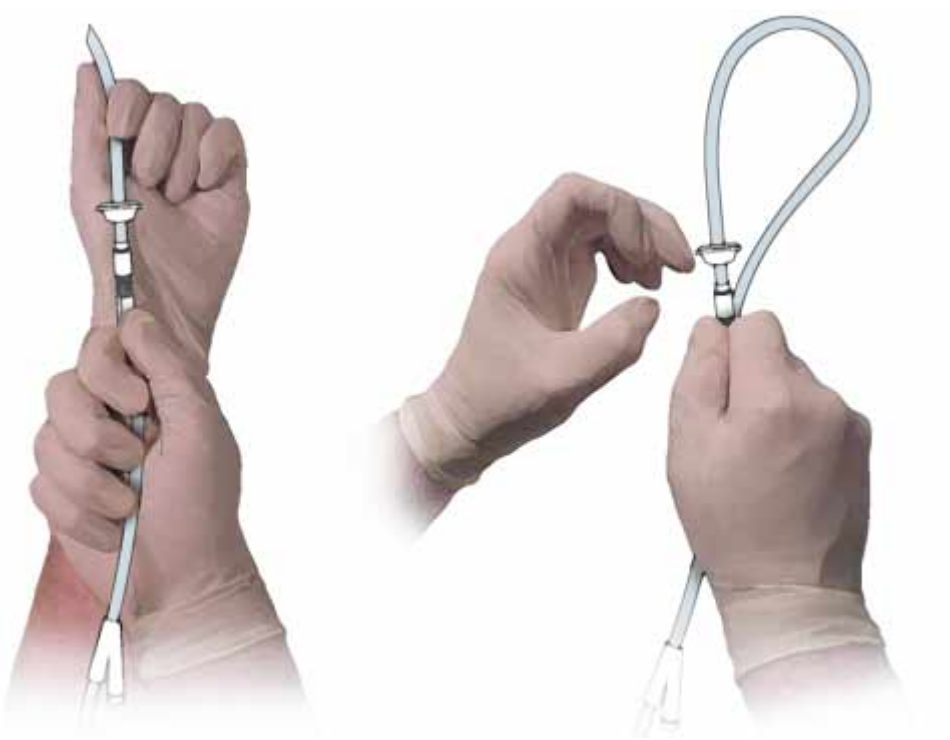


Figure 3–10 The nurse attaches a filter to an intravenous administration set.

ELECTRONIC INFUSION DEVICES

The nurse caring for a client receiving intravenous therapy must also be familiar with the use of intravenous electronic infusion devices. There are many types of equipment available, but they have a common purpose. Intravenous pumps are used because they maintain a more accurate flow rate than the control of a gravity drip by clamps or a standard administration set. (See Figure 3–11 for an example of a syringe infusion pump.) Some pumps, called nonvolumetric pumps, are designed to permit administration of a certain number of drops per minute (for example, the pump may be set to infuse between 1 and 99 drops per minute). Other pumps called volumetric pumps, are designed to administer fluid in milliliters per hour. Volumetric pumps are the most commonly used. New fluid management systems using computer-based pumps are now available. These systems can administer up to 10 medications simultaneously through two IV lines.

Special administration sets are used when an IV pump will be employed. Check the manufacturer's instructions for assembling the administration set and for setting and using the electronic device. It is important to understand the proper use of the infusion device to prevent serious complications.

Whenever an IV pump is to be used, the client should receive an explanation before the device is brought to the bedside. Clients should be told what the pump does, why it is being used, and that an alarm will sound whenever the infusion is not flowing properly at the prescribed rate. They should

Figure 3–11 Syringe infusion pump for the administration of small amounts of medication. *(Courtesy of Medex, Inc.)*

be told that a nurse will respond to the alarm and take corrective measures. The family should also be informed about the machine, preferably before it is used or as soon as possible thereafter. Family members are instructed not to turn off the machine, but to seek nursing assistance if the machine beeps or if they note problems with the infusion. The explanation is given to relieve anxiety associated with the use of equipment whose purpose is not understood.

There are several other things the nurse should remember when using an IV pump. One of these is the importance of flushing all the air out of the tubing before it is connected to the client. The danger of air embolism may be increased when fluid is delivered under pressure. Secondly, a beeping machine should be fixed as soon as possible. Some machines will stop running when they are beeping and an occluded line could result. Also, the nurse should periodically check the flow rate, rather than assume that the machine is delivering the correct rate or volume. Whenever a pump is used, the nurse should continually monitor the site of injection. Hourly monitoring is suggested. Never assume that if the pump is not beeping that the infusion is proceeding properly. Pumps may continue to function properly, even though the site is infiltrated or red and sore. The use of an electronic infusion device can never replace observation in preventing complications.

Complications of Intravenous Therapy. Whenever the client is receiving intravenous therapy, particularly ongoing infusion over a period of time, the nurse must observe carefully for the development of complications. The following are the most common complications:

- *infiltration*—occurs when the needle becomes dislodged from or pierces the vein or from weak, overextended, stretched veins, permitting fluid to collect in the tissues surrounding the vein. Discontinue the infusion and restart it, using a sterile needle in another site. Signs of infiltration include swelling around the insertion site, pain, coolness of the skin under the swelling, and, frequently, a loss of intravenous fluid flow.
- *extravasation*—fluid being infused escapes from the vein into surrounding tissues. This may occur when the infusion is running too rapidly. Check to see if the needle is still within the vein. If it is, a backflow of venous blood is noted on gentle aspiration with a sterile needle and syringe or when the fluid

KEY NURSING IMPLICATIONS 3–1

Intravenous Administration of Medications

1. The gauge of the needle is determined by the nature of the therapy and the size of the vein selected for injection. The smallest gauge needle possible should be used.
2. If long-term therapy is being initiated, the veins of the lower forearm are the initial preferred injection sites. Over the course of therapy, the nurse selects sites above, rather than below, the initial site.
3. If a single injection is to be given, the veins of the antecubital space are preferred.
4. Strict aseptic technique is required in performing any parenteral injection. This is particularly true with intravenous procedures.
5. Observe the client carefully during the intravenous administration of medications.
6. Prime all administration setups before use. Be especially careful in priming when an IV pump is to be used.
7. Filters may be used with intravenous setups to remove particulate matter and to decrease the risk of contamination.
8. Special electronic infusion devices are used to maintain IV patency, accurate flow rate of fluid, and medications.
9. Document all fluids and medications that have been administered intravenously and note the client's reaction.
10. Never intravenously inject a cloudy drug or one with a precipitate, with the exception of intralipids.
11. When injecting an intravenous medication by bolus (IV push) be sure to check with pharmacy and/or an intravenous medication resource book for dilution information, safe rate, and any special precautions associated with each particular IV push drug.
12. Check IV patency prior to injecting any medication by bolus and during administration.
13. With proper dilution, the safe "rule of thumb" rate is 1 ml per minute.
14. Be sure to assess client during bolus IV administration for effects of medication—both therapeutic and adverse—as these will be seen immediately.

container is lowered below the level of the vein. If the needle is still in the vein and the extravasation is not too severe and the fluid being infused is nonirritating, try slowing the rate of flow and observe the client. If the extravasation is considerable, or the fluid is damaging to local tissue, discontinue the infusion and change to a different site. Special measures must be taken when extravasation occurs while the client is receiving a *vesicant*, or drug likely to cause tissue *necrosis*. Some of the *antineoplastic* drugs (see Chapter 39) are vesicants. Hospitals have developed treatment policies regarding extravasation, particularly of vesicants. Extravasation kits containing antidotes and approved treatment protocols are often available to handle such events. The nurse should be familiar with the policy and treatment resources before caring for a client receiving these medications. If extravasation occurs, the nurse stops the infusion, applies cold compress to site, and carefully documents the date and time of the event, the needle type and size, and the insertion site. The drug being infused is identified with an estimate of the amount of drug that has extravasated. The nurse records the symptoms reported by the client, the nursing intervention, and the client's response. The chart must also contain the name of the physician and time he or she was contacted. It is common to take a photograph of the area to help document the extent of tissue damage. Tissue damage can be limited by early detection and intervention.

- *thrombophlebitis*—the formation of a blood clot and inflammation of the vein. The client may complain of pain and the nurse may note heat, redness, swelling, and, in severe cases, loss of motion of the body part. Discontinue the infusion and place warm, moist packs on the area. Report the development to the physician, who may order the use of anti-inflammatory agents in some clients.
- *pain*—occurs when irritating drugs such as **potassium chloride** are being infused, especially when superficial veins are used and/or the medication is infused too rapidly or is inadequately diluted. Pain may also occur when the needle touches the wall of the vein or if there is tension on the infusion apparatus. Check for tension, gently move the hub of the needle to see if pain decreases, and/or change the rate of flow, change to a larger vein, or increase the amount of fluid the medication is administered in.
- *fluid overload*—an overload of the circulatory system which may be due to the excessive or too rapid infusion of fluid. It is most common in children and in clients with impaired cardiovascular or renal systems. The client may have moist respirations, dyspnea, or cough. Slow the infusion and call someone to evaluate the client. Central venous pressure monitoring, most commonly employed in intensive-care settings, may help to prevent the development of this problem.
- *pyrogenic reactions*—the development of fever and chills often associated with nausea, vomiting, and headache. It is the result of introducing pyrogens, or substances like bacteria which can cause fever. Discontinue the infusion immediately and send the fluid and administration setup to the pharmacy for further study.
- *tissue necrosis*—tissue damage with breakdown and sloughing which occurs following infiltration of infusions containing some toxic drugs such as antibiotics, antineoplastics (see Chapter 39), and **norepinephrine bitartrate** (see Chapter 28). Discontinue the infusion immediately and treat according to hospital procedure (e.g., tissue damage is usually prevented or treated by the subcutaneous administration of **phentolamine** (**Regitine**) into the tissues surrounding the vein).

KEY NURSING IMPLICATIONS 3–2

Complications of Intravenous Therapy

1. Observe clients receiving infusions for infiltration, extravasation, thrombophlebitis, pain, fluid overload, pyrogenic reactions, and tissue necrosis.
2. Treat infiltration of toxic drugs promptly by discontinuing the infusion and following the institution's procedure for treatment.
3. Charting the progress of infusions should be done after the initial assessment at the beginning of the shift, hourly each time the infusion is checked, and immediately before leaving the client unit for the day.

Whenever the client is receiving intravenous therapy, it is important for the nurse to routinely check the infusion, infusion site, and the client's condition, and to chart pertinent observations. Charting should be done after the initial client assessment at the beginning of the shift, each time the infusion is checked, and immediately before leaving the client unit for the day. Whenever a problem with a site is noted, it is important to initiate appropriate intervention. Do not wait until infiltration, *phlebitis*, or other potentially serious problems arise before intervening.

Clients requiring long-term therapy often receive fluid and/or medication intravenously through tunneled *central venous catheters* (CVC) such as Hickman, Broviac, or Groshong catheters; implanted accesses such as PORT-A-CATH; vascular access devices; or other special equipment. Some of these devices are discussed in Chapter 39. For more detailed information, the student is encouraged to consult specialty texts.

Calculating Rate of Flow. Ideally, the physician should order the rate of flow for intravenous infusions in drops per minute. Often this is not the case, and the order may be written for the volume to be infused per hour or for a 24-hour period. In cases where drops per minute have not been specified for fluids being infused by gravity drip, the nurse must calculate the rate of infusion. First the nurse must check the order to determine the amount of fluid to be infused and the time over which it is to be delivered. Then the nurse checks the administration set to determine its calibration, or drop factor. A drop factor is defined as the number of drops needed to deliver 1 mL of fluid. Drop factors vary among manufacturers, but the drop factor is always listed on the administration package. Sets often deliver 10, 15, 20, or 60 drops per milliliter, called standard drip factor (SDF). Once these facts are known, the nurse calculates the rate of flow by using the following formula:

1. $\dfrac{\text{Total number of milliliters to be infused}}{\text{Time in hours}} = \text{mL/hr}$

2. $\dfrac{\text{mL/hr}}{\text{time in minutes}} = \text{mL/min}$

3. $\text{mL/min} \times \text{SDF} = \text{gtt/min}$

Suppose that the physician orders 1,500 mL of 5% dextrose in water to be infused in a 24-hour period. The administration set is calculated at 10 gtt/mL. Using the formula:

1. $\dfrac{1500 \text{ mL}}{24 \text{ hr}} = 62.5 \text{ mL/hr}$

2. $\dfrac{62.5 \text{ mL}}{60 \text{ min/hr}} = 1.04 \text{ mL/min}$

3. $1.04 \text{ mL/ min} \times 10 \text{ gtt/mL} = 10 \text{ gtt/min}$

The student is referred to Chapter 4 for additional information regarding the calculation of flow rate for intravenous infusions and to Chapter 9 for information on self-administration of medications intravenously, for example client-controlled *analgesia*.

HOME CARE / CLIENT TEACHING

1. Clients receiving IV therapy at home should be referred to and seen by a home health nurse.
2. Clients should have written guidelines about when to seek help and phone numbers of persons to call. For example, the nurse might prepare an instruction sheet advising clients to call the emergency medical system (EMS) if they experience chest pain, shortness of breath, or throat swelling.
3. Clients should be advised to call the nurse if complications are experienced from the medication administration, such as redness, swelling, or pain at intravenous site; fluid ceasing to flow; resistance when trying to infuse a drug; or swelling of the legs and/or feet (indicating possible fluid overload).
4. Clients should be instructed to call the physician or nurse if they develop a rash, itching, hives, or an elevated temperature.
5. Clients/families should receive written instructions about dressing changes using strict aseptic technique, and heparinizing and flushing of catheter, if they have a central venous catheter. They should have these procedures demonstrated and be able to demonstrate skill in performing these demonstrations before they can be expected to perform the processes independently at home.

CASE STUDY

David Sylvester, 45, is receiving **dactinomycin** (**Actinomycin D**) intravenously for the treatment of testicular cancer. Because this is a vesicant medication, known to be damaging to local tissue, the infusion is frequently monitored. An electronic infusion device is also in use. When the nurse checks the infusion at 3:30 PM, the client tells her that he is experiencing pain at the infusion site. The nurse notes that there is redness at the site and determines that extravasation has occurred.

Questions for Discussion

Select the lettered item that best answers the question or completes the sentence.

1. The nurse's first action is to:
   a. call the physician
   b. put hot compresses on the site
   c. put cold compresses on the site
   d. stop the infusion
2. The nurse charts:
   a. date and time of the observed extravasation
   b. location of the insertion site
   c. symptoms reported by the client
   d. nursing intervention
   e. all of the above
3. Besides extravasation, other causes of pain during infusion of medications include all of the following except:
   a. medication that is inadequately diluted
   b. an excessively slow rate of infusion
   c. the needle is touching the wall of the vein
   d. an irritating drug is being infused
4. All of the following are true about an electronic infusion device except:
   a. they maintain more accurate flow rates than standard administration sets
   b. clients should receive an explanation before it is brought to the bedside
   c. clients and family are advised to turn off the device if an alarm sounds
   d. all air should be flushed out of the administration set's tubing before use

CRITICAL THINKING EXERCISES

1. Describe the type of intravenous catheter or cannulae that are used for short- and long-term therapy and in which special cases they are used.
2. What are IVADs and how are they used?
3. Describe five complications of intravenous therapy and how the nurse assesses for each.
4. What special teaching needs to be done for clients/families preparing to receive IV therapy at home using a central venous catheter?
5. Obtain several administrations sets designed for intravenous infusion. Note their calibration (SDF). Compute the flow rate for each if 800 mL of fluid are to be infused in an 8-hour period.

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4 Calculating Medication Dosages

OBJECTIVES

After studying this chapter, the student will be able to:

- Interpret a medication order accurately
- Convert quantities stated in apothecary units to their equivalent units in the metric system
- Convert quantities stated in metric or apothecary units to other units within those systems, e.g., g to mg
- Set up valid proportions in order to perform calculations required in administering medications
- Calculate quantities to be administered when ordered in fractional doses
- Calculate safe dosages for infants and children
- Calculate dosages for individual clients given the client's weight and/or height and the recommended dose
- Perform calculations necessary for the infusion of IV medications
- List some steps to decrease errors in interpreting the strength of drugs from the written order

It is common practice in hospitals today for the pharmacist to calculate and prepare the drug dosage form for administration to the client. Often the drug is provided in a unit dose package. However, this practice does not relieve the nurse from the legal and professional responsibility of ensuring that the client receives the right dose of the right medication at the right time in the right manner. This chapter will review the necessary calculations involved in the safe administration of drugs to the client.

INTERPRETING THE DRUG ORDER

The welfare of the client necessitates proper interpretation of the medication order. If any doubt exists, or if a particular order appears unusual, it is the nurse's responsibility to check with the physician or the pharmacist.

Abbreviations derived from Latin are often used by physicians and pharmacists in writing and preparing drug orders. Refer to Tables 4–1 through 4–5 for common abbreviations. The nurse must be able to interpret these abbreviations correctly

TABLE 4–1

Amount/Dosage

ABBREVIATION	LATIN DERIVATION	ENGLISH
cc		cubic centimeter
g	gramma	gram
gr	granum	grain
gtt	gutta	drop
lb	libra	pound
♏	minimum	minim
mL		milliliter
no	numerus	number
qs	quatum sufficit	sufficient quantity
ss	semis	one-half
ʒ	dracama	dram
℥	uncia	ounce

(From Daniels and Smith, *Clinical Calculations: A Unified Approach*, 4E copyright 1999 by Delmar Thomson Learning.)

TABLE 4–2

Preparations

ABBREVIATION	LATIN DERIVATION	ENGLISH
cap	capsula	capsule
elix	elixir	elixir
EC		enteric-coated
ext	extracum	extract
fl	fluidus	fluid
sol	solutio	solution
supp	suppositorium	suppository
susp	suspensio	suspension
syr	syrupus	syrup
tab	tabella	tablet
tr	tinctura	tincture
ung	unguentum	ointment

(From Daniels and Smith, *Clinical Calculations: A Unified Approach*, 4E copyright 1999 by Delmar Thomson Learning.)

TABLE 4–3

Routes

ABBREVIATION	LATIN DERIVATION	ENGLISH
h		hypodermic
ID		intradermal
IM		intramuscular
IV		intravenous
OD	oculus dexter	right eye
OS	oculus sinister	left eye
OU	oculo utro	both eyes
po	per os	by mouth
sc	sub cutis	subcutaneous
sl	sub lingua	sublingual

(From Daniels and Smith, *Clinical Calculations: A Unified Approach*, 4E copyright 1999 by Delmar Thomson Learning.)

TABLE 4–4

Special Instructions

ABBREVIATION	LATIN DERIVATION	ENGLISH
aa	ana (Gr.)	of each
ad lib	ad libutum	as desired
c	cum	with
dil	dilutus	dilute
per	per	through or by
R_X	recipe	take
s	sine	without
stat	statim	immediately

(From Daniels and Smith, *Clinical Calculations: A Unified Approach*, 4E copyright 1999 by Delmar Thomson Learning.)

TABLE 4–5

Times

ABBREVIATION	LATIN DERIVATION	ENGLISH
a	ante	before
ac	ante cibum	before meals
am	ante meridian	before noon
bid	bis in die	twice a day
h	hora	hour
hs	hora somni	hour of sleep or at bedtime
noct	noctis	night
o	omnis	every
od	omni die	every day
p	post	after
pc	post cibum	after meals
pm	post meridian	after noon
prn	pro re nata	whenever necessary
q	quaque	every
qd	quaque die	every day
qh (q3h, etc.)	quaque horra	every hour (3, 4, etc.)
qid	quater in die	4 times a day
qod		every other day
sos	si opus sit	if necessary (one dose only)
tid	ter in die	3 times a day

(From Daniels and Smith, *Clinical Calculations: A Unified Approach*, 4E copyright 1999 by Delmar Thomson Learning.)

when they are encountered in the drug order. Some examples of drug orders encountered in practice are:

EXAMPLE 1:
Caps. **diphenhydramine** (**Benadryl**) 25 mg q4h po
Interpretation: "Give the client one 25 mg capsule by mouth every 4 hours."

EXAMPLE 2:
Elixir **acetaminophen** (**Elixir Tylenol**) 80 mg tid pc and hs po
Interpretation: "Give 80 mg of elixir acetaminophen by mouth 3 times a day after meals and at bedtime."

TABLE 4–6

Values of Single Roman Numbers

ROMAN NUMERALS		VALUE
ss	=	½
I or i	=	1
V or v	=	5
X or x	=	10
L or l	=	50
C or c	=	100
D or d	=	500
M or m	=	1,000

EXAMPLE 3:
100 mg Demerol IM stat. 50 mg q4h prn pain
Interpretation: "Give 100 mg of Demerol intramuscularly immediately, then give 50 mg of Demerol intramuscularly not more often than every 4 hours as needed for pain."

The abbreviation "prn" can often be a source of trouble if not interpreted carefully. In the order described in the last example, the medication (Demerol) can be administered if the dosing interval of at least 4 hours is maintained. The nurse assesses the client's need for the Demerol to control pain or the client requests the medication, and it may be administered if it has been 4 hours or more since the previous injection.

Most prescriptions are written in the metric system; however, the apothecary system using Roman numerals is still used by some prescribers through force of habit. A few of the most common Roman numerals are shown in Table 4–6.

RATIO AND PROPORTION

Nearly every problem that arises in calculations involving medication can be broken down to simple ratio and proportion. Developing skill in setting up ratios and proportions will be an invaluable aid to the nurse in solving medication problems quickly and accurately.

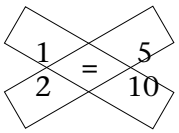
Ratio

A ratio is the relationship of two quantities. It may be expressed in the form 1:10 or 1:2500, or it may be expressed as a fraction—1/10 or 1/2500. The ratio expression 1:10 or 1/10 can be read as one in ten, or one-tenth, or one part in ten parts.

EXAMPLE 4:
For every 20 students there is 1 teacher. The ratio of teachers to students is 1 in 20 or 1:20 or 1/20.

Proportion

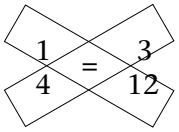
A proportion is formed by using two ratios that are equal. For example, 1/2 = 5/10. When two ratios, or fractions, are equal, their cross product is also equal. The cross product is obtained by multiplying the denominator of one ratio by the numerator of the other, as follows:



$= 2 \times 5 = 10 \times 1$

The cross products are equal: 10 = 10. Therefore, the ratio 1/2 is equal to the ratio 5/10.

Does 1/4 = 3/12?



$= \frac{12}{12}$

The cross products are equal: 12 = 12. Therefore, 1/4 is equal to 3/12.

This characteristic of proportions is very useful in solving problems that arise in drug administration. If any three of the values of a proportion are known, the fourth value can be determined.

EXAMPLE 5:
The prescriber orders 20 mg IM of a drug for a client. The drug is available in a 10 mL vial that contains 50 mg of drug. How many milliliters will be needed to supply the dose of 20 mg?

SOLUTION:
Three things are known from the statement of the problem.

1. 10 mL vial on hand
2. 50 mg of drug in the 10 mL vial
3. 20 mg is the desired dose

A ratio can be stated for the drug on hand:

$$\frac{10 \text{ mL}}{50 \text{ mg}} \text{ reduced to lowest terms} = \frac{1 \text{ mL}}{5 \text{ mg}}$$

A ratio can also be stated for the required dosage:

$$\frac{x \text{ mL}}{20 \text{ mg}}$$

Thus, the proportion is:

$$\frac{1 \text{ mL}}{5 \text{ mg}} = \frac{x \text{ mL}}{20 \text{ mg}}$$

Note in the proportion that the units are labeled and like units are located in the same position in each fraction or ratio (1 mL is opposite x mL and 5 mg is opposite 20 mg). It is important to label the parts of the proportion correctly. Note that the answer label is always the label with the "x."

Important: Three conditions must be met when using ratio and proportion.

1. The numerators must have the same units.
2. The denominators must have the same units.
3. Three of the four parts must be known.

To solve the last example, simply find the cross product and solve for the unknown (x).

$$\frac{1 \text{ mL}}{5 \text{ mg}} = \frac{x \text{ mL}}{20 \text{ mg}}$$

$$5 \times x = 1 \times 20$$
$$5x = 20$$

$x = 4$ mL (20 divided by 5)

Therefore, 4 mL of the solution contains 20 mg of drug.

It is helpful to note that a proportion is similar to the way we think logically: if this is so, then that will follow. Problems can be analyzed with the if–then approach.

In the last example, we could say IF we have 10 mL containing 50 mg of drug, THEN x mL of solution will contain 20 mg of drug.

$$\begin{array}{ccccc} \text{IF} & & & & \text{THEN} \\ 10 \text{ mL} & \text{or} & 1 \text{ mL} & = & x \text{ mL} \\ 50 \text{ mg} & & 5 \text{ mg} & & 20 \text{ mg} \end{array}$$

Remember that the first ratio of a proportion is always formed from the quantity and strength (concentration) of the drug on hand.

EXAMPLE 6:
Ampicillin oral suspension contains 250 mg of the drug in each 5 mL. How many milliliters would be measured into a medication syringe to obtain a dose of 75 mg of ampicillin?

SOLUTION:

1. Set up the proportion beginning with the drug on hand:

$$\begin{array}{cc} \text{IF} & \text{THEN} \\ 5 \text{ mL} & x \text{ mL} \\ 250 \text{ mg} & 75 \text{ mg} \end{array}$$

2. Cross multiply:

$$250(x) = 5(75)$$
$$250(x) = 375$$
$$x = 1.5 \text{ mL}$$

PRACTICE PROBLEMS

Solve the following problems by setting up the proportion and finding the unknown quantity. Answers are at the end of the chapter.

1. Elixir of digoxin contains 50 micrograms (mcg) of digoxin in each milliliter. How many micrograms of the drug are in 0.3 mL of the elixir?
2. Lugol's solution contains 50 mg of **iodine** per milliliter. How many milligrams of iodine are in 0.3 mL of the solution?
3. Elixir of diphenhydramine (elixir of Benadryl) contains 12.5 mg per 5 mL (teaspoonful). How many milliliters are needed to provide 30 mg of the drug?
4. The physician orders 2.5 mg of theophylline to be administered orally to a pediatric client. If elixir of theophylline contains 80 mg of theophylline per tablespoonful (15 mL), how many milliliters of the elixir should be administered?
5. A vial contains 250 mg of **tetracycline HCl** in a total of 2 mL of solution. How many mg of tetracycline HCl are contained in 0.6 milliliter of this solution?

CONVERSION BETWEEN SYSTEMS OF MEASUREMENT

Before reviewing the types of calculations used in determining medication dosages, it is necessary to examine conversions between systems of measurement. It was mentioned previously that nearly all medication orders today are written using the metric system. However, some orders will be written using apothecary notation. The nurse must be able to convert from the apothecary system to the metric system and from one unit to another unit within both systems.

Chapter 2 reviewed some commonly used approximate weight and measure equivalents (Table 2–2). The key word here is "approximate." These approximate values are not *exact* equivalents. For example, 1 gram = 15 grains approximately = 15.432 grains exactly. The pharmacist uses the exact equivalents in compounding medications. In calculations involving dosages, however, it is not necessary to use exact equivalents. In fact, as the exact equivalents involve many decimal places and fractional numbers, their use could lead to awkward calculations with an increase in errors. Thus, the approximate equivalents are used in calculations for medication dosages. Approximate equivalents are used in the examples and problems in the remainder of this chapter. For example, 30 milliliters (mL) = 1 fluid ounce (fl oz) in all calculations. Similarly, 1 gram (g) = 15 grains (gr).

Review of the Metric System

The three basic units of the metric system are the meter (length), the gram (weight), and the liter (volume). Only the units of weight and volume are considered in this chapter. Multiples or parts of these basic units are named by adding a prefix. Each prefix has a numerical value, as shown in Table 4–7.

Examples of the use of the metric prefixes are:

- 1 milliliter (mL) = 1/1000 liter = 0.001 L
- 1 milligram (mg) = 1/1000 gram = 0.001 g
- 1 microgram (mcg) = 1/1,000,000 gram = 0.000001 g
- 1 nanogram (ng) = 1/1,000,000,000 gram = 0.000000001 g
- 1 kilogram (kg) = 1,000 times 1 gram = 1,000 g
- 1 deciliter (dL) = 1/10 liter = 0.1 L

Table 4–8 shows examples of common metric abbreviations.

Liter. The liter is the basic unit of volume used to measure liquids in the metric system. It is equal to 1,000 cubic centimeters of water. One cubic centimeter is considered equivalent to one milliliter (mL); thus 1 liter (L) = 1,000 milliliters (mL).

Gram. The gram is the basic unit of weight in the metric system. The gram is defined as the

TABLE 4–7

Metric Prefixes

PREFIX		VALUE
nano (n)	=	1/1,000,000,000 (one-billionth of basic unit) = 0.000000001
micro (mc)	=	1/1,000,000 (one-millionth of basic unit) = 0.000001
milli (m)	=	1/1000 (one-thousandth of basic unit) = 0.001
centi (c)	=	1/100 (one-hundredth of basic unit) = 0.01
deci (d)	=	1/10 (one-tenth of basic unit) = 0.1
kilo (k)	=	1,000 (one thousand times basic unit)

TABLE 4–8

Common Metric Abbreviations

MEASURE	ABBREVIATION
nanogram	ng
microgram	mcg
milligram	mg
gram	g
kilogram	kg
milliliter	mL
deciliter	dL
liter	L
millimeter	mm
centimeter	cm
meter	m
kilometer	km

weight of one cubic centimeter of distilled water at 4°C.

Conversions. Using Table 4–7, the following values can be determined:

- 1,000 g = 1 kg
- 1,000 mg = 1 g
- 1,000 ng = 1 mcg
- 1,000 mcg = 1 mg
- 1,000 mL = 1 L
- 100 mL = 1 dL

Two rules apply to conversions within the metric system.

- *Rule 1.* To convert a quantity in the metric system to a larger metric unit (e.g., mg to g), move the decimal point to the left.
  —Smaller to larger (S to L) = Right to left (R to L)

  Smaller → Larger
  Right → Left

  Example:
  2.0 mg → 0.002 g

- *Rule 2.* To convert a quantity to a smaller metric unit, move the decimal point to the right.
  —Larger to smaller (L to S) = Left to right (L to R)

  Larger → Smaller
  Left → Right

  Example:
  2.4 L → 2400.0 mL

Note that the two Ls are on the same side in each rule.

EXAMPLE 7:
Convert 22 g to milligrams.

SOLUTION:
The change is from larger to smaller with a difference of 1,000 between the units. The rule in this case is
—Larger to smaller (L to S) = Left to right (L to R). Because the difference is 1,000 between grams and milligrams, the decimal point is moved three places to the right. Thus, 22 g = 22,000 mg.

EXAMPLE 8:
Convert 150 mL to liters.

SOLUTION:
In changing from milliliters to liters, the change is from smaller to larger (S to L), with a difference of 1,000 between the units (1,000 mL = 1 L). Therefore, move the decimal point from right to left (R to L). Because there is a difference of 1,000 between the units move the decimal point three places to the left. Thus, 150 mL = 0.15 L.

PRACTICE PROBLEMS

6. 2000 mg = _____ g
7. 50 g = _____ mg
8. 2 L = _____ mL
9. 230 ng = _____ mcg
10. 250 mg = _____ g
11. 2.5 kg = _____ g
12. 0.5 L = _____ mL
13. 1.5 L = _____ dL
14. 20 mg = _____ g
15. 0.7mg = _____ mcg

Apothecary System of Weights

The apothecary system of weights is based upon the grain (gr), which is the smallest unit in the system. The origin of the grain is uncertain, but it is believed that at one time solids were measured by using grains of wheat as the standard.

In practice, the nurse will seldom see apothecary units of weight with the exception of the grain, which is still commonly used in ordering medications such as nitroglycerin (1/100 gr, 1/150 gr), **atropine sulfate** (1/200 gr, 1/150 gr), **codeine sulfate** (1/8 gr, 1/4 gr, 1/2 gr, 1 gr) and **morphine sulfate** (1/6 gr, 1/8 gr, 1/2 gr). To convert grains to metric units, the following approximate equivalent is used:

15 grains = 1 gram

EXAMPLE 9:
Convert 15 milligrams to grains.

SOLUTION:

$$\frac{1 \text{ gr}}{60 \text{ mg}} = \frac{x \text{ gr}}{15 \text{ mg}}$$

$$60x = 15$$

$$x = \frac{15}{60}$$

$$x = 15 \text{ divided by } 60$$

$$x = .25 \text{ gr}$$

Apothecary System of Volume (Liquid) Measure

The apothecary liquid measures are the same as the avoirdupois measures which we use daily, such as ounces, pints, and quarts. The smallest unit of volume in the apothecary system is the minim (♏). The minim should *not* be confused with the drop, as they are not equivalent. The size of a drop varies with the properties of the liquid being dispensed or measured. Table 4–9 shows the common units of liquid measure in the apothecary system.

Apothecary System Notation

In the apothecary system, the unit is written first, followed by the quantity. For small numbers, lower-case Roman numerals are used. Arabic numbers are commonly used for large numbers, i.e., greater than 40. Table 4–10 shows examples of apothecary system notation.

Converting From the Apothecary System to the Metric System

The use of tabular information is helpful in converting between the systems of weights and measures (refer to Table 2–2). Many conversions, however, can be made readily by use of two important equivalents and the ratio and proportion method.

The equivalents are:

15 gr = 1 g
♏ 16 = 1 mL

EXAMPLE 10:
The physician orders 7½ grains of **aminophylline** po for a client. On hand are aminophylline tablets 500 mg. How many tablets are required for one dose?

SOLUTION:
First the physician's order must be converted to a metric unit, or the strength of the tablets on hand must be converted to an apothecary unit. It is preferable to convert to metric units in all cases.

TABLE 4–9

Liquid Measure in the Apothecary System

MEASURE		EQUIVALENT
8 fluid drams (fl dr)	=	1 fluid ounce (fl oz or fl ℥)* = 480 minims (♏)
16 fluid ounces	=	1 pint (pt)
2 pints	=	1 quart (qt) = 32 fluid ounces (fl oz)
4 quarts	=	1 gallon =128 fluid ounces

*The fluid dram sign (℥) is often used by physicians to represent 1 teaspoonful, or 5 mL. The apothecary symbol for one-half fluid ounce or 1 tablespoonful is ℥ ss. When this appears in the directions for use (signa), it is read as 1 tablespoonful, or 15 mL.

TABLE 4–10

Apothecary Notation

QUANTITY	NOTATION
1/10 grain	gr 1/10
1 grain	gr i
1½ grains	gr iss
10 grains	gr x
2½ ounces	℥ iiss

Setting up the proportion gives:

$$\frac{\text{IF}}{\text{1 g}} = \frac{\text{THEN}}{\text{x g}}$$
$$\text{15 gr} \qquad \text{7.5 gr}$$

Cross multiplying:

$$15x = 7.5$$

$$x = 0.5 \text{ g (500 mg)}$$

Thus, the 7½ gr ordered by the physician is equal to one of the 500 mg tablets on hand. The dose is 1 tablet of 500 mg aminophylline (7½ gr aminophylline).

EXAMPLE 11:
How many milligrams of nitroglycerin are in one 1/150 gr tablet of the drug?

SOLUTION:
This problem requires conversion from the apothecary system to the metric system. Use the equivalent 1 g = 15 gr. The proportion is:

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 1\text{ g} & = & x\text{ g} \\ 15\text{ gr} & & 1/150\text{ gr} \end{array}$$

Cross multiplying:

$$15x = 1/150 = .0067$$
$$x = 0.0004\text{ g} = 0.4\text{ mg}$$

Remember, when converting in the metric form from larger to smaller units, the decimal point moves left to right.

PRACTICE PROBLEMS

16. 6 pints = _____ fluid ounces
17. 17 g = _____ gr
18. 26 quarts = _____ gallons
19. 200 minims = _____ fluid ounces
20. 65 grains = _____ g
21. 3 gallons = _____ pints

CALCULATION OF FRACTIONAL DOSES

Nurses encounter fractional, or partial, medication dosages frequently, as physicians often order medication for a client in a strength that differs from the strength of the preparation on hand.

The ratio and proportion method can be used to solve all problems of fractional dosages. The concentration of the medication on hand forms the IF ratio of the proportion.

EXAMPLE 12:
The physician orders 1,000,000 units of **penicillin G** for a client. The penicillin G on hand is available as a solution containing 250,000 units/mL.

SOLUTION:
Find the strength of the product on hand. This expression forms the IF ratio of the proportion:

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 250{,}000\text{ units} & = & \\ 1\text{ mL} & & \end{array}$$

Place the number of units wanted in the THEN ratio and solve for the unknown x.

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 250{,}000\text{ units} & = & 1{,}000{,}000\text{ units} \\ 1\text{ mL} & & x\text{ mL} \end{array}$$

$$250{,}000x = 1{,}000{,}000$$
$$x = 4\text{ mL}$$

Remember to label all parts of the proportion carefully with the appropriate units.

EXAMPLE 13:
The physician orders 250 mcg of **cyanocobalamin (vitamin B_{12})** IM daily. The vitamin B_{12} on hand is labeled 1,000 mcg/mL. How many milliliters should be given to the client?

SOLUTION:
The concentration of B_{12} on hand is 1,000 mcg/mL. Therefore, the IF ratio is:

$$\frac{1{,}000\text{ mcg}}{1\text{ mL}}$$

Placing the number of micrograms needed opposite the micrograms of the IF ratio results in:

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 1{,}000\text{ mcg} & = & 250\text{ mcg} \\ 1\text{ mL} & & x\text{ mL} \end{array}$$

Solving for x yields:

$$x = 0.25\text{ mL}$$

To supply 250 mcg of vitamin B_{12} requires 0.25 mL.

EXAMPLE 14:
A client is to be given 25 mg of diphenhydramine (Benadryl) po. The Benadryl is available as elixir of Benadryl 12.5 mg/5 mL. How many milliliters should be given to the client?

SOLUTION:

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 12.5\text{ mg} & = & 25\text{ mg} \\ 5\text{ mL} & & x\text{ mL} \end{array}$$

$$x = \frac{125}{12.5}$$
$$x = 10\text{ mL}$$

EXAMPLE 15:
A medication order calls for 750 mg of **calcium lactate** to be given tid po. On hand are tablets of calcium lactate 0.5 g. How many tablets should be given for each dose?

SOLUTION:
Note: When using ratio and proportion the units must be alike. Grams cannot be used in a proportion with milligrams. Therefore, in this example the grams must be converted to milligrams or the 750 mg converted to grams. Changing the grams to milligrams yields:

$$0.5\text{ g} = 500\text{ mg}$$

Remember: Larger to smaller = left to right. A 1,000 difference means moving the decimal point three places to the right.

$$\begin{array}{ccc} \text{IF} & & \text{THEN} \\ 500\text{ mg} & = & 750\text{ mg} \\ 1\text{ tab} & & x\text{ tab} \end{array}$$

$$x = 1.5 \text{ or } 1\tfrac{1}{2}\text{ tablets}$$

PRACTICE PROBLEMS

22. A client is to receive a 100 mg dose of gentamicin. On hand is a vial containing 80 mg/mL of the drug. How many milliliters should be given to the client?
23. A multiple-dose vial of a **penicillin G potassium** solution contains 100,000 units per milliliter. How many milliliters of this solution must be administered to a client who requires a 750,000 unit dose?
24. A physician orders 30 mg of Demerol IM for a client. How many milliliters of a Demerol solution containing 100 mg/mL must be given to the client?
25. The nurse is asked to administer an intramuscular dose of 45 mcg of an investigational drug. How many milliliters must be withdrawn from a vial containing 20 mcg/mL of the drug?
26. A pediatric client is to be given a 70 mg dose of **Dilantin** by administering an oral suspension containing 50 mg of Dilantin per 5 mL. How many milliliters of the suspension must be administered?

CALCULATION OF DOSAGES BASED ON WEIGHT

The recommended dosages of drugs are often expressed in the literature as a number of milligrams per unit of body weight per unit of time (refer to package inserts or the *PDR Nurses' Drug Handbook* [2001]). Such dosage expressions are commonly used in depicting pediatric doses. For example, the recommended dose for a drug might be 5 mg/kg/24 hours. This information can be utilized by the nurse to:

1. calculate the dose for a given client
2. check on doses ordered that are suspected to be significant over- or underdoses.

EXAMPLE 16:
The physician orders **thiabendazole** (**Mintezol**) chewable tablets for a 110-pound child. The recommended dosage for Mintezol is 20 mg/kg per dose. How many 500 mg tablets of Mintezol should be given to this client for each dose?

SOLUTION:

1. As the dose provided is based on a kilogram weight, convert the client's weight to kilograms by proportion.

$$1 \text{ kg} = 2.2 \text{ lb}$$
$$\frac{1 \text{ kg}}{2.2 \text{ lb}} = \frac{x \text{ kg}}{110 \text{ lb}}$$
$$x = 50 \text{ kg}$$

2. Calculate the total daily dose using the recommended dosage information: 20 mg/kg. This is interpreted as, "For each kilogram of body weight, give 20 mg of the drug."

$$\frac{20 \text{ mg}}{1 \text{ kg}} = \frac{x \text{ mg}}{50 \text{ kg}}$$
$$x = 1{,}000 \text{ mg}$$

3. Calculate the number of tablets needed to supply 1,000 mg per dose. The concentration of tablets on hand = 500 mg/tablet.

$$\frac{500 \text{ mg}}{1 \text{ tab}} = \frac{1{,}000 \text{ mg}}{x \text{ tab}}$$
$$x = 2 \text{ tablets per dose}$$

EXAMPLE 17:
The recommended dose of meperidine (Demerol) is 6 mg/kg/24 h for pain. It is given in divided doses every 4–6 hours. How many milliliters of Demerol injection (50 mg/mL) should be administered to a 33-pound child as a single dose every 6 hours?

SOLUTION:

1. Calculate the daily dose for a 33-pound child.

$$\frac{6 \text{ mg}}{1 \text{ kg (2.2 lb)}} = \frac{x \text{ mg}}{33 \text{ lb}}$$

By inserting the conversion unit of 2.2 lb for 1 kg in the ratio, there is no need to do a separate calculation of the number of kilograms in 33 pounds.

x = 90 mg of Demerol per day (24 hrs)

2. Calculate the number of milliliters of Demerol injection (50 mg/mL) needed for the total daily dose.

$$\frac{50 \text{ mg}}{1 \text{ mL}} = \frac{90 \text{ mg}}{x \text{ mL}}$$
$$50x = 90$$
$$x = 1.8 \text{ mL every 24 hours}$$

3. Calculate the number of milliliters to be given every 6 hours.

$$\frac{1.8 \text{ mL}}{24 \text{ h}} = \frac{x \text{ mL}}{6 \text{ h}}$$
$$24x = 10.8$$
$$x = 0.45 \text{ mL}$$

PRACTICE PROBLEMS

27. The recommended dose of **cefamandole nafate** (**Mandol**) for a pediatric client is 50 mg/kg/day. How many milligrams must be given daily to a 60-pound child?
28. **Acyclovir** (**Zovirax**) is administered in a dose of 15 mg/kg/day. How many milligrams of the drug must be administered daily to a 175-pound adult?
29. The recommended dose for **methotrexate** is 2.5 mg/kg every 14 days. How many milligrams of this drug must be administered to a 125-pound adult for each dose?
30. **Chlorpromazine HCl** is to be administered in a dose of 0.25 mg/lb. How many milligrams of this drug must be administered to an 85-kilogram client?
31. A recommended dose for the administration of **streptomycin sulfate** is 10 mg/lb/day. How many milligrams of this drug must be administered daily to a 63-kilogram adult?

PEDIATRIC DOSAGE CALCULATIONS

When the manufacturer's recommended dosage is not available to determine dosages for children, the nomogram is the most accurate method to use. The *nomogram* is a chart that uses the weight and height (size) of the client to estimate his/her *body surface area (BSA)* in square meters (m^2). This body surface area is then placed in a ratio with the body surface area of an average adult (1.73 m^2). The formula used with the nomogram method is:

$$\text{Child's dose} = \frac{\text{Child's body surface area in } m^2}{1.73\ m^2 \text{ (BSA of average adult)}} \times \text{adult dose}$$

To determine the child's BSA, the weight and height of the child must be known. The nomogram scales contain both metric (kg, cm) and avoirdupois (lb, inches) values for height and weight. Thus, the BSA can be determined for pounds and inches or kilograms and centimeters without making conversions.

Figure 4–1 is the nomogram "Body Surface Area of Children." Note the three columns labeled height, body surface area, and weight. Also note that the height and weight scales show both metric and avoirdupois values.

To determine the body surface area, a ruler or straightedge is needed. (A piece of paper or cardboard can be used if there is at least one even, straight edge.) The following steps demonstrate the use of the nomogram.

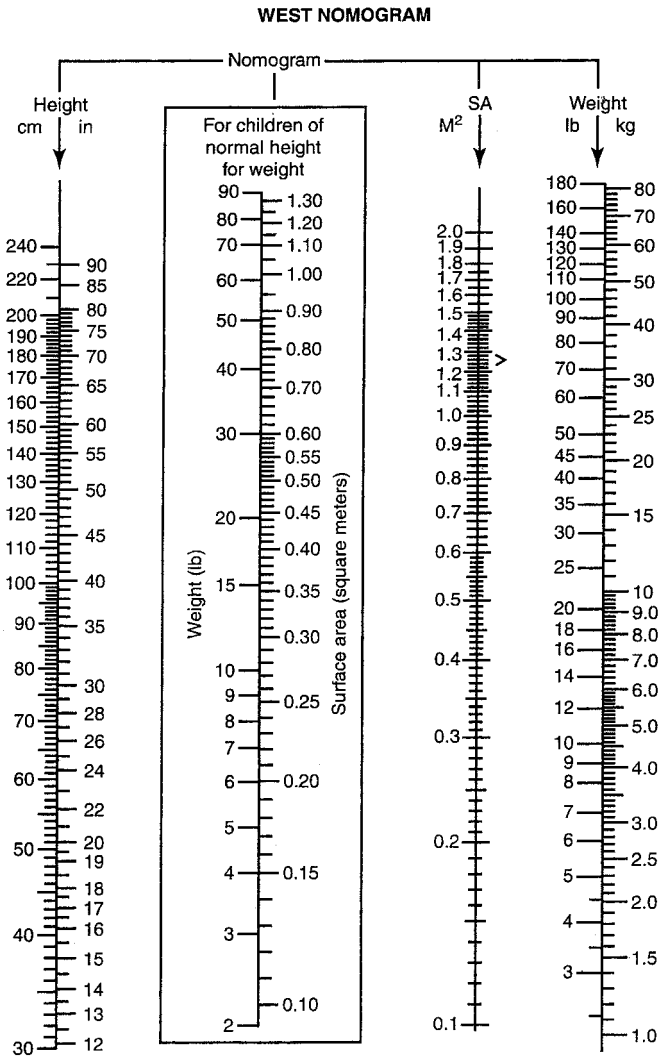


Figure 4–1 A nomogram is a chart that permits the estimation of BSA from the client's height and weight. Different charts are needed for children and adults. (note children's box in diagram). To find the BSA for your client, record the client's weight on the weight scale by placing a dot at the appropriate spot. Do the same for the client's height on the height chart. Using a ruler, draw a straight line between the two dots. Where the line crosses the body surface area graph, read the client's BSA. *(From* Nelson Textbook of Pediatrics *(16th ed.) By R. E. Behrman, R. M. Kleigman & A. M. Arvin, 2000, Philadelphia: Saunders. Reprinted with permission.)*

1. Determine the height and weight of the client. This information may be given in metric values, e.g., height = 84 cm, weight = 12 kg, or avoirdupois values can be used: height = 33.5 inches, weight = 26.5 pounds. Mixed values can also be used: height = 85 cm, weight = 26.5 pounds.

2. Place the straightedge on the nomogram connecting the two points on the height and weight scales that represent the client's values. Assume the client is a child weighing 26.5 pounds and standing 33.5 inches tall. Then, 26.5 pounds on the weight scale and 33.5 inches on the height scale are connected using the straightedge.
3. Where the straightedge crosses the center column (BSA) a reading is taken. This value is the BSA in m^2 for the client. In our example, BSA = 0.52 m^2.

   Note: The three scales are divided into five divisions between the major numbered sections, which vary in value as the scales are ascended. To interpret the value of the divisions, take the difference between the two numbers and divide by 5.

   For example, on the kg scale between 5 kg and 6 kg there is a difference of 1, so each division between 5 and 6 is 0.2 kg (1 divided by 5). Between 1.5 kg and 2 kg, the difference is 0.5. Therefore, each division between 1.5 and 2 kg is 0.1 kg (0.5 divided by 5).
4. Substitute the BSA value in the formula to calculate the dosage for the child. For example, if the dose of aminophylline is 500 mg for an adult, what is the dose for a child with a calculated BSA of 0.52 m^2?

$$\text{Child's dose} = \frac{\text{BSA of child in } m^2}{1.73\ m^2\ (\text{BSA of average adult})} \times \text{adult dose}$$

Therefore,

$$= \frac{0.52\ m^2}{1.73\ m^2} \times 500\ \text{mg}$$

$$= 0.3 \times 500\ \text{mg}$$

$$= 150\ \text{mg of aminophylline}$$

With practice, the nurse can become proficient in using the nomogram and will find it a useful tool for calculating dosages.

PRACTICE PROBLEMS

Solve the following problems using the nomogram in Appendix 1.

32. Find the BSA for the following children.
    a. 9 pounds, 23 inches BSA = _____ m^2
    b. 3.2 kg, 50 cm BSA = _____ m^2
    c. 15 kg, 40 inches BSA = _____ m^2
33. The adult dose of **methyldopa** (**Aldomet**) is 250 mg. What is the dose for the child in problem 32-c?
34. If the adult dose for **furosemide** (**Lasix**) is 40 mg, what is the dose for a child whose BSA is 0.53 m^2?
35. An adult dose of theophylline is 400 mg. What is the dose for a child who weighs 25 kg and who has a height of 105 cm?
36. If the adult dose of **diazepam** (**Valium**) is 10 mg, what is the dose for an 18-pound child with a height of 27 inches?

CALCULATIONS INVOLVING INTRAVENOUS ADMINISTRATION

Nurses are often required to determine the flow rates for intravenous infusions, to calculate the volume of fluids administered over a period of time, and to control the total volume of fluids administered to a client during a stated period of time. The calculations necessary to perform these tasks can all be accomplished by the use of ratio and proportion.

Chapter 3 provided information on the techniques involved in IV administration, the equipment used, and the documentation to be prepared by the nurse administering IV solutions. The calculations required for IV administration are detailed in the following sections.

Calculating the Rate of IV Administration

When the physician orders intravenous solutions to run for a stated number of hours, the nurse may have to compute the number of drops per minute to comply with the order.

To calculate the flow rate using the ratio and proportion method, three steps are required. One must determine:

1. the number of milliliters the client will receive per hour
2. the number of milliliters the client will receive per minute
3. the number of drops per minute that will equal the number of milliliters computed in step 2. The drop rate specified for the IV set being used must be considered in this step. The drop rate is expressed as a ratio of drops per mL (gtt/mL).

EXAMPLE 18:
The physician orders 3,000 mL of dextrose 5% in water (D5W) IV over a 24-hour period. If the IV set is calibrated to deliver 15 drops per milliliter, how many drops must be administered per minute?

SOLUTION:

1. Calculate mL/hr.

$$\frac{3{,}000 \text{ mL}}{24 \text{ hr}} = \frac{x \text{ mL}}{1 \text{ hr}}$$

$$x = 125 \text{ mL/hr or } 125 \text{ mL/60 min}$$

2. Calculate mL/min.

$$\frac{125 \text{ mL}}{60 \text{ min}} = \frac{x \text{ mL}}{1 \text{ min}}$$

$$x = 2 \text{ mL/min}$$

3. Calculate gtt/min using the drop rate per minute of the IV set.

$$\text{IV set drop rate} = 15 \text{ drops/mL}$$

$$\frac{15 \text{ gtt}}{1 \text{ mL}} = \frac{x \text{ gtt}}{2 \text{ mL (amt needed/min)}}$$

$$x = 30 \text{ gtt/min}$$

EXAMPLE 19:
The physician orders 1.5 L of lactated Ringer's solution to be administered over a 12-hour period. The IV set is calibrated to deliver 10 gtt/mL. How many drops per minute should the client receive?

SOLUTION:

1. Determine the number of milliliters to be administered in 1 hour. As the answer requested is in milliliter units, first convert liter quantity to milliliters.

$$1.5 \text{ L} = 1{,}500 \text{ mL}$$

$$\frac{1{,}500 \text{ mL}}{12 \text{ hr}} = \frac{x \text{ mL}}{1 \text{ hr}}$$

$$x = 125 \text{ mL/hr or } 125 \text{ mL/60 min}$$

2. Calculate the number of milliliters per minute.

$$\frac{125 \text{ mL}}{60 \text{ min}} = \frac{x \text{ mL}}{1 \text{ min}}$$

$$x = 2 \text{ mL/min (approx.)}$$

3. Calculate the number of drops per minute.

$$\text{IV set drop rate} = 10 \text{ gtt/mL}$$

$$\frac{10 \text{ gtt}}{1 \text{ mL}} = \frac{x \text{ gtt}}{2 \text{ mL}}$$

$$x = 20 \text{ gtt/min}$$

The following example shows how to calculate the time required to administer an IV solution when the volume and flow rate are known.

EXAMPLE 20:
How long will it take to complete an IV infusion of 1.5 L of D5W being administered at the rate of 45 drops/minute? The IV set is calibrated to deliver 15 drops/mL. This problem is a variation of the flow rate problem considered earlier.

SOLUTION:

1. Determine the number of milliliters/minute being infused.

$$\text{Drop rate of IV set} = \frac{15 \text{ gtt}}{1 \text{ mL}} = \frac{45 \text{ gtt}}{x \text{ mL}}$$

$$15x = 45$$

$$x = 3 \text{ mL/min}$$

2. Calculate the number of milliliters/hour.

$$3 \text{ mL/min} \times 60 \text{ min/hr} = 180 \text{ mL/hr}$$

3. Calculate the number of hours required to administer the total volume of the solution. If 180 mL are delivered each hour, then how many hours are required to administer 1,500 mL (1.5L)?

$$\frac{180 \text{ mL}}{1 \text{ hr}} = \frac{1{,}500 \text{ mL}}{x \text{ hr}}$$

$$180x = 1500$$

$$x = 8.3 \text{ hours, or 8 hours 20 minutes}$$

PRACTICE PROBLEMS

37. The physician orders 1,200 mL of D5W solution to be administered over a 10-hour period. The IV set is calibrated to deliver 18 gtt/mL. How many drops per minute should the client receive?
38. A client is to receive 150 mL of an IV infusion over a period of 4 hours. The IV set is calibrated to deliver 15 gtt/mL. How many drops per minute should the client receive? (Round off answer to nearest whole drop.)
39. An IV infusion containing 750 mL is to be administered at a drop rate of 40 gtt/min. The IV set is calibrated to deliver 20 gtt/mL. How long will it take to administer the entire infusion?
40. A nurse wishes to administer 1,200 mL of an IV infusion at a rate of 45 gtt/min. The IV set is calibrated to deliver 15 gtt/mL. How long will it take to administer the entire infusion?
41. The physician orders 100 mL of a drug solution to be administered at a rate of 20 gtt/min. The IV set is calibrated to deliver 12 gtt/mL. How long will it take to administer the entire infusion?

Calculations Involving Piggyback IV Infusion

The physician may order medications to be run piggyback with the IV electrolyte fluids. The

medications are usually dissolved in 50 or 100 mL of an IV solution and run for 1 hour through the open IV line. The flow rate for these piggyback infusions is calibrated the same way as the rate for the regular IV solutions.

EXAMPLE 21:
An IV piggyback of **cefazolin sodium** (**Ancef**, **Kefzol**) 500 mg in 100 mL/hour is ordered. The piggyback IV set is calibrated to deliver 10 gtt/mL. How many drops/minute should be administered?

SOLUTION:

1. The entire 100 mL is to be infused in 1 hour. Calculate the number of milliliters/minute.

$$\frac{100 \text{ mL}}{60 \text{ min}} = \frac{x \text{ mL}}{1 \text{ min}}$$
$$60x = 100$$
$$x = 1.7 \text{ mL/min}$$

2. Calculate the flow rate.

$$\text{Drop rate} = \frac{10 \text{ gtt}}{1 \text{ min}} = \frac{x \text{ gtt}}{1.7 \text{ mL}}$$
$$x = 17 \text{ gtt/min}$$

The volume of the piggyback and the time of its administration must be accounted for in calculating the daily fluid requirements of the client. In Example 21, assume that the client is to have a total of 2,000 mL of electrolyte solution administered in 24 hours, and that cefazolin sodium 500 mg in 100 mL/hr is ordered qid. The number of milliliters per day and the times of the piggyback infusion must be subtracted from the daily fluid requirement.

$$\text{cefazolin 100 mL qid} = 100 \times 4 = 400 \text{ mL}$$
$$\text{Run 1 hour} \times 4 = 4 \text{ hr}$$
$$\text{Daily requirement} = 2000 \text{ mL in 24 hours}$$
$$\text{Subtract piggyback} = -400 \text{ mL in 4 hours}$$
$$= 1600 \text{ mL in 20 hours}$$

Calculate the flow rate based on 1,600 mL over a 20-hour period in order to administer the correct amount of fluid to the client.

EXAMPLE 22:
The medication order indicates that the client is to have a maximum of 2,000 mL of IV fluids in 24 hours. In addition, the client is to receive gentamicin 50 mg in 100 mL D5W over 30 minutes q8h. The IV set is calibrated to deliver 10 gtt/mL. How many drops/minute should the piggybacks be run and how many drops/minute should the IV solution D5W be administered between piggybacks to keep the vein open?

SOLUTION:

1. Calculate the total volume of the piggyback solutions and the total hours they run. Order calls for 100 mL over 30 minutes q8h (q8h = 3 doses in 24 hours).

$$100 \text{ mL} \times 3 = 300 \text{ mL total}$$
$$30 \text{ min} \times 3 = 90 \text{ min or } 1.5 \text{ hr}$$

2. Subtract these totals from the daily total of IV fluid.

$$2000 \text{ mL} - 300 \text{ mL} = 1700 \text{ mL}$$
$$24 \text{ hr} - 1.5 \text{ hr} = 22.5 \text{ hr}$$

3. Calculate the flow rate for the D5W to be used between the three piggybacks using the adjusted totals.

$$\frac{1700 \text{ mL}}{22.5 \text{ hr}} = \frac{75x \text{ mL/hr}}{1 \text{ hr}}$$
$$75 \text{ mL/hr} \div 60 = 1.25 \text{ mL/min}$$

Using a drop rate of 10 gtt/mL, we have

$$\frac{10 \text{ gtt}}{1 \text{ mL}} = \frac{x \text{ gtt}}{1.25 \text{ mL}}$$
$$x = 12.5 \text{ or } 12 \text{ drops/min}$$

4. The piggyback calculation is as follows:

$$100 \text{ mL} = 30 \text{ min}$$
$$100 \text{ mL} \div 30 = 3.3 \text{ mL/min}$$
$$\text{Drop set calibration} = 10 \text{ gtt/mL}$$
$$\frac{10 \text{ gtt}}{1 \text{ mL}} = \frac{x \text{ gtt}}{3.3 \text{ mL}}$$
$$x = 33 \text{ drops/minute}$$

Will deliver 100 mL of gentamicin solution in 30 minutes.

PRACTICE PROBLEMS

42. An IV piggyback of cefazolin sodium containing 1 g of drug in 100 mL is to be infused over 20 min. The IV set is calibrated to deliver 15 gtt/mL. How many drops/minute should be administered?
43. An IV piggyback of **ampicillin sodium** containing 500 mg of drug in 50 mL of D5W is to be infused over 30 mins. The IV set is calibrated to deliver 20 gtt/mL. How many drops/minute should be administered?
44. An IV piggyback of **metoclopramide hydrochloride** containing 10 mg of drug in 50 mL of 0.9% sodium chloride injection is to be infused over 30 minutes. The IV set is calibrated to deliver 15 gtt/mL. How many drops/minute should be administered?

CALCULATIONS RELATED TO SOLUTIONS

Solutions are formed in two ways: (1) by dissolving a solid called the *solute* in a liquid called the *solvent*, or (2) by mixing two liquids together to form a solution. An example of the first way is adding salt to water to make a normal saline solution. Mixing Zephiran Chloride solution with water to make an antiseptic wash is an example of the second way.

Percentage Solutions

Many solutions are available in or are prepared to a specified percentage strength. To produce a solution of the desired strength, it is necessary to calculate the exact amount of drug to be added to a specific volume of liquid. Although most solutions are prepared by the pharmacist if they are not commercially available, the nurse must understand the concept of percentage to interpret medication labels.

Percentage is defined as the number of parts per hundred and is expressed as:

$$\frac{\text{No. of parts}}{100 \text{ parts}} \times 100 = \text{Percentage (\%)}$$

To calculate the percentage of active ingredient in a solution, the amount of active ingredient in grams is divided by the total volume of the solution. To convert the result to a percentage, it is multiplied by 100.

Problems in percentage solutions generally are concerned with three types of percentages: weight to volume, weight to weight, and volume to volume. Weight-to-volume percentage (W/V%) is defined as the number of grams of solute in 100 mL of solution. Typical W/V% examples are:

- One liter of D5W, which contains 5 g of dextrose in each 100 mL of solution
- A 1/4% solution of **pilocarpine HCl**, which contains 1/4 g (0.25 g) of pilocarpine HCl in each 100 mL of solution

EXAMPLE 23:
What is the weight-to-volume percentage (W/V%) of **sodium chloride** (solid solute) in normal saline solution if 9 g of the salt are dissolved in 1,000 mL of water?

SOLUTION:

$$\frac{\text{Amount of salt in grams: } 9 \text{ g}}{\text{Total volume of solution: } 1{,}000 \text{ mL}} \times 100 = 0.9\%$$

Weight-to-weight percentage (W/W%) is defined as the number of grams of solute in 100 g of a solid preparation. **Note:** Some W/W% solutions are used primarily in laboratory work. Concentrated hydrochloric and sulfuric acids are two examples of weight to weight percentage solutions. Typical W/W% examples are:

- A 10% ointment of **zinc oxide**, which contains 10 g of zinc oxide in each 100 g of ointment
- Hydrocortisone cream 1/2%, which has 1/2 g (0.5 g) of hydrocortisone in each 100 g of cream

The third form of percentage is volume to volume (V/V%), which is defined as the number of milliliters of solute in each 100 mL of solution. Examples of this form are:

- Rubbing alcohol 70%, which contains 70 mL of absolute alcohol in each 100 mL of the solution
- A 2% solution of **phenol**, which contains 2 mL of liquified phenol in each 100 mL of solution

When the type of percentage is not stated, assume that for solutions of a solid in a liquid the percentage is W/V; for solutions of a liquid in a liquid the percentage is assumed to be V/V; and for mixtures of two solids the percentage is typically W/W.

PREVENTION OF MEDICATION ERRORS

Medication errors fall into several categories, such as omitting the dose, administering the wrong dose, administering an extra dose, administering an unordered drug, administering by the wrong route, and administering at the wrong time. Here, the errors that occur when the drug order is misinterpreted are considered. Very often, the way the amounts are expressed in the original order for weights, volumes, and units can cause interpretational errors.

For instance, writing .5 instead of 0.5 can result in a tenfold error, if the decimal point is missed. In general, the following rules should be followed in transcribing orders.

- Never leave a decimal point naked. Always place a zero before a decimal expression less than one. Example: 0.2, 0.5.
- Never place a decimal point and zero after a whole number, because the decimal may not be seen and result in a tenfold overdose. Example: 2.0 mg read as 20 mg by mistake. The correct way is to write 2 mg.

- Avoid using decimals whenever whole numbers can be used as alternatives. Example: 0.5 g should be expressed as 500 mg and 0.4 mg should be expressed as 400 mcg.
- Whenever possible, use the metric system rather than grains, drams, or minims.
- Always spell out the word "units." The abbreviation "U" for unit can be mistaken for a zero. Example: 10 U interpreted as 100 units. The better way is to write out 10 units.

CRITICAL THINKING EXERCISES

1. Visit a pharmacy, ask to see the prescription balance, and examine the apothecary and metric weights. Compare the 1-gram weight with the 1-grain weight. Observe the size of the 10 mg, 50 mg, and 500 mg weights.
2. Examine a number of medication orders from past weeks. See how many orders violated the principles listed in the section on prevention of medication errors.
3. Examine the labels of some foodstuffs for sodium content (usually listed in milligrams). Calculate the percentage of sodium in the products.
4. Using the manufacturer's suggested dosage information found in the package insert for a drug, calculate the dose for several clients who have been taking the drug. Compare the prescribed dose with the calculated dose.
5. Prepare a chart of flow rates for the most commonly ordered IV volumes and times of administration. Use the calibrated flow rate of your institution's IV sets.
6. Using the information on the label, compare the alcohol content of various cough syrups by calculating the number of milliliters of alcohol present in 5 mL of each preparation.

ANSWERS TO PRACTICE PROBLEMS

1. 15 mcg
2. 15 mg
3. 12 mL
4. 2.34 mL
5. 75 mg
6. 2.0 g
7. 50,000 mg
8. 2000 mL
9. 0.23 mg
10. 0.25 g
11. 2,500 g
12. 500 mL
13. 15 dL
14. 0.02 g
15. 700 mcg
16. 96 fluid ounces
17. 255 gr
18. 6.5 gal
19. 0.42 fluid ounces
20. 4.33 g
21. 24 pints
22. 1.25 mL
23. 7.5 mL
24. 0.3 mL
25. 2.25 mL
26. 7 mL
27. 1364 mg
28. 1193 mg
29. 142 mg
30. 47 mg
31. 1386 mg
32. a. 0.25 m^2
    b. 0.198 m^2
    c. 0.65 m^2
33. 94 mg
34. 12.25 mg
35. 190 mg (BSA = 0.82)
36. 2.14 mg (BSA = 0.37)
37. 36 drops/min
38. 9 drops/min
39. 6.25 hr (375 min)
40. 6.67 hr (400 min)
41. 1 hr (60 min)
42. 45 gtt/min
43. 33 gtt/min
44. 25 gtt/min

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Drug Therapy for Pediatric Clients

5

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify anatomical and physiological factors that may result in altered drug effects in children
- Describe how pediatric dosages may be calculated
- Discuss need for caregiver consent prior to any procedures done to minor
- Apply the nursing process as related to the administration of medications to children
- Discuss general guidelines to use in teaching children about their drug therapy
- Apply the nursing process as related to the prevention of accidental poisoning in children

PEDIATRIC DRUG THERAPY

Providing safe and effective pediatric drug therapy represents a great challenge to the health professional. During the period from birth through adolescence, the pediatric client is continually undergoing dramatic changes in physical growth, psychosocial development, and sensitivity to drugs (Table 5–1). In addition to these complex changes, there is the problem of studying the effects of drugs in children. The U.S. Food and Drug Administration (FDA) regulations require that drug labeled for use in children must be fully investigated for safety and efficacy. Yet such investigations are often difficult because of the medical-legal and ethical problems posed by experiments involving children. It has been estimated that approximately three-fourths of the prescription drugs currently marketed in the United States lack full approval by the FDA for pediatric use and, therefore, lack specific dosage guidelines for pediatric clients.

Many physiological characteristics of the pediatric client may influence a drug's pharmacokinetic properties, i.e., its absorption, distribution, metabolism, and excretion (see Box 5–1).

Absorption

Absorption of an orally administered drug from the gastrointestinal tract is a complex process which is affected by gastric pH, gastric emptying time (i.e., the time it takes for a drug or food to leave the stomach and enter the small intestine) and the motility of the gastrointestinal tract. At birth, gastric pH is generally at a neutral or slightly acidic level. An adult level of gastric acidity is generally not reached until the child is 3–4 months of age. Reduced gastric acidity in the

TABLE 5–1

Classification of Pediatric Clients

AGE	CLASSIFICATION
<38 weeks of gestation	Premature or preterm infant
<1 month	Neonate or newborn infant
1 month to <2 years	Infant
2 years to <12 years	Child
12 years to <18 years	Adolescent

young child appears to be due to the relative immaturity of the hydrochloric acid-producing cells found in the stomach. Further reduction of stomach acidity may be the result of a constant diet of relatively alkaline foods, such as milk, which make up a major portion of an infant's diet. Gastric emptying is also slower in premature infants, compared with full-term infants, older children, and adults.

Absorption of drugs from intramuscular injection sites is dependent upon the size of the muscle mass injected, as well as the blood flow to the

BOX 5–1: Pharmacokinetic Differences in the Pediatric Client

ABSORPTION

- Reduced gastric acidity because the gastric acid-producing cells in the stomach are immature until the age of 3. As a result, medications, such as enteric-coated tablets, which are dependent on a low pH to break down, may pass through the digestive tract unchanged.
- Gastric emptying is slower, because peristalsis is irregular.
- The gastrointestinal tract is longer proportionately to total body size.
- Topical absorption is faster because of thinner skin and disproportionate skin surface area.
- Intramuscular absorption is more difficult to anticipate, because peripheral circulation is more affected by environmental changes. This can lead to variations in vasodilation and vasoconstriction, resulting in altered absorption.

DISTRIBUTION

- Total body water (TBW) content is much greater: between 60%–85% in infants. Percentages of circulating water are higher in the child and, therefore, children require higher doses per kilogram of weight of water-soluble medications than do older clients.
- Total body fat content is less because of increased TBW. Consequently, fat-soluble medications must be varied to achieve desired effects.
- Protein binding is decreased because of liver immaturity, resulting in reduced production of protein.
- The blood-brain barrier (a selective physiologic or anatomic capillary barrier that prevents potentially harmful chemicals from reaching the parenchyma of the brain) is immature, leading more drugs to enter the brain.
- Smaller muscle mass is due to increased TBW, reduced production of protein, and decreased muscle development from activities associated with small children.

BIOTRANSFORMATION (METABOLISM)

- The levels of enzymes are decreased because of the immaturity of the liver.
- Children (aged 2–6 years) have higher metabolic rates and, thus, may require higher levels of medication, especially older children, whose livers have established microsomal enzymes.
- Many variables affect metabolism of drugs, including the status of the liver enzymes used to break down chemicals, genetic differences, and maternal exposure to potentially harmful substances during pregnancy.

ELIMINATION

- Glomerular filtration rate is approximately 30%–50% less than an adult because of immaturity of the kidneys.
- Tubular secretion and reabsorption are decreased, due to renal immaturity.
- Perfusion to the kidneys is decreased, resulting in immature glomeruli, immature renal tubules, and a shorter loop of Henle.
- Urine pH is lower and the capacity to concentrate urine is less, which results in medications circulating longer and having the potential of reaching toxic blood levels.

injected area. As these factors may change dramatically from birth through infancy and childhood, intramuscular drug injections may result in widely varying responses depending on the child's stage of development.

Drug absorption following topical administration of a drug to a pediatric client also varies widely with age. In infants, the epidermis is relatively thin because of the relative immaturity of the stratum corneum, the outer layer of the skin. This permits topically applied drugs to be more rapidly and completely absorbed than they would be in older children or adults. It is essential, therefore, to use topical products sparingly in infants and to monitor the child for the development of both local and systemic adverse effects related to excessive absorption of the applied drug into the skin and circulatory system. A dramatic example of the hazard of rapid drug penetration through infant skin occurred a number of years ago, when several infants bathed in 3% **hexachlorophene** emulsion to control staphylococcal infection developed central nervous system toxicity because of excessive absorption of the hexachlorophene through the skin and into the circulation.

Intravenous drug administration appears to produce the least variable drug response in pediatric clients of different ages, as this method of administration completely bypasses the absorption step. As a result, this route is frequently used in hospitalized children.

Distribution

Drug distribution is the passage of a drug from its site of absorption to peripheral tissues. Distribution is dependent upon the amount of water and/or fat in the client as well as the affinity of the drug for plasma and tissue protein-binding sites. Age-related changes in the amount of water and fat are important in the pediatric client, as the amount of drug that dissolves in body water or fat often determines how much drug will eventually reach the receptor site or how quickly the drug will get there.

In the adult, water makes up about 55% of total body weight. In the full-term infant, total body water (TBW) may be about 70%–75% of total body weight, and in the premature infant, TBW may account for as much as 85% of body weight. This relatively greater proportion of water may significantly alter the concentration of an administered drug in body fluids, requiring the use of higher doses of water-soluble drugs in pediatric clients, per unit of weight, than would be given to an adult. The proportion of body weight consisting of fat tends to increase with increasing age. One would therefore expect fat-soluble drugs to undergo changing patterns of distribution as a child passes from infancy to adolescence.

The binding of drugs to plasma and tissue proteins is dependent upon the:

- concentration of binding proteins in the body
- affinity the proteins have for a drug
- presence of competing substances for protein-binding sites

Drugs that bind to protein are generally bound to a lesser degree in pediatric clients than in adults. This may be due to relatively lower protein concentration in the pediatric client or to decreased affinity of the protein for drug molecules. Diminished protein binding may result in a greater proportion of a drug remaining in the active, unbound state and, as a result, produce greater than expected activity. Care must therefore be exercised when administering drugs normally bound to plasma or tissue proteins to pediatric clients.

Metabolism

Drug metabolism involving liver enzymes is an important method by which the body inactivates potent drugs and promotes their elimination. During the last few years, it has become increasingly evident that age-related changes in metabolism occur in the pediatric client, but are frequently difficult to predict because of developmental and genetic differences from client to client. Maternal drug history seems to play a particularly important role in determining the neonate's drug-metabolizing capability, as intrauterine drug exposure may increase or decrease the liver's production of metabolizing enzymes. Similarly, drugs transmitted to infants through human milk may affect the level of metabolizing enzyme production in the nursing infant.

Excretion

Renal excretion is the primary pathway of elimination for most drugs. Such excretion is the net result of three processes:

- *glomerular* filtration
- active tubular secretion
- passive tubular reabsorption

Renal drug elimination in the pediatric client is greatly dependent upon the level of maturation of the kidney. In the neonate, the kidney receives a relatively low fraction of the total cardiac output. In addition, there is incomplete development of the glomeruli and renal tubules, as well as a significantly shorter loop of Henle than is found in adults. As a result, neonates generally exhibit a considerably lower level of renal function and concentrating ability than older children or adults. As glomerular filtration capability generally does not reach adult levels until the age of 5 months and tubular secretion levels do not reach a mature level until about 12 months of age, it is essential that appropriate attention be directed to the drugs and dosages employed in the treatment of neonates and young infants.

Pediatric Drug Sensitivity

Many pediatric clients, particularly neonates and infants, are more sensitive to the effects of drugs because of the immaturity of their organ systems. For example, many drugs that affect the central nervous system (**barbiturates** and morphine) produce exaggerated depressant effects in neonates and infants. This may be attributed to the central nervous system not being fully mature until the age of 8 months and the blood-brain barrier being more permeable in very young clients.

Body temperature control also may be disrupted by many drugs in infants and young children, because of the immaturity of the temperature regulatory system. **Salicylates** and acetaminophen reduce fever when administered at therapeutic doses, but may cause *hyperthermia* when an overdose is given. Similarly, **antihistamines** and other drugs with *anticholinergic* activity may cause hyperthermia in young children by interfering with sweating.

Agents that affect the cardiovascular system may also produce exaggerated effects in neonates and infants because of the immaturity of this system. General **anesthetics**, **diuretics**, and **antihypertensive** drugs may adversely affect the immature cardiovascular system.

Determining Pediatric Dosages

Establishing an appropriate drug dosage for a pediatric client is a complex task. Traditionally (as described in Chapter 4), such calculations were based upon the age or weight of a child as compared to those of a "normal" adult. For example, if 150 pounds was assumed to be a "normal" adult weight, then a 30-pound child would receive one-fifth of an adult dose of a drug. Such approximations are generally not very accurate, because they are based upon the incorrect assumption that a child is a miniature adult.

Pediatric dosage calculations based on age alone are not generally very accurate, as children of the same age may have widely varying height and weight. Likewise, using weight alone as a means of calculating dosage is often inaccurate, as weight alone does not provide for differences in maturation and organ development. Calculation of body surface area (BSA) by the use of a nomogram that combines height and weight data seems to provide fairly good correlation to appropriate pediatric dosage (Figure 4–1). Such nomograms are generally accurate only after maturation of liver and kidney function has been attained, however.

KEY NURSING IMPLICATIONS 5–1

Administration of Medication to Children

ASSESSMENT

1. Obtain baseline data on vital signs, height in centimeters, and weight in kilograms.
2. Take a medication history from the caregiver including any history of allergy.

PLANNING AND IMPLEMENTATION

1. Remember the seven rights of medication administration.
2. Always document medications administered appropriately.
3. The child's developmental stage is an important factor to consider when planning to administer medications.
4. In administering medications to children, there is no substitute for a warm, trusting relationship between child and nurse.

EVALUATION

1. Assess the child's response to medications carefully.
2. Discuss evidence of effectiveness, side effects, and adverse reactions with the caregiver.

NURSING CHILDREN RECEIVING MEDICATIONS

Special modifications of usual adult procedures are needed when caring for children receiving drug therapy. These include alterations in the techniques used to administer medications, teaching parent(s) and children about medication and drug administration procedures, and providing instruction about the prevention of poisoning.

Assessment

It is important to consider some aspects of nursing assessment as they are related to drug therapy in children.

When the nurse is admitting the client, it is important to obtain baseline data that may be helpful in determining drug dosages and evaluating the effects of treatment. Take the child's vital signs. Also take height (or length in infants) in centimeters and weight readings in kilograms. Secure from the parent(s) a medication history and a personal and family history of allergy. It is often helpful to determine at this time what experience the child has had with taking medications, including the routes of drug administration.

Nursing Diagnoses

Including but not limited to:

- Risk of injury related to administration of medications
- Risk of injury related to adverse effects of medications
- Risk of injury related to idiosyncratic reactions due to altered metabolism and excretion secondary to young age
- Risk of poisoning related to medicines stored in unlocked cabinets accessible to children
- Risk of altered nutrition related to medication therapy
- Deficient knowledge related to medications, safe doses, adverse effects of medications

Planning/Goals

- Client takes or receives medications safely without injury or poisoning.
- Client is free of complications associated with the adverse effects of medications.
- Client does not experience nausea, vomiting, weight loss, or decrease in food or fluid intake during medications.
- Client (or parents) verbalize understanding of precautions, medication administration, adverse effects, and when to contact physician.

Implementation: Administration of Medications

When giving medication to children, the nurse ensures that the seven rights of medication administration are adhered to. These are discussed in detail in Chapter 2. They are the right medication, in the right amount, to the right client, at the right time, in the right manner, the right for the client to refuse medication, and the right documentation of the medication administered. These rights are always important in administering medications, but are especially critical in working with children. For example, a small error in a child's drug dosage is likely to have more negative consequences than the same type of error made in an adult.

Two major factors govern medication administration in children. These are the child's developmental stage and the route by which the medication will be administered. These factors will be discussed in detail. It is important, however, to consider first the nurse's general approach in administering medications to children. General principles of administration, besides the seven rights, include ensuring that sufficient time is allowed for administering medication and approaching the child with a calm, firm, and positive manner. The nurse's manner indicates that the child is expected to take the medication. Allowing sufficient time is important for explanation, gaining the child's cooperation, and preventing problems such as choking or gagging when oral medication is administered. It is also important to pay particular attention to identifying the child, as children cannot always state their names and may give only a first name or nickname when asked to identify themselves. The nurse must ensure that all children wear an identification bracelet and that the child or the child's caregiver also identifies the child by name whenever possible.

Nurses must also provide support for the child before, during, and following the administration of medications. Not only is there no substitute for a warm, trusting relationship between the nurse and child, but a trusting relationship makes the child's cooperation more likely. Nothing should be done to threaten the relationship between the

BOX 5–2
Guidelines for the Administration of Medications to Children

- The nurse's approach to a child must be based on a knowledge of growth and development and on the individual needs and preferences of the child.
- Establish a trusting relationship with the child.
- Always be honest about what is unpleasant or painful. This may mean tasting a small amount of liquid medication to be able to describe its taste to the child.
- Use a kind but firm approach to the child.
- Secure assistance when giving parenteral drugs to children who may be restless or uncooperative.
- Explain the procedure to the child in terms that are easily understood. Whenever possible, relate the experience or sensations to something the child has experienced.
- Obtain information from the caregiver(s) about family and personal history of allergy, how the child usually takes medications, liquids the child likes, and the child's preferred name.
- Consent must be obtained from caregiver(s) before medication administration.
- Provide instruction and support for the parents or caregivers, as well as for the child.
- Avoid mixing medications into essential foods or milk, as this may cause the child to avoid these foods.
- Whenever possible, give children choices or involve them actively in taking their medication, e.g., selecting injection sites or juice to be taken with their medication.
- Never tell children the medication is candy or deceive them about what they are taking.
- Let other caregivers know which approaches have been most effective in getting the child to take medication.
- Praise children for their cooperation, but do not punish when they are uncooperative.

nurse and the client, so the nurse must be honest about procedures and clear in explanations. The nurse must never lie to the client by saying that an injection will be totally painless or that a drug has a pleasant taste when it does not. General guidelines for the administration of medications to children are listed in Box 5–2.

Oral Medications. The age and developmental stage of the child are important factors in determining the nurse's approach to the child and the equipment to be used in administering medications. Guidelines for the administration of oral and parenteral medications to young children are given in Table 5–2.

In addition to the information summarized in the table, several other hints may prove useful in administering medication to young children. If children object to the taste of medication, the medication may be mixed with honey or sweet syrup, unless this is contraindicated, e.g., for a diabetic child. In general, tablets can be crushed and capsules opened and mixed with a suitable vehicle. Exceptions to this are medications that are enteric-coated, because they are irritating to the stomach, and sustained-release preparations. (Review the guidelines in Chapter 2.) If there are questions about what drugs may be administered in this way, the nurse should consult with a pharmacist. Of course, children with *diabetes mellitus* (see Chapter 35) should not receive carbohydrates that are not calculated into their diet.

For some children, placing ice in the mouth for a few minutes before giving the medication may decrease taste sensation when bitter medications are being given. Also, swallowing something sweet after taking the medication may make the medication acceptable to the child. Giving the medication through a straw may also decrease its taste sensation.

KEY NURSING IMPLICATIONS 5–2

Administration of Oral Medications to Children

1. The child's developmental stage and the type of medication are important factors to consider in administering oral medications.
2. With some exceptions, tablets may be crushed and capsules opened and the powder mixed with a sweet syrup. The use of ice before taking bitter medication or using a straw may decrease taste sensation.
3. Liquid medications may be administered using a small spoon, dropper, or syringe without a needle.

TABLE 5–2

Guidelines for the Administration of Oral and Parenteral Medications to Young Children

BIRTH TO 3 MONTHS	
Oral Medications	• Hold the infant while supporting the head well. • Medications may be administered by nipple, dropper, or syringe, *without* a needle. • Administer the medication slowly, angling the medication slightly toward the child's cheek to prevent coughing, choking, or aspiration. • Schedule medication when the infant is hungry. • Medication is more easily taken in small volumes, and the amount given must be controlled to prevent choking or drooling.
Parenteral Medications	• The preferred intramuscular injection site is the vastus lateralis muscle of the thigh.
3 TO 12 MONTHS	
Oral Medications	• Hold the child securely. • Medication may be given by a syringe, *without* a needle, followed by juice or water from a bottle or cup. Angle the medication toward the cheek. • If the child has learned to drink from a cup, a small medicine cup may be used.
Parenteral Medications	• A second person can assist the nurse by providing support, diversion, and restraint.
12 TO 18 MONTHS	
Oral Medications	• Gain child's cooperation and determine what has been effective at home. • Allow child to explore empty medicine cup and to select a drink to wash down medication. • Disguise crushed tablets and disagreeable liquids in small amounts of solid or liquid foods.
Parenteral Medications	• Provide comfort and diversion following the injection so that the child does not learn to associate only pain with the nurse.
18 TO 30 MONTHS	
Oral Medications	• Gain child's cooperation. Offer choices of position, drink to wash down medication, etc. • Give simple directions about what you want the child to do. • Be prepared for resistive behaviors. Use a firm, consistent approach. • Allow child to drink liquids from medication cup.
Parenteral Medications	• Gain cooperation, give simple directions, and be prepared for resistive behavior when administering injectable or oral medication.
2½ TO 3½ YEARS	
Oral Medications	• Use a *calm*, positive approach. • Explain in simple words why the medication is given. • Offer the child choices whenever possible.
Parenteral Medications	• The same approaches apply to parenteral as to oral medication administration. • Allow child to express anger. • Child may be permitted to handle syringe without the needle.
3½ TO 6 YEARS	
Oral Medications	• In simple terms, explain the procedure and reason for the medication. • Allow the child to make a choice regarding the order in which medication is taken. • Disguising disagreeable medications may be difficult, as a child can distinguish tastes and smells.
Parenteral Medications	• Child may cooperate by selecting and helping to cleanse injection site.
7 YEARS AND OLDER	
Oral Medications	• Provide explanations suitable to the developmental maturity of the child.
Parental Medications	• Obtain the child's cooperation.

Various types of equipment are available for administering medications to children. Liquid medications may be administered using a small spoon, a dropper, or a syringe without a needle. For small amounts of liquid medication, a tuberculin syringe without the needle may be the most accurate measuring device. Never use the same syringe or dropper for more than one child. When you are finished administering medication using a dropper, rinse it in warm water, dry as much as possible, and store it in a clear plastic bag with the child's medication. Older children may use spoons specially designed to measure and administer standard dosages of medication (Figure 5–1). Such measuring devices are frequently available at local pharmacies. Older children should be permitted to handle the equipment, without the medication in it, to become familiar with devices and help overcome their anxiety.

Parenteral Medications. Children require special preparation whenever parenteral medication is to be administered. The type of the preparation and the language and detail that are used to prepare the child depend on a child's developmental level. Be sure to explain the procedure to the parent(s) and have them assist you in providing support to the child. Often pediatric units have materials available to help you provide and explain parenteral therapy to children of different ages. These materials include booklets, coloring books, puppets, dolls, and equipment such as an intravenous setup containing colored water. Never allow the child to play with a syringe that has a needle attached. Box 5–3 presents general principles of teaching children.

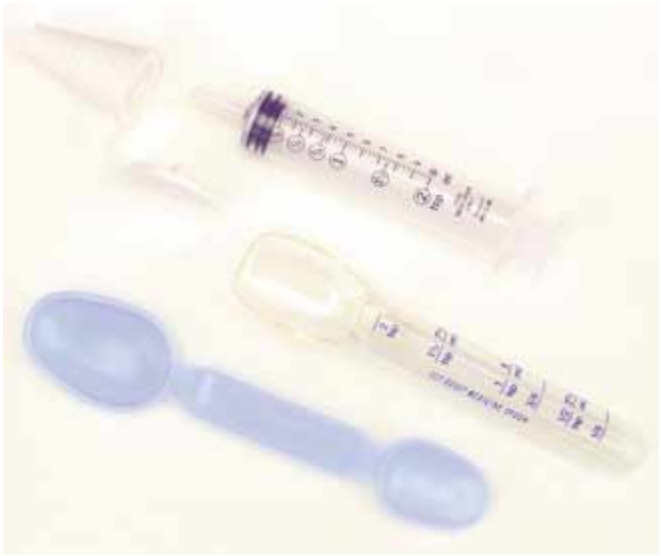

Figure 5–1 Devices for administering medications to a child.

In general, when administering medications parenterally, the following nursing considerations are important:

- The child must be prepared for the procedure, both physically and psychosocially. The application of EMLA (eutectic mixture of local anesthetics—lidocaine 2.5%, prilocaine 2.5%) cream to the proposed injection site 1–2 hours before the procedure will provide up to 0.5 mm of anesthesia.
- The nurse should explain the procedure based on the child's level of growth and development.
- Parents (caregivers) should be offered the option of staying with the child. If they choose to stay, they should only be offering psychosocial support and should not be expected to restrain the child.

KEY NURSING IMPLICATIONS 5–3

Administration of Parenteral Medications to Children

1. Always explain the procedure well and have parents provide support when possible.
2. Use a firm, positive manner.
3. Provide sufficient, appropriate restraint to ensure the child's safety.
4. Intramuscular site selection depends on the child's age and muscular development. In children under 3 years, the preferred site is the vastus lateralis muscle.
5. The deltoid muscle is not fully developed until adolescence and is not used as a site in children under 18 months.
6. The length of needle selected for a subcutaneous injection ranges from ⅜ to ⅝ inch, depending on the child's age and subcutaneous tissue.
7. Intravenous sites should be selected so that the child's activity is not limited.
8. Electronic infusion devices are often used to ensure accurate administration of intravenous fluids. Keep the controls away from the child.
9. Rectal medications are usually administered by suppository.

- Painful procedures should not be performed in the child's room, as this is a safe haven. Children should be escorted to a treatment room for the parenteral medication administration, if an IV access is being established or an intramuscular injection is being given.
- The nurse uses a firm, positive manner when approaching the child.
- Equipment should be assembled before entering the room.
- The procedure should be carried out as quickly and gently as possible.
- Consideration must always be given to the child's safety; this includes proper restraint of the child during the procedure and protection of intravenous injection sites.
- Support is provided for the child before, during, and following the procedure.
- Involve caregivers for teaching for future medication administration after discharge.

BOX 5–3 Teaching Children About Drug Therapy

1. Readiness to learn is a critical factor in initiating teaching.
2. Teaching must be geared to the developmental level of the child. This requires that the nurse gauge the child's mastery of language and ability to deal with ideas conceptually.
3. Find out what the child knows and believes about his/her illness and its treatment. Correct misconceptions.
4. Children generally have short attention spans, 1 to 5 minutes per year of development, so instruction and explanations must be provided in brief segments.
5. Relate information to the child's life experiences, whenever possible.
6. Make use of role playing and visual aids the child can handle.
7. Instructional booklets geared to the child's level of understanding may be useful teaching tools. Always remember to review these booklets with the child.
8. Provide instruction for the child's caregiver(s) as well as for the child.
9. Praise the child and provide rewards for learning skills.

Intramuscular Injections. An important consideration in giving intramuscular injections to children is the selection of a site. Site selection depends on the child's age and muscular development, as well as on such general considerations as the necessity to rotate sites. In children under 3 years, the preferred injection site is the vastus lateralis muscle. Figure 5–2 shows the location of this injection site. Keep in mind that this is also the most painful IM site because of innervation.

If the child is 3 or older and has been walking for at least a year, the ventrogluteal and dorsogluteal injection sites may be used (refer to Figures 2–10 and 2–11). The deltoid injection site is not frequently used in young children because this muscle is not fully developed until adolescence. This injection site is located one finger-width below the acromian process in children (see Figure 2–7).

Children receiving injections in the dorsogluteal site should be instructed to lie on their abdomen with the toes pointing inward to relax the buttock muscles. All children can be requested

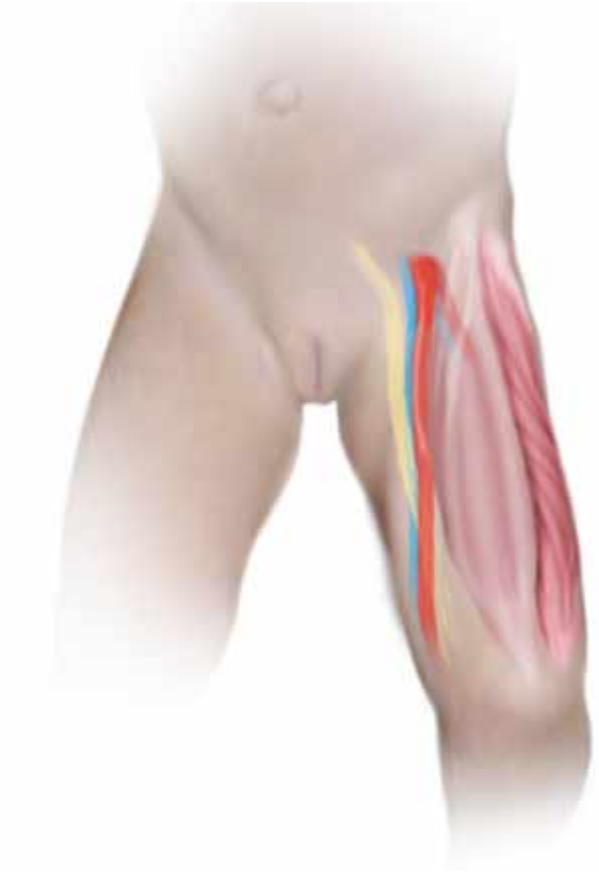

Figure 5–2 Anterior view of the location of the vastus lateralis muscle in a young child.

to squeeze the hand of an assistant when they feel the needle prick. Depending on the age of the child, diversions such as counting or talking may be helpful. Many children can be actively involved in the procedure by helping to cleanse the site or by applying a brightly colored bandage following the procedure.

The procedure for giving an intramuscular injection is described in Figure 2–6.

Subcutaneous Injections. Before giving a subcutaneous injection to a child, review the procedure given in Figure 2–11. Several modifications may need to be made in that procedure, depending on the child's age and the location and amount of subcutaneous tissue. Examine the child to locate a good site. Check the outside of the upper arms, the thighs, buttocks, or lower quadrants of the abdomen. Test for adequate subcutaneous tissue by gently pinching the skin between your thumb and forefinger. Site rotation is important whenever the child will be receiving frequent subcutaneous injections. The length of the needle selected for the injection depends on the child's age and amount of subcutaneous tissue. In infants and thin children, a ⅜-inch or ½-inch needle is used. In older children and those with greater subcutaneous tissue deposits, a ⅝-inch needle may be used.

Intravenous Therapy. As with other parenteral medication administration procedures, the child needs special preparation before receiving intravenous medications. A simple explanation geared to the child's level of understanding is important. For children up to preadolescence, it may be useful to allow them to handle the equipment and pretend to administer the medication to a doll or stuffed animal.

The general procedures for the administration of intravenous medications are given in Figures 3–1 through 3–10. There are some special considerations when the client is a child. The first consideration is selection of an appropriate site. Whenever possible, the site selected should not severely limit the child's activity. In infants and very young children, a scalp vein or superficial vein in the hand or arm is often chosen. A small area of hair may need to be shaved when a scalp vein is used. This may be upsetting to the parent(s), who should be prepared for the procedure and understand why a scalp vein is used. Older children generally receive intravenous medication through larger veins in their hands or arms. Whenever possible avoid using the dominant hand.

A second consideration is the *gauge* of the needle or catheter selected. In general, small-gauge needles or catheters are selected. The gauge may range from 21 to 27 depending on the size of the vein, age of the child, and fluid to be infused. For prolonged treatment a catheter is preferred to a needle.

Additional attention must be given to the selection of method and equipment. For example, most children will be receiving fluid and medication by way of administration sets that deliver 60 or 100 drops per milliliter. Low volume tubing that holds only 0.06 mL/foot may be used instead of standard tubing that holds 1.9 mL/foot.

There are four methods used to administer intravenous medications, particularly antibiotics, to young children when the child has an established intravenous line. The first method is IV push or bolus administration where the injection of medication occurs over five minutes or less. The advantage of this method is speed, and the nurse or other person administering the medication is present to assess the immediate response to the drug. In some hospitals, the physician is required to administer the first antibiotic dose by IV push to children since this is when adverse reactions are likely to occur. To minimize the risks, the nurse should ensure the injection is given over a period of at least one minute, and the client is carefully observed. The site selected is generally the port on the line closest to the child.

One way to administer antibiotics to children is through a special administration chamber as in the *soluset* method (see Figure 3–4). This method allows for an administration period of from 5 minutes to 2 hours. The disadvantage of the method is of timing, because if the flow rate of the infusion is low, the child may not obtain the benefit of the medication for several hours. For safety, the nurse should never permit more than 100 mL to be admitted into the administration chamber of volume control sets. The amount of fluid is dependent on the age of the child, the child's fluid needs or restrictions, and the nature of the drug and is often specified by the physician's order.

The third method to administer medications to children is the *retrograde* method. This method is used particularly with infants to prevent fluid

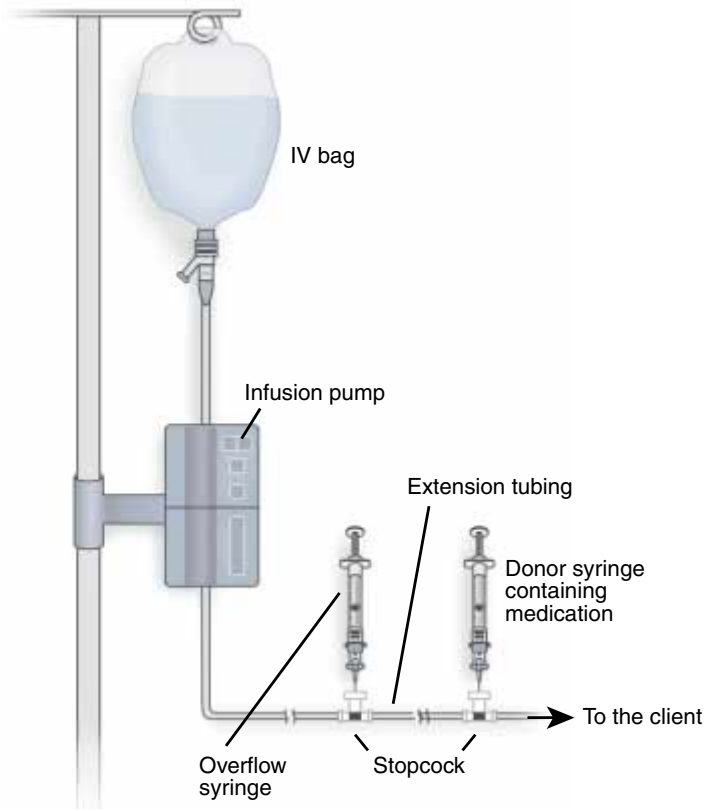

Figure 5–3 A retrograde infusion set permits drug administration while displacing an equal volume of fluid from the IV line.

overload. To administer drugs by retrograde infusion, a special administration set is used (Figure 5–3). The nurse first attaches this set to the current infusion line, then attaches the syringe containing the medication in its appropriate dilution to the stopcock closer to the child. The stopcock closer to the child is turned off. Next, the nurse connects the displacement syringe to the stopcock nearer to the infusion bag and closes the stopcock to the bag. The nurse then infuses the drug through the dosage syringe in a retrograde direction (away from the child). This causes an equal volume of fluid to be displaced into the displacement syringe. This fluid can then be discarded to prevent administration of excess fluid to the child. To deliver the drug, both stopcocks to the syringes are opened and the infusion is administered.

The last method of infusing drugs is called the *syringe pump*. This method gives the greatest control over the infusion. Although the pumps are very expensive, they are commonly used. When they are used, the nurse must be certain that the child is unable to tamper with the flow rate controls.

The method of intravenous administration is usually specified in the physician's order, which includes the amount of drug, amount of fluid, frequency of administration, and often the time for administration. Nursing assessment of the child and accurate recording of the amount of fluid infused are critical elements for children. Often when children are receiving infusions, an electronic infusion device is used to ensure accuracy in intravenous fluid administration. This is because children are very susceptible to fluid overload or dehydration and must have fluid administration carefully monitored. Keep the pump or controller out of the child's reach and turn the controls away from the child to prevent tampering. As with

adults, the use of an electronic infusion device does not decrease the importance of hourly assessing the integrity of the site, the progress of the infusion, and the general condition of the client.

Another nursing consideration for children receiving intravenous fluids is protection of the injection site. Children who are old enough to understand must be instructed not to tamper with the tape or equipment, but to call the nurse if they are uncomfortable. Younger children may need to have the IV site more strongly secured, with the goal of protecting the site while allowing for maximum activity. Meeting this goal requires considerable ingenuity on the part of the nurse. First, whenever possible use a clear occlusive dressing to secure the needle or catheter. This will permit easy inspection of the site. When the injection site is located in the hand or arm, an armboard of appropriate size may be used for restraint. Additional protection may be gained if a piece of stockinette is slipped over the arm and board and secured with tape (Figure 5–4A). As this obscures the injection site, an alternate method is to cut a clear plastic medicine cup in half lengthwise and to tape it over the site (Figure 5–4B). When this method is used, always be sure to protect the skin from the cut edge of the cup with tape or a small gauze pad. Professionally manufactured site protectors are available and are supplied with instructions for their use. If a scalp vein has been used, a small paper cup may be used to protect the site (Figure 5–4C). The cup is prepared by cutting off the bottom and making a small cut area for the tubing to pass through. The cup is then taped to the infant's head, taking care to avoid taping it to the child's hair.

Frequent monitoring of intravenous medication and fluid administration is required. Assess the child's tissue *turgor*, urinary output, and vital signs. Be sure to review the complications of intravenous therapy in Chapter 2. Also remember to record the amount of fluid received on the child's intake and output record.

Rectal Medications. Children may receive medication by retention enema or suppository but these should be avoided, if possible. Retention enemas are usually prepackaged and are supplied with instructions for use. The procedure for administering a suppository is given in Box 5–4.

Other Administration Procedures. See Figure 2–15 for the procedure for administering ear drops. Remember that in children under 3 years, the pinna should be pulled back and down. In older children, the pinna is pulled back and up.

See Figure 26–5 for the instillation of eye drops and Figure 27–1 for the instillation of eye ointment.

A. Stockinette and armboard
Slip a piece of 4" stockinette the same length as the child's arm over the armboard. Stretch the stockinette underneath the armboard and tape securely.

B. Medicine cup
Tape a clean, clear plastic medicine cup cut in half lengthwise over the IV site. Protect the skin from direct contact with the cut edge of the cup.

C. Paper cup
Cut the bottom of a small paper cup and cut an opening for the IV tubing to pass through. Tape the cup securely to the child's scalp.

Figure 5–4 Protecting an IV set in a child.

Teaching

Throughout the discussion of medication administration, comments have been made about explaining procedures to a child and parent(s). Teaching children about their medication can

BOX 5–4
Administration of Rectal Suppository

1. Wash your hands.
2. Check the order.
3. Assemble the equipment you need, including disposable gloves, water-soluble lubricant, tissues, and the medication.
4. Check to be certain you have the right client.
5. Explain the procedure to the child in clear, simple terms. Many young children have had their temperatures taken rectally, and the procedure for insertion of the suppository may be compared to temperature taking.
6. Provide the client with privacy and ask the child to turn onto the left side with the right leg drawn up. When giving a suppository to an infant or toddler, you can position the child on his/her back with legs flexed.
7. Put on disposable gloves. The suppository will be inserted using the index finger, except for children under 3 years. In very young children, you may use the little finger.
8. Remove the suppository from its protective wrapper and lubricate the tip with a small amount of water-soluble lubricant.
9. With the nondominant hand, separate the buttocks to expose the anus. If the suppository has been in a refrigerator, tell the child it may feel cool.
10. Ask the child to breathe deeply through the mouth and insert the suppository into the rectum, tip first.
11. Advance the suppository past the anal sphincter.
12. Withdraw your finger and press the buttocks together for a few minutes. Tell the child that he/she may feel like pushing the suppository out, but should not. Take the opportunity to hold the child and/or talk to the child.
13. Remove and dispose of the gloves and wipe excess lubricant from the child's anus. Position the child comfortably.
14. Wash your hands and record the procedure.

provide knowledge, increase cooperation, and decrease fear and anxiety. Chapter 2 discusses client teaching, and those general guidelines should be reviewed before planning a teaching program or providing explanations to parents and children. There are some additional guidelines, however, that should be reviewed before teaching children. Box 5–3 lists some of the factors to remember when providing instruction and explanations about drug therapy to children. The nurse must continually assess the child's understanding of explanations and instructions in order to modify the teaching plan.

Evaluation

Assessment is a critical factor in evaluating a child's response to drug therapy. Many children are too young to notice or to call the nurse's attention to physical or behavioral side effects, skin rashes, and other responses to medication. The nurse must be alert to the child's response to medications, record the response, and intervene appropriately. The nurse should discuss evidence of therapeutic effectiveness (e.g., decrease in body temperature, side effects, and adverse effects) with the prescriber.

- Client experienced no injury related to medication administration.
- Client demonstrated improvement in condition related to successful medication therapy.
- Client showed no evidence of complications associated with the adverse effects of medications.
- Client received medications safely without injury or poisoning.
- Client experienced no weight loss or decrease in food or fluid intake during medications.
- Client (or parents) could repeat the importance of taking medications as prescribed, an understanding of precautions, medication administration, adverse effects, and when to contact physician.

POISONING

In the United States there are an estimated five to seven million cases of poisoning reported each year. Approximately 80% of these are accidental poisonings occurring in children 5 years of age and younger. About 90% of all poisonings in children take place in the home and most are preventable.

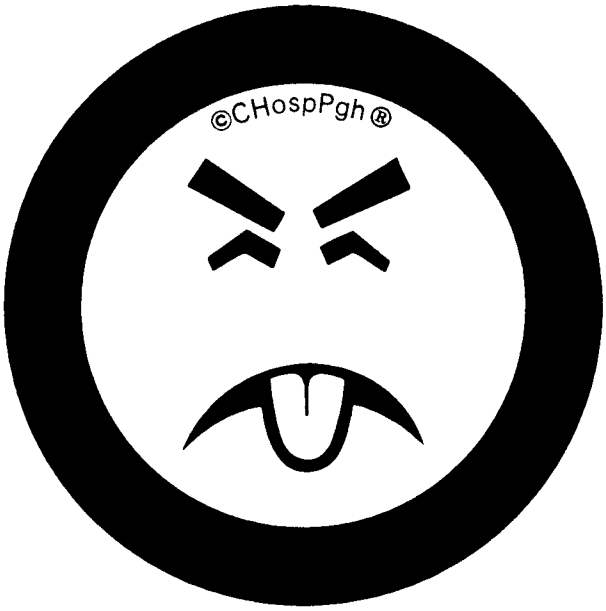

Figure 5–5 Mr. Yuk and similar symbols can be purchased as self-adhesive stickers. On these stickers, the local poison control center phone number may be printed. *(Permission to reproduce Mr. Yuk has been granted by Children's Hospital of Pittsburgh.)*

Nurses in institutional and community settings should provide instruction and guidance for parent(s) and child caregiver(s) in the prevention and treatment of poisonings. Such actions as providing proper supervision for children, use of child-resistant caps on medication containers, placing child-resistant locks on medicine and chemical cabinets, and keeping medications and chemicals out of the reach of children could prevent many poisonings each year. Appendix 4, Toxicology Guidelines, discusses poison prevention, toxicology of common poisons, and treatment of poisoning in more detail.

Whenever children are in a home, even temporarily as in the grandparent's home, a bottle of syrup of **ipecac** should be available. When used as directed, syrup of ipecac is both safe and effective in inducing vomiting. A 1-oz bottle may be purchased at the pharmacy without a prescription. This preparation will retain its effectiveness for years. Parent(s) should be instructed to keep the phone number of the local emergency room, ambulance service, personal physician, and poison control center by the phone. If the child ingests a poisonous substance, the parent or caretaker should be instructed to call a health care provider who will provide instruction about whether or not to induce vomiting. Vomiting should not be induced if the child is comatose, if the poison is corrosive, or if it is a petroleum product. In other cases, parent(s) are instructed to give children syrup of ipecac. Although there is not one standard dosage schedule, the following chart can serve as a general guide:

KEY NURSING IMPLICATIONS 5–4

Accidental Poisonings

1. Nurses should provide instruction in the prevention and immediate treatment of common poisonings.
2. Syrup of ipecac should be available in all homes where children spend time.
3. After ingesting a poison, vomiting is *not* induced if the child is comatose, if the poison is a corrosive, or if it is a petroleum product.

AGE	IPECAC SYRUP DOSAGE	FOLLOW IPECAC WITH THIS VOLUME OF WATER
6 months–1 year	1 teaspoonful (5 mL)	4–8 oz
1–2 years	2 teaspoonfuls (10 mL)	8 oz
2–12 years	1 tablespoonful (15 mL)	16 oz
Over 12 years	2 tablespoonfuls (30 mL)	24–32 oz

It is very important to give water with ipecac to ensure that the ipecac comes into contact with the entire lining of the stomach. If vomiting does not occur within 20 minutes, a second dose may be administered. Vomiting can also be induced by placing a finger or the handle of a spoon at the back of the throat while holding the head down. Gently bouncing the child often induces vomiting.

Recent research has indicated that **activated charcoal** or **magnesium sulfate** may be more effective in preventing absorption of salicylates than syrup of ipecac. Poison control centers can provide advice about this and other poisonings.

Prevention is the preferred means of reducing accidental poisonings in children. The nurse can play a major role in making parent(s) aware of the ways they can protect their children. One successful approach in reducing the incidence of childhood poisoning is conducting educational programs that teach the child to stay away from hazardous locations or dangerous products by labeling dangers with an easily identifiable symbol. One of the most popular of these is the "Mr. Yuk" symbol (Figure 5–5).

CASE STUDY

Mary Singh, 3 years old, developed an acute respiratory infection, which her pediatrician is treating with 200 mg of **Pediamycin** (**erythromycin ethylsuccinate**), an antibiotic. She is scheduled to receive this medication 4 times a day. This medication is available as a cherry-flavored premixed suspension. You will be giving the first dose to the child and instructing the parent(s) about the drug therapy. You check the label and note that 200 mg of Pediamycin are in each teaspoonful.

Questions for Discussion

1. What general guidelines are followed in administering an oral medication to young children?
2. What special factors will the nurse consider when administering medication to a child of this age?
3. What are the advantages of using a spoon specially designed to measure and administer medication to a child?
4. Why would the nurse instruct parents not to tell the child that the medication is candy or a treat?

HOME CARE/CLIENT TEACHING

1. Stress the importance of avoiding disguising medications in essential foods, e.g., don't put medication in infant formula, orange juice, or cereal, because child may not take all of a dose and child may refuse essential foods because of altered taste due to medication flavor.
2. Instruct parents not to treat medications as "candy." Medications should be called medications and the dangers associated with medication should be explained to the child.
3. Instruct parents to keep all medications out of reach of children and in a locked cabinet.
4. Medication administration routes should be taught and the nurse should have the parents demonstrate their ability to safely administer medication.
5. Emergency numbers should be kept close to the telephone including numbers for the local poison control center and the child's physician.
6. Parents should be encouraged to obtain syrup of ipecac for their home and be provided with instructions on its use.
7. Child-proof medication containers should be requested for medications stored in the home.

CRITICAL THINKING EXERCISES

1. Develop a plan to teach a 6-year-old and a 16-year-old about antibiotic therapy.
2. Prepare an instructional booklet about intravenous drug therapy for a particular age group, e.g., school-age children.
3. Develop a brief program on poison prevention for:
   - a kindergarten class
   - parent(s) of young children
   - teenage babysitters
   - grandparents
   - staff at a community residential center for children with mental or physical disabilities
4. Write a brief paper on accidental poisonings in children, including the most common poisons, usual times that poisoning occurs, and other important factors.
5. Make a chart that describes ten poisonous plants found in and around the home.
6. What is the only safe intramuscular site for children under 3 years old? What is this site's main disadvantage?

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Drug Therapy for Geriatric Clients

6

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify anatomic and physiological factors that may result in altered drug effects in the elderly
- Identify social and environmental factors related to drug problems in the elderly
- Describe the assessment of older persons who are using medications
- Apply the nursing process related to the administration of medications to elderly clients
- Discuss general guidelines to use in teaching the elderly about their drug therapy

GERIATRIC DRUG THERAPY

The elderly (65 years of age and over) make up about 15%–20% of the U.S. population and represent the fastest growing segment of the population. It has been estimated that the 65-and-over age group in the United States increases by about 2% a year, while the under-65 age group is growing at only 0.8% a year. As new disease prevention and treatment methods are developed, life expectancy will probably increase, and the proportion of the population in the elderly range can be expected to continue to grow at a rapid rate.

Although representing about 15%–20% of the population, the elderly consume about 30% of all prescription drugs in the United States. It is estimated that 70% of the elderly regularly use over-the-counter (OTC) medication as compared to only 10% of the general adult population. In a recent study of long-term care facilities, about 32% of all elderly clients received more than eight different medications daily and some received as many as fifteen. This is referred to as *polypharmacy*. As a result of this, clients taking five medications have a 50% chance of drug interactions, which rises to 100% if the client is taking eight or more medications. The elderly are more likely to have chronic illnesses than younger adults: 80% of the elderly have one or more chronic illnesses. It has been estimated that about 50% of the total spent on health care in the United States is directed toward the treatment of the elderly. A portion of these costs related to hospitalization is preventable by health professionals. It has been estimated that 20%–25% of the hospitalizations of persons beyond 65 years is the result of adverse drug reactions.

Drug activity may differ considerably in the elderly population group as compared to young adults. As with children, medical-legal and ethical considerations make it difficult to investigate the effects of drugs on the elderly. Drug therapy in the elderly is also often complicated by sensory impairment, social isolation, inadequate nutrition, and poverty.

The following are ways the pharmacokinetic properties of a drug may be different in the elderly than in younger adults.

Absorption

Drug absorption, as well as the absorption of some nutrients from the gastrointestinal tract, tends to diminish with advancing age. This can be explained by several phenomena that occur with aging. With advancing age, there is a gradual reduction in the production of hydrochloric acid in the stomach. This may influence drug absorption by affecting the way that a tablet or capsule dissolves in gastric fluids or by reducing the stability of the drug in the gastrointestinal tract. Gastric emptying rate appears to be prolonged in the elderly. This is believed to be due to a decline in muscle tone and motor activity of the gastrointestinal tract with advancing age. Prolonged gastric emptying is likely to be reflected in variable patterns of drug absorption in elderly clients. As absorption of *dissolved* drugs is not appreciably affected by gastric emptying rate, it would seem logical to *utilize liquid dosage forms, where possible, in treating elderly clients*.

The rate of passage of drugs through the lower gastrointestinal tract also seems to be affected by reduced muscle tone and motor activity. This is reflected in the development of constipation in the elderly and may explain why the elderly are the major users of laxatives in the United States. Diminished intestinal movement may alter the absorption of certain drugs from the gastrointestinal tract. The use of stimulant laxatives, on the other hand, accelerates the movement of drugs through the gastrointestinal tract and reduces their absorption. Bran and other high-fiber foods or drugs have also been shown to reduce the absorption of some drugs, for example digoxin.

Drug absorption from the gastrointestinal tract is dependent on a good blood supply to the stomach and small intestine, as blood generally acts to carry a drug from its gastrointestinal absorption site to its eventual site of action in the body. With advancing age, there is a general reduction in the flow of blood to the major organs because of the atherosclerotic changes in blood vessels and reduced cardiac output that frequently accompany the aging process. It is estimated that blood flow to the gastrointestinal tract is diminished by 40%–50% at age 65. Development of disorders that contribute to the reduction of cardiac output (e.g., congestive heart disease) can be expected to further reduce gastrointestinal blood flow and the absorption of drugs. Also with aging, the overall absorptive surface area of the intestinal tract decreases. This is due to a blunting, or flattening, of the villi that occurs as a result of the aging process. A decrease in absorption area results in a decrease in the amount of the drug that can be absorbed when taken orally.

Distribution

Drug distribution in elderly clients may differ considerably from that in younger adults. With advancing age, there is a gradual loss of water content from the body. This may diminish the volume of distribution of some water-soluble drugs and increase the blood concentration of a drug beyond expected levels.

The elderly client also experiences an age-related loss of muscle tissue because of atrophy and an increase in fatty tissue. This increase in fatty tissue with advancing age is quite pronounced. In males, there is an increase in fat from 19% to 35% from age 25 to age 65. In females the corresponding increase is from 33% to 49%. Such increases in the proportion of fatty tissue alter the distribution of fat-soluble drugs, such as some of the hypnotics and sedatives. This may result in diminished activity of these compounds in the elderly. At the same time, however, these drugs may be absorbed by the fatty tissue and released only slowly back into the bloodstream. This may prolong the effects of such drugs on the elderly and may explain why the elderly frequently experience cumulative long-term residual effects from the use of many drugs that depress the central nervous system.

The binding of drugs to proteins may influence the therapeutic response, as well as the rate of drug elimination. Any change in the binding characteristics of a drug is likely to be reflected, therefore, in the clinical response observed. In the elderly there appears to be a general decrease in the protein-binding capability of drugs. This may be the result of reduced serum albumin concentrations, which appears to be a consequence of the aging process. It may also be partially due to reduced protein intake in the diet and/or renal or hepatic disease. The presence in the plasma of other substances that compete for protein-binding sites may also decrease drug binding. Such competing substances may be other drugs or they may be chemical substances normally excreted by the kidney that have accumulated in the body because of diminished renal function.

Metabolism

With advancing age, there is generally a decline in the body's ability to transform active drugs into inactive *metabolites*. Although the causes of such a decline are still obscure, there are several possible explanations. Blood flow to the liver, as well as to most other major organs, tends to diminish with advancing age. A reduction in liver blood flow of 0.5% to 1.5% per year after age 25 has been reported. This may have a significant effect on the rate of metabolism of drugs which are primarily metabolized by the liver. The use of drugs in the elderly that are not greatly dependent on liver metabolism may reduce the likelihood of drug accumulation and toxicity.

Excretion

With aging there is a gradual reduction in renal function that may significantly affect the safe and effective use of drugs. This reduction is believed to be due to reduced blood flow to the kidneys and/or the loss of intact nephrons. At age 85, the level of renal function may be only a fraction of what it was at age 25. The presence of renal disease may even further reduce the ability to excrete active drugs and metabolites.

BOX 6–1
Pharmacokinetic Differences in the Geriatric Client

ABSORPTION

- Reduced gastric acidity because of the gradual reduction in production of hydrochloric acid in the stomach that may affect the way tablets or capsules dissolve. Because many medications require an acidic pH to break down, they may pass through the digestive tract unchanged.
- Gastric emptying is slower, because there is a decline in motor tone and motor activity in the gastrointestinal tract with advancing age.
- The rate of passage of drugs through the lower gastrointestinal tract is also slowed because of decreased muscle tone and motor activity.
- The elderly have a tendency for constipation and consequent use of laxatives and bran foods, which may accelerate the movement of drugs through the gastrointestinal system and reduce absorption.
- There is a general reduction in blood flow (diminished by 40%–50% by 65 years of age), causing blunting and flattening of villi in the intestinal tract, resulting in an overall decrease in absorptive surface area in the intestines.
- Topical absorption is faster because of thinner skin surface.
- Intramuscular absorption is more difficult to anticipate because the peripheral circulation is more affected by environmental changes. This can lead to variations in vasodilation and vasoconstriction, resulting in altered absorption.

DISTRIBUTION

- Total body water (TBW) content is decreased, resulting in diminished volume of distribution of some water-soluble medications.
- Total body fat content is increased, altering the distribution of fat-soluble medications, such as some sedatives and hypnotics. Drugs may be absorbed into fatty tissues and more slowly released into the bloodstream.
- Age-related loss of muscle tone due to atrophy alters distribution of some medications, especially those administered intramuscularly.
- There is a general decrease in protein-binding capability.

BIOTRANSFORMATION (METABOLISM)

- The levels of enzymes are decreased because of the decline in liver function with age.
- Liver blood flow is reduced by 0.5%–1.5% per year after the age of 25, thus, there is a decline in the body's ability to transform active drugs into inactive metabolites.

ELIMINATION

- Glomerular filtration rate is reduced by 40%–50%, because of the reduction of blood flow to the kidneys.
- Tubular secretion and reabsorption are decreased, because of decreased renal blood flow.
- The number of intact nephrons is decreased.
- The elderly are more likely to experience drug toxicity, because of accumulation of drugs.

Impaired renal function is an important consideration in determining the choice of drugs to be used in the elderly, as well as their dosage. In using drugs which are excreted in their intact form, i.e., not inactivated by metabolism, it is important to know whether or not the major pathway of elimination is by way of the kidneys and, if so, what the influence of renal impairment is on the elimination of the drug. The use of potent drugs eliminated unchanged by the kidneys should be preceded by assessment of a client's level of renal function. Often the determination of creatinine clearance is useful in such clients. Increasingly, manufacturers of drugs that may be potentially hazardous to renal-impaired clients provide mathematical formulas or nomograms that employ creatinine clearance data in determining appropriate dosages. A formula that relates creatinine clearance to age can be used (Figure 6–1). Even with the use of such calculations, however, it is essential to monitor elderly clients closely for the development of drug toxicity related to accumulation of creatinine in the body.

Other Factors Affecting Drug Action in the Elderly

Several other factors may affect the response of elderly clients to drug therapy. There is some evidence that the number and possibly the nature of drug receptors change with advancing age. This may result in either a greater or diminished response to certain drugs. Homeostatic mechanisms may also be impaired in the elderly. This may increase the likelihood of adverse responses to drug therapy to an extent far beyond what would be expected in younger clients. It is likely that further research will uncover other ways in which aging affects drug therapy. In the meantime, careful prescribing and close monitoring of drugs are the best means of avoiding or minimizing adverse drug effects in the elderly.

$$Cr_{male} = \frac{(140 - \text{age}) \times \text{body wt (Kg)}}{72 \times \text{serum creatinine}}$$

$$Cr_{female} = Cr_{male} \times 0.85$$

Figure 6-1 Formula suggested for estimating creatinine clearance as a function of age.

KEY NURSING IMPLICATIONS 6–1

Factors Related to Drug Problems in the Elderly

1. Sensory losses affect the elderly's ability to manage medication programs accurately.
2. Loss of recent memory affects self-care.
3. Medication problems increase with the use of multiple pharmacies and physicians.
4. As the number of drugs taken increases, medication errors increase.
5. Use of nonprescription drugs, sharing medications, hoarding drugs, and dietary factors are all related to drug problems in the elderly.
6. Communication problems also lead to drug problems.

NURSING CARE OF ELDERLY CLIENTS RECEIVING DRUG THERAPY

In addition to the physiological changes of late adulthood that have been discussed, a number of other factors may place the elderly at risk for drug-related problems. Among these factors are sensory losses. Elderly clients often have difficulty reading labels on medication containers and distinguishing among various capsules and tablets. With age, the lens of the eye clouds and yellows and clients have difficulty distinguishing colors, especially blue and green. Hearing loss may make it difficult for elderly clients to fully understand instructions given to them. There is often a loss of hearing for high-pitched tones like high voices and difficulty in discriminating the consonants c, f, g, j, s, and t. Sensory losses in taste, touch, and smell may also influence a client's ability to assume responsibility for accurate self-medication.

Many elderly people also suffer from memory loss. The type of memory lost is recent memory. Even if these clients understand instructions given by health care providers, they may shortly forget the instructions unless written down.

Another factor placing the elderly at risk is the number of medications taken. Because of the number of chronic health problems many of the elderly have, they may be taking multiple medications several times a day. Because of the trend toward specialization in medicine, the elderly person may

be seeing several physicians, all of whom prescribe medications without knowing the other medications the client is taking. This situation may be aggravated by the use of multiple pharmacies to fill the prescriptions. An accurate client profile cannot be maintained unless a pharmacist knows all the medications a client is receiving. Because of the use of multiple medications, the older client may be at risk of developing drug-drug interactions and other adverse drug reactions. Studies have shown that the likelihood of adverse drug reactions increases with an increase in the number of drugs taken.

The client's self-medication practices may also contribute to the development of adverse drug reactions. Many elderly people are frequent users of nonprescription medications, such as laxatives. Some use home remedies to treat symptoms. Others store unused medications and take them whenever they think they need medication. Another self-medication practice is the sharing of medications with a friend who may have similar symptoms. All of these behaviors may contribute to the development of drug-drug interactions and adverse reactions. Dietary factors, such as a low-protein diet and use of alcoholic beverages, can also contribute to adverse drug reactions.

Some clients never get their prescriptions filled. They may be concerned about the cost of the medication and their response to it. They may be afraid that after purchasing an expensive medication, they will not be able to tolerate it. Elderly clients can be advised to ask the physician for a sample of the medication or for a small number of tablets or capsules to see how they respond before paying for several months of medication. Follow-up care is very important in determining whether a prescription has been filled and is being used as directed.

Some elderly clients are ill-informed about how the body functions and how drugs influence bodily functions. In addition, they may hold unscientific beliefs about how illness should be treated. These factors make client instruction and future compliance to prescribed therapy challenging.

Finally, communication problems may increase the likelihood of misunderstanding when clients are instructed about drug therapy. The client may not speak English well or may not understand the technical language often used by health professionals. Pride, trust, or awe of the professional may keep the elderly person from admitting lack of understanding and from asking for clarification.

Assessment

As in caring for clients of any age, initial and ongoing nursing assessment is important in planning care for the elderly. It is important to obtain an accurate history of allergies and current use of prescription and nonprescription medication, as the drugs the client has been taking may have implications for the treatment to be given. As an example, the long-term use of antihypertensive or **glucocorticoid** medications may affect the drug therapy ordered during the surgical period. Their use also means that special attention must be given to monitoring and supporting vital signs following surgery.

A general assessment of vital signs, height and weight, disabilities, and sensory functioning may be useful in planning care including client instruction. Baseline measures are important as standards against which to compare a client's response to treatment. It is also important to obtain some information about the person's home environment, general financial concerns, and social support network, as these may influence the older person's ability to provide self-care. The nurse should also assess the client's attitude toward the illness and its treatment. Some older clients, particularly those with limited social networks or those recently bereaved, may show little interest in learning to manage their illness and its treatment. Depression in the elderly may be an underdiagnosed problem and an important factor in noncompliance.

Elderly clients often respond differently to drug therapy than other adults. The nurse should carefully assess the client's response to therapy and be

KEY NURSING IMPLICATIONS 6–2

Assessment

1. Obtain baseline measures on vital signs, height, and weight.
2. Take a history of allergies and current use of prescription and nonprescription drugs.
3. Also obtain information on disabilities, sensory functioning, client's home environment, general financial concerns, and social support network.
4. Be certain that persons responsible for self-medication are able to open containers and do not have difficulty in getting prescriptions filled.

alert for problems such as excessive sedation and *orthostatic hypotension*, which may occur more commonly in elderly persons. The nurse should be particularly alert for changes in a person's conditions or functioning that follow changes in the medication regimen. Common responses of the elderly to specific drugs are discussed in chapters dealing with the various classes of drugs.

Elderly clients require careful monitoring when medications are discontinued. Many medications should be withdrawn gradually to allow the client's body to adjust to their absence. These medications include narcotic analgesics (Chapter 10), psychotropic agents (Chapter 18), amphetamines (Chapter 19), anticonvulsants (Chapter 22), nitrate products (Chapter 29), potent antihypertensive agents (Chapter 31), beta-blocking agents (Chapter 31), anti-inflammatory agents (Chapter 12), and glucocorticoids (Chapter 12).

Many elderly clients take medications at home. To ensure the person's safety and ability to use medications, be certain that the client can open the medication container. Medications are generally dispensed in child-resistant packaging. If the client requests, however, the pharmacist can dispense the drug in packaging that may be easier for the client to open. Finally, determine if the client will have difficulty in getting the prescription filled and refilled. If so, help the client find a pharmacy that makes home deliveries. Clients with special problems affecting their ability to comply with drug therapy should be referred to visiting nurses.

Nursing Diagnoses

Including but not limited to:

- Altered health maintenance related to inability to manage costs of drug therapy
- Risk for injury related to self-administration of medications
- Noncompliance related to drug regimes
- Deficient knowledge related to medication regime and administration
- Risk for injury related to idiosyncratic responses to medications due to physiologic changes of aging

Planning/Goals

- Client will seek out help to manage costs of drug therapy.
- Client will not sustain injury from self-administration of medications.
- Client will demonstrate ability to safely administer medications to self.
- Client will communicate understanding of medication regime including dosage, adverse effects, signs and symptoms to report to his/her physician, and the importance of maintaining compliance with drug regime.
- Client will state the importance of taking medication as ordered.
- Client will not sustain injury from idiosyncratic responses to drug therapy.

Implementation

Administration of Drugs to the Elderly. For the most part, the techniques used in administering drugs to adults will also meet the needs of elderly clients. In addition, there are several nursing actions that may enhance the elderly person's comfort and improve the therapeutic outcome. For example, when giving oral medications to elderly clients, especially the institutionalized frail elderly, it is important to position the client in a comfortable, upright position. Be aware of the client's sensory defects. Speak loudly and clearly enough to be understood. Provide a simple, clear explanation of your intentions and expectations for the client. Be prepared to help the person manage capsules or tablets, which may be difficult to see or pick up. *Many older clients could benefit from taking liquid dosage forms rather than solid forms*, and the nurse should consult with the prescriber if this is the case. Offer the most important med-

KEY NURSING IMPLICATIONS 6–3

Administration of Drugs to the Elderly

1. Follow seven rights.
2. When giving oral medications, position the client in an upright position.
3. Use liquid dosage forms if the client has difficulty with tablets or capsules.
4. Do not rush the client.
5. Provide a sufficient amount of water or other liquid to ensure that the oral medication reaches the stomach.
6. Avoid injection into muscles which have lost their mass. The ventrogluteal site is preferred in the elderly.
7. Watch elderly clients receiving intravenous infusions for fluid overload.

ication first, and encourage the client to drink a sufficient quantity of fluid to be certain that the medication reaches the stomach. Do not rush older people or attempt to do things for them that they can accomplish without assistance.

When giving intramuscular injections, it is generally best to avoid the deltoid muscle, which has often lost much of its mass. Also, avoid injection into the vastus lateralis muscle of the thigh because of the loss of muscle mass, especially in clients who do not ambulate. Another reason for avoiding the vastus lateralis site is decreased circulation to the lower extremities. The ventrogluteal site is preferred. This site is an especially good choice in emaciated persons. Always avoid injections into edematous areas, as this decreases drug absorption. It is generally wise to minimize the number of injections given on the preferred side for a client fond of a side-lying position. Special attention should be paid to providing care for the skin overlying the areas most frequently used for injection in order to avoid skin breakdown.

Elderly clients receiving intravenous medications need special attention. The rate of flow must be carefully monitored and controlled to prevent circulatory overload, which would be more medication than the client's heart and kidneys can handle. Watch the client for respiratory distress, moist respirations, full bounding pulse, extended neck veins, and edema. Record intake and output. Clients who are receiving considerable fluid intake should also be toileted frequently, as some elderly people have bladder control difficulty and many have problems safely ambulating alone while attached to intravenous equipment.

Teaching the Elderly Person About Drug Therapy. Most elderly people (95%) live in the community. Many of the elderly clients in acute care settings will eventually return to their homes and be responsible for self-care, including administration of medications. Teaching clients about their medication and its proper administration is an important function of the nurse that helps clients maintain autonomy. When preparing to teach elderly persons, review the section on client teaching in Chapter 2. In addition, Box 6–2 presents guidelines for making teaching more effective when working with older persons.

Clients learning self-care need to obtain knowledge, skills, and attitudes to help them manage their health problems, especially chronic illnesses such as diabetes mellitus and hypertension. Knowledge about an illness and its treatment is best obtained through reading and discussion. Self-care skills are best learned by demonstration with a return demonstration by the client. Attitudes are best determined and learned by discussions between the health professional and client. The nurse must be certain to periodically evaluate what a client has learned by asking

BOX 6–2
Teaching Older People

- Be certain the older person is wearing his/her glasses and/or hearing aid, if these are used.
- Conduct all teaching sessions in an area with good lighting and minimal environmental distractions.
- Speak clearly and slowly with your voice pitched low so the client can hear. Always face the client when speaking.
- Keep teaching sessions brief, no longer than 15–20 minutes.
- Provide sufficient time for review, questions, and client demonstration.
- Use visual aids and reading materials that are attractive and have large print. Brightly colored aids may be useful in getting points across.
- Relate learning to prior life experiences. Try to tie administration times for medications to the person's daily schedule.
- Treat the client as mature and capable of understanding. Avoid treating the elderly person like a child.
- Teach clients never to share medications with anyone else and always to inform health care providers about the medications they are taking.
- Teach a family member, friend, or neighbor about the treatment. In some cases, the client may teach the other person under the nurse's supervision. This is a good test of how well the older person understands essential information.
- Caution the client never to take more or less of the medication than the prescriber ordered and not to use outdated medications. Outdated medications may lose their effectiveness or may become toxic because of chemical changes that occur with deterioration.

questions about the medications and by requesting demonstration of skills.

Cooperation with medication programs may be a problem despite a good teaching plan. Follow-up with elderly clients in the community is important to determine the extent to which they are following a treatment program, the reasons for less than full compliance, and the problems, if any, encountered. If cooperation is a problem because of forgetfulness, review the section on adherance in Chapter 2 for some hints on how to help the client remember to take medications. Color coding of medication containers and a companion color-coded schedule of medications may be helpful. When color coding is used, the nurse should avoid the use of both blue and green or yellow and white, as elderly people often are unable to distinguish between these pairs of colors. Because of possible age-related color distortion as a result of yellowing of the eye's lens, the nurse always should ask the client to name the color of the various tablets and capsules. This assists the nurse in preparing teaching plans and in developing strategies to improve cooperation. Clients taking a once-a-day medication who cannot remember taking a drug can be instructed to turn the bottle upside down once the drug is taken. Before retiring for the night, they can turn the bottle right side up again. There are several commercially available memory aids. Some have an alarm to remind the client to take medication, with others having compartments marked by administration times. Each day, the client can check to see if all medications have been taken from these special containers.

Emphasize the need for safe storage of medications in a cool, dry place, unless otherwise stipulated by the pharmacist. Medications must be out of the reach of children, as visiting grandchildren can be seriously harmed unless precautions are taken.

Promoting Health. A final strategy to minimize the likelihood of elderly persons developing adverse reactions to medication is for the nurse to promote general health and well-being. As a result, fewer medications may be required by the older person, and the person may respond more favorably when medications are necessary due to better nutritional and health status. It is important, for example, to prevent infections in elderly persons whenever possible. Many older persons are at greater risk of developing infections than are younger persons, particularly if they are dehydrated, confined to bed, or have poor nutritional intake. Stressing positive health may decrease the incidence of illness, the necessity for medication, and mortality.

The promotion of health is as equally important for residents of long-term care facilities as it is of elderly persons living in the community. When possible, nursing interventions should be used to improve nutrition, facilitate social interactions, encourage exercise and activity, and promote rest and sleep. When these interventions are successful in improving health and well-being, the need for medication may be decreased. Fewer medications, drug holidays, and lower dosages of medications, in turn, decrease the likelihood of adverse drug reactions.

KEY NURSING IMPLICATIONS 6–4

Teaching the Elderly Person

1. Maximize sensory input by having the client wear glasses or hearing aid, using bright colors, facing the client when speaking, and adjusting your voice so the client can hear.
2. Keep teaching sessions brief.
3. Relate learning to previous life experiences.
4. Teach someone close to the client about the drug therapy.
5. Direct the client to follow the treatment exactly as ordered and not to share medications with others.

KEY NURSING IMPLICATIONS 6–5

Promoting Health

1. Health promotion activities may minimize the likelihood of adverse reactions to medications.
2. Elderly persons, whether living in the community or long-term care facilities, benefit from nursing interventions to improve nutrition, facilitate social interactions, encourage exercise and activity, and promote rest and sleep.
3. Elderly persons at high risk of developing influenza may benefit from annual immunizations.

Health promotion may also include encouraging and facilitating routine medical and dental care. Many older persons, especially those at high risk, such as the frail, those with chronic respiratory conditions, and those confined to bed, may benefit from annual immunization with influenza vaccine.

Evaluation

- Client demonstrates understanding of need to seek assistance in managing costs of drug therapy.
- Client sustains no injury from self-administration of medications.
- Client can communicate understanding of medication regimen, including dosage, adverse effects, signs and symptoms to report to his/her physician, and importance of maintaining compliant with drug therapy.
- Client demonstrates ability to safely administer medications to self.
- Client states the importance of taking medication as ordered.
- Client experiences no idiosyncratic responses to drug therapy.

HOME CARE/CLIENT TEACHING

1. Alcohol abuse is often unrecognized in older persons, but it has important implications for their health and safety. Clients must understand that alcohol is a drug that may interact with prescribed and OTC medications.
2. Be certain that older clients can open medication containers and have a means of getting prescriptions filled and refilled.
3. Nurses visiting the client's home should ask to see the client's medications. The nurse should explain the importance of discarding outdated medications and be alert for possible interactions among the drugs being taken concurrently.
4. If the client has trouble remembering to take medication, work with them to establish memory aids using the material in the section on Teaching the Elderly Person About Drug Therapy.
5. Ensure that medications are stored appropriately and safely at home.
6. Refer to Box 6–2 for teaching hints.

CASE STUDY

Mrs. Chu, age 86, has been a resident at the Sunnyside Nursing Home for 4 years. Her failing vision is inadequately corrected with glasses and she has difficulty hearing. In addition to these sensory defects, she has a number of physical and mental health problems resulting from generalized hardening of the arteries. She spends much of the day in bed and shows little interest in activities around her.

In addition to the array of medications that Mrs. Chu receives routinely, she is taking several others for a respiratory infection troubling her for a week. Her 10:00 AM medications are:

- **Bisacodyl** (**Dulcolax**) 5 mg P.O. PRN (laxative)
- Digoxin 0.25 mg P.O. q.d. (heart medication)
- **Hydrochlorothiazide** (**HydroDIURIL**) 50 mg P.O. b.i.d. (diuretic)
- Ampicillin 500 mg suspension q.i.d. (antibiotic)
- Multivitamins 1 P.O. q.d. (general vitamin supplement)
- **Robitussin**–DM Syrup 1 tsp. (5 mL) q.i.d. and H.S. (cough syrup)

Questions for Discussion

1. All of these medications, except the bisacodyl, are to have a dose administered at 10:00 AM. In what order would you administer them? Why did you select this order?
2. If an injection is needed to be given for Mrs. Chu, which site(s) would be preferred for an injection of penicillin? Describe step-by-step the procedure you would use in administering this injection, paying particular attention to the client's age and physical condition.
3. What special consideration is used in administering medication such as Robitussin–DM Syrup?
4. What nursing measures are associated with safe and effective administration of medications to this client?

CRITICAL THINKING EXERCISES

1. An elderly client is experiencing problems you think are related to absorption secondary to the oral medications he is taking. He has been taking these medications for chronic health problems for the past 4 years and has not had any problems until just recently. What physiological change related to aging do you think is most likely the basis for his untoward reactions to his medications?
2. Which laboratory tests are most important to evaluate when monitoring renal functioning in the elderly?
3. Discuss the ways in which the diet of elderly persons may influence the effectiveness of drug therapy.
4. Develop a method to help an elderly woman living alone remember to take her medications. She takes digoxin once a day, an antibiotic every 6 hours, a diuretic twice a day, and a PRN medication for arthritis pain.
5. Interview five elderly friends or relatives and determine what prescription and nonprescription medications as well as home remedies they use.
6. Borrow two different "child-resistant" medication containers from a pharmacy and see if they can be easily opened by elderly acquaintances.
7. Identify the ways in which membership in a particular ethnic or cultural group might affect a person's compliance with a medication regimen.
8. Design a plan for a homebound visually impaired geriatric client to allow him/her to be able to take three drugs. The client has been given different instructions for each drug.

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SECTION 2

Agents that Interfere with Microbial Growth

MAJOR NURSING DIAGNOSES

- Risk for Infection
- Deficient Knowledge (Illness and Its Treatment)
- Risk for Injury
- Deficient Knowledge (Prevention of Recurring Infections)
- Deficient Knowledge (Medication Regimen)
- Deficient Knowledge (Infection Transmission)
- Infection
- Noncompliance

7 Antimicrobial Agents

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify factors determining the selection of an antimicrobial agent for the treatment of an infection
- Differentiate between a bactericidal and bacteriostatic antimicrobial agent and describe when the use of each would be appropriate
- Describe four ways in which antimicrobial agents may act in exerting therapeutic actions
- Differentiate between narrow and broad spectrum antimicrobial agents and explain when each would be appropriate to use
- Identify the major classes of antimicrobial agents and the drugs found in each class
- Identify the major adverse effects associated with the use of each class of antimicrobial agents
- Identify the appropriate nursing actions in the administration of each class of antimicrobial agents
- List the information clients should be told about their antimicrobial medication
- List the steps necessary to prepare an antibiotic solution from a powder

The concept that a chemical substance derived from one *microorganism* could be used to destroy another has been known for thousands of years. Ancient civilizations, for example, recognized the medicinal uses of herbs and molds derived from the soil and from spoiled food in the treatment of certain skin disorders. Yet infections, even those considered minor today, were responsible for more death and suffering through the ages than any other cause.

It was not until the latter part of the nineteenth century that Louis Pasteur and his colleagues first identified the role of microorganisms in the production of disease and recognized the possibility that some of these microbes could actually be employed in the treatment of disease. Although a number of antimicrobial substances were discovered in the late nineteenth and early twentieth centuries, virtually all proved to be too toxic for widespread human use.

The modern age of anti-infective therapy began with the discovery and use of **sulfanilamide** in 1936. This was followed in 1941 with the commercial introduction of penicillin, a drug probably responsible for saving millions of lives in the decades that have followed. During the last 50 years, an explosion of new anti-infective agents has made it possible to successfully treat almost all infectious disorders. Although many of these substances are derived from microorganisms, many newer agents are chemically synthesized.

SUSCEPTIBILITY OF THE BODY TO INFECTION

To understand the role of *antimicrobial* agents in treating infections, it is important to understand those factors that may increase the susceptibility of the body to infection: age, exposure to pathogenic organisms, disruption of the body's normal barriers to infection, inadequate immunological defenses, impaired circulation, and poor nutritional status (Figure 7–1).

Age

Young children and the elderly are more likely to develop infections than those people who are not at age extremes. In the young, infections are more likely because of immature immunological defense mechanisms, poor hygiene, and/or exposure to others who may harbor and transmit microorganisms. Similarly, the elderly are more susceptible to infection because of age-related diminished immunological mechanisms, debilitation due to poor nutrition or the presence of underlying chronic illness, and/or exposure to pathogenic organisms in institutional settings.

Exposure to Pathogenic Organisms

The greater the frequency of exposure of an individual to those who may be harboring disease-causing organisms, the greater the likelihood of

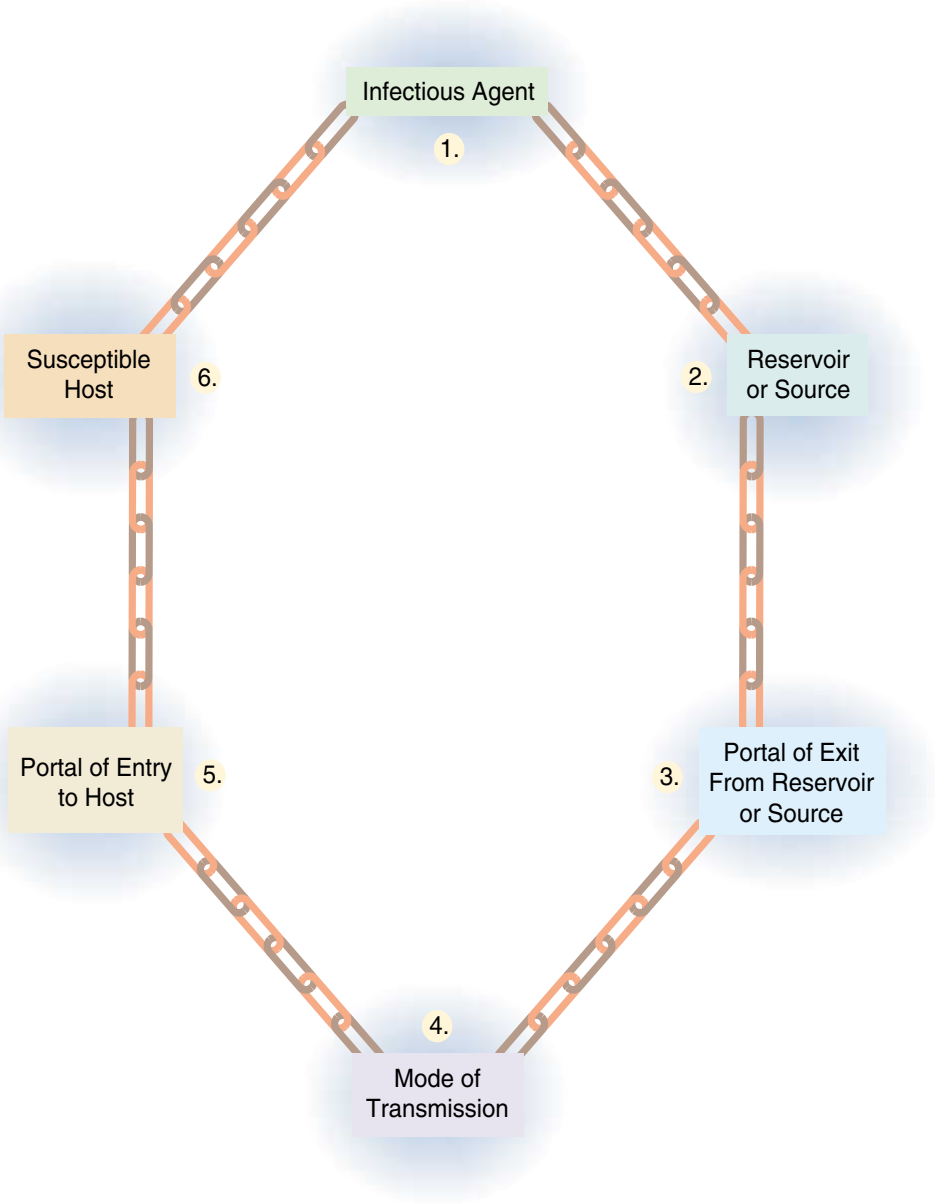

Figure 7–1 Chain of Infection

contracting an infection. Close exposure to many different persons (e.g., in school, public transportation, institutions) permits more rapid spread of organisms from one person to another.

Disruption of the Body's Normal Barriers to Infection

The body normally has a number of efficient barriers capable of blocking the entry of microorganisms. When the integrity of any one of these barriers is disrupted, the likelihood of infection increases. For example, a break in the dermal barrier from a cut, burn, or even by the insertion of a hypodermic needle greatly increases the possibility of entry of pathogenic microorganisms into the body. Likewise, interference with the normal functioning of the respiratory tract (e.g., due to a serious pulmonary disorder) may greatly predispose an individual to microbial invasion via the inspired air.

Inadequate Immunological Defenses

When the body's normal immunological defense mechanisms are inadequate in resisting the onslaught of disease-causing organisms, infection is more likely. For example, persons who have not been properly immunized against certain infectious disorders (e.g., measles, rubella, smallpox) may not have a sufficient concentration of immunoglobulins present in their blood to resist the development of such disorders when exposed to the infecting organism(s). Contracting an illness such as acquired immunodeficiency syndrome (AIDS), which reduces the effectiveness of the immune system, or using drugs that suppress the immunological response (e.g., *corticosteroids*, antineoplastic agents) will increase the susceptibility of a client to pathogenic organisms.

Impaired Circulation

Portions of the body not adequately supplied with blood are more likely to become infected, as these areas will not receive adequate amounts of blood components (e.g., white blood cells) that repel infecting organisms. For example, clients with diabetes tend to be highly prone to infections involving the lower extremities because of circulatory impairment that often accompanies this disorder. Clients with severe burns are also susceptible to infection at the burn site because of localized circulatory impairment caused by the damaged blood vessels in the involved area.

Poor Nutritional Status

Clients whose nutritional status is impaired (e.g., chronically ill clients, alcoholics) are less able to ward off infection because normal metabolic and immunologic mechanisms may be diminished.

SOURCES OF INFECTION

Bacteria

Agents that can cause infection differ widely in their mode of transmission, how they affect the body, and how drugs may successfully be used to destroy them. Bacteria are one-celled organisms that generally have several structural characteristics. They have a cell membrane that regulates passage of nutrients into the cell and waste materials out of the cell. Also, they generally have a cell wall that provides rigidity and support to the cell structure. Usually, the cell also has a nucleus that contains nucleic acids RNA and DNA, which provide the means for the cell to replicate itself.

Humans normally have many varieties of bacteria growing in various parts of the body (e.g., the colon) and on the skin and upper respiratory surfaces. Most of these organisms do not cause disease and may even play an important role in facilitating certain body functions (e.g., digestion). Other bacteria within the body may have the capability of causing disease but may never reach a sufficient number to adversely affect the body because of competition for nutrients from other organisms. When this balance of organisms is disrupted, e.g., because of the use of antimicrobial agents or a change of diet, the number of pathogenic organisms may increase to a level that results in the appearance of symptoms of infection.

As bacterial cells generally grow rapidly, have a different cell structure than human cells, and undergo different biochemical reactions than human cells, it is possible to successfully design a variety of chemical ways of destroying the bacterial cell without destroying human cells.

Fungi

Fungi are slow-growing organisms that may cause systemic infections or may affect parts of the body with a poor blood supply, such as the outer layers of skin, hair, or nails. Because of this poor blood supply, fungal infections are often more difficult to treat than bacterial infections. Antifungal drug action is further hindered by the granuloma-

tous tissue response, which may result in formation of a tissue capsule around areas of the body affected by fungal organisms. This also may make the penetration of the antifungal drug into the infected area more difficult.

Most antifungal drugs act by interfering with the synthesis of ergosterol, a chemical found in fungal cell membranes. This results in a change in the permeability of the fungal cell membrane and either slowed growth or destruction of the fungal organism. As bacteria do not generally contain ergosterol in their cell membranes, the antifungal drugs are not likely to affect bacteria. Human cells are not usually adversely affected by antifungal drugs because human cells can use preformed ergosterol.

Viruses

Viruses are among the simplest living organisms. They are composed of a core of nucleic acid consisting of either RNA or DNA, but not both. The nature of the nucleic acid determines, in part, the classification of the virus. Many viruses also have an outer coat of protein or lipoprotein.

Unlike bacteria or fungi, which can reproduce by themselves, viruses must enter living cells to sustain their growth and to reproduce (Figure 7–2). That is, viruses act as intracellular parasites that use the inner components of living host cells to sustain themselves. Because the viral particle grows and reproduces within the host cell, it is particularly difficult to develop drugs that can

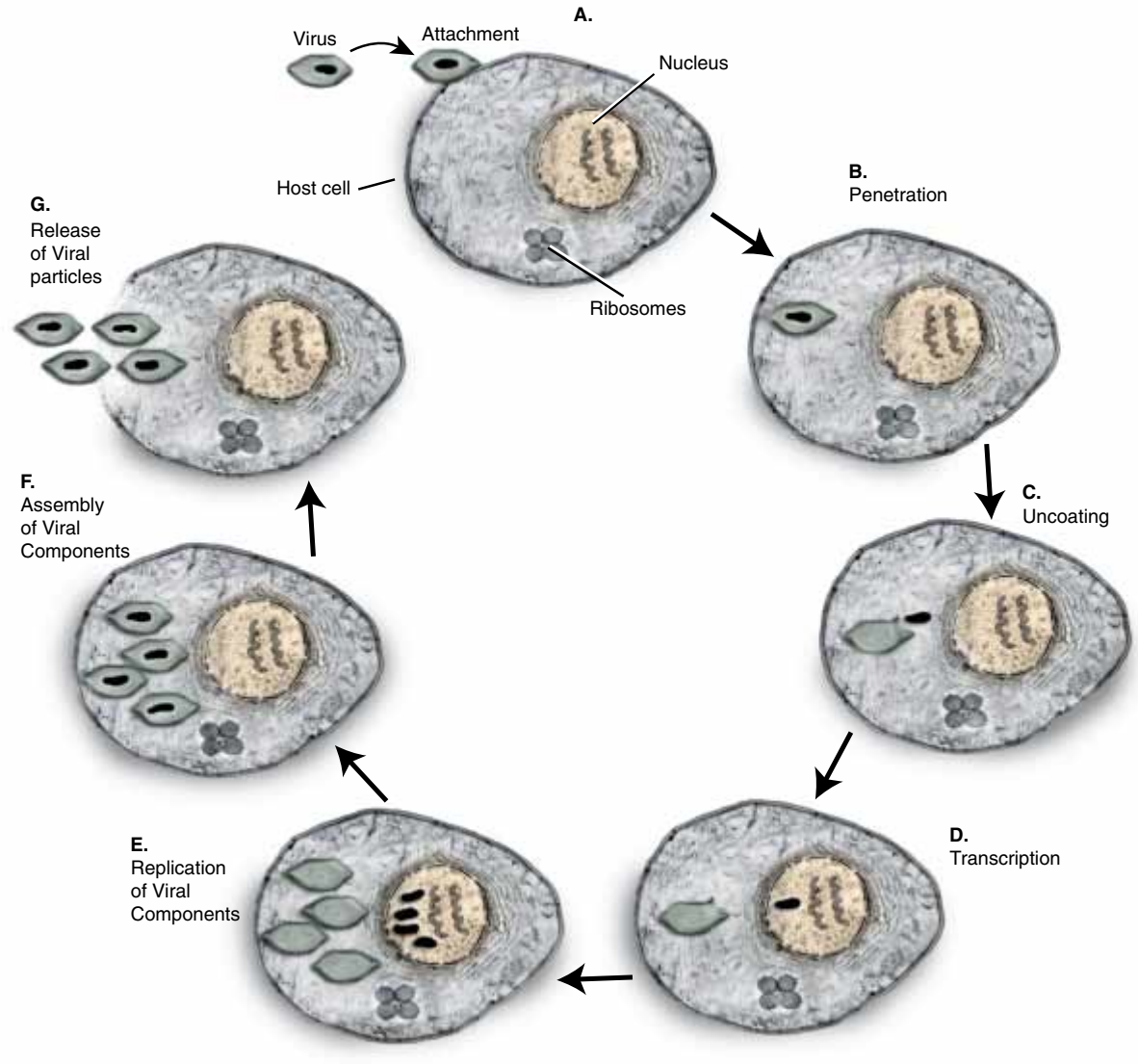

Figure 7–2 Life cycle of a virus. Virus first attaches onto a living cell (A). It then penetrates the cell (B) and loses its protective coating (C). The genetic material comprising the virus is then transcribed to the cell's genetic material (D) and is replicated (E). Newly formed viral components are then assembled (F) into intact viral particles and are released by the cell (G).

destroy a virus without adversely affecting the host cell. For this reason, few effective antiviral drugs have been developed. However, viral disease can often be controlled by immunological techniques, such as appropriate vaccination. Immunization has led to the control of many viral diseases such as measles, mumps, rubella, varicella, poliomyelitis, smallpox, and hepatitis B. Such immunological techniques have, however, been relatively unsuccessful in controlling viral disorders such as the common cold, herpes simplex infections, or AIDS.

Steps in Viral Interaction with Human Cells

1. Virus attaches to host cell membrane and penetrates membrane into cell.
2. The protein or lipoprotein coat of the virus is dissolved by viral enzymes, thus liberating free viral DNA or RNA.
3. The genetic structure of the virus is duplicated by the host cell and new viral proteins are synthesized.
4. The new viral components are assembled to form a mature virus particle. This may then be encapsulated by viral protein or lipoprotein.
5. The mature virus is released from the host cell, which often results in the death of the host cell.

IDENTIFICATION OF THE INFECTING ORGANISM

Rational use of antimicrobial therapy generally requires the identification of the causative organisms before selecting appropriate therapy. In some cases, the identity of the organism can be deduced by observing a client's symptoms or by being aware of what organisms are causing identical symptoms in other people to whom the client has recently been exposed. In other cases, the acute nature of an infection may require the use of antimicrobial agents without first confirming the identity of the infecting organism. When this is done, an "educated guess" as to the most appropriate antimicrobial agent is made by the prescriber.

When the identity of the organism is to be established prior to starting drug therapy, a specimen of blood, sputum, urine, feces, or tissue is collected. The type of specimen collected is based on the likelihood of finding the causative infecting organism in the sample. Once this has been accomplished, a number of tests may be performed on the specimen. These include:

- *microscopic examination*—Examination of the sample taken, under appropriate magnification, may enable the prescriber or technician to directly identify the organism.
- *gram stain*—This is a rapid method for establishing the biochemical nature of the bacterial cell wall. By the use of this staining technique, one can ascertain whether an organism is *gram-positive* or *gram-negative*. On the basis of this information, an antimicrobial agent that is effective in eradicating the organism can be chosen.
- *culture*—Culturing a microorganism involves the seeding of an appropriate nutrient medium with a specimen taken from the client that is likely to contain the infecting organism. By observing what organisms grow on the inoculated medium, a precise identification of the organism can be made.
- *sensitivity testing*—This procedure is used to establish the sensitivity of an infecting organism to various antimicrobial agents so that the most appropriate one can be selected. This may be accomplished in a number of ways. A popular method is to culture the infecting organism on a petri dish which contains a culture medium. Paper discs impregnated with standard concentrations of specific antimicrobial agents are placed on the culture medium. By observing the relative size of the zones of inhibition of microbial growth around each disc, the most effective agent can be identified, as well as the concentration of a specific drug required to destroy the organism (Figure 7–3).

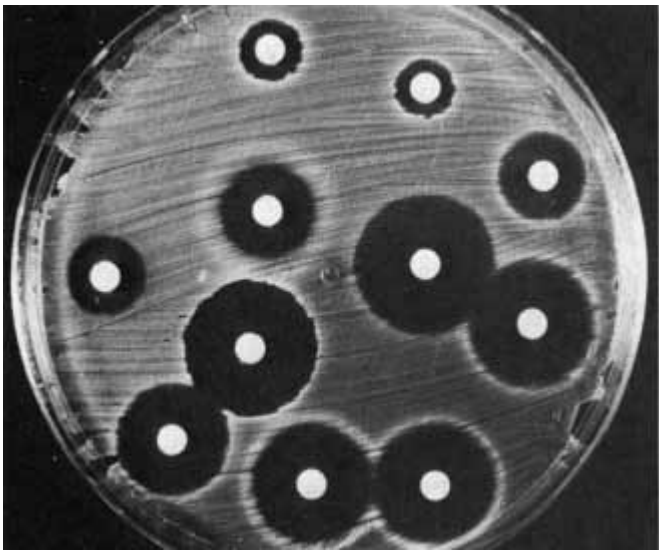

Figure 7–3 The antibiotic with the largest zone of inhibition of bacterial growth will probably be selected for administration to the patient. *(Reprinted with permission from Dr. David Purtillo.* A Survey of Human Disease. *Copyright 1978 by Addison-Wesley Publishing Co.)*

SELECTION OF ANTIMICROBIAL AGENTS

Once the identity of the infecting organism has been established, an appropriate antimicrobial agent must be selected for therapy. Such an agent should be one that exhibits selective toxicity for the infecting organism while producing minimal toxicity to the client. Selection should also be based on the following factors:

- location of the infecting organism
- status of the client's organ functions
- age of the client
- pregnancy and/or lactation
- likelihood of organisms developing that are resistant to the antimicrobial agent

Location of the Infecting Organism

Antimicrobial agents have varying ability to enter certain parts of the body. For example, an infection involving the cerebrospinal fluid requires use of an agent that can successfully penetrate the blood-brain barrier. Similarly, an infection involving the urinary tract requires the use of an agent that will reach the urinary tract in appropriate concentration to destroy the infecting organisms.

Status of the Client's Organ Functions

The metabolism and/or elimination of many antimicrobial agents is dependent on adequate *hepatic* and/or *renal* function. When the function of these organs is impaired, the use of an antimicrobial agent that does not require proper function of the impaired organ for its metabolism or elimination may be warranted. Alternatively, lower doses of the original drug chosen may be employed, so as to compensate for the impaired organ function, e.g., *dialysis* client dosing differs from that of other clients.

Age of the Client

Some antimicrobial agents are more toxic in children or the elderly. This may require the use of alternative drugs to treat a particular infectious disorder.

Pregnancy and/or Lactation

The use of some antimicrobial agents during pregnancy or lactation may pose a threat to the developing fetus or infant. For example, the use of **tetracycline** antibiotics during the second and third trimesters of pregnancy may result in damage to developing teeth of the fetus, with the use of certain *ototoxic* antimicrobial agents such as **streptomycin** during pregnancy possibly causing auditory nerve damage in the developing fetus. Many antimicrobial agents are secreted in breast milk and may, therefore, be transmitted to the nursing infant. This may produce drug-induced toxicity in the infant. See Table 38–1 for a list of some drugs reported to have been secreted in breast milk.

Likelihood of Organisms Developing That Are Resistant to the Antimicrobial Agent

Even though a particular antimicrobial agent may appear to be capable of slowing the growth of or eradicating an organism, some microorganisms may develop resistance to a particular antibiotic. For more than a decade, a concern in the health care community has been growing about the increasing number of bacteria that have developed resistance to some current antibiotics. MRSA (**Methcillin**-resistant *Staphylococcus aureus*) and VRE (vancomycin-resistant enterococcus) have been problems for some hospitalized clients. A more recent resistant strain, ORSA (**oxacillin**-resistant *Staphylococcus aureus*), has been documented. MRSA has been successfully treated using **vancomycin**, however, the treatment for VRE remained elusive until April 2000. At that time the FDA approved **linezolid** (**Zyvox**) a new synthetic antibacterial agent, the first of a new class of oxazolidinone derivatives. Linezolid is an important agent in the treatment of both VRE and MRSA. The judicious use of antibiotics by health care professionals, along with client compliance with prescriptions, are the two major ways to help reduce the development of future resistant strains. Clients must be informed of the importance of completing an entire prescription course of antibiotics when prescribed and to inform their health care providers if their symptoms do not improve as expected. Nurses also need to be sure they use Universal Precautions when caring for clients to prevent the transmission of microorganisms. This can also be managed by using an alternative agent or by using a combination of two or more antimicrobial agents, each of which exerts a different toxic effect on the organism. This will make it more difficult for the organism to develop strains resistant to a single drug. Such a strategy is widely used in the treatment of certain urinary tract

infections, in which the use of a combination of a **sulfonamide** drug and **trimethoprim** has been shown to be less likely to result in the development of resistant bacterial strains than if just a sulfonamide drug were used. Likewise, the use of two or three drugs (e.g., **isoniazid**, **ethambutol**, and **rifampin**) is often recommended for the treatment of active cases of tuberculosis to prevent the emergence of drug-resistant strains of the microorganism that causes tuberculosis.

CLASSIFICATION OF ANTIMICROBIAL AGENTS

Several different systems are used to classify antimicrobial agents. The following discussion briefly describes each of these systems.

Bactericidal—Bacteriostatic

Bactericidal agents are those which have a killing action on the microbial agent. Bacteriostatic agents simply inhibit the growth of bacteria, thereby permitting the host's immunological defenses to complete the job of destroying the organism. Bactericidal agents include the penicillins, **cephalosporins**, **polymyxin**, and vancomycin. The bacteriostatic category includes the tetracyclines, **sulfonamides**, **erythromycin**, and **lincomycin**. Some antimicrobial agents may exert either a *bactericidal* or a *bacteriostatic* action, depending on the dose used, the causative organism being acted upon, and/or the site of action of the drug. The use of bactericidal agents is generally preferred in the treatment of serious, life-threatening infections and/or when the host's immunological system is not functioning properly. For the treatment of minor infections in otherwise healthy individuals, there is little difference in the overall effectiveness of bactericidal or bacteriostatic agents.

Site of Action

Antimicrobial agents may also be classified on the basis of the site at which they exert their therapeutic actions in the bacterial organism:

- *agents that inhibit cell wall synthesis*—Some antibiotics interfere with the synthesis of the bacterial cell wall. This results in a loss of structural integrity of the bacterial cell and the death of the organism. Such agents are generally bactericidal in their action.
- *agents that inhibit protein synthesis*—Some agents exert their antimicrobial effect by interfering with protein formation in the bacterial cell. Although such an action rarely leads to the immediate death of the organism, it does prevent normal growth and reproduction and makes it easier for host defense mechanisms to finish the job of eradicating the organism. Drugs that exert such an antimicrobial action are, therefore, classified as bacteriostatic agents.
- *agents that interfere with the permeability of the bacterial cell membrane*—These drugs increase the permeability of the bacterial cell membrane, permitting leakage of intracellular components. As this results in the immediate death of the organism, such antimicrobial agents are usually considered to be bactericidal in their action.
- *antimetabolites*—Drugs with antimetabolite action generally block or alter a specific metabolic step essential for the normal function and/or growth of the bacterial cell (e.g., the synthesis of a specific essential nutrient). This action may result in either a bactericidal or a bacteriostatic effect, depending on the nature of the metabolic action and the concentration of drug achieved in the environment of the organism.

Narrow Spectrum—Extended or Broad Spectrum

Antimicrobial agents are often classified as having a narrow spectrum or an extended or broad spectrum of action. Those with a narrow spectrum are useful in treating infections caused by a relatively limited number of organisms (e.g., only gram-positive organisms). Extended or broad spectrum agents act on a wide variety of different organisms. The use of narrow-spectrum agents may be desirable when the identity of the infecting organism—as well as its susceptibility to the action of the antibiotic—has been established. Because of their limited action, such drugs are not likely to indiscriminately disrupt the normal bacterial *flora* of the body. They may, therefore, be somewhat safer to use than broader spectrum drugs that might disrupt both pathogenic and useful microorganisms found in the body.

Broad or extended spectrum antimicrobial agents are useful in treating infections in which the identity and susceptibility to antimicrobial treatment of the infecting organism(s) has not been established. Because of the wide range of

organisms that may be susceptible to a specific broad-spectrum antibiotic, there is an excellent likelihood that the drug will be effective in treating a specific infection. A drawback in the use of such broad-spectrum agents is their ability to destroy the body's normal microbial population. This may cause the development of diarrhea and may permit *superinfection*. Superinfection is a state in which organisms whose population is normally under control in the body begin to multiply rapidly as a broad-spectrum antibiotic reduces the number of the organism's normal microbial competitors. For example, clients who use systemic doses of the broad-spectrum antibiotic tetracycline for long periods in the treatment of acne often develop superinfections involving fungal organisms.

ADVERSE EFFECTS

Adverse effects of antimicrobial agents usually manifest themselves in three ways: as hypersensitivity reactions, organ toxicity, or *hematological* disorders. Careful monitoring of a client's response to therapy is therefore essential when such drugs are used.

Hypersensitivity Reactions

Allergic reactions to antimicrobial agents often interfere with therapy and may, in some cases, result in *anaphylactic shock* and/or death. The penicillins are particularly likely to produce hypersensitivity reactions. It has been estimated that as many as 15% of penicillin users will exhibit this phenomenon. Hypersensitivity reactions may be manifested as a rash, urticaria, fever, bronchospasm, and/or, in extreme cases, anaphylaxis. Often such reactions do not occur when the client is first exposed to the drug but upon subsequent exposures to the drug. In some clients a hypersensitivity reaction may seemingly occur with the first exposure to the drug but this is unlikely. Probably the client has unknowingly been previously exposed to the drug (e.g., by consuming meat from an animal which was fed with antimicrobial-containing feed).

When symptoms of hypersensitivity occur, discontinuation of the antibiotic is usually recommended. In some clients mild hypersensitivity reactions (e.g., rash) quickly subside even while the client continues to use the drug. A client who exhibits a hypersensitivity reaction to an antibiotic may develop a similar reaction with an agent in the same or related chemical class, a phenomenon known as *cross-sensitivity*. In such cases, selection of an alternative antibiotic from another chemical class is usually desirable.

The use of an appropriate skin test to ascertain the possibility of hypersensitivity of a client to a particular antibiotic may be useful. This would be done before the medication is administered.

Organ Toxicity

When used in high doses and/or over long periods of time, many antimicrobial agents may cause organ toxicity that can involve the liver, kidneys, central nervous system, or other sites. This is particularly likely to occur in clients who have impaired organ functions before therapy is begun (e.g., the elderly). Evaluation of organ function prior to and during therapy may help prevent such toxicity by providing a guide to the prescriber for determining the appropriate dosage regimen to use.

Irritation of the gastrointestinal tract is the most common form of toxicity observed with oral antimicrobial use. It is often manifested as nausea, vomiting, and/or diarrhea. Nephrotoxicity can result from the use of vancomycin. This is a special concern in children and the elderly because of their fragile renal systems. Nephrotoxicity usually is exhibited in what is called "*redman's syndrome*," in which clients develop a deep red color in the face and neck. Ototoxicity is common in clients who have been treated long-term with **gentamycin** and is caused by damage to the eighth cranial nerve.

Hematological Disorders

Alteration of the hematological system of a client, although a relatively rare phenomenon, has been associated with the use of several antimicrobial agents, particularly **chloramphenicol**. This agent, which was at one time widely used for the treatment of infectious disorders, is now only rarely employed because it has been shown to cause fatal *aplastic anemia* in a small proportion of clients.

ANTIBACTERIAL AGENTS

Antibacterial agents either destroy or inhibit the growth of both pathogenic and nonpathogenic bacteria. In other words, they exert a bactericidal or bacteriostatic effect. Major antibacterial agents include the penicillins, **macrolides**, cephalosporins, **fluoroquinolones**, tetracyclines, and **aminoglycosides**.

Penicillins

The penicillins are among the most widely used antibiotic agents, however an increasing use of cephalosporins has been occurring in the last decade. Penicillins are also called beta-lactams, which is a term relating to their chemical structure. They are all virtually bactericidal agents with a similar chemical structure and, therefore, a similar mechanism of action. Penicillins exert their antimicrobial effect by inhibiting the synthesis of the bacterial cell wall; this results in the destruction of the organism. As these agents do not disrupt the existing bacterial cell wall, but only newly forming and actively growing cell walls, they are most effective in destroying bacteria that are growing and multiplying rapidly (Figure 7–4). It is generally inadvisable to use a bactericidal agent and a bacteriostatic agent (e.g., tetracycline) at the same time in the same client, as the bacteriostatic agent may slow the rate of growth of the microbial cell wall and interfere with the action of the bactericidal agent.

The various penicillins differ in several respects. Some (e.g., penicillin G) are very unstable in the

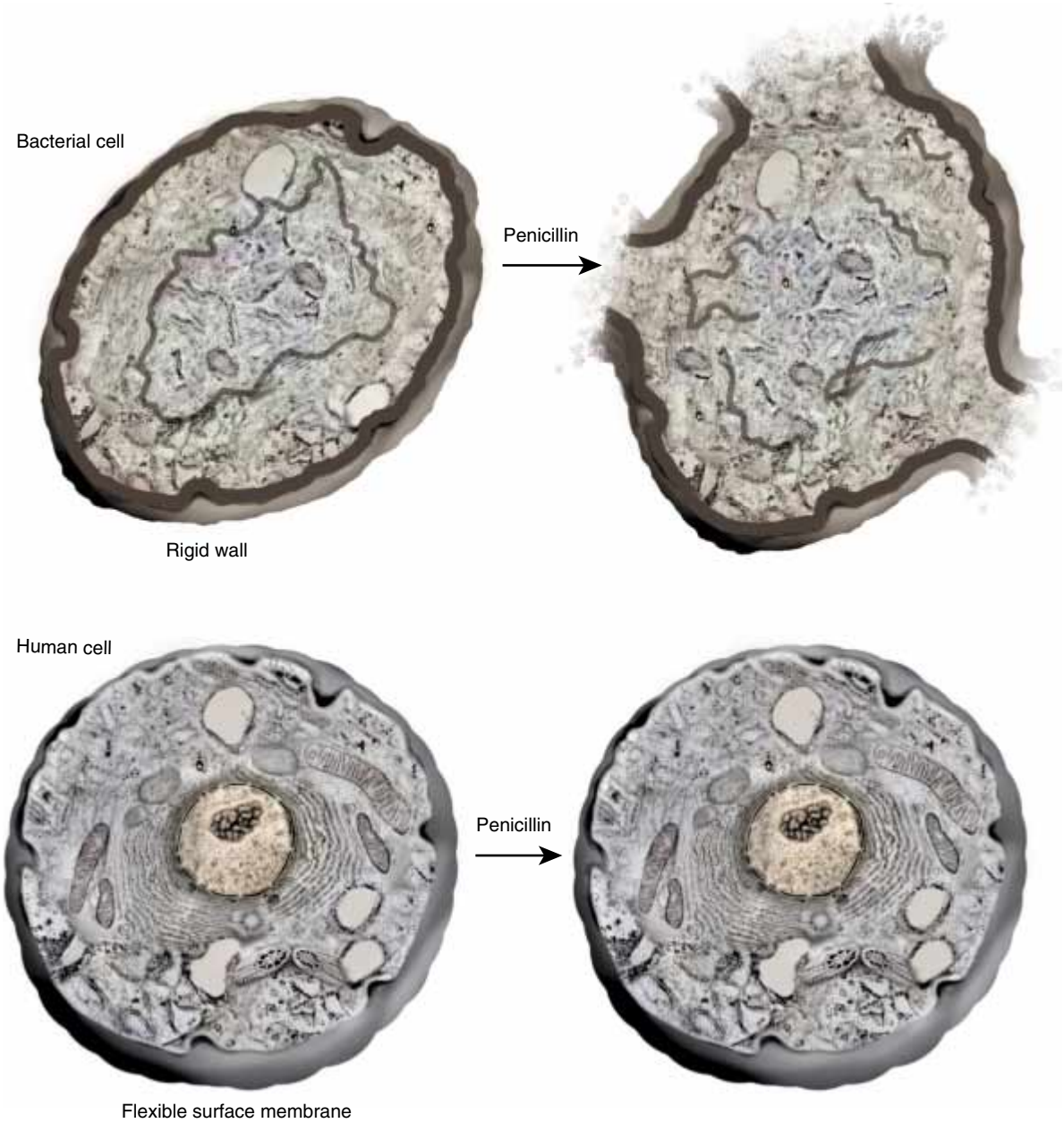

Figure 7–4 Penicillin kills bacteria by preventing them from forming the rigid cell wall needed for survival. Human cells have flexible plasma membranes rather than rigid cell walls and are therefore uninjured by penicillin. *(From Medicines and You, U.S. Department of Health and Human Services)*

presence of acids and are rapidly destroyed in the stomach; others (e.g., **amoxicillin**) are acid stable and are well absorbed when given orally. Many penicillins are susceptible to being destroyed by penicillinase, an enzyme released by some microorganisms; it destroys the chemical structure of these agents and renders the penicillin incapable of eradicating the microorganism. Other penicillins (e.g., **dicloxacillin**), are considered to be penicillinase-resistant and can be successfully employed in combating such organisms. Finally, some penicillins have a narrow spectrum of antimicrobial action, and others have an extended spectrum, which makes them useful in the treatment of a wide range of infections.

Different penicillins may be administered by varying routes of administration. Some products are suitable for both oral and parenteral administration; others can only be administered by one route. Oral therapy is generally desirable in treating mild to moderately severe infections caused by microorganisms that may be susceptible to the low serum levels produced when an oral dosage form of the drug is used. Penicillin G is the drug of choice for treating many infections caused by penicillin-sensitive organisms, but **penicillin V potassium** is preferred for oral administration because it is better absorbed from the gastrointestinal tract and is relatively stable in stomach acid. Both agents have a relatively narrow spectrum of action.

Parenteral penicillin therapy is desirable when treating clients with severe infections or when oral penicillin forms are not well tolerated. Parenteral administration of a penicillin will generally produce more rapid and higher penicillin blood levels than oral therapy. Aqueous penicillin G is usually the agent of choice for parenteral administration. It may be administered either intramuscularly or intravenously.

Several long-acting or repository forms of penicillin G are available. These are only administered by the IM route and provide a dose of penicillin released over a period ranging from 12 hours to several weeks. For example, **procaine penicillin G** releases penicillin over a period of about 4–24 hours, while the administration of a single intramuscular dose of **benzathine penicillin G** may produce low, but sustained, blood levels of penicillin G for as long as 4 weeks. Penicillin G benzathine and procaine combined is used to treat *streptococcal* infection of the upper respiratory tract, skin, and soft tissues, as well as *pneumococcal* infections and *otitis media*. Long-acting penicillin dosage forms should only be used to treat infections caused by penicillin-sensitive organisms that respond to low penicillin doses.

Penicillin dosage is usually expressed in milligrams or grams, although some may be expressed in units. As a general rule, 400,000 units of penicillin G or penicillin V are considered to be equivalent to 250 mg of these drugs. (Only used with penicillins).

In situations where the infecting organism has been shown to be capable of resisting penicillin action by producing penicillinase (beta lactamase) enzyme, the use of a penicillinase-resistant penicillin may be justified. These agents are less active than penicillin G against other penicillin-sensitive microorganisms. They should be employed only when the presence of a penicillinase-producing organism has been confirmed.

Ampicillin and those penicillins closely related to it (i.e., **bacampicillin** and **amoxicillin**) are bactericidal for both gram-positive and many gram-negative bacteria. When compared at equal dosage levels, ampicillin and related penicillins tend to produce higher plasma drug concentrations than does penicillin G. They are also concentrated rapidly in the urine, thereby making them useful in the treatment of certain urinary tract infections. Ampicillin and related penicillins have also been shown to be effective in eradicating the organisms that cause upper respiratory infections, otitis media, gonococcal *urethritis* and *meningitis*. Amoxicillin remains the drug of choice for otitis media in children.

Carbenicillin and compounds related to it (i.e., **ticarcillin**, **mezlocillin** and **piperacillin**) are extended-action penicillins and have an even wider spectrum of action than ampicillin and its related drugs. These carbenicillin-related compounds are somewhat less effective in treating infections caused by some gram-positive organisms, but are generally more effective against a wider range of gram-negative organisms, including *Pseudomonas* and certain *Proteus* species, which are often resistant to other penicillins. In addition, these carbenicillin-related penicillins are also useful in treating certain anaerobic infections that may not respond to other forms of penicillin therapy.

Because of their greater expense and toxicity, carbenicillin and its related compounds are generally reserved for use in the treatment of serious infections caused by organisms which do not respond to other forms of penicillin therapy. These

agents are also frequently combined with an aminoglycoside antibiotic to increase their effectiveness, since the penicillins and aminoglycosides exert different but complementary toxicity against certain organisms.

Several penicillin-containing products combine a penicillin (e.g., ampicillin, amoxicillin, ticarcillin, or piperacillin) with either **potassium clavulanate**, **sulbactam**, or **tazobactam**. These compounds inhibit penicillinase (beta–lactamase). In so doing, they protect the accompanying penicillin from breakdown by beta-lactamase enzymes and extend the antimicrobial spectrum of the penicillin to include bacteria that would normally be resistant to the penicillin.

A number of adverse effects are associated with the use of the penicillins. Hypersensitivity is the most common of these. It is particularly likely to occur in persons with a history of allergies and/or breathing difficulty. Although hypersensitivity associated with penicillin use often appears as dermatological symptoms (i.e., pruritus, urticaria, and/or rash) some sensitive clients may experience a life-threatening anaphylactic reaction when receiving a penicillin dose.

Adverse gastrointestinal symptoms may also occur with penicillin use, particularly when it is administered orally. These may assume many forms, ranging from nausea and vomiting to diarrhea and colitis. The use of newer and better absorbed penicillins, such as amoxicillin, seems to reduce the likelihood of adverse gastrointestinal effects.

Neurotoxicity, renal dysfunction, and other forms of damage to major organ systems have been reported in some clients receiving penicillins, particularly when the drug is administered in a large intravenous dose. Such administrations may also cause serious electrolyte disturbances, as many penicillins intended for intravenous use contain relatively high concentrations of sodium or potassium.

Table 7–1 summarizes information related to the important properties and administration of penicillins.

Cephalosporins

The cephalosporin group of antibiotics is chemically and pharmacologically related to the penicillins. They also act by interfering with bacterial cell wall synthesis, thereby altering the osmotic stability of the actively growing bacterial cell and resulting in its death. Cephalosporins may exert either a bactericidal or a bacteriostatic effect depending upon: (1) the susceptibility of the organism being treated, (2) the dose of drug used, (3) the tissue concentration of the drug, and (4) the rate at which the bacteria are multiplying.

The cephalosporins and cephalosporin-like compounds are classified into four different "generations." Each generation differs from the others in the spectrum of antimicrobial activity exhibited by its constituent drugs. Drugs within a given generation differ primarily in their pharmacokinetic properties, i.e., their absorption, distribution, metabolism, excretion, and elimination half-life.

First generation cephalosporins tend to have greatest activity against gram-positive and several gram-negative organisms and are generally quite susceptible to being inactivated by beta-lactamase enzymes produced by some bacteria. Second generation cephalosporins have a broader spectrum of activity against gram-negative organisms and a somewhat diminished activity against gram-positive organisms. Third generation cephalosporins have even broader gram-negative activity and less gram-positive activity than do second generation agents. Many of the second and third generation cephalosporins tend to be more resistant to being inactivated by beta lactamases. Fourth generation agents have the greatest action against gram-negative organisms among the four generations and minimal action against gram-positive organisms. In the transition from first to fourth generation there tends to be a corresponding increase in the cost of the drug.

Because of their chemical similarity to the penicillins, it is not surprising that hypersensitivity reactions to the cephalosporins are also fairly common. Extreme caution must be used in administering cephalosporins to clients with a history of penicillin allergy because of the possibility of cross-sensitivity, which has been estimated to occur in about 5%–16% of penicillin-sensitive clients.

KEY NURSING IMPLICATIONS 7–1

Penicillins Differ in Their:

1. chemical stability in stomach acid
2. susceptibility to penicillinase (beta lactamase) destruction
3. spectrum of action, i.e., narrow or extended
4. route of administration
5. duration of action
6. site of action

TABLE 7–1

Penicillins

Note: Monitor all clients receiving penicillins for signs of hypersensitivity, i.e., urticaria, laryngeal edema, skin rash, and anaphylactic shock. Discontinue therapy at the first sign of serious hypersensitivity reaction. Observe clients receiving penicillins in an emergency room or physician's office for 30 minutes before allowing them to leave.

Ticarcillin, mezlocillin, or piperacillin may cause bleeding abnormalities. Closely monitor clients with renal impairment.

Administration with bacteriostatic antibiotics, e.g., erythromycin or tetracycline, may diminish effectiveness.

Probenecid (Benemid) blocks renal tubular secretion of penicillins, and may cause higher blood levels and longer duration of action for penicillins.

High intravenous doses of sodium or potassium salts of penicillins may produce electrolyte disturbances.

Although not always essential, it is advisable to administer oral penicillin on an empty stomach with a full glass of water.

To prevent peripheral IV site irritation, avoid infusing medication rapidly.

PENICILLIN	SPECTRUM	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
penicillin G benzathine and procaine combined	narrow	IM	*Adults:* 2.4 million units in single session *Children:* 0.9–1.2 million units *Infants under 13.5 kg*: 0.6 million units	Give in single narrow IM session using multiple sites. Drug interactions may cause prolonged serum levels.
penicillin G procaine, aqueous *(pen-ih-**SILL**-in jee **PROH**-kayn)* (B Ayercillin, Wycillin, etc.)	narrow	IM	*Parenteral:* 600,000–1 million units/day in 1 or 2 doses for 10 days to 2 weeks *Adults and Children:* 600,000 units/day in 1 or 2 doses for 10–14 days	Administer by deep IM injection only. Upper outer quadrant of the buttock is preferred administration site in adults. Midlateral aspect of the thigh may be preferable in infants and small children. Observe client for development of procaine sensitivity. Refrigerate during storage. Avoid freezing.
penicillin G benzathine *(pen-ih-**SILL**-in jee **BEN**-zah-theen)* (Bicillin L-A, Permapen, etc.)	narrow	IM	*Adults:* 1.2 million units as a single dose *Children:* 300,000–1.2 million units as a single dose	In very young children (under 2 years of age) administration into the midlateral aspect of the thigh is preferable. Vary injection site if dose is to be repeated. Mixtures of penicillin G benzathine and penicillin G procaine (e.g., Bicillin C-R) are available for IM use.
penicillin G potassium	narrow	IM, IV	*Adults:* 5–24 million units/day in 4–6 divided doses *Children:* 50–100,000 units/kg/day in 4–6 divided doses	First choice of treatment for many infections because of low cost. Drug interactions may cause prolonged serum levels. Rapid IV administration may cause hyperkalemia and cardiac arrhythmias.

continues

TABLE 7–1 *continued*

See **Note** at beginning of Table 7–1, page 131

PENICILLIN	SPECTRUM	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
penicillin V potassium *(pen-ih-**SILL**-in vee poh-**TASS**-ee-um)* phenoxymethyl penicillin potassium *(fen-**OX**-ee-**METH**-ill pen-ih-**SILL**-in poh-**TASS**-ee-um)* (Pen-Vee K, V-Cillin K, Apo-Pen-VK (🍁), Nadopen-V (🍁), PVF (🍁), Novopen-VK (🍁), etc.)	narrow	oral	*Adults:* 125–500 mg 4 times a day *Children under 12:* 25–50 mg/kg/day in 3–4 divided doses	If renal impairment exists, i.e., creatinine clearance ≤ 10 mL/min, do not exceed 250 mg every 6 hours. Reconstituted oral suspension should be refrigerated. However, it is stable for 24–48 hours at room temperature.
Penicillinase-Resistant Penicillins				
methicillin sodium *(meth-ih-**SILL**-in **SOH**-dee-um)* (Staphcillin)	narrow	IM, IV	*Adults:* IM and IV: 4–12 g daily in divided doses every 4–6 hours *Infants and Children:* IM and IV: 100–300 mg/kg/day in divided doses every 4–6 hours	Do not mix other drugs with methicillin solutions. In preparing to administer drug reconstitute with sodium chloride injection, USP or sterile water for injection.
nafcillin sodium *(naf-**SILL**-in **SOH**-dee-um)* (Nafcil, Nallpen, Unipen)	narrow	oral, IM, IV	*Adults:* Oral: 250 mg–1 g every 4–6 hours IM: 500 mg every 4–6 hours IV: 500 mg–1 g every 4 hours *Children:* Oral: 25–50 mg/kg daily in 4 divided doses IM: 10–25 mg/kg twice daily	Oral therapy with nafcillin produces low and unpredictable serum drug levels. Intravenous route should not be used for more than 24–48 hours because of the possible development of thrombophlebitis, particularly in elderly clients. Monitor liver, renal, and hematologic function, especially platelets
oxacillin sodium *(ox-ah-**SILL**-in **SOH**-dee-um)* (Bactocill, Prostaphlin)	narrow	oral, IM, IV	*Adults:* Oral: 500 mg every 4–6 hours IM, IV: 250–500 mg every 4–6 hours *Children:* 50–100 mg/kg/day in equally divided doses every 6 hours	Oral therapy should be continued for a minimum of 5 days. Client should be placed on oral therapy as soon as possible. When administering drug parenterally reconstitute with sterile water for injection or sodium chloride injection. Assess IV site for severe phlebitis.

continues

TABLE 7–1 *continued*

See **Note** at beginning of Table 7–1, page 131

PENICILLIN	SPECTRUM	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
cloxacillin sodium *(klox-ah-**SILL**-in **SOH**-dee-um)* (Cloxapen, Tegopen, Apo-Cloxi (✱), Orbenin (✱), Novocloxin (✱), etc.)	narrow	oral	*Adults & children over 20 kg:* 250 mg–1.0 g every 6 hours *Children less than 20 kg:* 50–100 mg/kg/day in equally divided doses every 6 hours	Administer 1 hour before or 2 hours after meals. Peak plasma levels 7–15 mcg/ml after 30–60 min.
dicloxacillin sodium *(die-klox-ah-**SILL**-in **SOH**-dee-um)* (Dycill, Dynapen, Pathocil, etc.)	narrow	oral	*Adults & children over 40 kg:* 125–250 mg every 6 hours *Children under 40 kg:* 12.5–25 mg/kg/day in equally divided doses every 6 hours	Use of this drug in the newborn is not recommended. Oral solution is stable for 14 days when reconstituted and refrigerated in its original container.
Ampicillin and Related Penicillins				
ampicillin *(am-pih-**SILL**-in)* ampicillin sodium *(am-pih-**SILL**-in **SOH**-dee-um)* (Omnipen, Totacillin, Polycillin, Ampicin (✱), Apo-Ampi (✱), Penbritin (✱))	extended	oral, IM, IV	*Adults:* 1–12 g daily in divided doses every 6 hours *Children:* 50–400 mg/kg/day in equally divided doses every 4–6 hours	Parenteral form comes in powder requiring reconstitution. Short shelf life. Higher than listed doses may be used in treating severe infections. 3.5 g of ampicillin is available orally with 1 g of probenecid (e.g., Polycillin-PRB) to produce high and sustained plasma levels of ampicillin with a single administration for the treatment of uncomplicated urethral, endocervical, or rectal gonorrheal infections.
bacampicillin HCl *(bah-**kam**-pih-**SILL**-in)* Spectrobid, Penglobe (✱))	extended	oral	*Adults weighing 25 kg or more:* 400 mg every 12 hours *Children:* 25 mg/kg/day in 2 equally divided doses at 12-hour intervals	Bacampicillin is converted to ampicillin in the body and is more completely absorbed than ampicillin from the GI tract. In the treatment of gonorrhea in adults, 1.6 g of bacampicillin is given with 1 g of probenecid (Benemid) as a single oral dose.
amoxicillin *(ah-**mox**-ih-**SILL**-in)* (Amoxil, Polymox, Wymox, Apo-Amoxi (✱), Novamoxin (✱), etc.)	extended	oral	*Adults & children over 20 kg:* 250–500 mg every 8 hours *Children under 20 kg:* 20–40 mg/kg/day in divided doses every 8 hours	3 g of amoxicillin may be administered orally with 1 g of probenecid in the treatment of uncomplicated gonorrheal infections in *adults*. Also used for otitis media.

continues

TABLE 7–1 *continued*

See **Note** at beginning of Table 7–1, page 131

PENICILLIN	SPECTRUM	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
mezlocillin sodium *(mez-loh-**SILL**-in **SOH**-dee-um)* (Mezlin)	extended	IM, IV	*Adults:* 200–300 mg/kg/day in 4–6 divided doses *Children:* 150–300 mg/kg/day in 2–6 divided doses	Single IM injections should not contain more than 2 g of drug. Slow injection of IM doses over 12–15 seconds will reduce discomfort. Therapeutic serum levels: 35–45 mcg/mL
piperacillin sodium *(pie-**per**-ah-**SILL**-in **SOH**-dee-um)* (Pipracil)	extended	IM, IV	IM: 2–8 g daily in 2–4 divided doses IV: 6–18 g daily in 2–6 divided doses	Single IM injections should not contain more than 2 g of drug. A single IM dose of 2 g may be used in the treatment of uncomplicated gonorrhea infections. Monitor liver and renal function with IV route.
ticarcillin disodium *(tie-kar-**SILL**-in die-**SOH**-dee-um)* (Ticar)	extended	IM, IV	*Adults:* 150–300 mg/kg/day in 4–6 divided doses *Children:* 75–100 mg/kg q 8–12 hours	Single IM injections should not exceed 2 g of drug. Drug should *not* be combined with gentamicin, amikacin or tobramycin in the same IV solution.
Penicillin-Clavulanic Acid Combination Products				
amoxicillin and potassium clavulanate *(ah-**mox**-ih-**SILL**-in and poh-**TASS**-ee-um klav-you-**LAN**-ayt)* (Augmentin, Clavulin (🍁))	extended	oral	*Adults:* One 250 mg or one 500 mg tablet every 8–12 hours *Children:* 20–40 mg/kg/day in 3 divided doses	As both the 250 and the 500 tablets contain the same amount of potassium clavulanate, two 250 tablets are not equivalent to one 500 tablet. The suspension should be refrigerated upon reconstitution. Unused portions should be discarded after 10 days.
ticarcillin disodium and clavulanic acid *(tie-kar-**SILL**-in die-**SOH**-dee-um and klav-you-**LAN**-ick **AH**-sid)* (Timentin)	extended	IV	*Adults:* 3.1 g (3 g ticarcillin/100 mg clavulanic acid) every 4–6 hours For severe infections 200–300 mg/kg/day *Children:* 50–75 mg/kg 3–4 times daily	Treatment is generally continued for 2 days after signs and symptoms of infection have disappeared. Not recommended in children to treat haemophilus influenzae B

continues

TABLE 7–1 *continued*

See **Note** at beginning of Table 7–1, page 131

PENICILLIN	SPECTRUM	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
Penicillin-Sulbactam Combination Products				
ampicillin sodium and sulbactam sodium *(am-pih-**SILL**-in **SOH**-dee-um and sul-**BACK**-tam **SOH**-dee-um)* (Unasyn)	extended	IM, IV	*Adults*: 1.5 g (1 g ampicillin plus 0.5 g sulbactam) to 3.0 g (2 g ampicillin plus 1 g sulbactam) every 6 hours *Children 1 yr or older:* 100–300 mg/kg/day	Safety in children 1 year of age–12 years old for IM administration not determined. Potential for neurotoxicity, including seizure. Comes in powder form requiring reconstitution
Penicillin-Tazobactam Combination Products				
piperacillin sodium and tazobactam sodium *(pie-**per**-ah-**SILL**-in **SOH**-dee-um and tay-zoh-**BACK**-tam **SOH**-dee-um)* (Zosyn)	extended	IV	*Adults:* 12 g piperacillin sodium and 1.5 g of tazobactam daily divided into four doses given every 6 hours for 7–10 days	Use single dose vials immediately after reconstitution. Safety in children less than 12 years old not established.

The cephalosporins have also been shown to be capable of causing nephrotoxicity. This is more likely to occur in clients with a prior history of renal impairment, in the elderly, and in those receiving other potentially nephrotoxic drugs (e.g., the aminoglycoside antibiotics and the **loop diuretics**). Many cephalosporin drugs are now in widespread use. Some are only effective orally, some only parenterally; two, **cephradine** and **cefuroxime**, may be used orally or parenterally. The absorption of orally administered cephalosporins may be slowed in the presence of food, but this does not appear to alter the total amount of drug ultimately absorbed. As about one-third of the clients receiving oral cephalosporins may develop adverse gastrointestinal effects, such as nausea, vomiting, or diarrhea, oral cephalosporins are probably best administered with food or milk. Administration of **cefpodoxime** or cefuroxime with food may actually increase their absorption.

Parenteral cephalosporin administration, particularly by the intramuscular route, often produces pain and sterile abscess at the injection site. Administration of prolonged and/or high IV doses of cephalosporins may result in phlebitis or thrombophlebitis. It should be noted that the administration of either the penicillins or the cephalosporins concurrently with probenecid (Benemid) reduces the rate of excretion of the antibiotics and may increase the blood levels and toxicity of these agents unless dosage of the administered antibiotic is reduced. Table 7–2 compares the properties of the cephalosporin antibiotics.

TABLE 7–2

Cephalosporins

Note: Monitor clients for signs of hypersensitivity, i.e., urticaria, laryngeal edema, skin rash, and anaphylactic shock. Discontinue therapy at first sign of serious hypersensitivity reaction.

Use with caution in clients with renal impairment.

Make IM injections deep into musculature to reduce inflammatory reactions.

IV administration for prolonged periods or in high doses may cause thrombophlebitis. Use small gauge IV needles, large veins, and alternate infusion sites to reduce risk of such problems.

Bacteriostatic antimicrobial agents (e.g., erythromycins or tetracyclines) may interfere with cephalosporins' bactericidal action.

Probenecid administered with cephalosporins may increase and prolong their plasma levels by interfering with their renal tubular secretion.

Use of potentially nephrotoxic drugs, such as aminoglycosides or loop diuretics, with cephalosporins may increase likelihood of renal toxicity.

Use may result in a false positive reaction for glucose with Benedict's solution or Clinitest tablets. Glucose tests based on enzymatic reaction (e.g., Clinistix or Tes-Tape) are not affected by cephalosporin use.

Monitor clients for gastrointestinal distress, renal impairment and hematological changes. In clients with renal impairment, consult product information and adjust cephalosporin dose accordingly.

DRUG	ROUTE(S)	GENERATION		USUAL DOSE NURSING IMPLICATIONS
For Oral Use Only cefaclor *(**SEF**-ah-klor)* (Ceclor)	oral	2nd	*Adults:* 250–500 mg every 8 hours *Children:* 20–40 mg/kg/day in 3 equally divided doses, not to exceed 2 g daily. For otitis media and pharyngitis, total daily dosage may be divided and administered every 12 hours.	Refrigerate suspension after reconstitution. Discard unused portion after 14 days. Primary use for infections in upper respiratory system. Not approved for infants
cefadroxil monohydrate *(sef-ah-**DROX**-ill **mon**-oh-**HY**-drayt)* (Duricef, Ultracef)	oral	1st	*Adults:* 1–2 g daily in a single dose or 2 divided doses *Children:* 30 mg/kg/day in divided doses every 12 hours.	Monitor clients for development of bleeding. Store reconstituted suspension in refrigerator. Discard after 14 days. Creatinine clearance should be checked in clients with renal impairment.
cefdinir (Omnicef) *(**SEF**-dih-near)*	oral	3rd	*Adults:* 300 mg every 12 hours or 600 mg every 24 hours *Children:* 7 mg/kg every 12 hours or 14 mg/kg every 24 hours	Antacids, aluminum, or magnesium will decrease cefdinir absorption. Comes in oral suspension.
cefixime *(seh-**FIX**-eem)* (Suprax)	oral	3rd	*Adults:* 400 mg daily administered in a single daily dose or in 2 divided doses every 12 hours *Children:* 8 mg/kg/day as a single daily dose or divided into 2 doses given 12 hours apart	Only 3rd generation oral product. Use oral suspension to treat otitis media (achieves higher peak blood level.).

continues

TABLE 7–2 *continued*

See **Note** at beginning of Table 7–2, page 136

DRUG	ROUTE(S)	GENERATION		USUAL DOSE NURSING IMPLICATIONS
cefpodoxime proxetil *(**sef**-poh-**DOCKS**-eem **PROCKS**-eh-till)* (Vantin)	oral	3rd	*Adults:* 100–400 mg every 12 hours *Children:* 5 mg/kg/day divided every 12 hours	After reconstitution, suspension should be refrigerated. Any remaining suspension should be discarded after 14 days.
cefprozil *(sef-**PROH**-zil)* (Cefzil)	oral	2nd	*Adults:* 250–500 mg every 12–24 hours *Infants and Children under 12:* 7.5–20 mg/kg every 12 hours	Treatment should be at least 10 days in duration. Refrigerate suspension after reconstitution. Discard unused portion after 14 days.
cephalexin *(sef-ah-**LEX**-in)* (Keflex, Keflet, Keftab, Ceporex (🍁), Norolexin (🍁))	oral	1st	*Adults:* 1–4 g daily in 4 divided doses *Children:* 75–100 mg/kg/day in 4 divided doses	Administer with food if GI upset occurs. Refrigerate reconstituted suspension. Discard unused portion after 14 days. Nephrotoxic.
loracarbef *(lor-ah-**KAR**-bef)* (Lorabid)	oral	2nd	*Adults:* 200–400 mg every 12 hours at least 1 hour before or 2–3 hours after a meal *Children (6 mo–12 yo):* 15–30 mg/kg/day in divided doses every 12 hours	Not a true cephalosporin (beta-lactum antibiotic) but similar to cefaclor.
ceftibuten *(cef-**TYE**-byou-ten)* (Cedax)	oral	3rd	*Adults:* 400 mg once daily for 10 days *Children:* 9 mg/kg every 12 hours or 14 mg/kg every 24 hours	Use adjusted dose in clients with elevated C CR or in renal failure and on dialysis. Resistant to beta-lactamase.
For Oral and Parenteral Use				
cefuroxime sodium *(sef-your-**OX**-eem **SOH**-dee-um)* (Ceftin, Kefurox, Zinacef)	oral, IM, IV	2nd	*Adults:* Oral: 125–500 mg every 12 hours IM,IV: 0.75–3 g every 8 hours *Children under 12:* Oral: 20–30 mg/kg day IM, IV: 50–100 mg/kg/day in equally divided doses every 6–8 hours	Inspect prepared solutions for presence of particles prior to administration. Oral absorption of drug is increased when administered with food. If oral tablets are crushed and mixed with food, a strong bitter taste will be produced. Single dose of 1,000 mg for early Lyme disease.

continues

TABLE 7–2 *continued*

See **Note** at beginning of Table 7–2, page 136

DRUG	ROUTE(S)	GENERATION		USUAL DOSE NURSING IMPLICATIONS
cephradine *(**SEF**-rah-deen)* (Velosef)	oral, IM, IV	1st	*Adults:* Oral: 1 g daily in 2–4 divided doses IM, IV: 2–4 g daily in 4 divided doses *Children (over 9 mo old):* Oral: 25–100 mg/kg/day in 2–4 divided doses IM, IV: 50–100 mg/kg/day in 4 divided doses	Protect drug solutions from light. In prolonged infusions, replace infusion solution every 10 hours with fresh solution. After reconstitution, oral suspension is stable for 7 days at room temperature and 14 days if refrigerated.
For Parenteral Use Only				
cefamandole nafate *(sef-ah-**MAN**-dohl **NAF**-ayt)* (Mandol)	IM, IV	2nd	*Adults:* 0.5–2 g every 4–8 hours *Children:* 50–100 mg/kg/day in 3–6 divided doses	Monitor client for development of bleeding. Avoid alcohol consumption during and for several days following therapy.
cefazolin sodium *(sef-**AYZ**-oh-lin **SOH**-dee-um)* (Ancef, Kefzol)	IM, IV	1st	*Adults:* 0.25–1.5 g every 6–12 hours *Children:* 25–50 mg/kg/day in 3–4 divided doses	Report evidence of renal impairment. High doses may cause seizures. Used also or preoperative prophylaxis. Monitor carefully for antibiotic-associated colitis.
cefepime HCl *(**SEF**-eh-pime)* (Maxipime)	IM, IV	4th	*Adults:* 0.5–2 g twice a day for 7–10 days *Children:* 50 mg/kg twice a day	Use with caution during lactation Aminoglycosides increase risk of nephrotoxicity and ototoxiocity.
cefmetazole sodium *(sef-**MET**-ah-zohl **SOH**-dee-um)* (Zefazone)	IV	2nd	2 g IV every 6–12 hours for 5–14 days For prophylaxis 1–2 g single doses may be given 30–90 minutes before and 8 hours and 16 hours after surgery	Renal baseline studies should be obtained. Report evidence of renal impairment.
cefoperazone sodium *(sef-oh-**PER**-ah-zohn **SOH**-dee-um)* (Cefobid)	IM, IV	3rd	*Adults:* 2–4 g daily in equally divided doses every 12 hours Up to 12–16 g/day for severe infections	Protect sterile powder from light and refrigerate prior to reconstitution. See cefamandole nafate. Serum half-life of cefoperazone may be increased 100%–400% in clients with hepatic disease or biliary obstruction.
cefonicid sodium *(seh-**FON**-ih-sid **SOH**-dee-um)* Monocid)	IM, IV	2nd	*Adults:* 0.5–2 g once every 24 hours	Give IM dose into large muscle mass. If dose of 2 g is ordered IM, give half of dose into each of two sites.

continues

TABLE 7–2 *continued*

See **Note** at beginning of Table 7–2, page 136

DRUG	ROUTE(S)	GENERATION		USUAL DOSE NURSING IMPLICATIONS
cefotaxime sodium *(sef-oh-**TAX**-eem **SOH**-dee-um)* (Claforan)	IM, IV	3rd	*Adults:* 1.0–2.0 g every 4–12 hours not to exceed 12 g/day *Children:* 50–180 mg/kg/day	Protect drug solutions from light.
cefotetan disodium *(sef-oh-**TEE**-tan die-**SOH**-dee-um)* (Cefotan)	IM, IV	2nd	*Adults:* 1 or 2 g every 12 hours for 5–10 days 3 g for prophylaxis prior to surgery	Do not store unopened vials above 22°C (71.6°F). Protect from light.
cefoxitin sodium *(seh-**FOX**-ih-tin **SOH**-dee-um)* (Mefoxin)	IM, IV	2nd	*Adults:* 1–2 g every 6–8 hours *Children 3 months and older:* 80–160 mg/kg/day in divided doses every 4–6 hours	Administer IV doses slowly because drug is irritating to veins. Broad spectrum.
ceftazidime *(sef-**TAY**-zih-deem)* (Fortaz, Tazicef, Tazidime)	IM, IV	3rd	*Adults:* 0.25–2 g every 8–12 hours *Children:* 30–50 mg/kg every 8–12 hours (IV only)	For IM injections, inject deeply into a large muscle mass. IV use for pseudamonas infections—drug of choice.
ceftizoxime sodium *(sef-tih-**ZOX**-eem **SOH**-dee-um)* (Cefizox)	IM, IV	3rd	*Adults:* 1–4 g every 8–12 hours *Children over 6 months old:* 50 mg/kg every 6–8 hours	For IM doses of 2 g, divide dose equally and give in different sites.
ceftriaxone sodium *(sef-try-**AX**-ohn **SOH**-dee-um)* (Rocephin)	IM, IV	3rd	*Adults:* 1–2 g once daily, not to exceed 4 g *Children:* 50–100 mg/kg/day in divided doses every 12 hours	Use with caution in clients with a history of GI disease, especially colitis.
cephalothin sodium *(sef-**AL**-oh-thin **SOH**-dee-um)* (Keflin, Ceporacin (🍁))	IM, IV	1st	*Adults:* 0.5–1 g every 4–6 hours *Children:* 80–160 mg/kg/day in divided doses	Cephalothin sodium solutions have been used intraperitoneally in concentrations of 0.1%–4% as irrigants. Slight warming may hasten drug dissolution in various diluents. Observe client for development of phlebitis and thrombophlebitis.
cephapirin sodium *(sef-ah-**PIE**-rin **SOH**-dee-um)* (Cefadyl)	IM, IV	1st	*Adults:* 0.5–1 g every 4–6 hours *Children:* 40–80 mg/kg/day in 4 equally divided doses	Stable at room temperature for 12 hours. Each 1 g must be reconstituted with at least 10 ml sterile water.

KEY NURSING IMPLICATIONS 7–2

Cephalosporin Generation Characteristics

1. *First Generation*—exhibit gram-positive and some gram-negative activity and are generally susceptible to beta lactamase inactivation.
2. *Second Generation*—exhibit a greater spectrum of gram-negative activity and somewhat less gram-positive activity. Some agents in this group are resistant to beta lactamases. Generally drug cost is greater than first generation cephalosporins.
3. *Third Generation*—broader spectrum of gram-negative activity and weaker gram-positive activity. Some agents in this group are resistant to beta lactamases. Generally drug cost is greater than first and second generation drugs.
4. *Fourth Generation*—broadest action against gram-negative organisms of the four generations and minimal action against gram-positive organisms.

Tetracyclines

The tetracyclines are a series of chemically related compounds that have a number of unique properties. They are all bacteriostatic at dosage levels usually employed. They are considered to be broad-spectrum agents because of their effectiveness in treating infections caused by many gram-positive and gram-negative organisms. Their action is attributed to the ability to inhibit protein synthesis in the bacterial cell, thereby slowing its growth and reproductive rate so that it becomes more susceptible to the body's own immune defenses.

Although once popularly used for the treatment of a wide variety of infectious diseases, the tetracyclines have lost some of their popularity with the introduction of newer antibiotic classes that have often proven to be safer and more effective in their action. The primary drawback in the use of tetracyclines is their toxicity. Of particular concern is the:

- effect on bone and tooth enamel
- *photosensitivity* that they may cause
- likelihood of superinfection with prolonged or repeated tetracycline administration

When administered during the period of tooth development, i.e., from the fourth month of fetal development through the eighth year of life, tetracyclines may interfere with normal calcification of both temporary and permanent teeth and may cause discoloration of the developing teeth. Tetracyclines should therefore not generally be used to treat children in this age group. Tetracyclines may also interfere with normal bone growth and development, particularly in very small infants and is toxic when outdated.

Some clients receiving tetracyclines become more susceptible to sunburning when they are exposed to direct sunlight or ultraviolet light. This effect appears to be most apparent in the use of **demeclocycline** (**Declomycin**), although it may occur with any of the tetracyclines. Superinfection may also take place. This happens because of the broad spectrum of tetracycline activity and the ability to suppress the normal bacterial competitors of fungi and other microbial organisms, which are not susceptible to the action of the tetracyclines.

Six tetracyclines are currently available in the United States. Of these, all are excreted primarily in the urine, except **doxycycline** and **minocycline**. This permits these two agents to be used with greater safety in clients with renal impairment. In most situations for which the tetracyclines are used, the specific agent to be administered is chosen on the basis of its specific spectrum of action, the desired route of administration, and duration of action, plus the cost of the medication to the client. Table 7–3 summarizes the properties of the tetracyclines.

Macrolides

The **macrolides**, which include erythromycin, **clarithromycin**, **azithromycin**, and **troleandomycin**, are bacteriostatic antibiotics that act by inhibiting protein synthesis in the bacterial cell. They are used primarily for oral therapy of respiratory, GI, urinary, skin, and soft tissue infections caused by gram-positive and some gram-negative organisms, particularly in clients in whom penicillins, cephalosporins, or tetracyclines are contraindicated. Parenteral forms of erythromycin, although available commercially, are not commonly used. Although a number of different chemical derivatives of erythromycin are available, their dosage is usually stated in terms of how much erythromycin base they are equivalent to.

Erythromycin is primarily metabolized by the liver. It must, therefore, be administered with caution to clients with impaired liver function. Azithromycin and troleandomycin are either excreted unchanged in the urine or in the bile. Clarithromycin and its active metabolite are primarily excreted in the urine. Table 7–4 lists the macrolides currently in use.

TABLE 7–3

Tetracyclines

Note: Avoid use in children under 8 because of possible interference with development of teeth and bones and staining of teeth.

Clients must avoid unprotected exposure to direct sunlight or UV light to reduce risk of *phototoxicity*.

IV therapy in excess of 2 g/day of drug may produce hepatotoxicity.

Should not be used during pregnancy.

Monitor clients for bacterial or fungal superinfection, particularly involving the GI tract and/or vagina.

Avoid use with calcium supplements, antacids, iron, or dairy products as these may reduce tetracycline absorption.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
demeclocycline hydrochloride *(dem-**ee**-kloh-**SYE**-kleen **hy**-droh-**KLOR**-eyed)* (Declomycin)	oral	*Adults:* 150 mg qid or 300 mg bid *Children over 8:* 6–12 mg/kg/day divided into 2 or 4 doses	Some clients on long-term therapy may develop diabetes insipidus syndrome.
doxycycline hyclate *(dox-ih-**SYE**-kleen **HIGH**-klayt)* (Doryx, Vibramycin, Apo-Doxy (🍁), Doxycin (🍁), Novodoxylin (🍁), etc.)	oral	*Adults:* 100 mg bid on first day, 100 mg daily thereafter *Children over 8:* 4.4 mg/kg/day in 2 divided doses on first day followed by 2.2 mg/kg/day as a single or divided dose thereafter	May be taken with food or milk. Drug of choice to treat Lyme disease.
minocycline hydrochloride *(mih-noh-**SYE**-kleen **hy**-droh-**KLOR**-eyed)* (Minocin)	oral, IV	*Adults:* 200 mg initially followed by 100 mg every 12 hours *Children over 8:* 4 mg/kg initially followed by 2 mg/kg every 12 hours	Some clients may experience dizziness or vertigo while using this drug. This is reversible when drug is discontinued. May be taken with food or milk.
tetracycline hydrochloride *(teh-trah-**SYE**-kleen **hy**-droh-**KLOR**-eyed)* (Achromycin V, Panmycin, Sumycin, Apo-Tetra (🍁), Novotetra (🍁), Nu-tetra (🍁), etc.)	oral, ophthalmic	*Adults:* Oral, IV: 250–500 mg every 6–12 hours *Children over 8:* Oral: 25–50 mg/kg/day divided into 2–4 doses	—

TABLE 7–4

Macrolides/Erythromycins

Note: Monitor clients for signs of hepatotoxicity, i.e., malaise, nausea, vomiting, abdominal cramping, fever, jaundice, and/or abnormal hepatic function tests.

Hypersensitivity reactions may occur in some clients, ranging from mild skin rashes to anaphylaxis.

Oral doses should be taken 1 hour before or 2 hours after meals. Administer with food if GI upset occurs.

DRUG	USUAL DOSE	NURSING IMPLICATIONS
Oral Products		
azithromycin *(ah-**zih**-throh-**MY**-sin)* (Zithromax) macrolide class	500 mg as a single dose on the first day, then 250 mg once daily on days 2–5 for a total dose of 1.5 g 1–2 g in single dose for nongonococcal and gonococcal urethritis	Only approved for individuals 16 years of age or older. Drug should be administered at least 1 hour before a meal or at least 2 hours after a meal. Avoid use of aluminum- or magnesium-containing antacids at the same time as when taking azithromycin doses.
clarithromycin *(klah-**rith**-roh-**MY**-sin)* (Biaxin) microlide class	*Adults:* 250–500 mg every 12 hours *Children:* 7.5 mg/kg twice a day	Safety and efficacy in children under 6 months has not been established. Drug may be administered without regard to meals. Do not refrigerate suspension. Many drug interactions.
Erythromycins		
erythromycin base *(eh-**rih**-throw-**MY**-sin bays)* (E-mycin, Ery-Tab, Eryc, Apo-Erythro (🍁), Erythromid (🍁), Novorythro (🍁), etc.)	*Adults:* 250–500 mg every 6 hours, or 333 mg every 8 hours *Children:* 30–50 mg/kg/day in 3–4 divided doses for 10 days	Do not crush or chew enteric-coated or delayed-release products. Oral doses should be taken with water and food rather than fruit juices, which could affect absorption. Multiple drug interactions.
erythromycin estolate *(eh-**rih**-throw-**MY**-sin **ES**-toh-layt)* (Ilosone)	See erythromycin base.	Hepatotoxicity has been reported most commonly with this erythromycin form.
erythromycin ethylsuccinate *(eh-**rih**-throw-**MY**-sin **eth**-ill-**SUCK**-sih-nayt)* (E.E.S., EryPed, Apo-Erythro-ES(🍁), etc.)	See erythromycin base.	400 mg erythromycin ethylsuccinate is equivalent to 250 mg of erythromycin base, stearate, or estolate.
erythromycin stearate *(eh-**rih**-throw-**MY**-sin stee-**AIR**-ayt)* (Erythrocin Stearate, Wyamycin S, Apo-Erythro-S (🍁), etc.)	See erythromycin base.	Causes more allergic reactions than other erythromycins.
Parenteral Products		
erythromycin lactobionate *(eh-**rih**-throw-**MY**-sin **lack**-toh-**BYE**-oh-nayt)*	15–20 mg/kg/day up to 4 g/day by intermittent or continuous IV infusion	Continuous infusion is preferred method of administration.

Aminoglycosides

The aminoglycoside antibiotics are a series of compounds sharing similar chemical and pharmacological properties. Although some of these agents are used orally to treat intestinal infections, none of the aminoglycosides are absorbed from the GI tract. Therefore, they are most commonly administered parenterally. All aminoglycosides act by inhibiting protein synthesis in the bacterial cell and may exert either a bactericidal or bacteriostatic action, depending on the drug dosage employed. All members of this group are capable of producing nephrotoxicity and ototoxicity even in conventionally used doses. Because of this narrow therapeutic range, peak and trough plasma concentrations are frequently done to maintain plasma levels within this narrow range. As these drugs are primarily excreted by the kidneys in an unchanged form, clients with renal impairment are particularly susceptible to the development of toxicity. Aminoglycosides are also capable of exerting a neuromuscular blocking action that may result in the development of respiratory paralysis in some clients. For this reason, aminoglycosides must be used with particular caution in clients also receiving certain anesthetics or muscle relaxants. Table 7–5 compares the aminoglycoside antibiotics in current use.

OTHER ANTIBACTERIAL AGENTS

Many other antibacterial agents are available, although they tend to have differing chemical structures and are not part of large classes of agents. The nursing implications for these agents are presented in the following material rather than being presented in "Applying the Nursing Process" section.

Imipenem-Cilastatin (Primaxin). **Imipenem** is an antibacterial agent active against a wide range of gram-positive and gram-negative organisms. It is also resistant to the action of beta lactamases, enzymes released by some microorganisms capable of destroying the chemical structure of many penicillin and cephalosporin antimicrobial drugs. This resistance to beta lactamases permits imipenem to be employed successfully in the treatment of infections that would be resistant to the effects of most penicillins and cephalosporins.

When administered alone, imipenem is metabolized in the kidney by the enzyme dehydropeptidase I. This results in relatively low levels of the drug in the urine and greatly diminishes its ability to treat urinary tract infections. **Cilastatin** is an inhibitor of this kidney enzyme and permits, therefore, high urine levels of imipenem to be achieved.

Imipenem-cilastatin is administered by IV infusion or IM injection in the treatment of serious infections caused by organisms susceptible to it. It is also useful in treating infections that do not respond to penicillins, cephalosporins, or aminoglycosides. Because imipenem is chemically related to the penicillins and cephalosporins, clients who have a history of hypersensitivity to these drugs may experience a similar reaction to imipenem.

Aztreonam (Azactam). This is a synthetic bactericidal agent that is in a newer class of antimicrobial agents known as the **monobactams**. It is particularly useful in the parenteral treatment of many gram-negative infections including those caused by *Pseudomonas aeruginosa* and *E. coli*. Like the penicillins and cephalosporins, **aztreonam** seems to produce its bactericidal effect by interfering with bacterial cell wall synthesis. It is, however, highly resistant to beta lactamases.

Lincomycin and Clindamycin. These are chemically related agents that appear to act like erythromycin in suppressing protein synthesis of susceptible microorganisms. These agents have antimicrobial activity similar to erythromycin and are particularly useful in the treatment of infections caused by anaerobic organisms. **Clindamycin** is preferred to lincomycin, because it is better absorbed, more potent and less toxic.

Use of either of these drugs may result in the development of severe and possibly fatal colitis, which is characterized by severe diarrhea, abdominal cramps, and the passage of blood and mucus in the stool. If significant diarrhea develops during therapy, administration of the drug should be discontinued or continued with close observation of the client. Such diarrhea or colitis may begin up to several weeks after therapy is discontinued. Some clients receiving these drugs have developed *pseudomembranous enterocolitis*, a condition resulting in severe diarrhea and possible death. This condition is believed to result from a toxin produced by *Clostridium difficile*, an organism that seems to emerge in the gastrointestinal tract in some clients receiving antimicrobial therapy. Vancomycin (see Table 7–6) has been employed successfully in the treatment of antibiotic-associated pseudomembranous enterocolitis.

TABLE 7–5

Aminoglycosides

Note: Monitor clients for signs of nephrotoxicity.

Neuromuscular blockade and respiratory paralysis may occur when administered with or shortly after anesthetics or muscle relaxants.

Provide good hydration to reduce likelihood of nephrotoxicity or neurotoxicity.

Avoid use of other drugs that produce ototoxicity, nephrotoxicity, or neurotoxicity.

To prevent peripheral IV site irritation, avoid infusing medication rapidly.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
amikacin sulfate *(am-ih-**KAY**-sin **SUL**-fayt)* (Amikin)	IM, IV	15 mg/kg/day in 2–3 equally divided doses	Less likely to result in development of bacterial resistance than other aminoglycosides. Do not mix with other drugs.
gentamicin sulfate *(jen-tah-**MY**-sin **SUL**-fayt)* (Garamycin, Cidomycin (🍁))	IM, IV, intrathecal	IM and IV: 3 mg/kg/day in 3 equally divided doses Intrathecal: *Adults:* 4–8 mg once daily *Infants 3 months and older and children:* 1–2 mg once daily	For intrathecal administration, use only product containing no preservatives and marked for intrathecal use. Monitor for ototoxicity. Monitor peak and trough levels.
kanamycin sulfate *(kan-ah-**MY**-sin **SUL**-fayt)* (Kantrex)	oral, IM, IV, intraperitoneal, inhalation	Oral: 8–12 g daily in divided doses depending on use IM and IV: 15 mg/kg/day in 2 equally divided doses Intraperitoneal: 500 mg diluted in 200 mL of sterile water Inhalation: 250 mg (1mL) diluted with 3 mL of normal saline nebulized 2–4 times daily	0.25% kanamycin solution may be used as irrigant in various body cavities. For IV use, do not physically mix with other antibacterial agents. Loss of hearing may occur, particularly in elderly clients.
neomycin sulfate *(nee-oh-**MY**-sin **SUL**-fayt)* (Mycifradin, etc.)	oral	*Adults:* 4–12 g daily in divided doses *Children:* 50–100 mg/kg/day in divided doses	Do not administer to infants or children or to clients with renal impairment.
netilmicin sulfate *(neh-till-**MY**-sin **SUL**-fayt)* (Netromycin)	IM, IV	*Adults:* 3–6.5 mg/kg/day in 2 or 3 divided doses *Infants and children:* 5.5–8 mg/kg/day in 2 or 3 divided doses *Neonates less than 6 weeks:* 4–6.5 mg/kg/day in 2 divided doses	Determine client's pretreatment weight.
streptomycin sulfate *(strep-toh-**MY**-sin **SUL**-fayt)*	IM	*Adults:* 1–4 g daily in 2–4 divided doses *Children:* 20–40 mg/kg/day in 2–4 divided doses	Aminoglycoside most likely to cause ototoxicity. Client's hearing should be assessed before administration of first dose. Store in refrigerator.
tobramycin sulfate *(toh-brah-**MY**-sin **SUL**-fayt)* (Nebcin)	IM, IV	*Adults:* 3–5 mg/kg/day in 3–4 divided doses *Children:* 6–7.5 mg/kg/day in 3 or 4 equally divided doses	Do not mix with other antimicrobial agents. For IV use, do not physically mix with other antimicrobial agents.
paromomycin sulfate *(pair-**oh**-moh-**MY**-sin **SUL**-fayt)* (Humatin)	oral	25–35 mg/kg/day in 3 doses	Usually used for treatment of intestinal amebiasis. May also be used to treat hepatic coma. Administer with meals.

TABLE 7–6

Other Antibacterial Agents

Note: Report evidence of allergic reaction, such as rash or itching.
Report symptomatic improvement.
Review administration and storage instructions that accompany product.
To prevent peripheral IV site irritation, avoid infusing medication rapidly. Monitor site.

DRUG	ROUTE(S)	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
aztreonam *(az-**TREE**-oh-nam)* (Azactam)	IM, IV	*Adults:* 0.5–2 g every 6 to 12 hours *Children:* 30 mg/kg/dose	discomfort, swelling, phlebitis at injection site	Use of probenecid or furosemide with aztreonam may increase aztreonam serum levels.
bacitracin *(bass-ih-**TRAY**-sin)* (Baci-IM)	IM	*Infants under 2.5 kg:* 900 units/kg/day in 2–3 divided doses *Infants over 2.5 kg:* 1,000 units/kg/day in 2–3 divided doses	renal toxicity, nausea and vomiting, pain at injection site, skin rash	Store unreconstituted and reconstituted drug in refrigerator. Bacitracin solutions are stable for 1 week when stored in a refrigerator. Maintain fluid intake and output at proper levels to avoid toxicity. Systemic bacitracin is only indicated for the treatment of infants with pneumonia and empyema caused by staphylococci shown to be sensitive to the drug. Administer injection deep into a large muscle mass to minimize pain. Monitor for nephrotoxiciy.
chloramphenicol *(klor-am-**FEN**-ih-kohl)* (Chloromycetin)	oral, IV	50 mg/kg/day in divided doses every 6 hours	bone marrow depression; serious blood dyscrasias, GI upset	Drug is ineffective when given by IM injection. Monitor client for signs of bone marrow depression and blood dyscrasias (sore throat, fatigue, unusual bleeding or bruising). Clients with impaired or inadequate liver function, such as newborn infants and the elderly, are at greater risk of developing adverse effects to this drug.
ciprofloxacin HCl *(sip-row-**FLOX**-ah-sin **hy**-droh-**KLOR**-eyed)* (Cipro)	oral, IV	Oral: 500 mg every 12 hours IV: 200–400 mg every 12 hours	nausea and vomiting, diarrhea, rash, bronchospasm, blood dyscrasias, hepatotoxicity	Aluminum or magnesium-containing antacids or products containing iron or zinc should not be administered within 4 hours before or 2 hours after dosing. Administer 2 hours after meals. Avoid excessive exposure to sunlight.
clindamycin HCl *(klin-dah-**MY**-sin **hy**-dro-**KLOR**-eyed)* (Cleocin HCl)	oral	*Adults:* 150–300 mg every 6 hours *Children:* 8–25 mg/kg/day divided in 3–4 equal doses	nausea and vomiting, hypersensitivity reactions, diarrhea	Report development of diarrhea or abdominal cramps to physician. Antiperistaltic agents (e.g., Lomotil) should not be used while client is on this medication. Do not refrigerate reconstituted oral solution. Used to treat anaerobic infections.

continues

TABLE 7–6 *continued*

See **Note** at beginning of Table 7–6, page 145

DRUG	ROUTE(S)	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
clindamycin phosphate *(klin-dah-**MY**-sin **FOS**-fayt)* (Cleocin Phosphate, Dalacin (🍁))	IM, IV	Parenteral *Adults:* 600–2,700 mg daily in 2–4 divided doses *Children:* 15–40 mg/kg in 3–4 divided doses		IM injections may cause pain, induration and sterile abscess formation. They should, therefore, be made deep into a large muscle. Injection sites must be rotated. Drug should *not* be administered by IV as a bolus. Infuse over 10–60 minutes.
enoxacin *(en-**OCK**-sah-sin)* (Penetrex)	oral	200–400 mg every 12 hours for 7–14 days	See ciprofloxacin.	A single 400 mg dose may be used to treat gonorrhea. Administer at least 1 hour before or 2–3 hours after a meal.
gatifloxacin *(**GAT**-eh-flox-ah-sin)* (Tequin)	oral, IV	400 mg once daily	nausea, local IV site reactions, cardiac dysrhythmias, dizziness, nervousness, tendon pain and inflammation, photosensitivity, pseudomembranous colitis	Monitor clients taking both gatifloxacin and digoxin. Dilute contents of single dose vials before administration. Administer IV over 60 minutes. Do not infuse IV with any other drugs. One of two newest flouroquinolones (see moxifloxacin).
imipenem-cilastatin *(im-ee-**PEN**-em-sih-lah-**STAT**-in)* (Primaxin)	IM, IV	*Adults:* IV: 250–500 mg every 6–8 hours IM: 500–750 mg every 12 hours *Children:* 15–25 mg/kg/dose	hypersensitivity reactions, phlebitis, thrombophlebitis	Inspect solution of drug carefully prior to administration to assure that no undissolved particles are present. Do not mix with other antimicrobial agents. Do not use in clients with heart block.
lincomycin HCl *(**lin**-koh-**MY**-sin **hy**-droh-**KLOR**-eyed)* (Lincocin, Lincorex)	oral, IM, IV, subconjunctival	*Adults:* Oral: 500 mg every 6–8 hours IM: 600 mg once or twice daily IV: 600–1,000 mg every 8–12 hours *Children over 1 month old:* Oral: 30–60 mg/kg/day divided into 3–4 equal doses IM: 10 mg/kg once or twice daily IV: 10–20 mg/kg/day divided into 2–3 doses Subconjuntival Injection: 75 mg	nausea and vomiting, diarrhea, hypersensitivity reactions, hematopoietic changes	Report development of diarrhea or abdominal cramps to physician. Administer orally on an empty stomach. For IV use, each 1 gram of drug must be diluted in a minimum of 100 mL of solution. Antiperistaltic agents (e.g., Lomotil) should not be used while client is on the medication. Not a first choice drug, but used in clients allergic to penicillins.

continues

TABLE 7–6 *continued*

See **Note** at beginning of Table 7–6, page 145

DRUG	ROUTE(S)	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
lomefloxacin HCl *(loh-meh-**FLOX**-ah-sin **hy**-droh-**KLOR**-eyed)* (Maxaquin)	oral	400 mg once daily	nausea, headache, dizziness, photosensitivity	May be given without regard for meals. Discontinue drug at the first sign of phototoxicity. Used primarily to prevent (pre-op) or treat UTI.
metronidazole HCl *(meh-troh-**NYE**-dah-zohl **hy**-droh-**KLOR**-eyed)* (Flagyl, Protostat, Neo-Metric (🍁), Novonidazol (🍁), Trikacide (🍁), etc.)	oral, IV	*Adults:* Oral: 500–750 mg 3 times a day *Children:* Oral: 7.5 mg/kg every 6 hours IV: initially 15 mg/kg infused over 1 hour as a loading dose; thereafter 7.5 mg/kg infused over 1 hour every 6 hours	nausea and vomiting, diarrhea, skin rash, seizures, peripheral neuropathy	Monitor client for development of neurological symptoms. Client must not receive alcoholic beverages during therapy since abdominal cramps, nausea, vomiting, headaches, and flushing may occur. Do not administer as an IV bolus. Drug may cause darkening of urine.
moxifloxacin HCl *(mox-eh-**FLOX**-ah-sin)* (Avelox)	oral	400 mg once daily for 10 days	nausea, diarrhea, cardiac dysrhythmias, dizziness, nervousness, tendon pain and inflammation, photosensitivity, pseudomembranous colitis.	Monitor clients taking both moxifloxacin and digoxin. Monitor for adverse effects. One of two newest flouroquinolones (see gatifloxacin).
norfloxacin *(nor-**FLOX**-ah-sin)* (Noroxin)	oral	400 mg every 12 hours	nausea, headache, dizziness	Give 1 hour before or 2 hours after meals with a glass of water. Administer fluids liberally.
ofloxacin *(oh-**FLOX**-ah-sin)* (Floxin)	oral, IV	Oral and IV: 200–400 mg every 12 hours	nausea, diarrhea, headache, dizziness, insomnia	Drug should not be administered IM, SC, intrathecally, or intraperitoneally. Use with caution in client with CNS disorders.
polymyxin B sulfate *(pol-ee-**MIX**-in bee **SUL**-fayt)* (Aerosporin, etc.)	IM, IV, intrathecal	IV: 15,000–25,000 units/kg/day Intrathecal: *Adults and children over 2:* 50,000 units daily for 3–4 days, then 50,000 units once every other day for at least 2 weeks *Children under 2:* 20,000 units daily for 3–4 days, then 25,000 units once every other day for at least 2 weeks	nephrotoxicity, neurological changes, hypersensitivity reactions, meningeal irritation with fever following intrathecal injection	IM injection not recommended due to severe pain at injection site. Injection should be made deep in muscle. Polymyxin B sulfate solutions must be stored in refrigerator. Unused portions must be discarded after 72 hours. Monitor client for development of nephrotoxicity, neurotoxicity, or hypersensitivity reactions.

continues

TABLE 7–6 *continued*

See **Note** at beginning of Table 7–6, page 145

DRUG	ROUTE(S)	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
spectinomycin *(speck-tin-oh-**MY**-sin)* (Trobicin)	IM	2 g once or twice daily	pain at injection site, hypersensitivity reactions	Do not refrigerate or freeze solutions. Discard reconstituted suspension after 24 hours. Monitor client for development of hypersensitivity reactions. Inject deep into a large muscle mass to reduce pain.
vancomycin *(van-koh-**MY**-sin)* (Vancocin, Lyphocin Vancoled)	oral, IV	*Adults:* Oral and IV: 500 mg every 6 hours or 1,000 mg every 12 hours *Children:* Oral: 40 mg/kg/day in 3–4 divided doses IV: 40 mg/kg/day in divided doses every 6 hours	ototoxicity, nephrotoxicity, nausea, hypersensitivity reactions, redman's syndrome	Monitor client for development of ototoxicity, nephrotoxicity or hypersensitivity reactions (redman's syndrome). Renal and auditory baseline function should be evaluated prior to beginning therapy. Phlebitis development at IV injection site can be minimized by infusion into a subclavian line or by dilution of drug in at least 200 mL of IV fluid. Administer IV dose over at least 60 minutes. IV use also for clients with MRSA and/or ORSA infections.

Gatifloxacin and moxifloxacin HCl. These are the latest of a group of antibiotics known as *flouroquinolones*. These agents are primarily used for respiratory infections. Both gatifloxacin and moxifloxacin HCl are indicated in the treatment of acute sinusitis and exacerbation of chronic bronchitis. Although rare, one of the complications of agents classified as flouroquinolones is hypersensitivity reactions which can be severe. Other adverse effects include cardiac dysrhythmias, so these agents should not be used in clients receiving antiarrhymics (see Chapter 28). The most common adverse effects of gatifloxacin and moxifloxacin HCl are gastrointestinal irritation (nausea and diarrhea) and central nervous system (CNS) disturbances (headache, dizziness, and CNS stimulation). Mineral-containing products such as certain antacids and vitamins containing iron, zinc, or magnesium can affect the absorption and action of gatafloxacin and moxofloxacin HCl. Refer to Table 7–6 for other information concerning these two agents.

Chloramphenicol. **Chloramphenicol** has a broad spectrum of action and was, at one time, widely employed for treating a wide variety of infections. The development of *aplastic anemia* in some clients using chloramphenicol, although quite uncommon (about 1 in 40,000), has resulted in a drastic decline in the use of this agent except for serious infections where it is clearly an agent of choice (e.g., typhoid fever). The use of chloramphenicol in premature or newborn infants has been associated with the development of "gray syndrome," a toxic reaction often leading to death. Clients receiving chloramphenicol should have baseline blood studies performed prior to initiating therapy and every 2 days during therapy to quickly identify the development of any hematological abnormality.

Colistin sulfate (polymyxin E). **Colistin sulfate** is an agent active against most gram-negative organisms. Its use has been limited in recent years by the development of agents apparently superior in effectiveness (e.g., gentamicin and carbenicillin). The development of neurotoxicity and/or nephrotoxicity has been reported with high blood levels of colistin. For this reason, clients receiving this agent must be carefully observed for the emergence of toxic symptoms, and the use of this agent with other neurotoxic or nephrotoxic drugs should be avoided.

Bacitracin. **Bacitracin** is primarily employed in the treatment of infections caused by gram-positive organisms. It is rarely used for treating systemic infections because it may cause renal failure due to tubular and glomerular necrosis. It is, however, commonly employed topically for the treatment and prophylaxis of superficial skin infections.

Spectinomycin. **Spectinomycin** is an antibiotic which acts by inhibiting protein synthesis in the bacterial cell. It is used almost exclusively in the treatment of gonorrhea, a venereal disease caused by the organism *Neisseria gonorrhea*. It is also used in treating clients who may have been recently exposed to this organism but who have not yet exhibited symptoms of a gonorrheal infection. Spectinomycin is not effective in the treatment of syphilis or other venereal diseases. Clients receiving this drug for the treatment of gonorrhea must be carefully monitored for the development of resistance by the infecting organism.

Vancomycin. Vancomycin is an antibiotic that is bactericidal against many gram-positive organisms. It is used primarily for the treatment of serious infections that cannot be treated with less toxic agents, such as the penicillins or cephalosporins. It is particularly useful in the treatment of *pseudomembranous enterocolitis* produced by the organism *Clostridium difficile*.

Clients receiving vancomycin must be closely monitored for the development of ototoxicity and nephrotoxicity, as well as hypersensitivity reactions. In addition, when vancomycin is administered by the IV route, hypotension, pain, and thrombophlebitis frequently occur. For this reason, each dose of the drug must be diluted in at least 200 mL of glucose or saline solution and *should be administered over at least 60 minutes*. Injection sites should be rotated to avoid local irritation.

Novobiocin. This antibiotic is a bacteriostatic agent that appears to interfere with several functions of the bacterial cell. It is indicated only for use in treating certain serious infections when less toxic antibiotics (i.e., penicillins, cephalosporins, and erythromycin) cannot be used. **Novobiocin** is associated with a high incidence of hypersensitivity reactions, which usually appear as skin rashes. It may also cause hematological disorders and liver dysfunction.

Metronidazole. **Metronidazole** is an agent long successfully used in treating protozoal infections. It is also useful in the treatment of serious anaerobic infections. Clients receiving parenterally administered metronidazole must be carefully monitored for the development of neurologic disturbances such as convulsive seizures and peripheral *neuropathy*. Some clients may also exhibit hematological, dermatological and/or gastrointestinal reactions while receiving this drug.

Ciprofloxacin HCl (Cipro), Enoxacin (Penetrex), Lomefloxacin (Maxaquin), Norfloxacin (Noroxin), Floxacin (Floxin). These are drugs that are part of the fluoroquinolone chemical group of drugs. They are chemically related to several urinary tract anti-infectives including **nalidixic acid** (**NegGram**), and **cinoxacin** (**Cinobac**). Unlike these drugs, **ciprofloxacin**, **enoxacin**, **lomefloxacin**, **norfloxacin**, and **floxacin** are not only useful for the treatment of urinary tract infections, but also for systemic infections caused by a wide range of gram-positive and gram-negative organisms.

The bactericidal action of these agents appears to be the result of their ability to interfere with the synthesis of bacterial DNA. Their chemical structure differs appreciably from the penicillins and cephalosporins, so these drugs may be used in most clients who are sensitive to those other agents. Additive activity may result when the fluoroquinolones are combined with other antimicrobial agents, such as the penicillins, cephalosporins, aminoglycosides, clindamycin, or metronidazole.

Sulfonamides. The sulfonamides were the first antibacterial agents to be widely and successfully employed in the treatment of systemic infections. Although the development of more effective and less toxic agents have greatly reduced the use of the sulfonamides, they are still employed in the treatment of uncomplicated urinary tract infections, otitis media, certain vaginal infections, and other disorders.

Sulfonamides have a relatively broad spectrum of action and primarily exert a bacteriostatic effect. They act by interfering with incorporation of para-aminobenzoic acid (PABA) into the reaction, which permits the organism to synthesize its own folic acid (Figure 7–5). As humans do not synthesize their own folic acid, but use preformed folic acid, the sulfonamides do not affect folic acid utilization in humans.

The usefulness of the sulfonamides is limited by the ease with which many organisms become resistant to their action and by the adverse effects they may cause in some clients. The development of resistance can be minimized by using adequate doses of drug, by maintaining therapy long enough to completely eradicate the infecting organism, and by using combination therapy. Development

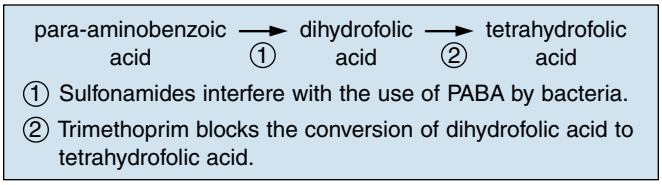

Figure 7–5 Mechanism of action of sulfonamides and trimethoprim

TABLE 7–7

Sulfonamide Products for Systemic Use

Note: Administer drugs on an empty stomach.
Monitor for development of hypersensitivity reactions, particularly in clients with severe allergies or bronchial asthma. Skin rash is a common indication of hypersensitivity.
Maintain adequate fluid intake to prevent crystalluria and stone formation.
Monitor for development of hematological changes, such as a drop in white blood cell count.
Protect client from direct sunlight or UV light to avoid phototoxic reaction.
Initial therapy with these products may require somewhat higher doses than those listed below.
Report symptomatic improvement.

DRUG	ROUTE(S)	USUAL MAINTENANCE DOSE	NURSING IMPLICATIONS
sulfacytine *(**sul**-fah-**SYE**-teen)* (Renoquid)	oral	250 mg 4 times daily	Not to be used in children under 14.
sulfadiazine *(**sul**-fah-**DIE**-ah-zeen)* (Microsulfon)	oral	*Adults:* 4–8 g daily in 3–6 divided doses *Children:* 75–150 mg/kg/day in 4–6 divided doses, not to exceed 6 g daily	May be ordered prophylactically for clients with history of rheumatic fever who are having invasive procedures.
sulfamethizole *(**sul**-fah-**METH**-ih-zohl)* (Thiosulfil Forte)	oral	*Adults:* 0.5–1 g 3–4 times daily *Children and infants over 2 months:* 30–45 mg/kg/day in 4 divided doses	—
sulfamethoxazole *(**sul**-fah-meth-**OX**-ah-zohl)* (Gantanol, Apo-Sulfamethoxazole (🍁), etc.)	oral	*Adults:* 1 g in the morning and evening *Children or infants over 2 months:* 25–30 mg/kg in the morning and evening	Lower doses are used for clients with impaired renal function.
sulfasalazine *(**sul**-fah-**SAL**-ah-zeen)* (Azulfidine, PMS Sulfasalazine (🍁), Salazopyrin (🍁), S.A.S. (🍁), etc.)	oral	*Adults:* 500 mg 4 times daily in evenly divided doses *Children:* 30 mg/kg/day in 4 divided doses	Indicated only for treatment of ulcerative colitis. May produce orange-yellow discoloration of the urine and/or the skin. Do not use in clients who are hypersensitive to salicylates or those under 2 years of age.
sulfisoxazole *(**sul**-fih-**SOX**-ah-zohl)* (Sulfizole, Novo-soxazole (🍁), etc.)	oral	*Adults:* 4–8 g daily in 4–6 divided doses *Children and infants over 2 months:* 150 mg/kg/day in 4–6 divided doses, not to exceed 6 g daily	—

of bacterial resistance to sulfonamides has been reduced considerably by the use of a combination of a sulfonamide and trimethoprim, a drug that blocks the conversion of dihydrofolic acid to tetrahydrofolic acid. By blocking two steps required by the organism to form folic acid, the likelihood that the organism can develop resistance to this drug combination is greatly reduced.

The most prominent adverse effects seen with the use of sulfonamides are hypersensitivity reactions, renal dysfunction, and hematological changes such as a decrease in the white blood cell count. Careful monitoring of clients as well as maintaining adequate hydration is therefore essential. Table 7–7 lists some of the sulfonamides in current use.

URINARY TRACT ANTI-INFECTIVES

Infections of the urinary tract are the most common form of urological disease and may be acute, chronic, or recurrent. Such infections may be classified as being asymptomatic or symptomatic. An asymptomatic urinary tract infection (UTI) is one in which the infection is evidenced only by the presence of bacteria in the urine without other symptoms. Symptomatic urinary tract infections are characterized by the presence of symptoms, such as burning and urinary frequency and/or urgency.

Urinary tract infections may also be described as complicated or uncomplicated. An uncomplicated UTI is one in which no structural or neurological abnormality of the urinary tract interferes with normal urine flow. A complicated UTI is characterized by some impairment that interferes with the ability of the urinary tract to wash bacteria out of the system. Such impairment may be the result of a congenital distortion of the urinary tract, a kidney stone, an enlarged *prostate gland* or a variety of other causes.

The nature of drug therapy employed in the treatment of a UTI depends on the desired goal. Potent antimicrobial agents (e.g., penicillins, cephalosporins, fluoroquinolones, aminoglycosides, sulfonamides)—which were discussed earlier in the chapter—are often used in treating acute UTIs. Therapy with such agents, however, subjects the client to a wide variety of systemic side effects and increases the likelihood of the development of bacterial resistance. This limits the use of such drugs to short-term therapy. When recurrent or chronic UTIs are treated, less potent anti-infectives are often employed. These anti-infectives exert an antiseptic action primarily on the urinary tract. They are less likely to cause systemic side effects or the development of bacterial resistance than the more potent antimicrobial agents.

Nalidixic Acid (NegGram). This agent has been successfully employed for many years as a urinary antiseptic. It exerts a bactericidal action on most gram-negative bacteria by interfering with their ability to transmit genetic information. In adults a dose of 1 g 4 times daily is generally employed as initial therapy for 1–2 weeks. This is reduced to 0.5 g 4 times daily after the initial treatment period.

In children 12 years of age and younger, nalidixic acid is administered according to body weight at an initial dose of 55 mg/kg/day divided equally into 4 doses. This is reduced to a level of about 33 mg/kg/day divided equally into 4 doses for prolonged therapy. The drug is not used in treating children under 3 months of age.

Although adverse effects are infrequent, the use of nalidixic acid has been associated with GI upset, drowsiness, dizziness, and the development of skin rashes. There is also a greater susceptibility to sunburning when exposed to sunlight. Tolerance to the action of nalidixic acid often develops quickly and limits the drug's effectiveness.

Cinoxacin (Cinobac Pulvules). **Cinoxacin** is chemically and pharmacologically related to nalidixic acid. However, it is somewhat less likely to result in the development of bacterial resistance and has a longer duration of action. Cinoxacin is indicated only for the treatment of UTIs in adults and is administered in a dose of 1 g/day in 2 or 4 divided doses for 7–14 days. Clients using this drug should be monitored for the development of skin rash and/or gastrointestinal distress.

Nitrofurantoin (Furadantin, Macrodantin, etc.). **Nitrofurantoin** is an agent believed to act as a urinary tract anti-infective by interfering with carbohydrate metabolism of bacteria. It is administered orally. Therapy should be maintained for at least 3 days after sterile urine is obtained. The oral administration of nitrofurantoin has been associated with the development of gastrointestinal distress. The likelihood that this effect will occur may be somewhat reduced by the administration of a product that contains nitrofurantoin macrocrystals (large crystals) such as **Macrodantin**. All nitrofurantoin products may produce a yellowish-brown discoloration of the urine.

A dose of 50–100 mg of nitrofurantoin is generally administered orally 4 times daily for the treatment of adults with UTIs. When long-term therapy is desired, this dose may be reduced to 50–100 mg at bedtime. Children generally respond to a nitrofurantoin dose of 5–7 mg/kg/day administered in 4 divided doses.

Methenamine Products. Various drug products intended for use as urinary antiseptics contain methenamine or its salts. The most popular of these are **methenamine mandelate** (**Mandelamine**, etc.) and **methenamine hippurate** (**Hiprex**, **Urex**). When these agents are administered orally, methenamine reaches the urine and, if the urine is acidic (i.e., the pH is less than 5.5), the drug is converted to formaldehyde, which exerts a local bactericidal effect in the urinary tract. If the urine is not sufficiently acid, the

liberation of formaldehyde is impaired and the desired antiseptic action diminishes.

Methenamine mandelate is generally administered in an oral dose of 1 g 4 times daily. It is best taken immediately after meals to avoid gastric upset. Methenamine hippurate is administered in an oral dose of 1 g twice daily. With the use of either of these agents, the client should be encouraged to maintain adequate fluid consumption while undergoing therapy; adults should drink from 8–10 glasses of water daily.

Trimethoprim (Proloprim, Trimpex). **Trimethoprim** is an agent which blocks the synthesis of folate in bacteria, thereby interfering with their ability to form nucleic acids and protein. It is effective against most organisms that cause urinary tract infections and is administered orally in a dose of 100 mg every 12 hours or 200 mg every 24 hours for 10 days. Trimethoprim is popularly used in combination with the sulfa drug **sulfamethoxazole** (**Bactrim**, Septra, etc.), as each agent works to inhibit a different step involved in the synthesis of folate by bacteria. This action makes the development of bacterial resistance less likely than if either drug were used alone.

Other Agents Used in the Treatment of Urinary Tract Infections

Several other products are employed in treating clients with urinary tract infections. **Phenazopyridine HCl** (**Pyridium**) is an agent that exerts a topical *analgesic* effect on the mucosal lining of the urinary tract. It is often employed in conjunction with anti-infective therapy. A urinary analgesic relieves pain and discomfort that may persist during the first several days of anti-infective therapy, before complete infection control occurs. Clients should be informed that this drug may cause a reddish-orange discoloration of the urine. Phenazopyridine HCl is generally administered in a dose of 200 mg 3 times daily after meals.

A sterile solution containing the antimicrobial agents **neomycin** and **polymyxin B** (e.g., **Neosporin GU Irrigant**) may sometimes be useful as prophylactic therapy in preventing the growth of bacteria in the urinary tract when an indwelling catheter is used. Such a solution may be employed either as a continuous bladder irrigant or as a short-term bladder rinse.

Table 7–8 lists the classification of microbials, along with possible laboratory interactions.

TABLE 7–8

Lab Test Interactions

CLASSIFICATION	LAB INTERACTIONS
Sulfonamides	Increase serum levels of aspartate aminotransferase, acetyltransferase, and alkaline phosphatase.
Penicillins	High-dose penicillins—decrease in platelet aggregation. May cause a positive Coomb's test.
Cephalosporins	May cause a positive Coomb's test, increased SGOT, SGPT, alkaline phosphatase.
Tetracyclines	May increase SGOT, SGPT, alkaline phosphatase, amylase, bilirubin.
Macrolides	May increase SGOT, SGPT, alkaline phosphatase, bilirubin.
Aminoglycosides	May increase SGOT, SGPT, alkaline phosphatase, creatinine, BUN, LDH; may decrease serum calcium, magnesium, potassium and sodium concentrations.
Other Antibacterial Agents	
ciprofloxacin hydrochloride	May increase creatinine, prolactin, transaminase; may decrease parathyroid concentration.
clindamycin hydrochloride	May increase SGOT, SGPT, alkaline phosphatase.
vancomycin hydrochloride	May increase BUN, creatinine.

DRUGS USED TO TREAT TUBERCULOSIS

Tuberculosis is a contagious disease caused by strains of *Mycobacterium tuberculosis*. The tubercle bacillus thrives in organs having a good supply of oxygen, i.e., the lungs, kidneys, and growing ends of bones. Unlike most bacteria, tubercle bacilli do not release toxins to surrounding tissue and do not cause a tissue reaction. Therefore, they often multiply unopposed for weeks or months before an immunological defense is mounted by the body. To further complicate such infections, some Mycobacterium tuberculosis organisms enter into a dormant stage during which they are resistant to the immunological defenses of the body, as well as to the action of antitubercular drugs. Such dor-

mant organisms may become active at any time and produce clinical symptoms.

During the past several years, tuberculosis has again emerged as a serious disease, particularly among members of the population who may be immunocompromised (e.g., clients with HIV infection). This has been further exacerbated by the development of tuberculosis organisms resistant to conventional antitubercular drugs.

Since tubercle bacilli are slow growing, dormant organisms may be present in a person affected by this disease. Therefore, drug therapy is often maintained for prolonged periods and the development of bacterial resistance to antitubercular drugs is common.

Drug therapy of tuberculosis often assumes one of two forms: preventive therapy and treatment of the active tuberculosis infection. Preventive therapy is aimed at reducing the number of tubercle organisms in a host individual to prevent development of tuberculosis symptoms. Such therapy is often useful in persons who are in close proximity to clients with active tuberculosis, i.e., nurses, physicians, and family members of newly diagnosed tuberculosis clients. Isoniazid (INH) is considered to be the drug of choice for preventive therapy (chemoprophylaxis) because of its relative effectiveness, safety, and low cost as compared to other forms of therapy. Isoniazid exerts both a tuberculostatic and tuberculocidal effect. The "cidal" effect is exerted only when the tubercle bacilli are actively growing. It is believed to act by inhibiting the synthesis of mycolic acid, an essential constituent of the mycobacterium cell wall.

The most prominent adverse effects associated with isoniazid (INH) use are skin rashes, headache, *vertigo*, nausea, *jaundice*, and peripheral *neuritis*. The neuritis is believed to be due to vitamin B_6 (**pyridoxine**) deficiency caused by isoniazid. This difficulty can, to a great extent, be avoided by providing clients on isoniazid therapy with supplemental pyridoxine doses at a level of at least 10 mg daily for each 100 mg of isoniazid administered daily to the client.

Within the general population, some individuals metabolize isoniazid slowly and are known as slow acetylators. Others metabolize the drug 5–6 times more rapidly and are known as rapid acetylators. Approximately 50% of Caucasians and African-Americans are slow acetylators, with the rest being rapid acetylators. The majority of Eskimos and Asians are rapid acetylators. Although the rate of metabolism does not alter the effectiveness of isoniazid, slow acetylators are more likely to have the drug accumulate in their body to toxic levels.

When active tuberculosis infections are to be treated, single-drug therapy is not desirable, as the development of bacterial resistance is likely to occur. Multiple-drug therapy, often employing isoniazid in combination with two or even three other drugs, has proven to be an effective means of treating active tuberculosis infections. Although the combination of isoniazid and rifampin has become a popular regimen for active tuberculosis, other drugs may also be used in combination therapies. The properties of the antitubercular drugs are summarized in Table 7–9.

DRUGS USED TO TREAT LYME DISEASE

Lyme disease, caused by a *spirochete*, *Borrelia burgdorferi*, is the most common tick-transmitted disease in the United States. It is most prevalent in the northeastern and western regions of the U.S., although cases have been reported in all regions. More than 80% of cases are reported between May and September annually.

Initially, symptoms of Lyme disease include the development of a rash and flu-like symptoms. These are followed by arthritis, headache, and fatigue. If left untreated, cardiovascular and neurological complications generally develop. As symptoms of Lyme disease may take from several days to several months to develop, diagnosis may be delayed or completely missed.

Oral therapy with tetracycline HCl (250 mg four times daily) or doxycycline (100 mg two times daily) for 10 to 21 days is recommended for adults, nonpregnant women, and children beyond 8 years of age.

The nurse has an important role in public education about Lyme disease. Information is given about preventing ticks from biting, including advice about proper attire when visiting infested areas, frequent examinations of skin and clothing for ticks, and use of insect repellants. Most popular insect repellents are effective in repelling the northern deer tick, the principal vector for Lyme disease. Flea and tick collars or other tick repellants should also be used on all pets allowed outdoors during the summer months. Finally, persons in infested areas can be instructed in the procedures to take if they are bitten by a tick. This includes

TABLE 7–9

Antitubercular Drugs

Note: Determine prior use of these medications and therapeutic response.
Note color and nature of sputum.
Teach client appropriate hygiene to ensure safety of others.
Stress the importance of completing the course of treatment.

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
aminosalicylate sodium *(ah-**mee**-noh-sal-ih-**SILL**-ayt **SOH**-dee-um)* (Sodium P.A.S.)	oral	14–16 g daily in 2–3 divided doses	hepatotoxicity	Do not use tablets that have turned brown or purple. Drug should be taken with food or milk.
capreomycin sulfate *(**cap**-ree-oh-**MY**-sin **SUL**-fayt)* (Capastat Sulfate)	IM	1 g daily for 60–120 days followed by 1 g 2–3 times weekly	hypokalemia, nephrotoxicity, ototoxicity	Drug should be administered by deep IM injection. Monitor clients for eighth cranial nerve toxicity or renal injury.
cycloserine *(sigh-kloh-**SER**-een)* (Seromycin)	oral	0.5–1 g daily in divided doses	psychoses, seizures	Supplement client with 200–300 mg/day of vitamin B_6.
ethambutol *(eh-**THAM**-byou-tohl)* (Myambutol, Etibi (🍁))	oral	15–25 mg/kg as a single oral dose every 24 hours	decreased visual acuity, fever	Drug should be taken with food. Prescriber should be contacted if vision changes or skin rash occur.
ethionamide *(ee-thigh-**ON**-ah-myd)* (Trecator-SC)	oral	0.5–1.0 g/day in divided doses	anorexia, nausea and vomiting	Drug should be taken with food to reduce GI upset.
isoniazid (INH) *(eye-soh-**NYE**-ah-zid)* (Nydrazid, Isotamine (🍁), etc.)	oral, IM	300 mg daily in one dose	hepatotoxicity, peripheral neuritis	Monitor client for development of jaundice. Supplement client with vitamin B_6.
pyrazinamide *(peer-ah-**ZIN**-ah-myd)* (Tebrazid (🍁))	oral	15–30 mg/kg once daily	hepatotoxicity, hyperuricemia	Monitor client for development of jaundice.
rifabutin *(rih-fah-**BYOU**-tin)* (Mycobutin)	oral	300 mg once daily	rash, GI upset, neutropenia	If GI upset occurs, drug dose may be given divided into two doses and taken with food. Used primarily for the prevention of Mycobacterium avium complex (MAC) in clients with advanced HIV infection. See rifampin.

continues

TABLE 7–9 *continued*

See **Note** at beginning of Table 7–9, page 154

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
rifampin *(rih-**FAM**-pin)* (Rimactane, Rifadin, Rofact (🍁))	oral, IV	*Adults:* 600 mg daily in one dose *Children:* 10–20mg/kg/day	hepatotoxicity, thrombocytopenia, renal failure	Drug may turn body secretions a red-orange color. Drug may permanently discolor soft contact lenses. Monitor client for development of jaundice. Administer oral doses 1 hour before or 2–3 hours after meals. Drug may reduce effectiveness of oral contraceptives.
rifapentine *(rih-fah-**PEN**-teen)* (Priftin)	oral	600 mg twice a day	nausea, vomiting, diarrhea, anorexia, headache	Experience is limited to HIV-infected clients. Safety and effectiveness have not been determined in children under 12 years old.
streptomycin sulfate *(strep-toh-**MY**-sin **SUL**-fayt)*	IM	0.75–1 g 5 times per week	ototoxicity, nephrotoxicity	Use reduced doses in clients with renal impairment. Monitor client for eighth cranial nerve damage.

removal of the tick using fine tipped tweezers by grasping the tick as close to the skin as possible. The tick is pulled out firmly and steadily. After the tick is removed, antiseptic is immediately applied to the bite to prevent secondary infection.

ANTIFUNGAL DRUGS

Diseases caused by fungi range in severity from superficial, localized skin infections to life-threatening systemic infections. Some fungal diseases (e.g., ringworm infections) are the result of skin contact with fungal spores. Others are contracted by breathing in spores emanating from contaminated soil or bird droppings. These include aspergillosis, blastomycosis, coccidioidomycosis, cryptococcosis, and histoplasmosis and are often most prevalent in geographical areas having a warm and moist climate. Still other fungal diseases (e.g., candidiasis) are the result of an overgrowth of fungi that are part of the normal human microbiological flora. Such diseases often develop when the client is receiving broad-spectrum antibiotics (e.g., tetracycline HCl) or when the client's immune system is suppressed by disease or by the use of potent antineoplastic agents and/or corticosteroid therapy.

Therapy of fungal infections is often more difficult and prolonged than that employed in treating bacterial infections, because the cell structure of fungi closely resembles that of human cells. This increases the likelihood that drugs toxic to fungi will also be toxic to human cells. None of the antibacterial agents discussed previously in this chapter are of value in treating fungal infections. In fact, their selective toxicity for bacterial cells often permits the development of opportunistic fungal infections in clients who are receiving high-dose and/or prolonged therapy with broad-spectrum antibacterial drugs.

Most antifungal drugs take advantage of the slight biochemical differences between fungal and human cell membranes. For example, the polyene antifungal agents (**amphotericin B**, **nystatin**, etc.) are more selectively toxic to fungal cell membranes because the drugs have a greater affinity for ergosterol in fungal cell membranes than for the cholesterol found in human cell membranes.

The following discussion describes the antifungal agents used in the systemic treatment of fungal infections. The student is referred to Chapter 40 for a discussion of antifungal agents employed topically.

Nystatin (Mycostatin, Nilstat, etc.). Nystatin is a polyene antifungal agent employed exclusively for the treatment of candidiasis—that is, fungal infections caused by *Candida* species. It is believed to act by binding selectively to ergosterol in the

fungal cell membrane, thereby impairing ergosterol's ability to prevent leakage of intracellular components. The drug is generally administered orally, although little, if any, is absorbed into the bloodstream. This limits the usefulness of the drug to the treatment of candidiasis infections involving the gastrointestinal tract.

Therapy with nystatin usually requires the administration of 500,000 to 1,000,000 units of the drug 3 times daily. This regimen is maintained for at least 48 hours after the client's symptoms have disappeared to prevent a relapse. As nystatin is not appreciably absorbed into the bloodstream, its use is not associated with serious negative side effects although some clients may experience a hypersensitivity reaction or gastrointestinal distress.

Flucytosine (Ancobon, Ancotil ✱). This antifungal drug is also employed orally for the treatment of infections caused by the *Candida* species of fungi. It also acts against *Cryptococcal* fungal species. **Flucytosine** appears to act by penetrating the fungal cell where it is then converted by the enzyme cytosine deaminase to **5-fluorouracil**—an agent that acts as an antimetabolite to prevent the normal synthesis of nucleic acid by the cell. As human cells do not contain the cytosine deaminase enzyme, they are not affected by the drug.

Flucytosine is usually administered at a dosage of 50–150 mg/kg/day in 4 divided doses given at 6-hour intervals. As many clients experience nausea and vomiting when this drug is used, a single dose may be administered in small portions over a 15-minute period. Particular caution must be used when administering this drug to clients with impaired renal function, as the drug may accumulate to toxic blood levels. In addition, flucytosine must be used with caution in clients with bone marrow depression (e.g., those receiving radiation and/or antineoplastic drug therapy); this drug may worsen the bone marrow depression.

Miconazole (Monistat i.v.). **Miconazole** is a broad spectrum antifungal agent that exerts fungicidal activity against many fungal species including *Candida*, *Coccidioides*, and *Cryptococcus*. It is systemically administered only by intravenous infusion and its use, therefore, is limited only to the treatment of severe fungal infections caused by organisms known to be sensitive to the drug.

An initial test dose of 200 mg of miconazole is usually administered to determine possible hypersensitivity to the drug. This is followed by the administration of a daily dose of 200–3600 mg of drug, depending on the nature of the client's disease. The drug dose must be diluted in at least 200 mL of an appropriate infusion fluid (0.9% sodium chloride solution or 5% dextrose solution) and infused over a 30-to-60 minute period. The total daily dosage may be divided over 3 daily infusions. Clients receiving miconazole intravenously must be monitored carefully for the development of phlebitis, as well as dermatological problems (pruritus and/or rash) and gastrointestinal distress.

Ketoconazole (Nizoral). This agent is chemically and pharmacologically related to miconazole. It is also considered to be a broad-spectrum antifungal agent. **Ketoconazole** has the advantage of being effective when administered orally and appears to cause fewer adverse effects than miconazole. In addition, it requires only single daily dosing at a level of 200–400 mg.

To be properly absorbed from the stomach, ketoconazole must be in an acid environment. Clients using this drug should, therefore, be instructed to avoid the use of antacids, anticholinergic drugs, and/or agents that reduce stomach acid secretion (e.g., **cimetidine**) within 2 hours of the ketoconazole administration. Therapy with ketoconazole must be continued until no evidence of the fungal infection remains. The use of ketoconazole may cause a broad array of drug interactions. When combined with the antihistamines **astemizole** or **terfenadine**, plasma levels of the antihistamine may increase, resulting in severe cardiac effects. Ketoconazole may also increase the effects of anticoagulants, such as warfarin or of corticosteroids such as **prednisone**. Ketoconazole may also increase the likelihood of hepatotoxicity.

Amphotericin B (Fungizone Intravenous). **Amphotericin B** is a polyene antifungal agent that is also effective against a wide variety of fungal species. Its use is limited, however, to the treatment of clients with progressive and potentially fatal fungal infections. This restriction is the result of a wide variety of serious adverse effects associated with its use. The adverse effects range from renal impairment to cardiotoxicity and necessitate the careful monitoring of all clients receiving this drug.

Amphotericin B is administered by slow IV infusion at a dosage level of 0.25–1 mg/kg/day. The dose is generally administered over a period of 6 hours. Prior to the initial administration of this drug, a 1 mg test dose should be slowly infused to determine the client's tolerance to the drug. Because of its chemical instability, amphotericin B

vials must be stored in a refrigerator and protected from exposure to light. Once intravenous solutions of this drug have been prepared, they should be administered promptly and protected from direct exposure to light as much as possible. **Note:** Administration and client monitoring should only be undertaken by those who are fully aware of the precautions that must accompany the use of this drug.

Griseofulvin (Fulvicin, Grisactin, Grifulvin v, Grisovin (🍁), etc.). **Griseofulvin** is a fungistatic drug active against a variety of fungal organisms that affect the skin, nails, and hair. It is commonly used in treating *Tinea* infections such as tinea corporis (ringworm), tinea cruris ("jock itch"), tinea capitis (ringworm of the scalp), and tinea unguium (infection of the nails). When administered orally, griseofulvin is deposited in the keratin precursor cells of the skin. As new noninfected skin cells develop, older infected ones are *sloughed*. Griseofulvin has a greater affinity for diseased tissue than for normal tissue.

Depending on the location of the fungal disease, griseofulvin therapy may continue for 1 to 6 months or longer. The duration of therapy is generally related to the time required for infected tissue to be completely replaced by noninfected tissue. Griseofulvin is available in oral dosage forms containing either microsized or ultramicrosized crystals of the drug. Those containing the smaller ultramicrosized crystals are about 50% better absorbed than microsized products, thereby permitting the use of lower doses of the ultramicrosized form.

Single or divided daily doses of 500 to 1,000 mg of the microsized griseofulvin (330 to 750 mg of the ultramicrosized) are generally administered to adults until the disorder has been eradicated. Children over the age of 2 may be given 11 mg/kg/day of the microsized or 7.3 mg/kg/day of the ultramicrosized griseofulvin products.

Fluconazole (Diflucan). **Fluconazole** is a broad-spectrum antifungal agent employed in the treatment of oropharyngeal, esophageal, and systemic candidiasis, as well as cryptococcal meningitis. When administered orally or intravenously, fluconazole exerts fungistatic activity. Orally, 200 mg is generally administered on the first day of therapy. Thereafter, 100 mg are administered daily for 2–4 weeks. When administered intravenously, fluconazole is administered by IV infusion at a maximum rate of 200 mg/hr. Most common adverse effects related to the use of the drug include nausea, vomiting, and diarrhea.

Itraconazole (Sporanox). **Itraconazole** is also a potent, broad-spectrum antifungal agent used in the treatment of a variety of superficial and serious systemic fungal disorders in both immunocompromised and nonimmunocompromised clients. It is generally administered orally with food in a dose of 200–400 mg daily in one or two divided doses. The most common adverse effects associated with its use are nausea, vomiting, skin rash, and headache. The use of itraconazole has also been associated with increased, and potentially cardiotoxic, levels of the antihistamine **terfenadine**.

ANTIVIRAL DRUGS

Viruses are responsible for many infectious disorders ranging from the common cold to AIDS. Such infections may be classified as being acute, chronic, or slow. Acute viral infections (e.g., the common cold) are characterized by a rapid onset and quick resolution. Few, if any, aftereffects are evident. Chronic viral infections (e.g., herpes virus infection, AIDS) are characterized by recurrent episodes of the active disease, separated by latent periods when the client may be asymptomatic. Slow-growing viral infections are, perhaps, the most poorly understood. They appear to invade the host and progress slowly for periods of months or years before eventually causing death. It is believed that disorders such as *multiple sclerosis* and Alzheimer's disease may be caused by slow-growing viral infections of the central nervous system.

Progress in developing therapy for viral diseases has lagged far behind that of treating other infectious diseases. Fortunately, many serious viral disorders (e.g., poliomyelitis, rabies, and smallpox) can be prevented because of the ability to elicit the formation of antibodies in healthy individuals by administering an appropriate vaccine (see Table 42–4). Vaccines have not, however, been developed for the prevention of all viral disorders.

In recent years, substances called *interferons* have been identified. These appear to be released from cells that have been attacked by a virus and by T-type *lymphocytes*. The interferons seem to alter unaffected cells to render them resistant to the attacking virus. Studies are underway to evaluate the specific role of interferons in preventing viral infections and/or to develop the economical commercial preparation of these agents. Techniques that employ genetic engineering appear to hold the greatest promise for fulfilling the latter objective.

Over the last few years, several interferon products have been introduced.

Relative to the number of antibacterial agents, only a few antiviral drugs have been successfully employed in the United States. However, much research is focused on the development of an increasing number of antivirals. The reason for the deficit of antiviral agents is that viruses reproduce in the human host by utilizing host cell components rather than their own. Agents toxic to the virus would, therefore, probably be toxic to the host as well. A discussion of currently available antiviral agents follows (see Table 7–10).

Amantadine HCl (Symmetrel) and Rimantadine HCl (Flumadine). **Amantadine** and **rimantadine** are drugs that appear to be effective against influenza type A virus. The drugs' primary use has been in preventing respiratory tract illness caused by this virus in high-risk clients (e.g., those with chronic cardiovascular or pulmonary disease and/or the elderly).

The use of amantadine has been associated with the development of depression, congestive heart failure, *orthostatic hypotension,* and urinary retention, as well as drowsiness and dizziness. As the drug is also employed in the treatment of Parkinson's disease (see Chapter 21) at higher dosage levels, the likelihood of the appearance of adverse effects is greater in such therapy. Rimantadine use has been associated with insomnia and GI upset. The likelihood of adverse effects is higher in elderly clients.

Vidarabine (Vira-A). **Vidarabine** is an agent that appears to inhibit the replication of certain viruses by interfering with the synthesis of viral DNA. It is employed primarily in the treatment of infections caused by *Herpes simplex* virus types 1 and 2 (HSV-1 and HSV-2). It is employed systemically only for the treatment of *Herpes simplex encephalitis*, a condition that—without treatment—is fatal in up to 70% of those who contract it. Vidarabine is not given by intramuscular or subcutaneous routes because of its low solubility and poor absorption. Vidarabine is also available for ophthalmic use in the treatment of acute *keratoconjunctivitis* caused by *Herpes simplex* virus types 1 and 2 (HSV-1 and HSV-2).

Ribavirin (Virazole). **Ribavirin** is an antiviral agent that appears to be active against respiratory syncytial virus (RSV), influenza virus, and *herpes simplex* virus. It is currently indicated, however, only for use in hospitalized infants and young children for the treatment of lower respiratory infections caused by RSV.

For the treatment of respiratory viral infections, ribavirin is administered by inhalation in an aerosol form using a small particle aerosol generator. An appreciable proportion of the inhaled drug is absorbed into the systemic circulation. Inhalational therapy with ribavirin is carried out for 12 to 18 hours per day for at least three and not more than seven days.

Ribavirin is contraindicated in females who are or may become pregnant during exposure to the drug. This is based on evidence that the drug is *teratogenic*.

Interferon alfa (Roferon-A, Intron A.). **Alpha interferon** is an interferon produced in the body by peripheral blood *leukocytes* and commercially by recombinant DNA technology.

Interferon alfa-2a is currently indicated primarily for the treatment of hairy cell leukemia, a form of *leukemia* that seems to respond favorably to interferon therapy. It is also used in the treatment of AIDS-related Kaposi sarcoma.

Interferon alfa-2b is used to treat certain forms of chronic hepatitis, venereal warts, and conditions in which interferon alfa-2a is employed.

It is anticipated that further antiviral and antineoplastic uses for alpha interferon will be forthcoming as scientific investigation of this and similar agents continues.

Clients receiving alpha interferon frequently experience adverse effects. The most common of these are flu-like symptoms, including fever, chills, muscle aches, and headache.

Zidovudine (AZT, Retrovir). **Zidovudine** is an antiviral agent that inhibits the replication of some *retroviruses*. It appears to be useful in the management of adult clients with AIDS or advanced stages of AIDS-related complex (ARC) who have confirmed *Pneumocystis carinii* pneumonia (PCP). Although zidovudine does appear to reduce morbidity in such clients, it is not a cure, nor has it been shown to reduce the risk of transmitting the human immunodeficiency virus (HIV) to others.

Zidovudine is frequently associated with the development of hematological abnormalities and it is not curative, so clients using this drug should be closely monitored. If hematological abnormalities are detected, dosage interruption or reduction may be required. Drugs such as aspirin, acetaminophen, or **indomethacin** may inhibit zidovudine

TABLE 7–10

Antiviral Drugs

Note: Many viruses cannot be treated with antivirals because, by the time symptoms arise, the viruses have already replicated and most antiviral action is during replication.

Used for a variety of viral infections from *influenzae A*, *herpes simplex*, *RSV*, AIDS-related Kaposi sarcoma, *pneumocystic carinii* pneumonia associated with AIDS, HIV infections

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
abacavir sulfate *(ah-**BACK**-ah-veer **SUL**-fate)* (Ziagen)	oral	*Adults:* 300 mg twice a day *Children 3 months –16 years:* 8 mg/kg twice a day	Hypersensitivity, life-threatening hypotension, nephrotoxicity, hepatotoxicity	May give with or without food. Monitor for hypersensitivity response. Monitor electrolytes and liver function tests.
acyclovir *(a-**SIGH**-kloh-veer)* (Zovirax)	oral, IV infusion, topical	*Adults:* 200–800 mg up to 6 times daily* Intravenous infusion: *Adults:* 5–10mg/kg 3 times daily *Children:* 250–500 mg/m^2	Nausea and vomiting; IV infusion phlebitis at site, nephrotoxicity	*Dose dependent on type of herpes or varicella being treated. Monitor BUN and creatinine with IV infusion. Monitor IV site for signs of phlebitis. Fatal complications may occur in immunocompromised clients.
amantadine HCl *(a-**MAN**-tah-deen)* (Symmetrel)	oral	*Adults:* 200 mg a day as a single or divided dose *Children 1–9 years old:* 4.4–8.8 mg/kg/day	Nausea, vomiting, anorexia, seizures, headache	Protect capsules from moisture. Assess for history of seizures. Monitor intake output in clients with renal impairment. Use in Parkinson's disease.
cidofovir *(sih-**DOF**-oh-veer)* (Vistide)	IV	5 mg/kg once a week for 2 weeks, then 5 mg/kg every 2 weeks	Nephrotoxicity, seizures, Fanconi's syndrome, nausea, vomiting	A full course of probenecid and IV saline prehydration must be taken with each dose. Use probenecid after a meal or with an antiemetic to decrease nausea. Dilute in 100 ml of 0.9% normal saline and infuse over 1 hour.
didanosine *(die-**DAN**-oh-seen)* (Videx)	oral	*Adults:* 125–250 mg once or twice daily *Children:* 120 mg/m^2 twice a day	Pancreatitis, peripheral neuropathy, GI hemorrhage, seizures	Administer on empty stomach. Give adult and pediatric clients (over 1 year old) a 2-tablet dose to prevent gastric acid degradation. Mix buffered powder for oral solution with 4 oz of drinking water. Do not use fruit juice or other acid-containing beverage. Instruct client not to swallow tablet whole, but to chew tablet.

continues

TABLE 7–10 *continued*

See **Note** at beginning of Table 7–10, page 159

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
famciclovir *(fam-**SIGH**-klo-veer)* (Famvir)	oral	250–500 mg 2–3 times daily*	headache	*Dose depends on type of herpes being treated. May be taken with meals.
fomivirsen sodium *(foh-mah-**VEER**-sin)* (Vitravene)	ophthalmic injection	330 mcg every other week then 330 mcg every 4 weeks	ocular inflammation, blurred vision	Used to treat CMV retinitis. Prior to injection use a topical or local anesthetic and antimicrobial therapy. Follow steps for injection from drug insert.
interferon alfa 2a and 2b *(in-ter-**FEER**-on **AL**-fah)* (Roferon-A, Intron A)	IM, SC IM, SC, IV	*alfa-2a:* 3 million units a day for 16–24 weeks *alfa-2b:* 2 million units/m^2 3 times a week for 6 months or longer	Flu-like symptoms, fever, chills, muscle aches, headache	Consider SC route, if platelet count $<50{,}000/mm^3$. Client should drink 2–3 L/day of fluids.
nevirapine *(neh-**VYE**-rah-peen)* (Viramune)	oral	*Adults:* 200 mg/day for 14 days *Children:* 4mg/kg/day for 14 days	Rash that can be life-threatening, fever, nausea, headache	Monitor for rash. Use with caution in clients with hepatic and/or renal impairment. May be given without regard to food. Women being treated with nevirapine should not rely on oral contraceptives as nevirapine may reduce contraceptive effectiveness.
ribavirin *(rye-bah-**VYE**-rin)* (Virazole)	aerosol	*Infants:* 190 mcg/L of air	Worsening of pulmonary status	Contraindicated in women who are or may become pregnant as this agent has been shown to be teratogenic. Special concern is deterioration of respiratory function in infants with COPD or asthma.
rimantadine HCl *(rih-**MAN**-tih-deen)* (Flumadine)	oral	*Adults and children >10 years old:* 100 mg twice a day *Children < 10 years old:* 5mg/kg/day	Nausea, vomiting, anorexia, CNS symptoms	Determine when immunized. Initiate as soon as symptoms appear. Assess liver and renal function.

continues

TABLE 7–10 *continued*

See **Note** at beginning of Table 7–10, page 159

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
stavudine *(**STAH**-vyou-deen)* (Zerit)	oral	*Adults:* 30–40 mg twice a day *Children:* 1mg/kg/dose	Peripheral neuropathy, headache, nausea	May be taken without regard to food. Instruct client to take exactly as prescribed. Drug is not a cure, but alleviates/manages symptoms of HIV infections.
valacyclovir HCl *(val-ah-**SIGH**-clo-veer)* (Valtrex)	oral	*Adults:* 500–1,000 mg 1–2 times daily for 5–10 days*	Headache	*Physician orders depend on type of herpes being treated and whether treating first outbreak or recurrent outbreak or whether using drug prophylactically. Drug works best if used within 48 hours of outbreak of shingles or herpes simplex.
vidarabine *(vye-**DAIR**-ah-been)* (Vira-A)	ophthalmic ointment	3% ointment	Photophobia, conjunctival infection, pain	Drug must be administered within 72 hours of appearance of vesicular lesions to be effective. Inform clients to wear sunglasses when outdoors. Concomitant use of corticosteroids usually contraindicated.
zidovudine *(zye-**DOH**-vyou-deen)* (Azidothymidine, AZT)	oral, IV	capsules, syrup Oral: *Adults:* 600 mg/day in 6 divided doses *Children:* 720 mg/m^2/day in 4 divided doses *Infants:* 2 mg/kg every 6 hours IV: *Adults:* 1–2 mg/kg infused over an hour. *Children:* 0.5–1.8 mg/kg as continuous infusion	Hematologic disorders, such as anemia or granulocytopenia	Must administer around the clock. Multiple drug interactions. Use with caution in clients with hemoglobin <9.5 g/dL. Used in neonates to prevent maternal–fetal HIV transmission.

metabolism and result in an increased likelihood of toxicity.

Didanosine (Videx). **Didanosine** is an agent active against HIV. It is employed in treating adults and pediatric clients over 6 months of age with advanced HIV infection who cannot tolerate zidovudine therapy or who have not responded well to zidovudine.

Many serious adverse effects are associated with the use of didanosine. Clients using the drug should be monitored for the development of numbness and tingling or pain in the feet or hands, as these may be associated with the development of peripheral neuropathy. Also, clients should be monitored for the development of abdominal pain, nausea, and/or vomiting, which may reflect the development of pancreatitis. As administration of didanosine with food may

reduce the absorption of the drug by as much as 50%, didanosine should be administered on an empty stomach.

Zalcitabine (Hivid). **Zalcitabine** is an antiviral agent that is used in combination with zidovudine in the treatment of advanced HIV infection. The major adverse effect seen in the use of this drug is peripheral neuropathy, which may range in severity from mild numbness to severe pain. The use of the drug has also been associated with the development of pancreatitis.

Stavudine (Zerit). **Stavudine** is used for the treatment of adults with advanced HIV infection who do not tolerate or respond to other forms of therapy. As with the use of zalcitabine, the major adverse effect of stavudine is peripheral neuropathy. Chills, fever, asthenia, and abdominal or back pain are also adverse effects.

Other Antiviral Agents

Several antiviral agents are available for ophthalmic use in the treatment of keratoconjunctivitis and *keratitis* due to HSV infections. **Idoxuridine** (**Herplex**), **trifluridine** (**Viroptic**), and **vidarabine** (**Vira-A**) interfere with normal HSV DNA synthesis, thereby blocking its reproduction. Idoxuridine and trifluridine cannot be administered systemically, because of their toxicity to human cells.

Acyclovir (Zovirax) is one of the most effective antiviral agents thusfar introduced. It is available in oral, topical, and parenteral forms for the management of HSV-1 and HSV-2. It appears to be preferentially taken up by HSV-infected cells and converted to the active triphosphate form. Acyclovir triphosphate inhibits viral DNA replication by interfering with HSV DNA polymerase. Although not a curative agent, acyclovir use does reduce the duration of acute infection and lesion healing. It has also been proven to be effective in reducing the frequency and severity of recurrent episodes of active HSV infections.

When administered parenterally, acyclovir should be given by IV infusion. The dose to be administered must be given over at least 1 hour to prevent renal tubular damage. The usual adult dose is 5 mg/kg infused IV every 8 hours for 7 days. In children under 12, 250 mg/m^2 is administered intravenously over 1 hour every 8 hours for 7 days. Adequate hydration should be provided for clients receiving intravenous acyclovir to reduce the likelihood of renal damage.

Orally, acyclovir is usually administered to adults in a dosage of 200 mg every 4 hours while awake, for a total of five 200 mg capsules daily for 10 days. In seriously ill clients, therapy may need to be initiated by the intravenous route. Lower dosage is provided to clients with renal impairment.

When used topically, a sufficient quantity of acyclovir ointment is applied to cover all lesions every 3 hours 6 times daily for 7 days. It is recommended that a rubber glove or finger cot be worn when applying acyclovir ointment to prevent *autoinoculation* of other body sites and to prevent transmission of the virus.

Ganciclovir (**Cytovene**) and **foscarnet sodium** (**Foscavir**) are antiviral drugs active against cytomegalovirus (CMV). They are currently employed in the treatment of CMV retinitis in immunocompromised individuals, including clients with AIDS. Ganciclovir and foscarnet sodium are administered only by IV infusion. Because solutions of the drug are quite alkaline, infusion rates must not exceed those specified by the manufacturer.

Administration of ganciclovir or foscarnet sodium may result in a variety of serious adverse effects, ranging from hematological changes (granulocytopenia and thrombocytopenia) to carcinogenicity and teratogenicity. This dramatically limits the widespread use of these drugs in the treatment of other viral disorders.

MISCELLANEOUS ANTI-INFECTIVE AGENTS

Furazolidone (Furoxone). **Furazolidone** is an agent that exerts broad-spectrum bactericidal activity by interfering with a number of bacterial enzyme systems, thereby minimizing the likelihood that bacterial resistance will develop.

Since only a small proportion of an orally administered furazolidone dose is absorbed from the gastrointestinal tract, the drug has emerged as a useful drug for the treatment of diarrhea and *enteritis* caused by many different bacteria or protozoa. The small amount of drug absorbed into the blood is ultimately excreted in the urine, along with brown-colored metabolites of the drug. Adults generally receive 100 mg of furazolidone 4 times daily, while children, 5 years of age and older, receive 25 to 50 mg 4 times daily.

Clients receiving furazolidone should avoid the consumption of alcohol during therapy and for 4 days after therapy to avoid a disulfiram-like reaction (see Chapter 41). In addition, furazolidone

acts as a monoamine oxidase (MAO) inhibitor. This requires that clients avoid foods containing tyramine (see Table 18–4) as well as OTC or prescription medications containing *sympathomimetic* drugs (e.g., cold and hay fever remedies, weight control products) since the use of such medications could result in a dramatic increase in blood pressure.

Pentamidine Isethionate (Pentam, NebuPent, Pentacarinat (🍁)). **Pentamidine** is an agent effective against *Pneumocystis carinii*, an organism that commonly produces Pneumocystis carinii pneumonia (PCP), a serious disorder frequently seen in high-risk, HIV-infected clients. The drug appears to act by inhibiting DNA, RNA, phospholipid, and protein synthesis in the organism.

Pentamidine is generally administered intramuscularly or intravenously for the treatment of active cases of PCP in high-risk, HIV-infected clients. When administered intramuscularly or intravenously, a dose of 4 mg/kg is given daily for 14 days. When given intramuscularly, the drug is injected deeply into a large muscle. Intravenously, pentamidine is diluted in 50 to 250 mL of 5% dextrose solution and then administered over a 60-minute period. Intramuscular or intravenous administration may induce severe hypotension, hypoglycemia, and/or cardiac arrhythmias, even after a single dose.

When employed in an aerosol form for the prevention of PCP, 300 mg of pentamidine are administered once every 4 weeks using a *nebulizer* device. When reconstituted for aerosol administration, the contents of one vial (300 mg) of pentamidine must be dissolved in 6 mL of sterile water for injection, USP. Saline solution should not be used as a diluent because it may result in precipitation of the drug. Although pentamidine inhalations are an effective prophylactic measure for PCP, clients may still develop PCP while receiving pentamidine therapy. In addition, clients using this drug by inhalation often develop decreased appetite, cough, and bronchospasm.

Table 7–11 lists antiviral drug-to-drug interactions.

TABLE 7–11

Antiviral Drug Interactions

DRUG	DRUG INTERACTIONS
Acyclovir	1. Zidovuline causes increased risk of neurotoxicity. 2. Probenecid causes increased acyclovir levels by decreasing creatinine clearance.
Amantadine	1. Anticholinergic drugs cause increased cholinergic blocking effects. 2. CNS stimulants cause increased CNS effects.
Didanosine	1. Antacids cause increased absorption of Didanosine (ddi). 2. Ketoconazole absorption is decreased by ddi. 3. Quinolones absorption is decreased by ddi. 4. Tetracyclines absorption is decreased by ddi so should be given 2 hours before tetracyclines. 5. Zidovudine has a synergistic effect against HIV.
Ganciclovir	1. Zidovudine may cause increased risk of hematologic toxicity (bone marrow suppression). 2. Imipenem may cause increased risk of seizures.
Zidovudine	1. Acyclovir increases neurotoxicity. 2. Didanosine has synergistic effect against HIV. 3. Ganciclovir and ribavirin antagonize the antiviral action of zidovudine. 4. Cytotoxic agents increase the risk of hematologic toxicity. 5. Beta-interferon increases serum levels of zidovudine.

LEPROSTATIC AGENTS

Leprosy (Hansen's disease) is a chronic infectious disease caused by the organism *Mycobacterium leprae*. Although the mode of transmission of this disease is unknown, it is believed to be related to prolonged exposure to the microorganism during childhood. The disease is most commonly seen in tropical and subtropical areas of Asia, Africa, Central and South America, and southern parts of the U.S.

Lesions related to leprosy most often appear on cooler tissues of the body such as the skin, nose, pharynx, eyes, and testicles. Most often, affected areas become disfigured and nerves also may be affected. If untreated, leprosy is a progressive disease that may be fatal within 10–20 years, although spontaneous recovery may occur with some forms of the disease.

The goal of drug therapy for leprosy is to destroy all living causative organisms. Within 3 to

6 months after appropriate drug therapy is begun, all of the bacteria should have been eradicated. Prolonged drug therapy is then required to prevent a relapse. Because of the complexity, disfigurement, and social stigma associated with this disease, clients often require extensive surgery, physical therapy, education, and psychological counseling.

Dapsone (**Avlosulfon** (🍁)) is a drug chemically classified as a sulfone. It has been successfully used to treat leprosy for many years. Dapsone is generally administered in a dose of 50–100 mg daily for 5 to 10 years or longer to prevent recurrence of the disease. **Clofazimine** (**Lamprene**) is a newer agent that also has been found to be useful in treating leprosy. It is employed in a dose of 100–200 mg daily for several months to several years depending on the nature of the disease. Common adverse effects associated with clofazimine are abdominal distress and a pink-to-brownish-black skin pigmentation. Doses should be administered with meals.

APPLYING THE NURSING PROCESS

ASSESSMENT

In health care settings, clients are routinely observed for the development of infections. This includes the monitoring of vital signs and laboratory work. The nurse observes the client particularly for an elevated temperature, rapid pulse rate, and moist respirations. The nurse also inspects surgical wounds for redness, swelling, and *purulent* drainage. In addition, the nurse investigates any complaint of redness, swelling, or warm areas of skin and other signs and symptoms the client may report, such as cough or burning on urination.

Nurses also assist in diagnosing the cause of the infection by the collection and proper handling of specimens. Also, information about the client and laboratory work (e.g., increased white blood count and results of culture and sensitivity testing) should be promptly passed on to the physician.

One final caution is necessary before discussing the nursing implementation and evaluation of clients receiving antimicrobial agents. It is of grave importance that both nurse and physician be aware of any past history of hypersensitivity reactions to antimicrobial agents before a particular drug is administered. Clients should be asked if they have ever taken the particular antimicrobial drug and whether an untoward reaction occurred. If so, the exact nature of this reaction and its remedy should be determined. If this was an allergic reaction, prominent notes must be made on the client's medication record and chart that he/she is allergic to the particular drug. Skin testing procedures may be ordered to determine if the drug reaction was a true allergic response.

Whenever antimicrobial drugs are administered, particularly early in therapy and when administered parenterally, the client's reaction to the drug must be carefully assessed. Clients with a history of multiple allergies are especially at risk. The client must be observed for difficulty in breathing, moist respirations, local inflammatory reactions at the injection site, and rashes. The latter must be described fully as to its nature and distribution. Resuscitation equipment must always be available when parenteral drugs are being used, and clients should not be discharged from the health care setting immediately following an injection of a parenteral antibiotic. An observation period of 30 minutes follows each injection. Because of the possibility of delayed reactions, the client should be instructed whom to contact if untoward reactions are noted.

NURSING DIAGNOSES

Including but not limited to:

- Infection related to specific etiology
- Risk for infection related to incidence of recurring infections or host susceptibility
- Risk for transmission of infection related to specific conditions (tuberculosis)
- Risk for injury related to adverse effects of antimicrobials
- Deficient knowledge related to infection process, medication regime, prevention of recurrence of infection (UTIs)
- Risk for noncompliance with medication regimen

PLANNING/GOALS

- Client will recognize symptoms of infection and seek medical attention promptly.
- Client will verbalize understanding of how to keep healthy through nutrition, exercise, etc.
- Client will verbalize methods of preventing recurrence of infections.
- Client will verbalize and demonstrate techniques such as handwashing, proper disposal of tissues, etc., to prevent the transmission of infection.
- No injuries will occur from medication administration.
- Client will not experience side effects from medications.
- Client will verbalize understanding of infection process, medication regime, prevention of recurrence.
- Client will demonstrate compliance with medication regimen.

IMPLEMENTATION

As the primary role of nursing is to promote health and prevent infection, one significant way this can be accomplished is through client education and measures the nurse takes to minimize the risk of developing nosocomial infections (infections acquired in health care facilities). Such nursing measures include isolation of infectious or immunosuppressed clients, routine handwashing between clients, use of aseptic technique, proper disposal of infectious materials, and limiting client contact with infectious persons or carriers. These measures are not new to nursing, having been strongly promoted by Florence Nightingale, but they have never been more important to client welfare. There are multiple reasons for concern about the prevention of infections, especially in health care settings. Some of these reasons include the larger number of immunosuppressed clients being treated in hospitals, the frequent misuse of antimicrobial agents, and the development of resistant strains of microbes to some antimicrobial agents. Nursing's contribution to the control of infections takes place on an individual nurse–client level, on an organizational level through infection-control nursing, and on a community level through home health nursing.

Despite the best efforts of health professionals, however, infections do occur. When they do, a number of nursing actions are involved in providing care. When the client is located in the community, the nurse is often consulted prior to physician contact to see if symptoms are serious enough to schedule a physician visit. Advice nurses are a standard part of the health maintenance community. In many cases—for example, with uncomplicated respiratory infections or flu—the nurse may recommend supportive care including rest, fluids, and use of an antipyretic such as acetaminophen (Tylenol) or ibuprofen (**Motrin**). If the infection is serious, persistent, or not likely to improve with time or if the client is in a high-risk group—infant, aged, debilitated, or pregnant—referral is made to an appropriate physician.

Until a definitive diagnosis is made, the nurse provides supportive care, including promoting rest and sleep, ensuring adequate hydration and nutrition, and providing relief of pain and general hygiene care. Once the diagnosis is made and a suitable antimicrobial agent has been identified, the nurse has responsibility for the administration of the medication and for assessing therapeutic and untoward effects of drug therapy, as well as for providing supportive care. To provide this care, the nurse must be familiar with the major classes of antimicrobial agents and specific information about the product being used. Nursing interventions related to the major classes of antimicrobial agents are identified following a discussion of general principles of antibiotic administration.

Nurses provide client education to ensure maximal effectiveness of the antimicrobial agent. Special considerations for each class of antimicrobial agent, including time of administration and food and drug interactions, are provided when the classes of drugs are discussed. Client education must also include advice about avoiding abuse of these drugs. Caution is given to complete the course of therapy as prescribed to avoid incomplete removal of the causative organism and the development of resistant strains of the microbe. The client should also be advised to contact the prescriber if adverse reactions occur, to avoid taking someone else's medication, to avoid using outdated medication, and to see the primary care provider for an examination and treatment rather than self-medicating

BOX 7–1
Clients Taking Antimicrobial Drugs Should:

1. Know the drug's name, dosage, administration schedule, and why the medication is being taken.
2. Know any special instructions related to storage (e.g., refrigerate medication) and administration (e.g., do not take with milk or milk products).
3. Be told the major adverse effects and what to do if these should occur.
4. Be advised never to use an expired medication.
5. Be encouraged to complete the course of treatment as prescribed.
6. Be instructed not to give their medication to someone else, as it may result in an adverse reaction.
7. Avoid taking any antimicrobial drug that has not been prescribed for a particular course of illness.
8. Report failure of the medication to successfully treat the infection.
9. Be encouraged to keep all follow-up appointments.

with antimicrobial agents. Box 7–1 reviews the pertinent information which clients taking any antimicrobial agent should know.

Reimbursement systems are resulting in shorter hospital stays for some clients. If the client who is being discharged still needs intravenous antibiotic therapy, some home health care programs provide for this treatment at home (Figure 7–6). Candidates for this type of therapy must be selected carefully and the therapy must be planned jointly by health professionals, the client, and the client's family or caregivers. A nurse is usually responsible for instructing the client and family in aseptic technique, the mechanisms of intravenous antibiotic administration, possible adverse reactions to the drug or intravenous therapy, and care of the intravenous equipment. In addition to the initial teaching, a daily visit is made by a nurse from the home health agency to monitor the therapy and assess the client's response. These nurses will also change the catheter site based on the established protocol. This type of treatment

Figure 7–6 Infusion Pump *(Courtesy of Alaris Medical Systems)*

costs about half as much as therapy in the hospital and is likely to become more common in the future.

Antibiotics can be administered by many routes, but the focus in this chapter is on oral and parenteral administration. Other chapters discuss topical administration (see Chapter 27 and Chapter 40). When antibiotics are to be administered orally, an important aspect of planning is scheduling medication administration. In general, the daily dosage must be spaced across 24 hours to maintain a constant blood level of the antibiotic. This is tempered by the fact that the client's sleep should be disturbed as little as possible. For example, if an antibiotic is ordered to be taken 4 times a day, a schedule of 12:00 PM, 6:00 PM, 12:00 AM, and 6:00 AM may accomplish this purpose. The precise hours should be tailored to the client's needs and schedule. Hospitalized clients should have other necessary activities, e.g., assessment of vital signs, scheduled for the same time to disturb their rest as little as possible. Additional consideration must be given, however, to avoiding concomitant administration of drugs that may interact and avoiding the simultaneous administration of drugs with foods that may interact with or affect their absorption.

BOX 7–2
Reconstituting Parenteral Antibiotic Powder

1. Wash your hands.
2. Carefully read the directions for reconstituting the drug, bearing in mind the dosage ordered.
3. Assemble the equipment, including antiseptic sponges, syringes, and needle (an 18-gauge is ideal) and sterile diluent and powder to be reconstituted. **Note:** In most cases normal saline is used as the diluent, although some drugs must be reconstituted with sterile water or special diluents that will accompany the vial or be specified in the package insert and/or on the label.
4. Swab the stopper on the vial of diluent with an antiseptic sponge. Using a syringe with an 18-G needle, introduce into the vial an amount of air equal to the recommended amount of diluent.
5. Draw up the recommended amount of diluent into the syringe and withdraw the needle from the vial.
6. Swab the stopper of the vial containing the antibiotic powder and inject the diluent into the vial.
7. Thoroughly mix the medication and the diluent and withdraw the dosage of medication that has been ordered. Change the needle on the syringe to an appropriate gauge before proceeding with administration.
8. If the antibiotic is in a multiple-dose vial, be certain that you label the vial with the name and concentration of the drug contained in the vial, the date and time of reconstitution, and your initials. Store the drug as directed in the product literature.
9. If you have any questions, call the pharmacist for assistance.

Special attention needs to be given to the instruction of parents in administration of antibiotics to their children. The parents must know why the antibiotic is being given and the time schedule for administration. They should also be given information about schedule of administration and measurement of dose. Many young children will be taking liquid preparations measured in teaspoons. The size of teaspoons may vary considerably; parents should be told that they may purchase a standard measuring spoon at their pharmacy. See Chapter 5 for additional information on administration of medication to children.

When parenteral antibiotics are to be administered, it is important to examine the vial or ampule and the package insert to determine the expiration date of the drug, its storage conditions, and the instructions for reconstituting the drug if it comes in powder form. To reconstitute the drug, follow the procedure indicated in Box 7–2. Refer to Chapter 3 for principles and methods to be followed in administering drugs parenterally.

In some clients, such as those who have recently had a *myocardial infarction* (MI), intramuscular injection of antibiotics may be contraindicated. Local trauma to muscles may increase serum creatinine phosphokinase (CPK) levels, which are often used as a diagnostic test to determine myocardial injury. The remainder of this chapter discusses application of the nursing process to the care of persons receiving specific antimicrobial drugs or receiving drug therapy for the treatment of particular illnesses.

CLIENTS RECEIVING PENICILLINS

The nurse is particularly alert for allergic reactions developing after the administration of penicillin. Some sources have estimated that up to 15% of the population could be allergic to this group of antibiotics. Whenever penicillin is to be given, the nurse asks the client about past history of allergic reactions to this drug. In addition, the client should be asked about allergic responses to semisynthetic penicillins (e.g., ampicillin) and to cephalosporins, as cross-reactivity is common. Clients should be instructed to call the physician if rash, fever, chills, or other signs of allergic response appear.

Occasionally because of life-threatening infections, penicillin may be given to persons with a history of prior allergic reactions and/or positive skin test for sensitivity to penicillin. Recently, desensitization procedures have been developed. Whenever desensitization is performed, the nurse must observe the client carefully for signs of anaphylaxis (circulatory and respiratory collapse). Ideally, these clients should

KEY NURSING IMPLICATIONS 7–3

Clients Receiving Penicillins

1. Take a careful medication history before administering penicillins.
2. Observe the client for indications of allergic reaction, including rash, fever, chills, and anaphylaxis.
3. Oral penicillins should be given 1–2 hours before or 2–3 hours after meals.
4. Injection sites must be checked carefully for signs of local reactions (e.g., redness, phlebitis). Do not use the same needle for withdrawing the solution from the vial and administering it.
5. Never give procaine penicillin intravenously.

be treated in an intensive care unit. Resuscitative equipment, epinephrine, antihistamines, theophylline, and corticosteroids to control allergic reactions must be available.

In addition to hypersensitivity reactions, a nonallergic reaction that initially appears similar to an allergic reaction can occur when aqueous procaine penicillin is given. Within 60 seconds of the injection, the client may experience excitation, anxiety, dizziness, motor agitation, auditory and visual disturbances, and a sense of impending death. This reaction is differentiated from an allergic reaction in that there are no cardiovascular or respiratory symptoms such as those that occur in allergic responses. In fact, the blood pressure may increase 10–30 mm, rather than decrease, as is common in shock. This nonallergic reaction occurs most often following the administration of a large single dose of aqueous procaine penicillin, such as administered to treat gonorrhea. The symptoms are transient and resolve within 30 minutes. During the episode, the nurse ensures the client's safety, provides support, and administers oxygen. It is believed that this response may be due to a procaine reaction, and it is suggested that the medication be refrigerated and shaken well before use. In addition, it is important to take a careful medication history before administering penicillins.

When penicillins are given orally, they may cause gastrointestinal disturbances, such as nausea or diarrhea. In addition, food may interfere with drug absorption, so oral penicillins should be given 1–2 hours before or 2–3 hours after meals.

Long-term use of penicillins has been associated with bacterial or fungal superinfections, especially in elderly, debilitated, or immunosuppressed persons. A number of laboratory tests may be affected by penicillin use, including Coombs, bilirubin, and potassium. Drug interactions are rare when the penicillins are used, but interactions have been reported with other antibiotics, oral anticoagulants (causing an increase in anticoagulation), and with antacids, which decrease the absorption of oral penicillins if taken at the same time. One positive drug interaction occurs when probenecid is given. This results in increased blood levels of penicillin and is often used for this purpose during penicillin therapy.

Injection sites should be checked carefully, as localized tissue reactions may occur. Highly concentrated intravenous solutions may cause phlebitis, so the site must be checked for swelling, tenderness, warmth, and redness. When given intramuscularly, it is suggested that the same needle *not* be used to withdraw the solution from the vial and to administer the medication. Changing the needle may decrease the incidence of local tissue reactions.

Note: A special caution must be given about procaine penicillin. This form of penicillin is for intramuscular injection only. It could cause emboli and severe cardiac reactions if given intravenously. Finally, clients with cardiac and renal diseases must be monitored carefully when receiving penicillins, as these preparations may contain significant amounts of sodium and potassium.

High doses of penicillins given parenterally may cause convulsions, particularly in clients with renal impairment. The nurse must observe such clients carefully and provide for their safety.

KEY NURSING IMPLICATIONS 7–4

Clients Receiving Cephalosporins

1. Clients who are allergic to penicillin may also be allergic to cephalosporins.
2. Administer intramuscular injections into a large muscle mass to decrease pain.
3. Observe intravenous sites carefully for phlebitis.

CLIENTS RECEIVING CEPHALOSPORINS

Special nursing considerations include the recognition that some clients who are allergic to penicillins are also allergic to cephalosporins. When cephalosporins are given to such persons, they must be observed carefully. When the intramuscular route is used to administer cephalosporins, deep IM injections are given to decrease pain and tissue reactions. During infusion, the nurse must check IV injection sites carefully for indications of phlebitis. Any indication of phlebitis should promptly be reported to the physician.

Some cephalosporins, e.g., **cefotetan**, **cefamandole** and **cefoperazone**, may cause a disulfiram-like reaction if the client ingests alcohol while taking the medication. This may include the development of abdominal cramps, nausea, vomiting, and headache. The reaction has occurred up to 3 days following cessation of treatment. Clients are instructed not to ingest alcohol or alcohol-containing medications during that period of time.

Diagnostic tests that may be altered by cephalosporins include direct Coombs, glucose urinalysis (but not Clinistix or Tes-Tape), urine protein, and 17-ketosteroid determinations. It has been suggested that the possibility of nephrotoxicity is increased when cephalosporins are used with furosemide (Lasix) or aminoglycoside antibiotics.

Finally, as with penicillins, clients should be instructed to complete the entire course of therapy, not to self-medicate or share these drugs with friends, and to report significant symptoms, particularly rashes, to their physician.Δ

CLIENTS RECEIVING TETRACYCLINES

Tetracyclines are most frequently used orally. It is important to counsel the client about substances that adversely affect the absorption of oral tetracyclines:

- antacids
- sodium bicarbonate
- iron
- zinc
- drugs containing aluminum, calcium, or magnesium (such as laxatives)
- some foods, especially milk and dairy products

Some tetracyclines, such as doxycycline (**Vibramycin**, etc.) and minocycline (**Minocin**), seem to be adequately absorbed in the presence of these substances (except for aluminum). With other preparations, however, the client is advised to take the tetracycline at least 1 hour before or 2 hours after these substances. It is generally best to avoid taking tetracyclines on an empty stomach just before bedtime to avoid gastrointestinal upset. Clients should also be counseled regarding several other aspects of therapy, including that phototoxicity may occur, particularly when taking demeclocycline (Declomycin). Instruction should be given to avoid direct sunlight and ultraviolet light when possible. A sunscreen agent is applied to the exposed skin and lips when exposure is unavoidable.

Because of their broad spectrum of activity, superinfections may develop when tetracyclines are used. Good oral care is essential, and the oral cavity should be checked daily to determine if thrush, a fungal infection, is developing. Thrush can be treated with antifungal preparations.

KEY NURSING IMPLICATIONS 7–5

Clients Receiving Tetracyclines

1. Avoid administering tetracycline simultaneously with sodium bicarbonate, iron preparations, dairy products, and drugs containing zinc, aluminum, calcium, or magnesium.
2. Avoid administration of tetracycline on an empty stomach.
3. Clients should avoid excess exposure to the sun or use a sunscreen if taking demeclocycline.
4. Superinfections may develop. Good oral care is essential. Women prone to the development of vaginal infections should advise the physician about this before beginning therapy.
5. Because of effects on teeth and bone, tetracyclines are generally avoided in children under 8 years and in women during the last two trimesters of pregnancy.
6. Never administer a tetracycline preparation containing procaine intravenously.

Women particularly sensitive to the development of vaginal infections should be instructed to advise the physician of this before beginning tetracycline therapy. Yogurt and/or **lactobacillus acidophilus** (**Bacid**, **Lactinex**) capsules or granules may be helpful in reestablishing the normal flora of the intestinal tract, which can be destroyed by this therapy.

Tetracyclines are not recommended for children under 8 years or for women during the last two trimesters of pregnancy, since they may produce staining of the teeth, dental malformations, and retarded bone growth. It is important to ask female clients about pregnancy before therapy is begun.

The intramuscular injection of tetracycline is painful and not often used. The IM preparation contains procaine to reduce pain. **Note:** This form must never be given intravenously because it can cause cardiac arrhythmias.

Tetracyclines may affect the following tests: ammonia, amylase, and glycosuria determinations (false positive with Clinitest and false negative with Clinistix or Tes-Tape). They may also delay blood coagulation by destroying the intestinal bacteria that normally produce vitamin K, which is required for normal blood coagulation. In addition to drug interactions already discussed, potentially nephrotoxic drugs should not be used concurrently with any tetracycline except doxycycline; this includes avoiding the use of the anesthetic agent **methoxyflurane** (**Penthrane**).

CLIENTS RECEIVING AMINOGLYCOSIDES

Other than the use of oral neomycin to cleanse the bowel prior to surgery, most aminoglycosides are administered parenterally. Several nursing actions are indicated before therapy begins. As drug dosages are determined by a client's weight, measured in kilograms, the first step is to obtain an accurate body weight. If aminoglycosides are being prescribed for the treatment of a urinary tract infection, a urine specimen must be obtained for culture and sensitivity testing. Preferably it should be a midstream specimen collected under aseptic conditions or one obtained by catheterization. Even if aminoglycoside therapy is being used for treatment of infection elsewhere in the body, a pretreatment urine specimen may prove helpful in evaluating possible nephrotoxicity that may develop during treatment. Creatinine clearance tests and serum assay of drug levels may also be used to monitor therapy and to detect toxicity. One of the most common tools for monitoring both therapeutic and toxic effects is the blood trough and peak levels. As noted in Chapter 1, the trough level represents the lowest blood concentration of the drug and is drawn just prior to the dose specified by the physician; the peak denotes the drug's highest blood concentration and is drawn following the dose specified by the physician. The nurse is responsible for monitoring these drug levels and notifying the physician of the results. In addition, because ototoxicity may occur, assessment should also be made regarding the functioning of the eighth cranial nerve. This assessment should include evaluation of the client's balance and hearing. Hearing may be tested by audiometry or by speaking in a normal voice and noting the client's response to questions or commands. Balance is assessed by observing the client's ability to change positions and to ambulate without support. Again, such information is useful as a baseline against which to evaluate later assessments.

Because nephrotoxicity is a relatively common problem with aminoglycoside therapy, the nurse carefully observes the nature and quantity of urine output. Clients who are dehydrated should receive fluids to correct their hydration. Clients taking diuretics, as well as dehydrated clients, should be observed carefully, as they are

KEY NURSING IMPLICATIONS 7–6

Clients Receiving Aminoglycosides

1. Obtain an accurate body weight before therapy is begun.
2. Observe the patient for nephrotoxicity and eighth cranial nerve damage (hearing and balance problems).
3. When aminoglycosides are used for treating urinary tract infections, avoid urine acidifiers such as cranberry, plum, and prune juices, as well as vitamin C.
4. Monitor peak and trough levels.

at special risk of developing nephrotoxicity. Aminoglycosides do not work most effectively in the presence of acid urine. Therefore, when urinary tract infections are treated with aminoglycosides, it is best to avoid cranberry, plum, and prune juices, as well as **ascorbic acid** (vitamin C), which acidify urine.

Throughout therapy, the nurse should continue to make observations on the functioning of the eighth cranial nerve. It is particularly important to report *tinnitus* (ringing in the ears), as this may be the first sign of ototoxicity. Inability of the client to hear whispering may also be an early sign of auditory damage. Clients may also experience nausea, vomiting, dizziness, loss of balance, and hearing loss. Persons at risk of eighth cranial nerve dysfunction are the aged, dehydrated clients, those with previous ear damage, and those taking other potentially ototoxic drugs. The concomitant use of antihistamines such as **dimenhydrinate** (**Dramamine**) and diphenhydramine (Benadryl) may mask signs of vestibular damage.

Neuromuscular blockage is rare, but may occur in *hypocalcemic* persons, those who have recently received muscle relaxants intravenously, and those who have had general anesthesia. This blockage may be reversed by the administration of **calcium salts** or neostigmine.

As with the use of other antibiotics, the nurse observes the client for the development of superinfections. Monitoring includes assessment of body temperature 4 times a day.

KEY NURSING IMPLICATIONS 7–7

Clients Receiving Chemotherapy for Tuberculosis

1. Instruct the client about the importance of taking medication faithfully over a long period of time, often a year.
2. Clients taking para-aminosalicylic acid or isoniazid should avoid the use of alcohol and should call the prescriber if signs or symptoms of hepatic dysfunction develop.
3. Pyridoxine (vitamin B_6) is used to prevent the development of peripheral neuropathy in clients taking isoniazid.
4. Clients taking para-aminosalicylic acid must avoid the use of vitamin C, which could result in crystalluria.
5. Rifampin should be taken on an empty stomach. Clients experiencing drowsiness are instructed to avoid tasks requiring alertness.
6. Clients should be advised that rifampin and rifabutin may stain soft contact lenses a reddish-orange and that urine, feces, saliva, and tears may become reddish-orange.

CLIENTS RECEIVING CHEMOTHERAPY FOR TUBERCULOSIS

Drug therapy has dramatically decreased the institutionalization and increased the survival rate of clients with tuberculosis. Much of the nursing care for these clients now focuses on client education. Because clients become noninfectious within a few weeks of beginning *chemotherapy*, they need to receive intensive counseling while hospitalized. Of primary importance is the emphasis on taking medication faithfully over a long period of time. Good hygienic measures include handwashing and covering the nose and mouth during coughing and sneezing. In addition, clients should be instructed in the proper and safe method for collection of respiratory secretions and in the sanitary disposal of tissues. During the infectious stage, clients may be asked to wear a disposable mask when visitors enter the room or when traveling outside of their room. Good ventilation is also important for preventing spread of tuberculosis. Ultraviolet irradiation of the upper part of the room in which acute, infectious cases are treated helps to decrease the number of infectious particles in the air. Client education programs frequently stress positive nutrition and avoidance of smoking.

It is particularly important that clients have a sound knowledge of the drugs they are taking and why these must be taken over a long period. They should know the names, dosages, the best schedule for taking drugs, the most common side effects, and what to do if side effects occur. If the client is taking **INH** (isoniazid), instruction

should be given to contact the physician or clinic if signs and symptoms of hepatic dysfunction appear. These would include loss of appetite, fatigue, *malaise*, jaundice, or dark urine. Clients taking INH should avoid the use of alcohol to decrease the likelihood of isoniazid-related hepatitis. Clients taking INH who also take the anticonvulsant phenytoin may need to have the dosage of the anticonvulsant drug decreased to avoid phenytoin toxicity. Peripheral neuropathy can occur, especially in malnourished persons. Pyridoxine (vitamin B_6) is usually given to prevent this. Clients should also avoid concomitant use of aluminum-containing antacids with INH. The INH should be taken at least 1 hour before these drugs. If gastrointestinal irritation occurs, the INH should be taken with meals rather than with an antacid. Persons in high-risk groups may take INH prophylactically for extended periods to decrease morbidity from tuberculosis. Prophylactic use of INH is common in persons less than 35 years, as the likelihood of liver toxicity increases after this age. Again, client education is a critical component in ensuring compliance with this long-term therapy.

Clients taking **aminosalicylate sodium** should also notify the physician if they note signs of liver impairment. They may experience gastrointestinal upset when therapy is begun. Temporarily decreasing the dosage or taking the drug with meals and avoiding concomitant antacid use may decrease the discomfort. The client is advised to avoid the use of ascorbic acid (vitamin C), as this may acidify the urine, increasing the possibility of *crystalluria*.

Client instructions about the use of rifampin include reporting indications of liver impairment and scheduling administration for 1 hour before or 2 hours after meals. Clients should be informed that drowsiness may be associated with rifampin use. Tasks requiring alertness, such as driving, should be avoided when this occurs. Also, a red-orange discoloration of urine, feces, saliva, sweat, sputum, and tears may appear in clients using rifampin or **rifabutin**. This is no cause for alarm, although clients should be forewarned. Soft contact lenses, however, may be permanently stained. The discoloration of body fluids indicates that the client is taking the drugs as directed. Rifampin or rifabutin may increase the enzyme activity of the liver, requiring increased doses of warfarin, corticosteroids, oral contraceptives, and oral hypoglycemic agents.

Any client taking drugs for the treatment of tuberculosis is encouraged to keep physician or clinic appointments. This permits periodic assessment of the therapeutic effectiveness of the drugs and permits timely intervention in dealing with side effects.

CLIENTS RECEIVING SULFONAMIDES AND URINARY TRACT ANTI-INFECTIVES

When a client is to receive the initial dose of a sulfonamide, the nurse must inquire about allergies to this group of drugs. This inquiry must be made prior to administration. Clients should be observed carefully during therapy for allergic reactions, particularly for skin rash, a common sign of sulfonamide allergy. Some sulfonamides may produce blood *dyscrasias*. The nurse must observe the client for sore throat, fever, and *pallor* or jaundice and immediately report these signs to the prescriber. If these signs occur in an outpatient, the client should be advised to stop the medication and to see the prescriber.

When administering sulfonamides, the nurse encourages the client to take the medication with a full glass of water. Although newer sulfonamides are not as likely to produce crystals in the urine as older sulfas did, adequate hydration minimizes the likelihood of developing this problem. In addition, because sulfonamides are frequently used in the treatment of urinary tract infections, this fluid intake helps to facilitate the production and movement of urine through the urinary tract. It also helps to wash inflammatory products out of the body. Fluids should be encouraged, up to 3,000–4,000 mL/day in adults, if not contraindicated (as in heart or kidney disease).

Client counseling must include instructions to continue to take the sulfonamides as prescribed, even when symptoms are relieved. Therapy with sulfonamides is often combined with phenazopyridine hydrochloride (Pyridium), a local analgesic agent. This drug rapidly

decreases the burning associated with bladder infections and the client begins to feel better. Once symptom relief occurs, the client may stop therapy before the infection is adequately treated. Symptoms may then recur. Clients taking phenazopyridine should be told that the urine will become orange-red. This is a result of the medication and not bleeding, as they may fear. Clients should also be advised that some sulfonamides produce photosensitivity reactions and direct sunlight should be avoided or a sunscreening agent should be used on the exposed skin and lips. Some preparations produce false-positive tests for glucose when Clinitest is used. Persons with diabetes mellitus who are taking these sulfonamides may be advised to use Accu-Check method for glucose testing.

Clients should be instructed to avoid foods and medications that would acidify urine and possibly produce precipitation of the sulfonamide and result in crystalluria. Such drugs include **ammonium chloride**, **paraldehyde**, and ascorbic acid (vitamin C). This warning about substances to be avoided is particularly important because a number of people take relatively large doses of ascorbic acid in an attempt to prevent respiratory infections.

Urinary tract germicides are also used to treat infections. One commonly used for control of chronic infections is methenamine mandelate (Mandelamine). Clients treated with methenamine mandelate are advised to avoid foods and drugs that might alkalinize the urine (e.g., **Alka-Seltzer**, **sodium bicarbonate**, milk, and fruit juices other than cranberry, plum, or prune juice). Suggestions are often made to take ascorbic acid or the aforementioned three fruit juices in an attempt to acidify the urine. Fluid intake should be encouraged. Gastrointestinal distress may be reduced by administering this drug shortly after meals.

Clients taking nalidixic acid (NegGram) should be monitored for visual disturbances, such as double or blurred vision and changes in color perception. These improve with a decrease in dosage. Gastrointestinal upset may occur; so may photosensitivity reactions. Sensitivity to sunlight may persist for several months following therapy.

Two other agents used in the treatment of urinary tract infections are nitrofurantoin (**Furadantin**) and **nitrofurantoin macrocrystals** (**Macrodantin**). The most common negative side effect associated with nitrofurantoin treatment is gastrointestinal distress. This drug should always be given with food or milk to minimize this discomfort. Nitrofurantoin macrocrystals (Macrodantin) seems to be better tolerated;

KEY NURSING IMPLICATIONS 7–8

Clients Receiving Sulfonamides and Urinary Tract Anti-Infectives

1. Before beginning therapy with sulfonamides, the client must be questioned about allergy to this group of drugs.
2. Encourage clients receiving sulfonamides and urinary tract germicides to take an adequate fluid intake. Adults with conditions not contraindicating a high fluid intake should be encouraged to take 3,000–4,000 mL of fluid a day.
3. Clients taking phenazopyridine should be told that their urine will become orange-red.
4. Clients taking sulfonamides are instructed to avoid ammonium chloride, paraldehyde, and ascorbic acid, which could result in crystalluria.
5. Clients taking methenamine mandelate are encouraged to take substances that can acidify their urine. These substances include ascorbic acid and cranberry, plum, or prune juice.
6. Clients taking nalidixic acid are monitored for the development of visual disturbances, gastrointestinal upset, and photosensitivity reactions.
7. Clients receiving nitrofurantoin or nitrofurantoin macrocrystals should be instructed to take their medication with food or milk. They are observed for changes in pulmonary status and are also advised that their urine may turn darker while taking these drugs.
8. Instruction should be given regarding ways to avoid recurrences of lower urinary tract infection.

administration with food or milk may be helpful in decreasing nausea and gastrointestinal discomfort. Clients taking either of these drugs should have periodic urine cultures. They should also have their intake and output monitored and must be observed for changes in their pulmonary status. Various pulmonary reactions have been noted when these drugs have been used; some of these are life-threatening. The nurse must, therefore, note changes in the rate and quality of respirations and report signs of *asthma* and respiratory distress.

In addition to client teaching regarding hygiene and fluid intake, clients taking these drugs should be advised that their urine may become darker or brown. They should be reassured not to be concerned if this occurs.

A prominent nursing diagnosis for clients with urinary tract infections is deficient knowledge related to prevention of recurring infections. Because of their shorter urethra, women are more at risk for lower urinary tract infections than are men. All female clients with lower urinary tract infections should receive instruction by the nurse to prevent future infections. This instruction includes a brief description of anatomy, common causes of lower urinary tract infections, and advice to use care in always wiping with toilet tissue from the urinary meatus backward toward the anus. Recent research has shown that most bladder infections in women occur within 48 hours of having vaginal sexual intercourse. Urinating immediately after intercourse seems to have a protective effect, as does avoiding intercourse when the bladder is full. In addition, rocking motions during intercourse are less frequently associated with *cystitis* than are penile thrusts.

CLIENTS RECEIVING ANTIFUNGAL AGENTS

Antibiotics which have controlled bacterial infections in immunosuppressed clients (e.g., those receiving cancer chemotherapy) have created an environment conducive to the overgrowth of organisms not susceptible to the antibiotic. As a result, fungal infections have become increasingly prevalent. Such fungal infections may become serious enough to be life-threatening. For such an infection, intravenous antifungal agents are used. When preparing an intravenous solution of amphotericin B (Fungizone) or if using a solution prepared by someone else, be certain that the drug was added to dextrose and water (D5W), rather than to a solution containing saline, electrolytes, or bacteriostatic agent(s). Use of these other solutions may produce precipitation. The drug is reconstituted by adding sterile water for injection, USP without a bacteriostatic agent. Good aseptic technique in reconstituting the drug is essential. **Note:** Do not use any solution which contains a precipitate. If the solution containing amphotericin B is not to be used within 24 hours, it must be refrigerated and protected from light. Also protect the drug from light during its infusion. If the amphotericin B-containing IV solution is to be administered through a line used for infusion of drugs other than heparin, hydrocortisone, and electrolyte solutions, the line must be flushed with sterile water before and after the amphotericin B is administered. If sterile water is used, it must contain no bacteriostatic agent or preservative. It is recommended that the line be flushed with D5W. If the client is receiving other intravenous drugs or fluids, an auxiliary setup of D5W should be prepared to permit flushing the line before and after an infusion of amphotericin B. In some cases a second IV line will be established solely for the administration of the antifungal agent.

Clients receiving amphotericin B infusions should have vital signs monitored every 4 hours. Temperature elevation may occur within 2 hours of starting the infusion and subside several hours following its discontinuation. In order to prevent chills, fever, nausea, vomiting and headaches, clients are often premedicated with acetaminophen (Tylenol, **Panadol**, etc.) and diphenhydramine (Benadryl) or other antihistamine before the infusion is begun. These drugs are given every 3–4 hours if needed. Hydrocortisone may also be added to the infusion to help decrease these symptoms. Clients should also be observed for signs of *hypokalemia*; for example, weakness, tingling in fingers or toes, and nausea. Routine monitoring of the client's intake and output is also important, and any indication of

KEY NURSING IMPLICATIONS 7–9

Clients Receiving Antifungal Agents

1. Never reconstitute amphotericin with saline or water containing a bacteriostatic agent. Use only sterile water for injection, USP, with a bacteriostatic agent.
2. Intravenous solutions of amphotericin should be added to infusions of dextrose and water only.
3. Never use a solution of amphotericin which contains a precipitate. Use a prepared amphotericin solution within 24 hours or refrigerate it and protect it from light.
4. Monitor the vital signs and intake and output of all clients receiving amphotericin and miconazole infusions. Observe the client for fever, nausea, chills and headaches and for hypokalemia if the client is receiving amphotericin.
5. Observe the intravenous injection site for indications of phlebitis.

impaired renal functioning should be reported to the physician immediately. Clients receiving amphotericin B over a period of time will probably have periodic blood studies to monitor kidney and liver function; for example, weekly serum creatinine tests, blood counts, and blood urea nitrogen tests.

Discomfort at the infusion site is common and clients should be told about this possibility. Frequent checks should be made of the site, as phlebitis may occur. Heparin is sometimes added to the infusion to decrease the risk of thrombophlebitis. Any indication of developing phlebitis (e.g., heat, redness, induration) should be reported immediately so treatment may be begun.

Another agent that may be given intravenously for the treatment of fungal infections, miconazole (**Monistat i.v.**), may produce fewer negative side effects than amphotericin B. Clients must be observed, however, for phlebitis at the injection site, indications of hepatic or renal toxicity, nausea, vomiting, fever, and chills. Premedication with acetaminophen and an *antiemetic* may be helpful in reducing client discomfort.

CLIENTS RECEIVING ANTIVIRAL AGENTS

Some persons, particularly those who are elderly or debilitated and at risk of viral infections, may take amantadine HCl (**Symmetrel**) or rimantadine HCl (**Flumadine**) for the prevention or treatment of influenza. A variety of negative side effects, including dizziness, depression, gastrointestinal distress, and urinary retention can occur and should be brought to the physician's attention. The dizziness may be due to orthostatic hypotension and clients should be instructed not to stand or to change positions too quickly to avert this possibility. Insomnia may also occur, but can generally be alleviated if the daily dose of the drug is given in the morning or if the last dose is given several hours before bedtime. To promote maximal absorption, clients are instructed to take the drug after meals. Institutionalized persons receiving one of the drugs should have intake and output monitored. Periodic laboratory determinations of serum electrolytes should be done.

Another antiviral agent in use, **vidarabine monohydrate** (Vira-A), is given intravenously. The infusion is given slowly, and clients are monitored carefully. Rapid infusion and bolus injection of this drug must be avoided. It can cause a variety of side effects. The nurse must observe the client for gastrointestinal upset, rash, central nervous symptoms such as tremor, dizziness, and confusion, and for indications of blood abnormalities. Clients prone to fluid overload, such as those with renal disease, must be monitored very carefully.

Frequent blood tests, particularly for hemoglobin, hematocrit, platelets, and white cell counts, are done during therapy to detect blood dyscrasias. The physician should be notified immediately of any significant change in these tests.

Clients receiving **vidarabine HCl** should have intake and output monitored and be weighed daily. Weight loss may occur with this therapy. Before treatment begins, the nurse inquires about the possibility of pregnancy in all women of childbearing age, as this drug is not given to pregnant women.

The intravenous solution of vidarabine should not be refrigerated, as it is stable at room

KEY NURSING IMPLICATIONS 7–10

Clients Receiving Antiviral Agents

1. Amantadine HCl should be taken after meals. Clients are observed for orthostatic hypotension, depression, gastrointestinal distress, and urinary retention.
2. Clients receiving vidarabine should have intake and output monitored and be weighed daily.
3. A filter is used for vidarabine infusions.
4. Acyclovir is always administered intravenously as an infusion. Watch for nephrotoxicity, phlebitis, nausea, and vomiting, plus the development of hypersensitivity reactions.

temperature for 2 weeks. A filter is used for intravenous infusion. The nurse observes and regulates the infusion carefully to ensure a constant rate of administration over the time period ordered.

Clients taking acyclovir must be assessed carefully. This drug may cause renal toxicity and adequate fluid intake must be assured. Nephrotoxic drugs, such as aminoglycoside antibiotics, should not generally be given to clients receiving acyclovir. When administered intravenously it is given as an infusion, never as a bolus, as this could result in nephrotoxicity.

Clients receiving intravenous acyclovir are observed for phlebitis, nausea, vomiting, decreasing renal function, and the development of hypersensitivity reactions as indicated by rash or hives. A small percentage of clients may develop lethargy, confusion, or tremors during treatment. Promptly report any of these occurrences to the prescriber.

NURSING IMPLEMENTATION FOR CLIENTS WITH AIDS RECEIVING DRUG TREATMENT

AIDS is a serious epidemic, both in the United States and in many other parts of the world. Research is directed at developing a vaccine against HIV (human immunodeficiency virus), developing antiviral agents with direct effect on HIV, and developing immunomodulators, or drugs that reconstitute or restore immune function. No curative treatment has been found. It is presently believed that an approach using antiviral drugs to destroy or prevent replication of HIV and immunomodulators to restore immunological function may be the most promising treatment for newly diagnosed clients.

Zidovudine (**Retrovir**), didanosine (**Videx**), zalcitabine (Hivid), and stavudine (Zerit) have been approved by the Food and Drug Administration for the treatment of AIDS. Other drugs are currently undergoing clinical trials. These agents are virustatic, not virucidal, and AIDS can be transmitted to others through infected body fluids while the client is undergoing drug treatment.

The adverse effects of therapy that the nurse assesses the client for include blood disorders, especially anemia and low granulocyte counts. These usually develop after 4 to 6 weeks of treatment. Also, many clients develop flu-like syndromes with fever, chills, muscle aches, headache, malaise, and fatigue. These symptoms often ease after the first week of treatment. Other clients develop abdominal discomfort, tremors, confusion, or neurotoxicity. Carefully assess clients and instruct them to report the development of these problems to the prescriber.

In addition to these adverse effects, a number of precautions must be taken when clients are using zidovudine. In general, zidovudine and acetaminophen should not be used together, as zidovudine toxicity may occur. Nonsteroidal anti-inflammatory agents are also avoided. Clients must be instructed to take this drug every 4 hours, around-the-clock, even though it interferes with sleep. Finally, the nurse monitors the client for signs of opportunistic infections, such as cough, changes in mucous membranes, and temperature elevation. Clients taking immunomodulators, particularly alpha interferon, may also develop a transient flu-like syndrome, blood dyscrasias, confusion, insomnia, depression, and loss of appetite and weight.

Often the initial indication of AIDS is PCP, which can also occur throughout the course of the illness. The drug most frequently used to treat this problem is pentamidine (NebuPent, Pentam). Pentamidine is also sometimes used to prevent recurrences of PCP. Pentamidine is generally administered intramuscularly or intravenously for the treatment of PCP. Pentamidine is administered primarily by inhalation for the prevention of PCP in high-risk, HIV-infected

clients who have had one or more episodes of PCP and/or are seriously immunocompromised.

Thorough medical and nursing assessments are conducted before pentamidine is prescribed. The nurse takes a medication history with particular emphasis on whether pentamidine has been previously used and the client's response. Also, inquiry is made about a history of asthma, other lung diseases, and smoking. If the client has asthma or a history of smoking or bronchospasm, bronchodilators may be used before pentamidine aerosol treatments. This assists in ensuring the drug is deposited within the *alveoli* where it is most effective. The nurse also notes a history of diabetes mellitus or glucose intolerance. Use of pentamidine is associated with release of insulin from the pancreatic beta cells, so clients with diabetes or glucose intolerance must be monitored carefully. The nurse asks women about the possibility of pregnancy, since pentamidine therapy is generally avoided during pregnancy.

The medication is prepared for administration by injecting 6 mL of bacteriostatic water into the vial containing the powdered pentamidine. The vial is shaken until the drug is dissolved. Using a sterile syringe, the drug is then withdrawn and added to the drug chamber of the nebulizer.

Before the medication is administered, baseline measurements of the pulse and blood pressure are taken. The client is seated upright in a comfortable chair and instructed to breathe normally, inhaling and exhaling slowly through the mouth. After the mouthpiece is placed in the mouth, the nebulizer is connected to the oxygen tubing and the flow rate set as ordered. Administration of the medication generally takes 30–45 minutes.

After 15 and 30 minutes the nurse should *auscultate* the client's lungs to check for wheezing and *dyspnea*. Treatment is discontinued if these signs occur, and the physician is informed. Other complications of treatment include coughing, dizziness or fatigue, metallic taste in the mouth, and burning sensation in the throat. Mouthcare and sipping lukewarm fluids, especially water, may be helpful in treating the latter two problems (see Nursing Care Plan 7–B). The nurse also observes the client for rashes, respiratory difficulties that could indicate the presence of air in the pleural cavity (pneumothorax), and spitting up of blood (*hemoptysis*). In all cases, the physician must be notified.

KEY NURSING IMPLICATIONS 7–11

Clients Receiving Drug Treatment for AIDS

1. Observe clients taking zidovudine or didanosine for blood abnormalities, flu-like syndromes, abdominal discomfort, tremors, confusion, and neurotoxicity.
2. Avoid the use of acetaminophen when zidovudine or didanosine are taken.
3. Instruct clients to take zidovudine or didanosine around the clock.
4. Observe clients taking alpha interferon for flu-like syndromes, blood abnormalities, confusion, depression, and loss of appetite and weight.
5. Before treatment, carefully assess clients taking pentamidine aerosol for respiratory problems, history of allergy to pentamidine, pregnancy, diabetes mellitus, or glucose intolerance.
6. Reconstitute pentamidine powder using bacteriostatic water only.
7. Measure pulse and blood pressure before administering pentamidine aerosol and after and during treatment as indicated.
8. During administration of pentamidine aerosol, auscultate the client's lungs at 15 and 30 minutes. Discontinue treatment, if wheezing or dyspnea develops.
9. Clients taking pentamidine are observed for respiratory difficulties, rashes, and hemoptysis.
10. Skin or conjunctiva in contact with pentamidine must be flushed immediately with water. Control the release of aerosol pentamidine into the environment.

Recently, considerable attention has been given to the safety of staff responsible for administering pentamidine aerosol. The drug is a skin irritant and can cause *conjunctivitis* and skin rashes. Areas of contact with pentamidine must be flushed immediately with water. Of great concern is the escape of the aerosol drug into the client's immediate environment. Ideally, treatment should be in areas equipped with negative air pressure systems. In their absence, well-ventilated areas should be used, and gas flow should be stopped when the client takes a break during the treatment.

NURSING CARE PLAN 7–A

A Client with Urinary Tract Infection (UTI) Taking Nitrofurantoin Macrocrystals and Phenazopyridine HCl

Abby Lansdale, 38 years old, visits her physician with complaints of burning on urination and urinary frequency and urgency. She first experienced these symptoms 2 days ago and has slept poorly because of nocturia. The nurse takes Ms. Lansdale's vital signs, which are within normal limits, and acquires a clean catch urine specimen for culture and sensitivity. The client reports an allergy to sulfonamides. The physician orders nitrofurantoin macrocrystals (Macrodantin) 50 mg QID for 10 days and phenazopyridine HCl (Pyridium) 200 mg TID for 5 days. A follow-up urine specimen is needed in 2 weeks.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Vital signs.	Risk for hyperthermia related to infection.	The client will recognize signs of infection and begin treatment.	Ask client to report temperature elevations. Remind her about follow-up visits and laboratory study appointments.	Vital signs have returned to normal limits as a result of treatment.
Report of frequency, urgency, dysuria, and nocturia.	Altered urinary elimination patterns related to lower urinary tract infection.	The client will return to her normal urination patterns within 1 week of treatment.	Explain the importance of compliance with treatment program for full length of time medication is prescribed.	Infection subsided with treatment. UTI will not recur because of inadequate treatment.
Nocturia.	Sleep pattern disturbance related to nocturia from UTI.	The client will be able to have 6–8 hours of uninterrupted sleep within 2 days.	Explain to client the need to void before bedtime.	Client has returned to normal sleep patterns.
Dysuria.	Pain: Acute related to infectious process.	The client will have relief of pain within 48 hours.	Review frequency of administration and advise patient to take medications with meals.	Client has become pain-free. GI upset did not occur.
General hygiene practices.	Risk for infection due to poor hygienic practices.	Client will demonstrate understanding of good hygienic practices.	Explain relationship between poor hygiene and UTIs. Review proper post-elimination hygiene.	Client verbalizes how to control and prevent any UTI.
Current fluid intake.	Risk for fluid volume deficit related to increased need for fluid secondary to infectious process.	Client will increase fluid intake to 8 oz. per hour while awake.	Explain that fluids are needed to dilute urine and flush out infectants. Also, adequate fluids increase comfort. Encourage client to drink cranberry juice.	Client drinks 8 oz. of fluid per hour. Increased fluid intake leads to pain-free elimination.
Medication history.	Risk for injury related to history of allergic reaction to sulfonamides.	Client will be free of allergic reaction.	Inform prescriber of allergy to sulfonamides. Record this information in a prominent place on client's record.	Appropriate medication was prescribed. Client did not suffer an allergic reaction.

Sexual history.	Knowledge deficit (relationship between sexual activity and UTI).	Client will demonstrate understanding of relationship of sexual activity and UTI.	Explain that most UTIs in women occur within 48 hours of intercourse. Altering type of intercourse and urinating immediately after intercourse may decrease frequency of infections.	Client demonstrates understanding of relationship between sexual activity and urinary tract infections.
Knowledge of illness and its treatment.	Deficient knowledge (cause of this health problem and its treatment).	Client will demonstrate understanding of treatment regimen.	Explain common causes of UTIs. Explain the complete course of each medication as ordered. Advise patient that phenazopyridine HCl will turn the urine orange-red, while nitrofurantoin will turn it darker or brown. Follow-up urine specimen needed.	Compliance with treatment regimen. Adequate treatment of this episode of UTI as indicated by sterile urine and absence of symptoms. Occurrence of future UTIs is decreased.

NURSING CARE PLAN 7–B

A Client with Acquired Immunodeficiency Syndrome (AIDS)

Stephen Burt, 27 years old, is admitted to the hospital for treatment of multiple problems associated with AIDS, including a diagnostic workup to determine the cause of his elevated temperature. On administration he is thin and fatigued with the following vital signs: T 102.2, P 94, R 14. He reports that he has been taking zidovudine (Retrovir) 200 mg q4h around the clock for 6 months and pentamidine aerosol (NebuPent) 300 mg every 4 weeks for 4 months.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Vital signs.	Imbalanced body temperature: hyperthermia related to infectious process.	Client will recognize signs of infection and seek treatment.	Take vital signs every 4 hours. Request order for aspirin and administer aspirin q4h PRN.	Temperature returns to normal as result of identifying cause of elevation, using antipyretic, and beginning appropriate treatment.
Current fluid intake.	Risk for deficient fluid volume deficit related to increased perspiration and malnutrition.	Client will increase fluid intake to 8 oz. per hour while awake.	Explain that fluids are needed to replace those lost by perspiration. Increased fluids also help to facilitate elimination of waste products of infection. Provide fluids client likes.	Client maintains adequate fluid volume as evidenced by absence of weight loss, normal urine specific gravity, and good skin turgor.
Medication history.	Risk for ineffective health maintenance related to noncompliance with therapeutic regimen.	Client will demonstrate understanding of therapeutic regimen and health behaviors needed to manage condition.	Review past and current medication schedules with patient and importance of 24–hour schedule for administration of zidovudine. Give aspirin q4h PRN to decrease temperature and to avoid zidovudine–acetaminophen interaction.	Client adheres to therapeutic regimen. Client verbalizes understanding of symptoms of zidovudine therapy. Physical condition improves. Zidovudine toxicity does not occur.
Medication history. Respiratory rate. Breath sounds.	Risk for infection: recurrence of *Pneumocystis carinii* pneumonia (PCP) related to altered immune system.	Client will demonstrate understanding of medication regimen and list symptoms of recurrence.	Assess vital signs before beginning pentamidine aerosol and as indicated throughout and at the end of treatment. Auscultate lungs at 15 and 30 minutes for wheezing and dyspnea.	Client verbalizes symptoms of recurrence and knows when to call physician. Respirations are within normal limits. Breath sounds are present and clear.
Nutritional status.	Nutrition, imbalanced: Less than body requirements related to catabolic illness.	Client's nutritional status will improve, and client will maintain or gain weight.	Take a nutrition history. Obtain foods client likes. Schedule nutrition consult if necessary. Weigh client every other day.	Client's food intake improves, and client maintains or gains weight.
Hygiene practices.	Risk for infection transmission related to lack of knowledge of modes of transmission.	Client will verbalize how AIDS is transmitted and a plan to avoid infecting others.	Determine what client knows about AIDS transmission and provide information about ways to avoid transmitting to others.	Client describes the means by which AIDS can be transmitted and takes measures to avoid transmission.

Knowledge of illness and its treatment.	Deficient knowledge (course of this health problem and its treatment).	Client will verbalize understanding of treatment regimen, disease process, transmission, and complications.	Assess client's knowledge about AIDS and its treatment. Provide additional information, if necessary. Explain purposes of zidovudine and pentamidine therapy.	Client is able to explain the purpose of zidovudine and pentamidine therapy and is compliant with medication regimen.
Activity tolerance sleep/rest pattern.	Activity intolerance related to generalized weakness and malnourished state secondary to AIDS.	Client will maintain an activity level within capabilities as evidenced by normal heart rate and blood pressure during activity.	Assist client in gradually increasing his daily activities. Provide uninterrupted time for rest and sleep. Schedule other procedures for times when zidovudine must be administered during the night.	Client's tolerance for activities improves. He reports absence of shortness of breath, weakness, and fatigue.
Discomfort.	Pain: Acute related to irritation of throat mucosa from deposition of pentamidine particles.	Client will verbalize relief from burning after drinking water.	Instruct client to take small sips of lukewarm water every 10 minutes if burning sensation occurs during treatment. Advise continued drinking of lukewarm water for several minutes after treatment to decrease soreness.	Client experiences minimal discomfort from treatment and is compliant with regimen.
Taste.	Distributed sensory perception: Gustatory.	Client will not experience bitter aftertaste resulting from treatment.	Tell client bitterness disappears in a few hours. Have client rinse mouth with baking soda paste and saline immediately after treatment. Sucking on hard candy also may help to decrease the aftertaste.	Client reports minimal alteration in taste and continues treatment as scheduled.

Clients are encouraged to keep appointments for regular blood testing and to refrain from engaging in behaviors that would put others at risk of developing AIDS. Throughout therapy, the nurse provides sustained emotional support for the client and significant others and diagnoses the need for appropriate nursing intervention.

EVALULATION

- Client recognizes symptoms of infection and seeks medical attention promptly.
- Client verbalizes understanding of how to keep healthy through nutrition, exercise, etc.
- Client verbalizes methods of preventing recurrence of infections.
- Client verbalizes and demonstrates techniques such as handwashing, proper disposal of tissues, etc. to prevent the transmission of infection.
- No injuries occurred from medication administration.
- Client did not experience negative side effects from medications.
- Client verbalizes understanding of infection process, medication regimen, prevention of recurrence.
- Client demonstrates compliance with medication regimen.

CASE STUDY

Josephine Chee, a 37-year-old woman, received a severe bite on her left wrist from a pet cat. She was seen within the hour by a physician who cleaned the wound with **povidone-iodine** (**Betadine**), dressed the wound, and ordered penicillin V potassium 250 mg to be taken p.o. QID for 10 days.

The client obtained the medication and began to take it as ordered. Within 12 hours, however, the client noted a red streak that gradually progressed up her arm. She called the physician to report that a tender red streak had developed and had now progressed up to her elbow. It was about 18 hours after the bite. The physician immediately admits the client to the hospital with the orders:

- Continuous warm saline soaks to the left wrist and hand
- Blood culture—Stat
- Penicillin G potassium 5 million units IV qid for 4 days then D/C IV and give penicillin V potassium 500 mg p.o. q 6 hours for 10 days.

The blood culture shows alpha-hemolytic streptococcal septicemia. To facilitate treatment, a saline lock is inserted so that intravenous treatment can be given periodically without having to do a venipuncture each time an infusion is to be given. The saline lock is inserted into a superficial vein and the infusion is run rapidly. Mrs. Chee complains of pain in the vein. The saline lock is moved to a larger, deeper vein and the drug is administered without pain.

After 4 days of treatment, the soaks and the intravenous infusion are stopped and the client is discharged. A prescription for oral penicillin is given and the client is instructed to see the physician in his office in 1 week.

Questions for Discussion

1. What instructions should have been given to the client regarding oral penicillin therapy when she first visited the physician?
2. If the client's supply of penicillin G potassium is exhausted, could the nurse substitute penicillin G procaine? Why or why not?
3. What nursing measures are indicated in the intermittent administration of an antibiotic through a saline lock?
4. What supportive nursing measures are indicated in the case of this client with an infection?
5. What advice should the nurse give the client about the prescription and follow-up visit ordered at the time of discharge?

HOME CARE / CLIENT TEACHING

1. Remind clients to always complete their course of antimicrobial drugs.
2. When monitoring parenteral antibiotic therapy at home, the nurse should confirm the organism's susceptibility, observe the client for adverse drug reactions, monitor serum antibiotic levels, observe the patient for superinfections, and assess the therapeutic response to treatment.
3. Encourage clients to safely discard antibiotics that have expired.
4. Review client teaching under "Implementation" in this chapter.
5. All clients receiving antimicrobials should drink at least 2,400–3,000 mL of fluid a day, unless contraindicated.
6. Remind all clients taking antibiotics that the medications are absorbed better if taken with 6–8 oz of water.
7. Clients receiving oral cephalosporins and erythromycins need to take the medications with meals to decrease gastrointestinal irritation.
8. Because of the photosensitivity associated with tetracyclines, clients should avoid sun exposure and use of tanning beds.
9. Milk and other dairy products, iron preparations, and antacids should be avoided when taking tetracyclines, as these products will decrease the effectiveness of the medications.
10. Due to the concern for VRE, clients taking vancomycin should be instructed to take the medication exactly as prescribed, for the number of days prescribed, and taken around the clock to maintain medication blood levels to ensure that the microorganism is completely destroyed.
11. Clients receiving antitubercular medications should **not** consume any alcohol products while taking these medications.
12. Women taking oral contraceptives should be instructed to use alternate means of birth control when receiving antitubercular agents, because these agents cause oral contraceptives to be ineffective.
13. As with all clients taking antimicrobials, those taking antitubercular agents should be sure to have adequate nutrition, rest, and decrease stress.
14. Remind clients taking antivirals that some of these agents cause dizziness, with the client cautioned about driving and other activities requiring alertness until the client is able to determine his/her reaction to these agents.
15. Clients receiving amphotericin B should be instructed that this treatment is long-term and compliance is necessary.
16. Clients should be instructed about side effects of any antimicrobial agents prescribed and when to notify the physician.

CRITICAL THINKING EXERCISES

1. Identify factors that increase the body's susceptibility to infection.
2. Describe the role of each of the following techniques in identifying the organism responsible for causing an infection:
   - microscopic examination
   - Gram stain
   - culture
   - sensitivity testing
3. Discuss the role of nursing in infection control with an infection-control nurse.
4. Discuss the treatment and control of infections before the development of antibiotics.
5. Discuss the preparation of intravenous antibiotic solutions. Note the precautions taken to ensure the sterility of the solution.
6. Write instructions for a parent in the administration of antibiotics to his/her child.
7. Prepare a visual on the care of an IV injection site.
8. Discuss the antibiotic treatment of a particular infection (e.g., typhoid, staphylococcal or streptococcal infections of the throat).
9. Discuss the prevention of respiratory infections.
10. Compare the causes of complicated and uncomplicated urinary tract infections.
11. Identify the role of the nurse in the prevention and control of infection.
12. Describe the supportive nursing care for a client with an infection.
13. Discuss the treatment of AIDS with drugs not currently approved by the FDA and dietary treatment.
14. Create a nursing care plan for a client receiving acyclovir.

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Antiparasitic Drug Therapy

8

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the ways in which humans may contract parasites
- Identify ways in which drugs may exert antiparasitic effects
- Apply nursing care process in the administration of each antiparasitic agent class
- Describe nursing interventions to prevent reinfestation with parasites

Parasitic infections are caused by the feeding of one organism on the living body of another. Parasitic infections were once thought to be a problem only in tropical and subtropical regions of the world. It has now become apparent that parasitic infections can occur in almost any climate and can affect the old and young and affluent as well as poor people.

In the United States parasitic infections have become more prevalent as the population has grown and as immigration of persons from highly infested parts of the world (e.g., Southeast Asia) has increased.

Parasites may be contracted in a variety of ways:

- person-to-person contact
- ingestion of contaminated water or food
- transmission by an insect (e.g., a mosquito or tick)
- direct contact with the parasite (e.g., walking barefoot in an area in which the soil harbors parasites)

Human parasitic infections may be classified as systemic, gastrointestinal, or dermatological.

SYSTEMIC PARASITIC INFECTIONS

In addition to malaria, there are several commonly occurring *protozoal* infections. These include amebiasis and trichomoniasis. However, the most common systemic parasitic disease affecting humans is malaria.

Malaria

Malaria is caused by parasitic protozoal organisms of the genus *Plasmodium*. Although it is usually encountered in tropical and subtropical regions, malaria has become more common in the United States. Many former members of the armed forces contracted the disease while serving in Southeast Asia and returned with the protozoan parasite in their red blood cells.

Human malaria may be caused by any one of the four *Plasmodium* species. The organisms are often inoculated into humans by the bite of a mosquito, but may also be transmitted by transfusions of blood that contain the organism, or by injection with syringes or needles that have been used by an affected individual. After an initial asymptomatic period (usually 1–2 weeks) during which the organisms develop and multiply, characteristic symptoms, such as recurrent chills, fever, and prostration, develop.

As the malarial organism enters and destroys the red blood cells, the development of anemia and impaired oxygen delivery to the major organs of the body frequently accompany the malaria. Diagnosis of this disorder is made by recognizing its symptoms and by identifying the offending parasite within the red blood cells. As the organism is only present within the red blood cells during one stage of its life cycle, i.e., the symptomatic stage, it is essential that a blood smear be examined during this period.

Drug therapy of malaria should ideally provide effective prophylaxis and should suppress symptoms during the acute symptomatic stage of the illness. Treatment should also be quickly effective and produce a minimal level of adverse effects. Although a detailed discussion of the drug therapy of malaria is beyond the scope of this text, the most commonly used antimalarial drugs are discussed.

Quinine Sulfate. This medication has been used for many decades in the treatment of malaria. Although its precise mechanism of action is still in question, **quinine** is believed to exert its antimalarial effect by producing a variety of toxic effects, including interference with the ability of protozoa to properly utilize oxygen and carbohydrates. Its use as an antimalarial has declined considerably in recent years because of its ability to produce significant toxic effects. One toxic effect, *cinchonism*, is often seen with regular quinine use and may appear as an array of symptoms, including tinnitus, dizziness, headache, GI distress, and visual disturbances. Many adverse hematological effects have also been reported with the use of quinine. They may include *hemolytic anemia*, *thrombocytopenia*, and *agranulocytosis*. The use of quinine has also been associated with the development of a wide variety of other adverse effects involving the central nervous system, the eye, and other physiological systems.

As quinine has some skeletal muscle relaxant as well as analgesic effects, it is sometimes employed in the prevention and treatment of nocturnal leg cramps in clients with arthritis, diabetes mellitus, varicose veins, and other disorders with which such cramps are associated.

Mefloquine HCl. This agent is chemically related to quinine. It is employed both in the prevention of malaria and in the treatment of acute malarial infections. Although similar to quinine, **mefloquine** appears to cause fewer adverse effects, causing vomiting, dizziness, headache, chills, and/or diarrhea in a small proportion of users.

Quinacrine Hydrochloride. Once the most popular drug for malaria prophylaxis, the use of **quinacrine** has declined sharply with the development of safer and more effective agents. Quinacrine acts to interfere with the replication of DNA and thereby reduces the parasite's ability to synthesize protein. When administered in therapeutic doses, quinacrine often causes GI distress, as well as dizziness and headache. Some clients may experience skin eruptions and/or neuropsychiatric effects, such as nightmares and vertigo. Quinacrine administration has also been associated with the development of a yellowish discoloration of the urine and skin not caused by jaundice and that generally subsides upon discontinuation of the drug.

Chloroquine. One of the safest and most effective antimalarials currently available is **chloroquine**. Although somewhat similar in action to quinacrine, chloroquine is more effective in controlling the clinical symptoms of malaria. It does not discolor the skin or produce the serious adverse effects associated with the antimalarial compounds previously discussed. Its relatively low level of toxicity is attributed, in part, to its ability to preferentially accumulate in affected red blood cells instead of other body tissues.

Unlike quinine or quinacrine, chloroquine may be administered orally or intramuscularly. The availability of a parenteral form may be an advantage in treating clients who are unable to take an oral dosage form.

In addition to its antimalarial effects, chloroquine also has anti-inflammatory properties. For this reason it has been employed with some success in the treatment of *rheumatoid arthritis* and *discoid lupus erythematosus*. As larger doses of the drug must be used in treating these disorders than are required for the treatment of

malaria, toxicity is much more likely to occur with such use.

Hydroxychloroquine. A close chemical relative of chloroquine is **hydroxychloroquine**. It is generally only employed in situations where chloroquine is not available. Its toxicity and dosage are almost identical to those of chloroquine, but it is not available for parenteral administration.

Primaquine Phosphate. This is an antimalarial agent which, unlike chloroquine, is particularly effective against exoerythrocytic forms of several *Plasmodium* organisms, i.e., those forms that exist outside of the red blood cell. **Primaquine** is therefore employed primarily in combination with chloroquine for the prevention of malarial attacks. It is also used to prevent relapses once the acute malarial attack has been controlled with an agent such as chloroquine.

Primaquine appears to be relatively safe for use in Caucasians. However, its administration to dark-skinned persons and others likely to be deficient in the enzyme glucose-6-phosphate dehydrogenase (e.g., Sardinians, Sephardic Jews, Greeks, and Iranians) is likely to result in the development of hemolytic reactions. These may be serious and life-threatening.

Halofantrine Hydrochloride (Halfan). This drug is used to treat adults with mild to moderate malaria, who have developed resistance to the drug of choice (chloroquine). **Halofantrine HCl** was approved by the FDA in 1992, but was not marketed until 1998 because of concerns about serious ECG (electrocardiogram) changes, including prolonged QT interval resulting arrhythmias. An ECG should be performed as a baseline prior to beginning halofantrine HCl therapy and cardiac rhythm should be monitored throughout treatment.

Folic Acid Antagonists. Agents such as **pyrimethamine** and sulfa drugs interfere with the synthesis of folic acid. They may be used alone or in combination to suppress and prevent malaria caused by susceptible strains of *Plasmodium*. They are of little value in the treatment of an acute malarial attack. Table 8–1 summarizes the properties of drugs used in the treatment of malaria.

OTHER PROTOZOAL INFECTIONS

Amebiasis is a parasitic disorder characterized by the invasion of the large bowel by the protozoal organism *Entamoeba histolytica*. This disease is most often the result of ingesting contaminated food or drinking water. Some infected clients may remain asymptomatic, even though positive identification of the organism in the stool has been made. In other clients, gastrointestinal symptoms ranging from mild-to-severe diarrhea (dysentery) may be evident. In rare instances, extraintestinal amebiasis may be present; amebic organisms may invade the liver, lungs and other major organs of the body.

Trichomoniasis is primarily a disease of the vagina and is caused by *Trichomonas vaginalis*. This infection is associated with a thin, yellow, foul-smelling discharge and pruritus. Trichomonal infections may affect both sexual partners and frequently recur.

Although there are many other protozoal infections prevalent in the world, one of the most common is African trypanosomiasis (African sleeping sickness), a condition caused by trypanosome parasites transmitted by tsetse flies.

Metronidazole (Flagyl). The most useful drug in the treatment of amebiasis is metronidazole. It is also employed in the treatment of other protozoal infections (e.g., trichomoniasis) as well as in the treatment of certain infections caused by *anaerobic* bacteria. Metronidazole appears to enter the protozoal cell and interfere with its ability to function and replicate. It may be employed in treating all stages of amebiasis and is administered to adults in a dose of 500–750 mg 3 times daily for 5–10 days and to children in a dose of 35–50 mg/kg/day in 3 divided doses for 10 days.

When administered in therapeutic doses, metronidazole may cause nausea, headache, and abdominal cramping. Some clients experience a metallic taste while undergoing metronidazole therapy. Consumption of alcohol while using this drug may precipitate a disulfiram reaction, which may include abdominal cramps, nausea, and headache.

Paromomycin (Humatin). This is an aminglycoside antibiotic that is not appreciably absorbed from the GI tract and passes through the GI tract unchanged. **Paramomycin** does, therefore, exert a local amebicidal and antibacterial effect in the GI tract. It does not generally produce systemic side effects. It may, however, cause gastrointestinal distress or hearing impairment in some clients. Paromomycin is generally administered to children and adults in a dose of 25–35 mg/kg/day in 3 divided doses for 5–10 days. Paromomycin should be administered with meals.

Atovaquone (Mepron). This is an antiprotozoal drug that is also active against *Pneumocystis*

TABLE 8–1

Drugs Used in the Treatment of Malaria

Note: Evaluate client for symptomatic improvement.
Teach client about the importance of taking the drug exactly as ordered.
Provide information about the causative organism, treatment of this illness, and the importance of follow-up visits and laboratory studies.

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
chloroquine HCl *(**KLOR**-oh-kwin **hy**-droh-**KLOR**-eyed)* (Aralen HCl)	IM IM, SC	*Adults*: 160–200 mg of chloroquine base initially; repeat in 6 hours if necessary, not to exceed 800 mg (base) in first 24 hours *Children*: 5 mg base/kg/24 hours; repeat in 6 hours, not to exceed 10 mg base/kg/24 hours	retinal or corneal damage, headache	Observe client for development of visual changes. Use in clients with psoriasis may precipitate acute attack. Drug is sometimes used in long-term treatment of rheumatoid arthritis. 50 mg of chloroquine HCl is equivalent to 40 mg of chloroquine base. Colors urine brown.
chloroquine phosphate *(**KLOR**-oh-kwin **FOS**-fayt)* (Aralen Phosphate, etc.)	oral	*Suppression:* 300 mg of base once weekly starting 2 weeks prior to exposure and continued for 4 weeks after leaving endemic area *Acute attack:* 500 mg of base as initial dose, 500 mg 12 hours later, then 500 mg daily for next 2–3 weeks	See chloroquine hydrochloride. GI distress, anorexia	See chloroquine hydrochloride. Take with food to minimize GI distress. Monitor client for the development of visual or hearing disturbances. 500 mg of chloroquine phosphate is equivalent to 300 mg of chloroquine base.
hydroxychloroquine sulfate *(hy-**drox**-ee-**KLOR**-oh-kwin **SUL**-fayt)* (Plaquenil Sulfate)	oral	*Suppression:* 400 mg of base weekly on the same day each week *Acute attack:* 800 mg of base as initial dose, 400 mg 6 hours later, then 400 mg daily for next 2 days *Children, acute attack:* 3–5 mg/kg/day using a maximum of 400 mg/day	See chloroquine phosphate	See chloroquine phosphate. Agent sometimes used in treatment of malarial strains resistant to chloroquine. 200 mg of hydroxychloroquine sulfate is equivalent to 155 mg of hydroxychloroquine base. Use in psoriasis causes acute attack. Avoid use of alcohol. Use in children is limited.

continues

TABLE 8–1 *continued*

See **Note** at beginning of Table 8–1, page 188

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
mefloquine HCl *(meh-**FLOH**-kwin **hy**-droh-**KLOR**-eyed)* (Lariam)	oral	*Suppression:* 250 mg once weekly for 4 weeks, then 250 mg every other week *Treatment:* 1,250 mg as a single dose *Children, suppression:* 62.5-250 mg weekly depending on weight.	vomiting, dizziness, fever, chills, headache, leukocytosis, thrombocytopenia	Do not administer on an empty stomach. Administer with at least 240 mL of water. Monitor for blood dyscrasias.
primaquine phosphate *(**PRIM**-ah-kwin **FOS**-fayt)*	oral	*Adults:* 15 mg of base daily for 14 days *Children:* 0.3 mg base/kg/day for 14 days.	nausea, vomiting, headache–may cause hemolytic anemia in clients deficient in G-6-PD enzyme	Generally administered with last 2 weeks of chloroquine therapy after leaving endemic area. 26.5 mg of primaquine phosphate is equivalent to 15 mg of primaquine base.
quinidine bisulfate *(**KWIN**-ih-deen)* (D Biquin Durules)	IV	*Adults:* 15 mg/kg in 250 ml NSS infusing over 4 hours, then 7.5 mg/kg every 8 hours for 7 days	cardiovascular effects in ECG tracings	Use of this drug is primarily as an antiarrhythmic. Infusion must be given over 4 hours. Multiple drug interactions.
quinine sulfate *(**KWYE**-nine **SUL**-fayt)* (Quinamm, Novoquinine (🍁), etc.)	oral	*Adults*: 650 mg every 8 hours for 5–7 days *Children*: 25 mg/kg/day in divided doses every 8 hours for 5–7 days	visual disturbances, headache, nausea and vomiting, ringing of the ears	Administer with food or milk to minimize GI distress. Dose of 260–300 mg administered at bedtime for the treatment of nocturnal leg cramps.
Halofantrine HCl *(hal-oh-**FAN**-treen)* (Halfan)	oral	*Adults:* 500 mg every 6 hours for 3 doses followed by repeat dose 7 days after first course.	cardiovascular effects in ECG tracings	Used primarily for malarial strains resistant to chloroquine. Must be followed by primaquine. Safety for use in children has not been established. Monitor cardiac rhythm.

carinii, an organism that commonly causes pneumonia in AIDS clients. It is used when safer therapy for these clients (e.g., trimethoprim/sulfamethoxazole) cannot be used. Common adverse effects associated with the use of this drug include skin rash, GI upset, fever, and insomnia. Administration of **atovaquone** doses with food significantly improves drug absorption. The usual adult dose for this drug is 750 mg 2 times daily with meals for 21 days.

Eflornithine HCl (Ornidyl). This is the first new drug to be developed in 40 years for African trypanosomiasis (African sleeping sickness). It is administered by IV infusion in a dose of 100 mg/kg

every 6 hours for 14 days. Because the drug may cause anemia and decreased leukocyte and platelet counts, blood cell monitoring must be done twice a week while clients are receiving this drug.

Miscellaneous Amebicidal Agents. **Emetine HCl** is an agent available for the treatment of amebiasis, although it is only rarely used because of its toxicity. Chloroquine, a drug previously described in its use as an antimalarial agent, has also been shown to be effective in the treatment of hepatic amebiasis. It is generally administered orally in combination with an effective intestinal amebicide at a dose of 1 g daily for 2 days followed by 500 mg (0.5 g) daily for at least 2–3 weeks.

ANTHELMINTIC AGENTS AND INTESTINAL PARASITIC DISORDERS

Helminthiasis, or infestation with parasitic worms, is believed to be the most common form of parasitic disease affecting humans. Although a number of helminths (worms) may infest the human GI tract, most are eradicated by the use of relatively safe oral anthelmintic drugs. Most of these drugs are effective with a single course of therapy, although two or more treatments are sometimes required.

Albendazole (C Albenza). This is used to treat cystic hydatid caused by the larval form of the canine tapeworm. The agent acts by interfering with tubular polymerization, which disables larval cell function. In affected clients weighing more than 60 kg, the dosage is 400 mg twice a day with meals for a 28-day cycle. For those persons less than 60 kg, the dosage is 15 mg/kg/day given in divided doses twice a day with meals for the same duration as those clients weighing more than 60 kg.

Mebendazole (Vermox). This agent interferes with the uptake of glucose by susceptible parasitic worms and thereby depletes the supply of glycogen stored within the parasite. As glycogen is required by the organism for its reproduction and survival, the appropriate use of this drug will eradicate the parasite efficiently. In most affected clients (adults and children) a dose of 100 mg is administered morning and evening for 3 consecutive days. Systemic toxicity related to the use of this agent is rare, although the development of fever has been reported in some clients.

Pyrantel Pamoate (Antiminth, Combantrin ✱). This drug exerts a neuromuscular blocking action in susceptible intestinal helminths which paralyzes them, allowing excretion through the intestines. **Pyrantel pamoate** is generally administered in a single dose of 11 mg/kg of body weight. Not more than a total of 1 g should ever be administered. Some clients using this drug may experience GI distress, as well as headache, dizziness, drowsiness, and/or skin rash. It is the agent of choice for the treatment of pinworms and roundworms.

Thiabendazole (Mintezol). Although its precise mechanism of action is still unclear, thiabendazole is an agent that is *vermicidal* against a wide variety of intestinal parasitic worms. It is believed to interfere with one or more biochemical systems of the parasite. The most common adverse effects associated with the use of this drug involve the development of GI distress, but some clients have developed *hepatotoxicity*. Serious hypersensitivity reactions to the use of this drug have also been reported.

The dosage regimen employed in the administration of thiabendazole is dependent on which parasitic worm is the causative agent. In most cases, a dose of 22 mg/kg/dose is administered, with a maximum of 1,500 mg (1.5 g) per dose.

Praziquantel (Biltricide). This agent is a useful anthelmintic that appears to increase the cell membrane permeability of susceptible worms. This results in the loss of intracellular calcium with accompanying contraction and paralysis of the worm's musculature. The drug also appears to cause disintegration of the worm's outer tissue cover and, as a result, its death.

Praziquantel is administered orally in 3 doses of 20 mg/kg as a single day treatment. The time interval between doses should not be less than 4 hours or longer than 6 hours. Doses should be swallowed unchewed with some liquid during meals. Although generally well-tolerated, praziquantel may cause drowsiness and/or dizziness during the day of therapy or during the following day. Clients should be advised to use caution while driving or performing other tasks requiring alertness during this period.

Ivermectin (Stromectol). This agent binds selectively to certain chloride channels in invertebrate nerve and muscle cells, which ultimately causes paralysis and death of the parasite. It is used to treat intestinal strongyloidiasis and onchocerci-

TABLE 8–2

Drugs of Choice for the Treatment of Intestinal Parasitic Worm Infestations

WORM INFESTATION	COMMON NAME	DRUG(S) OF CHOICE
ascariasis	roundworm	pyrantel pamoate or mebendazole
enterobiasis	pinworm	pyrantel pamoate or mebendazole
strongyloidiasis	threadworm	thiabendazole
taeniasis	beef tapeworm	praziquantel
trichuriasis	whipworm	mebendazole
uncinariasis	hookworm	mebendazole or pyrantel pamoate
dipylidium caninum	tapeworm	albendazole

asis. When used to treat strongyloidiasis, clients may experience gastrointestinal upset. For clients being treated for onchocerciasis, most adverse effects are dermatologic. The dosage is dependent on which condition is being treated, but ranges from 150–200 mcg in a single oral dose.

Other Intestinal Antiparasitic Drugs. A number of other drugs are available for the treatment of specific helminth infestations, e.g., **piperazine** and **oxamniquine** (**Vansil**). They are less widely used than the drugs previously discussed. Table 8–2 lists the current drugs of choice for the treatment of intestinal parasites.

DERMATOLOGICAL PARASITIC DISORDERS

Several parasites commonly inhabit the skin or hair. Pediculosis is an infestation of lice, small wingless insects ranging in length from 1 to 4 millimeters. Several varieties of lice affect humans and are classified according to the areas of the body which they infest. The most common of these are the head louse (*Pediculus capitis*), body louse (*Pediculus corporis*) and pubic, or crab, louse (*Pediculus pubis*) (Figure 8–1).

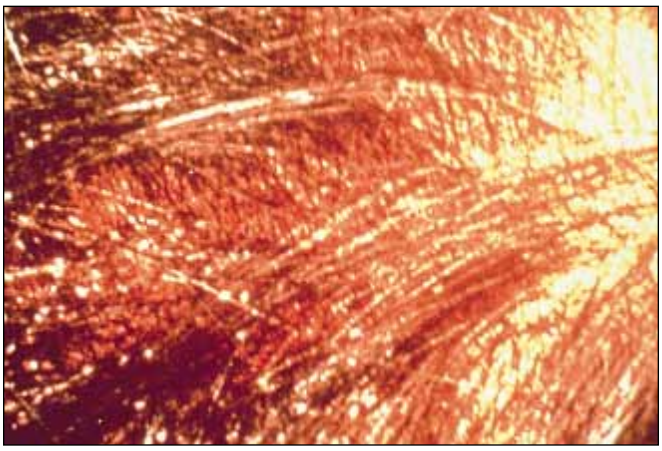

Figure 8–1 Head lice (Pediculus capititis) often appears in epidemics in school children. *(Courtesy of Reed and Carnick Pharmaceuticals)*

Lice infestations are transmitted by direct contact with an infested individual or with an infested article of clothing or bed linen. Once in contact with the host, the female louse lays eggs (nits) which—in the case of head and pubic lice—are attached to the hair shaft by a cement-like substance the louse produces. Body louse eggs are generally deposited onto the fibers of the client's clothing. The eggs hatch within several days to 2 weeks and release a new generation of organisms.

Human lice require human blood to survive and cannot exist away from their host for more than 12–24 hours. Periodically, the louse pierces the skin and gorges itself with blood. The combination of the skin puncture and the release of a small amount of saliva into the wound by the louse causes pruritus. If the pruritus is intense, the client may *excoriate* the affected area and subject it to the development of secondary bacterial infection.

Scabies is a highly contagious parasitic disorder caused by the mite *Sarcoptes scabiei*, an organism considerably smaller than a louse and only barely visible to the human eye without magnification (Figure 8–2). The organism is most commonly transmitted by contact with an infested individual or article of clothing or bedding. When the organism comes in contact with the human host, it burrows into the skin. The female mite deposits eggs in the burrow that hatch in about 5 days. The presence of the mite and the feces the organism deposits in the burrow often causes intense pruritus, which may also produce excoriation and secondary infection of the affected area. Scabies lesions may occur in almost any part of the body.

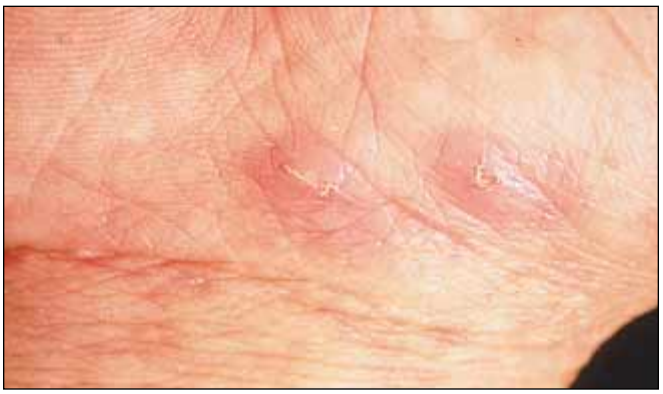

Figure 8–2 Scabies is a highly contagious disorder caused by the mite *Sarcoptes scabiei*. *(Courtesy of Reed and Carnick Pharmaceuticals)*

Drug treatment of pediculosis and scabies is quite similar. The therapy is aimed at killing the causative organisms, as well as their eggs, with the application of a topical pediculocide/scabicide product.

Lindane (**Kwell, gamma benzene hexachloride**) is the most useful pediculocide/scabicide. It is considered the treatment of choice for these infestations. Lindane appears to act by being absorbed directly into the organism and its eggs to produce seizures and death of the parasite. An appropriate dosage form (cream, lotion, or shampoo) containing this agent is applied to the affected area with a single application. Although not generally required, the product may be reapplied after 24 hours in treating pediculosis. In the treatment of scabies, it may be reapplied after 7 days.

Lindane-containing products must be used with care and in strict accordance with the directions that accompany the product. Excessive use may cause serious systemic effects and contact with an eye may cause considerable irritation. Some clients may experience skin irritation, even with proper use of the product.

A variety of other scabicides and pediculocides are available as prescription and nonprescription products. **Crotamiton** (**Eurax**), a scabicide; **malathion** (**ovide**), a pediculoside; and **permethrin** (**Nix, Elimite**), a pediculocide/scabicide, are considered to be alternatives to lindane. A number of nonprescription pediculocide products are available. Most contain a combination of **pyrethrins** and **piperonyl butoxide** as their active ingredients. Pyrethrins act on the insect's nervous system and cause convulsions and paralysis in the parasite. Piperonyl butoxide seems to enhance the toxic effect of pyrethrins on an organism.

APPLYING THE NURSING PROCESS

CLIENTS RECEIVING ANTIMALARIAL DRUGS

Assessment

Assessment is an important part of providing care to clients receiving antimalarial drugs. Overdosage with commonly used antimalarials can quickly lead to toxic symptoms, and the nurse must be alert for headaches, drowsiness, and visual disturbances. More severe indications of toxicity include cardiovascular collapse, convulsions, and cardiac and respiratory arrest. Children seem to be particularly susceptible to toxicity. Clients on long-term therapy generally have periodic blood cell counts and liver function tests, and the nurse should encourage the client to keep appointments for such testing. It is also recommended that baseline and periodic vision and hearing tests be conducted. The nurse should report any evidence or client complaints of blurred vision, sensitivity to light and/or eye muscle weakness.

It is also important for the nurse to be aware of the possibility of the development of hemolytic reactions in dark-skinned persons taking primaquine phosphate. Routine assessment of the skin and oral mucous membranes of these clients is recommended.

Nursing Diagnoses

Including but not limited to:

- Risk for altered tissue perfusion related to disease process.
- Risk for injury related to adverse effects of antimalarial therapy.

- Deficient knowledge related to infection process and medication regimen.
- Risk for noncompliance of long-term medication regimen.

Planning/Goals

- Client will recognize symptoms of anemia and promptly seek medical attention.
- Client will not experience negative side effects from medications.
- Client will verbalize understanding of the infection process and medication regimen.
- Client will demonstrate compliance with medication regimen.

Implementation

The scheduling of medication administration is important, as most antimalarials cause gastrointestinal distress. To prevent gastrointestinal upset, these drugs are generally given immediately before or after meals. When weekly administration of antimalarials is used prophylactically to suppress attacks, the client should be instructed to take the drug on the same day each week.

Clients taking antimalarial drugs require monitoring for adverse effects of the therapy, including periodic blood cell counts, liver function tests, and vision and hearing evaluation. Clients should also be instructed to report any evidence of bleeding, such as nosebleeds or blood in their urine.

Evalulation

- Client recognizes symptoms of altered tissue perfusion and seeks medical attention promptly.
- Client does not experience side effects from medications.
- Client verbalizes understanding of infection process, medication regimen.
- Client demonstrates compliance with medication regimen.

KEY NURSING IMPLICATIONS 8–1

Clients Receiving Antimalarial Drugs

1. Observe the client carefully for toxicity, including headaches, drowsiness, visual disturbances, cardiac collapse, convulsions, respiratory arrest, and bleeding.
2. Administer these medications immediately before or after meals.

CLIENTS RECEIVING DRUGS FOR AMEBIASIS AND TRICHOMONAL INFECTIONS

Assessment

The nurse has several functions in caring for clients receiving drug treatment of amebiasis. Client assessment is important, and the nurse observes the client for adverse effects related to drug therapy. For example, the nurse records the pulse rate and blood pressure at least twice a day in clients receiving emetine hydrochloride. The drug should be discontinued, if *tachycardia* or a marked fall in blood pressure occurs. Often weakness and neuromuscular symptoms precede the development of more serious adverse effects of this drug.

Assessment also includes observing and recording the number and character of stools. Collection and prompt delivery of stool specimens to the laboratory is important for the initial diagnosis and for assessing the effectiveness of drug therapy. It is important to deliver the stool specimen while it is still warm.

Nursing Diagnoses

Including but not limited to:

- High risk for infection related to transmission of current infection.
- Risk for injury related to adverse effects of medication therapy.
- Deficient knowledge related to infection process and medication regimen.
- Risk for noncompliance of medication regimen.

Planning/Goals

- Client will verbalize an understanding of the infection process and its transmissibility.

- Client will not experience adverse side effects from medications.
- Client will verbalize understanding of need for medical care and treatment for both the client and his or her sexual partners.
- Client will demonstrate understanding of medication regimen.
- Client will demonstrate compliance with medication regimen.

Implementation: Client Instruction

Another major function of the nurse is client instruction. Clients must understand the nature of their condition and its transmissibility. They are instructed to wash their hands after using the toilet and before eating.

In caring for clients with trichomonal infections, the nurse stresses the importance of completing the course of therapy. Clients should know that these infections tend to recur and that conscientious treatment may prevent recurrence. It is important for both male and female sexual partners to be treated simultaneously, as this may also decrease the likelihood of recurrence. Because metronidazole has been found to cause cancer in laboratory animals, the nurse stresses the importance of preventing recurrent infection to limit the number of courses of therapy required by the client. Also, whenever possible, this drug is not used during pregnancy, because of possible damaging effects to the fetus. Finally, the nurse discusses with the client the importance of general hygiene and handwashing.

Clients taking metronidazole are instructed to avoid using alcoholic beverages during the course of therapy, as alcohol may cause nausea, vomiting, headache, and abdominal cramps. These clients are also advised that metronidazole may cause the urine to darken or to turn a reddish-brown color. Some clients also experience a metallic taste in their mouth. If this should affect appetite, use of a mouthwash before meals may be beneficial.

Evalulation

- Client verbalizes understanding of the infection process and how it is transmitted.
- Client does not experience adverse side effects from medications.

KEY NURSING IMPLICATIONS 8–2

Clients Receiving Drugs for Amebiasis and Trichomonal Infections

1. Assess vital signs and record the number and character of stools in clients receiving drugs for the treatment of amebiasis.
2. Stress the importance of completing therapy in clients being treated for trichomonal infections.
3. For treatment of trichomonal infections to be effective, all sexual partners need to be treated simultaneously.
4. Clients taking metronidazole are instructed to avoid the use of alcohol during treatment. They should be informed that their urine may darken or turn reddish-brown while taking metronidazole.

- Client verbalizes understanding of need for medical care and treatment for both client and the client's sexual partners.
- Client demonstrates compliance with medication regime and strongly encourages sexual partners to receive treatment.

CLIENTS RECEIVING ANTHELMINTICS

Assessment

Nursing care for clients with worm infestations includes assisting with the diagnosis, administration, and monitoring of medication and client and family instruction to prevent reinfestation. Careful nursing assessment can aid in making the diagnosis of worm infestation. Nurses are alert for restless sleep and perianal itching, particularly in malnourished children and those in areas where parasitic worms are endemic. Visual and laboratory examination of stool specimens may confirm the diagnosis.

The dosages of some vermicidal agents, e.g., pyrantel pamoate, are based on the client's body weight. Therefore, an accurate weight must be obtained just before initiating therapy.

Nursing Diagnoses

Including but not limited to:

- Risk for reinfestation related to transmission of current infection.
- Risk for altered skin/tissue integrity related to perianal itching.
- Risk for injury related to adverse effects of medication therapy.
- Deficient knowledge related to infestation process and medication regimen.

Planning/Goals

- Client (family) will verbalize information concerning client's close contacts, so they can be examined and treated.
- Client's perianal skin/tissue remains intact.
- Client will not experience adverse side effects from medications.
- Client (family) will verbalize understanding of infestation process and medication regimen.
- Client will demonstrate good handwashing technique.

Implementation

Mebendazole (Vermox), pyrantel pamoate (Antiminth), and thiabendazole (Mintezol) may be taken with food. Thiabendazole tablets are chewed before they are swallowed and suspensions of this medication are shaken before measuring the dose. Following administration of the medication, the nurse is alert for adverse effects, including skin rashes and gastrointestinal disturbances, and continues to make observations about the client's stools.

To prevent reinfestation, the client's close contacts are examined and treated when necessary. Information about the parasite and instructions on ways to avoid reinfestation are provided to the client and/or family members. These methods include proper cooking of pork and beef (to control tapeworms), avoidance of walking barefoot in areas where hookworms are endemic, careful cleansing of fruits and vegetables before eating (to control roundworms), and hygienic measures (all types). Hygienic measures include daily cleansing of the perianal area and careful cleansing of the hands and nails before meals and after using the bathroom.

KEY NURSING IMPLICATIONS 8–3

Clients Receiving Anthelmintics

1. Obtain an accurate weight before beginning the course of therapy.
2. Observe the client for skin rashes and gastrointestinal disturbances. Note the nature of the client's stools.
3. Close contacts should be examined and treated, if necessary, and instruction in hygienic measures should be given.

Evalulation

- Client (family) provides information concerning client's close contacts, so they can be treated.
- Client's perianal tissue/skin remains intact.
- Client does not experience adverse side effects from medications.
- Client (family) verbalizes understanding of how infestation occurs, how it can be prevented, and medication regimen.
- Client demonstrates appropriate handwashing techniques.

CLIENTS RECEIVING DRUGS FOR DERMATOLOGICAL PARASITES

Assessment

The nurse is often responsible for case finding in the home, school, clinic, or hospital setting. Careful nursing assessment includes noting pruritus, areas of excoriation, and evidence of secondary infection of affected areas. Often the parasites or nits may be seen in hairy areas of the body.

Nursing Diagnoses

Including but not limited to:

- Risk for reinfestation related to transmission of current infection.
- Risk for altered skin integrity related to pruritis.
- Deficient knowledge related to infestation process, medication regimen.

Planning/Goals

- Client (family) will verbalize information concerning client's close contacts, so they can be examined and treated.
- Client's skin will remain intact.
- Client (family) will verbalize understanding of infestation process and importance of exactly following application instructions.

Implementation

Common dermatological parasites can be eliminated from an individual and personal belongings through the conscientious use of topical drug therapy and hygienic measures. The nurse often plays a key role in this treatment by assuming responsibility for applying these products or by providing detailed instructions on their proper use.

Once the diagnosis of pediculosis or scabies has been made, the client is instructed to scrub the entire body with soap and water and to towel dry. Clothing and towels are to be treated as contaminated and placed in plastic bags or special laundry hampers to be taken care of at a later time. An appropriate dosage form of lindane (Kwell, gamma benzene hexachloride) or other pediculocide or scabicide is then applied. When a cream or lotion is used, a thin layer must be applied to the entire skin surface. Use of an excessive amount of medication should be avoided. The nurse applying the medication wears a gown, gloves, and protective cap for long hair, or the hair is securely drawn back from the face. Care is taken to avoid applying the drug to wounds, mucous membranes, face, eyes, and urethral meatus. Any drug accidently applied to these areas must be flushed with water immediately. With pediculosis, special attention is given to applying the medication to hairy areas. With scabies, special attention is given to body folds, creases, interdigital areas, and genital area. The medication should remain on the body for 8–12 hours before it is removed by a second complete bath. If the client is being treated for head lice, 30–60 mL of medicated shampoo are worked into dry hair for 4–5 minutes. Care is taken to protect the eyes from the shampoo. The hair is then rinsed thoroughly and dried. If the eyebrows and/or eyelashes are affected, these can be treated by applying a thick layer of petroleum jelly twice a day for 8 days, followed by removal of eggs with a fine-tooth comb, such as a comb used on infants' hair.

After applying the medication, the nurse removes gloves and gown and washes his/her hands. The client is instructed in prevention of reinfestation. Clients should be told that it may be several weeks before itching stops. This is particularly true with scabies. Periodic inspections are done to determine if reinfestation has occurred or if the initial treatment has been ineffective. Treatment for pediculosis may be repeated after 24 hours and scabies treatment may be repeated after 1 week.

A client infested with head lice should be instructed to machine wash in hot water all the clothes that have been worn. These clothes should be dried using the hot cycle of the dryer for at least 20 minutes. Nonwashable items should be dry-cleaned or sealed in plastic bags for at least 2 weeks. Personal items such as combs and brushes are soaked in hot water (above 130°F) for 5 to 10 minutes, or cleansed with the drug and then rinsed with water to remove the drug residue. Carpets and chairs should be vacuumed thoroughly. Family members are examined and treated as necessary.

Body lice are somewhat easier to treat. Following bathing, special attention must be given to cleaning the client's clothing. These lice tend to live in clothing seams, especially around the axillae, collar and beltline. These areas may be treated with a hot iron or the clothes may be dry cleaned.

Pubic lice are transmitted by sexual contact. Therefore, the client is instructed to have sexual partners seek treatment. Bed linens must be washed in hot water and dried in a hot dryer.

Scabies is transmitted by direct, prolonged person-to-person contact. It may take 4–6 weeks for itching to develop in persons not previously affected. In adults, the majority of the lesions occur between the fingers and on the wrist. Infants and young children are often affected on the soles of the feet. These areas are reexamined periodically for evidence of reinfestation or treatment failure.

In general, it is not necessary to clean outer clothing or furniture as mites do not survive very long away from body heat. It is important, however, to machine wash underwear, socks, pajamas, towels, and bed linens. Mites cannot be transmitted 24 hours after treatment with an

NURSING CARE PLAN

A Client with Pinworms Taking Mintezol Suspension (Thiabendazole)

Joshua Michael Estes is a 6-year-old brought to the pediatrician by his mother. She reports that his sleep has been restless, he is not gaining weight despite a good appetite, and he complains of itching in his anal area. A physical examination and a test for pinworms are conducted. His weight is recorded as 40 pounds. The test for pinworms is positive, and the physician orders Mintezol Oral Suspension (thiabendazole) 1 tsp. BID for 2 days. The physician suggests the use of a pediatric multivitamin and mineral supplement and requests the nurse to instruct the mother about general hygienic measures necessary to prevent reinfestation.The mother mentions that Joshua has an 8-year-old sister and asks if she should also be treated.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Weight, nutritional intake.	Delayed growth and development related to pinworm infection.	Client will gain weight and attain normal weight for age.	Encourage mother to purchase and use pediatric multivitamin and mineral supplement. Take a nutrition history and suggest alterations in food intake to encourage weight gain. Have the mother weigh the child once a week and report progress in weight gain to the physician.	Client attains normal weight for age within 3 months.
Repeat pinworm test, pinworm test for other family members.	Risk for infection transmission related to contact transmission exposure.	Client will be negative on retest. Other family members testing positive will be treated.	Teach mother about the life cycle of the pinworm (transmission from anus to fingers to mouth). Encourage her to keep the child's fingernails short. Encourage handwashing before and after toileting. Wash underclothes and bed linens in hot water. Encourage other family members to be tested for pinworms and to be treated, if positive.	On retest the child is negative. His 8-year-old sister tests positive and is treated at the same time.
Sleep pattern.	Sleep pattern disturbance related to pruritus.	Client will state he experiences relief from itching. Client will return to normal sleep pattern.	Wash anal area with soap and water following defecation. Dry the area well and apply a soothing ointment. Explain to mother that sleep pattern should return to normal when treatment is completed. In the interim, she should provide appropriate anal hygiene.	Client experiences relief from itching and sleep pattern returns to normal within 4 days.
Skin integrity in anal area.	Impaired skin integrity related to anal itching secondary to pinworms.	Client will demonstrate healing in perianal tissues without secondary bacterial infection.	Encourage mother to be conscientious about anal hygiene. Suggest the use of tightly fitting underwear at night to keep child from scratching the area. Suggest that light mittens may be used at night to prevent scratching.	Child stops scratching anal area and perianal tissues heal without secondary bacterial infection within 1 week.
Understanding of treatment.	Deficient knowledge (health problem and its treatment).	Mother will verbalize how treatment is to be conducted and will ask questions about prevention of reinfection.	Inform mother that the medication should be given twice a day following meals. Gastrointestinal upset and hypersensitivity reactions can occur. Provide opportunity for mother to ask questions. Provide support for mother and convey information that parasitic infections occur in childhood and do not reflect negatively on her care of the child.	Mother carries out treatment as instructed. She verbalizes understanding of the nature of this health problem and its prevention in the future.

effective agent, but until that time, nurses providing direct client care should wear gloves.

When used as directed, few adverse effects are associated with pediculicides and scabicides. The nurse must warn the client to discontinue use and wash off any residual drug if skin irritation, rash, or dermatitis appear.

Client instruction about proper use of treatment agents and hygienic measures is a primary factor contributing to successful eradication of these parasites. There is a tendency to avoid personal contact with clients who have dermatological parasites. Some of this is due to concern about contagion. It is important for the nurse to know about the life cycle of these parasites to provide information, ensure effective treatment, and give supportive nursing care.

Evaluation

- Client (family) provides information concerning client's close contacts, so they can be examined and treated.
- Client's skin remains intact.
- Client does not experience adverse side effects from medications.
- Client (family) verbalizes understanding of how infestation occurs, how it can be prevented, and medication regimen.
- Client (family) demonstrates appropriate application of topical medications.

KEY NURSING IMPLICATIONS 8–4

Clients Receiving Drugs for Dermatological Parasites

1. The client with dermatological parasites is instructed to wash with soap and towel dry before the pediculicide or scabicide is applied.
2. The nurse applying the medication must wear a gown and gloves and either wear a protective cap or draw the hair back from the face.
3. Avoid applying lindane to wounds, mucous membranes, the face, eyes, and urethral meatus.
4. For body parasites, the medication should remain on the body for 8–12 hours and be removed by a second complete bath.
5. Avoid getting medicated shampoos in the eyes.
6. To be effective, the treatment of dermatological parasites requires client instruction and cooperation in eradicating these parasites in the environment and on other hosts in the environment.

CASE STUDY

Victoria is an 8-year-old female who complains to her mother of an "itchy head." Her mother takes her to the local clinic, where she is examined by a physician. The examination reveals several nits on the child's hair shafts and an intense excoriation with a localized infection on the scalp surface.

A diagnosis of pediculosis humanus capitis is made and the physician prescribes:

- Lindane 1% Shampoo 8 oz.
- Sig: Shampoo scalp of each family member once.
- Repeat in 10 days if needed.

Questions for Discussion

1. Compare pediculosis and scabies. Be specific.
2. What is the action of lindane in treating pediculosis?
3. What are the various forms of Kwell? How is each product used for each condition? What information should be conveyed to Victoria's parents?
4. What measures should be taken by Victoria's family to prevent further transmission of lice?

HOME CARE/CLIENT TEACHING

1. Clients on long-term antimalarial therapy should be instructed to keep appointments for testing for blood cell counts and liver function.
2. Clients receiving antimalarial drugs should be encouraged to have periodic vision and hearing testing conducted.
3. Clients receiving primaquine phosphate need to be reminded to report any evidence of bleeding such as nosebleeds or blood in the urine.
4. Clients receiving drugs for the treatment of amebiasis and trichomonal infections need to be instructed on the nature of the disease, its transmission, and good handwashing techniques.
5. Clients treated for trichomonal infections need to be taught how the disease is transmitted during sexual contact and that both partners need to be treated.
6. Clients receiving metroniodazole need to be reminded not to consume alcohol during their drug therapy.
7. Clients receiving anthelminics and medications for dermatologic parasites should be instructed on the transmission of the infestation and need for all close contacts to be treated in addition to the client.
8. Clients being treated for dermatologic parasites require step-by-step instructions on how to apply the topical medications used to treat these infestations.
9. Clients infested with head lice and those with scabies should be instructed to machine wash in hot water all clothes and bed linens, and to use the hot cycle of the dryer, as well as about care of personal items and that carpets should be vacuumed thoroughly.
10. When visiting a household to provide care for any member, the nurse should take the opportunity to examine young children for head lice, because this problem can be an epidemic in school children.
11. Teaching about and reinforcing the use of hygienic measures are important activities of the nurse.

CRITICAL THINKING EXERCISES

1. Obtain a world map showing the distribution of malaria. Present a report to your classmates about the precautions travelers to these areas should take to prevent malaria.
2. Prepare a teaching plan for a woman who has been prescribed metronidazole therapy for the treatment of a trichomonal infection.
3. Prepare a report on the control of parasitic infections in congregate living facilities, such as shelters and military barracks.
4. Describe the specific action of the following drugs:
   - Albendazole
   - Pyrantel pamoate
   - Ivernectin
   - Lindane
5. Identify the primary lab values that need to be monitored for a client being treated with antimalarial agents.
6. Discuss the primary and most life-threatening adverse effects of primaquine phosphate.

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9 Antiseptics and Disinfectants

OBJECTIVES

After studying this chapter, the student will be able to:

- Differentiate among the uses for antiseptics, disinfectants, and germicides
- List the major classes of antiseptics and disinfectants and give an example of a drug from each class
- List several factors the nurse should consider in selecting an antiseptic or disinfectant for use
- Apply major nursing interventions related to the safe storage and effective use of antiseptics and disinfectants
- List the most important factors in effective handwashing

Antiseptics and disinfectants are among the most commonly used agents in client care. Their usage has been responsible for preventing considerable pain, suffering, and death caused by infection. Long before microorganisms and their role in the disease process were recognized, ancient civilizations were aware of the preserving qualities of spices, vegetable oils, and extracts of certain trees and plants. During the nineteenth century Koch, Pasteur, and others began to identify and define the role of bacteria in disease development. At the same time, specific agents began to be recognized as being capable of slowing the growth or causing the destruction of certain *pathogenic* organisms. In the decades to follow, the application of germicides in water purification and surgery became widespread.

Many terms have been coined to describe agents that inhibit the growth of microorganisms. The use of these terms has often led to confusion because of indiscriminate usage by the public and even by health care practitioners. The following are definitions of specific terms used to describe these agents:

- *antiseptic:* an agent that kills or inhibits the growth of microorganisms. The term is commonly used to describe preparations applied to living tissue, particularly to the skin. Curiously enough, this term was used long before microorganisms were recognized. It derives its original meaning from the belief that these agents opposed *sepsis*, *putrefaction*, and *decay*.
- *disinfectant:* an agent that rapidly destroys pathogenic microorganisms and thereby prevents infection. It is a term commonly used to describe agents used on inanimate objects, such as floors, surgical instruments, and clothing. Disinfectants are licensed by the U.S. Environmental Protection Agency (EPA), which monitors the products to ensure they perform as indicated on the labels.
- *germicide:* a general term for agents capable of destroying microorganisms. More specific derivations of this term include bactericide, *fungicide*, etc.

Although the development of antiseptics and disinfectants revolutionized the *prophylaxis* and treatment of infection, they were generally too toxic to be used internally. The discovery of antibiotics, which were often more effective and less

toxic than the older agents, dramatically reduced the internal use of disinfectants and antiseptics. Their use, however, is still often preferred to the antibiotics for topical therapeutic and prophylactic therapy. The agents that inhibit the growth of microorganisms are less costly and less sensitizing than most currently available antibiotics.

Several mechanisms of action have been described to explain how antiseptics and disinfectants work.

The agents may:

- cause a chemical change in the structure of the protein within the *microbial* cell wall, thereby *denaturing* the protein and destroying the cell.
- increase the permeability of the bacterial cell membrane and permit the escape of vital cell contents.
- interfere with a step in the bacterial cell's metabolism so as to impair its ability to survive.
- *oxidize* critical microbial cell components and thereby incapacitate the cell.

Although antiseptics and disinfectants can be classified in a number of ways, consideration of germicidal agents by chemical class will be used. Table 9–1 summarizes the properties of commonly used disinfectants and antiseptics.

PHENOLIC AGENTS

Phenol (**carbolic acid**) is a corrosive agent that was first shown to have germicidal activity by Joseph Lister in 1867 (Figure 9–1). It acts by precipitating protein and destroying the bacterial cell. When used in concentrations above 1.3%, it also exerts fungicidal activity. Phenol produces local anesthetic action and is occasionally employed in *topical* products (e.g., in **calamine lotion**) as an *antipruritic*. It is no longer widely used as a germicide because of its corrosiveness and limited effectiveness at safe concentrations.

Several derivatives of phenol have proven to be more effective germicides than phenol itself, but are also quite corrosive. **Cresol** is about three times as potent as phenol and is the active component in **saponated cresol solution** (**Lysol**). **Resorcinol** is a phenol derivative used in the topical treatment of acne, *psoriasis*, and some fungal skin disorders. Resorcinol is only about one-third as effective as phenol as a germicidal agent. It has a tendency to remove the outer layer of skin (keratin layer). This action may be more important in the treatment of some dermatological disorders than its germicidal action.

Hexachlorophene is a potent bacteriostatic agent effective against gram-positive organisms.

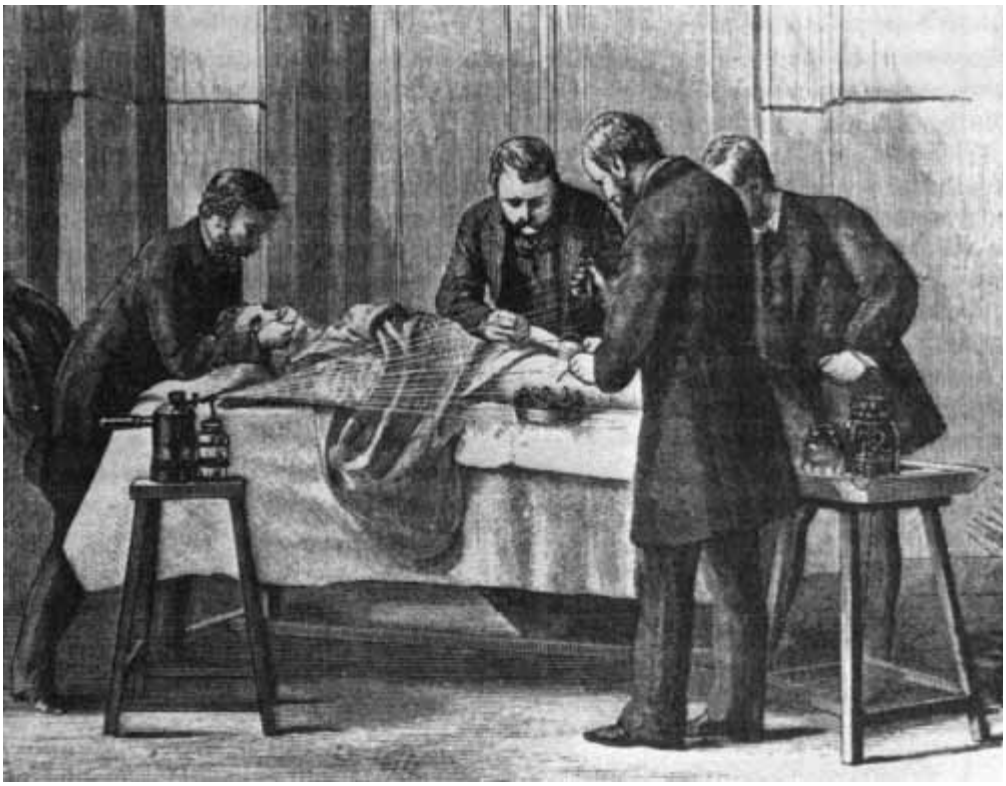

Figure 9–1 This operation, occurring about 1880, made use of a carbolic acid spray developed by Joseph Lister. *(From Inglis, Brian,* A History of Medicine. *Cleveland: The World Publishing, Co., 1965*)

TABLE 9–1

Commonly Used Antiseptics and Disinfectants

Note: Before soaking any instrument in disinfectant, thoroughly wash it in soapy water, using friction. Also, when germicides are to be applied to the skin, clean the area of blood, pus, or drainage before application.

Store all antiseptics and disinfectants safely and according to the manufacturer's directions.

DRUG	USUAL CONCENTRATION RANGE	COMMON USES	NURSING IMPLICATIONS
acetic acid *(ah-**SEE**-tick **AH**-sid)*	0.25%–5%	surgical dressings, douche, spermatocide	Bacteriostatic when used in less than a 5% concentration.
benzalkonium chloride *(benz-al-**KOH**-nee-um **KLOR**-eyed)* (Zephiran, Benza)	0.0025%–0.2% 1:40,000–1:500	skin antiseptic, ophthalmic and mucous membrane irrigation, instrument disinfection	Rapidly inactivated in the presence of soap. Cleanse skin of all soap before use. Incompatible with iodides, nitrates, peroxides, oxides, and aluminum. Do not store cottonballs, swabs, or gauze in benzalkonium solution.They will absorb the antiseptic and may reduce the strength of the solution. Do not use with occlusive dressings.
benzoic acid, sodium benzoate *(ben-**ZOH**-ick **AH**-sid, **SOH**-dee-um **BEN**-zoh-ayt)*	0.1%	preservative for foods and drugs, topical antifungal	Most active at an acid pH.
benzoyl peroxide *(**BEN**-zoh-ill peh-**ROX**-eyed)* (Benoxyl, PanOxyl, etc.)	2.5%–10%	keratolytic, antiseptic, and irritant in treatment of acne	Peeling of skin likely with use. Must be kept away from eyes.
boric acid *(**BOR**-ick **AH**-sid)* (Borofax)	0.25%–10%	ophthalmic and topical antiseptic	Not for use in infants, as systemic absorption and toxicity may occur. May be absorbed through abraded skin or wounds.
chlorhexidine gluconate *(klor-**HEX**-ih-deen **GLOO**-koh-nayt)* (Hibiclens, Hibistat, Exidine)	0.5%–4%	skin scrub and wound cleanser	Avoid getting into eyes and ears; may irritate skin. Rinse skin thoroughly after use. Low potential for skin reaction.
cresol *(**KREE**-sol)* (saponated cresol solution, Lysol)	0.02%–50%	disinfection of inanimate objects, skin wash	May irritate skin.
ethanol, ethyl alcohol *(**ETH**-ah-nol, **ETH**-ill **AL**-koh-hall)*	50%–70%	skin antiseptic, instrument disinfection	Volatile, flammable. Not for use on open wounds, may dry skin. Effective as a fat solvent.

continues

TABLE 9–1 *continued*

See **Note** at beginning of Table 9–1, page 202

DRUG	USUAL CONCENTRATION RANGE	COMMON USES	NURSING IMPLICATIONS
formaldehyde *(for-**MAL**-dih-hide)*	2%–8%	disinfection of inanimate objects	Vapors are irritating. Avoid contact with skin and mucous membranes if solution is stronger than 0.5%. 10% solution used for disinfection of inanimate objects.
glutaraldehyde *(**gloo**-tah-**RAL**-dih-hide)* (Cidex, Cidex-7)	2%–3.2%	disinfection of inanimate objects	Cidex solution is stable for 14 days and activated Cidex-7 solution is stable for 28 days. Use on inanimate objects only.
hexachlorophene *(**hek**-sah-**KLOR**-ah-feen)* (pHisoHex, Septisol)	0.25%–3%	skin scrub	Must be used with caution in care of infants and burn clients. Rinse thoroughly after use, especially scrotum and perineum. Not scrub of choice for many clients. Monitor for neuropathies.
hippuric acid, methenamine hippurate *(hih-**PYOU**-rick **AH**-sid, meth-**EN**-ah-meen **HIP**-you-rayt)* (Hiprex, Hip-Rex 🍁, Urex)	—	usually administered orally as a methenamine salt used as a urinary antiseptic	Most urinary antiseptic action can be attributed to the action of methenamine. Keep urine at a pH below 5.5.
hydrogen peroxide *(**HY**-droh-jen peh-**ROX**-eyed)*	3%–6%	cleansing of wounds, mouthwash	Solutions are unstable; keep in cool dark place and in tightly closed container. When used in combination with saline for mouth care, prepare solution immediately before use.
iodine *(**EYE**-oh-din)*	0.1%–5%	irrigation of wounds, topical antiseptic	May stain skin and clothing. Observe for hypersensitivity reaction. Effective against a broad range of organisms, including bacteria, viruses, fungi, and yeasts.
isopropanol, isopropyl alcohol *(**eye**-soh-**PROH**-pah-nol, **eye**-soh-**PROH**-pill **AL**-koh-hal)*	70%–95%	See ethanol	See ethanol. More effective than ethanol as a germicide. May result in prolonged bleeding from injection sites, especially IV sites.
methenamine hippurate, methenamine mandelate *(meth-**EN**-ah-meen hip-**UR**-ate, meth-**EN**-ah-meen **MAN**-dih-layt)* (Mandelamine)	—	urinary antiseptic—oral route	Usually administered orally as methenamine salt.

continues

TABLE 9–1

See **Note** at beginning of Table 9–1, page 202

DRUG	USUAL CONCENTRATION RANGE	COMMON USES	NURSING IMPLICATIONS
merbromin *(mer-**BROH**-min)* (Mercurochrome)	2%	topical antiseptic	Least effective of mercury-containing antiseptics. Clean wound of all organic matter before application.
nalidixic acid *(nal-ih-**DICKS**-ick **AH**-sid)* (NegGram)	—	orally administered as urinary antiseptic	Observe client for adverse effects (see Chapter 7).
oxychlorosene sodium *(**ock**-see-**KLOR**-oh-seen **SOH**-dee-um)* (Clorpactin XCB, etc.)	0.1%–0.5%	topical irrigation of infected or necrotic tissue	Refrigerate dry crystals until reconstituted with saline. Wide range of effectiveness includes bacteria, fungi, viruses, and yeast.
phenol *(**FEE**-nol)*	0.2%–2%	topical antipruritic and antiseptic	Concentrated form can cause skin necrosis.
povidone-iodine *(**POH**-vih-dohn - **EYE**-oh-din)* (Betadine, Operand, etc.)	2%–10%	skin scrub and topical antiseptic	Prolonged use may result in systemic absorption. Observe client for hypersensitivity reactions. Do not use if client is sensitive to iodine. Is bacteriocidal during the drying process on the skin; otherwise is bacteriostatic. Used for central venous access dressing changes.
resorcinol *(reh-**ZOR**-sih-nol)*	2%–20%	irritant, keratolytic, and antiseptic for treatment of dermatological disorders	Apply lotion with cottonball. Avoid using medication near the eyes. Watch for local irritation.
salicylic acid *(**sal**-ih-**SILL**-ick **AH**-sid)*	5%–60%	keratolytic, topical antiseptic	Hydration of skin prior to application improves keratolytic activity.
silver nitrate *(**SIL**-ver **NIGH**-trayt)*	0.01%–10%	bladder, urethral, ophthalmic, and topical irrigation	Drug is inactivated by chloride-containing compounds. Stains skin. Store in dark container and protect from light. When used in the eye, flush with normal saline.
silver protein, mild *(**SIL**-ver **PROH**-tee-in)* (Argyrol S.S.)	10%	antiseptic applied to mucous membranes	Less irritating to skin than silver nitrate. Store in dark container and protect from light.
silver sufadiazine *(**SIL**-ver **sul**-fah-**DIE**-ah-zeen)* (Silvadene, SSD, Thermazene)	1%	topical antiseptic for burn treatment	Can cause hypersensitivity reaction.

continues

TABLE 9–1 *continued*

See **Note** at beginning of Table 9–1, page 202

DRUG	USUAL CONCENTRATION RANGE	COMMON USES	NURSING IMPLICATIONS
sodium hypochlorite solution *(**SOH**-dee-um **hy**-poh-**KLOR**-ite)* (Dakin's Solution)	0.25%–0.5%	topical antiseptic for soaks and irrigation	Avoid contact with hair and clothing because of its bleaching action.
thimerosal *(thigh-**MER**-oh-sal)* (Mersol, Aeroaid, etc.)	0.1%	topical antiseptic	May cause hypersensitivity reaction. Allow skin to dry thoroughly following application before applying a dressing. Should not be used as preservative for vaccines.
triclocarban *(**try**-kloh-**KAR**-ban)*	–	topical antiseptic	Commonly employed in topical hand soap products.
triclosan *(try-**KLOH**-san)* (Septisol, Septi-Soft)	–	topical antiseptic, deodorant, toothpaste additive	Commonly employed in topical hand soap products. Toothpaste additive shown to help protect against peridontal disease.

It reaches its maximal concentration in the skin within 2–4 days of regular use and accumulates in the skin on repeated applications. Therefore, products containing hexachlorophene (e.g., **pHisoHex**) are used as routine scrubs for those involved in surgery, or other tasks in which bacterial contamination of the skin can be dangerous. Once commonly used as the handwashing soap of choice and in detergent products to bathe infants, the use of hexachlorophene for this purpose has been discontinued. Evidence indicates that hexachlorophene can be absorbed through the skin and the substance has been shown to be toxic on the central nervous system, particularly binding to myelin and causing intramyelinic edema, thus damaging the nerves. It has also been associated with seizures and encephalopathy, including the increase of intracranial pressure. As a result, the use of hexachlorophene-containing products for total body bathing or surgical skin preparation is now discouraged by the U.S. Food and Drug Administration (FDA).

ALCOHOLS AND ALDEHYDES

Many alcohols and aldehydes have germicidal activity. The two most commonly used alcohols in medical procedures are **ethyl alcohol** (**ethanol**) and **isopropyl alcohol** (**isopropanol**). Ethanol is a moderately effective germicide that is active against gram-positive and gram-negative organisms when used in appropriate concentrations. Although a 70% concentration is most useful for rapid skin disinfection before parenteral drug administration, a 50% concentration of ethanol appears to be a more effective germicide when long contact can be maintained (e.g., in the disinfection of instruments). Ethanol appears to act by destroying the chemical structure of protein. Ethanol can be irritating if applied to open wounds or on closed skin for prolonged periods. Therefore, it is not generally applied to open lesions.

When used in concentrations above 70%, isopropyl alcohol (isopropanol) is at least as germicidal as ethanol. Unlike ethanol, isopropanol may cause local *vasodilation* at its site of application and is, therefore, more likely to promote bleeding at incision or injection sites. As both ethanol and isopropanol evaporate quickly from the surface of the skin, they must be rubbed on the skin for at least 2 minutes to be maximally effective. When used repeatedly, both alcohols tend to dry and/or irritate the skin.

Aldehydes, such as **formaldehyde**, have long been used as germicidal agents. Although they are effective when used in appropriate concentrations, their action is slow and prolonged contact must be maintained with them. **Glutaraldehyde**

(**Cidex**) is more effective than formaldehyde as a germicide, but is used only to disinfect instruments and other inanimate objects.

ACIDS

Acidic substances have been used for centuries to preserve foods and provide a topical antiseptic action. Some of the more caustic acids (e.g., **glacial acetic acid**, **trichloroacetic acid**, etc.) are used to *cauterize* surface skin lesions such as warts. The antiseptic action of these agents appears to be the result of their ability to establish an acidic environment, which is not compatible with normal microbial metabolism.

Benzoic acid and **sorbic acid** are relatively nontoxic and are commonly employed in the food, drug, and cosmetic industries as preservatives. **Salicylic acid**, although having mild antiseptic activity, has powerful *keratolytic* properties, making it useful in the topical treatment of corns, calluses, psoriasis, and other *hyperkeratotic* conditions. **Boric acid** has long been used as a topical and ophthalmic anti-infective. It has become clear that not only is boric acid a weak germicide, but it is also quite toxic and can be absorbed directly through the relatively thin skin of infants. Because of these properties, boric acid is no longer widely used in the United States.

Mandelic acid and **hippuric acid** have been widely used as urinary tract antiseptics, more so before effective antibiotics were available. They are particularly useful in the treatment of chronic urinary tract infections because they are less likely to promote the development of bacterial resistance than the antibiotics. These acids are most commonly used as methenamine salts (**methenamine mandelate** [**Mandelamine**], **methenamine hippurate** [Hiprex]). In acid urine (pH below 5.5), methenamine is converted to formaldehyde, a potent germicide. The combination of formaldehyde and the mandelic or hippuric acid that accumulates in the urine provides good urinary antiseptic action.

Nalidixic acid (NegGram) is also used to treat urinary tract infections. It has been shown to be effective in treating infections caused by *Escherichia coli* and some strains of *Proteus*. However, the use of nalidixic acid has also been associated with rapid development of bacterial resistance and a variety of adverse effects. See Chapter 7 for a discussion of agents used to treat urinary tract infections.

IODINE AND IODOPHORS

Iodine is a substance used since the mid-nineteenth century. It is still considered to be among the most potent germicides available. Major advantages of iodine include its low level of toxicity and its effectiveness in rapidly destroying bacteria, as well as many fungi and viruses. Its disadvantages include that it can stain and production of hypersensitivity reactions in a small proportion of clients. Because iodine is only slightly soluble in water, it is often used topically as an alcoholic solution (**iodine tincture**) or as an aqueous solution in combination with **sodium or potassium iodide** (**Iodine Topical Solution, U.S.P.**). Aqueous solutions of iodine are somewhat less effective as germicides than alcoholic solutions, but also tend to produce less stinging when applied to open wounds.

Several complexes of iodine with other substances (iodophors) have gained popularity during the last few years. Products containing **povidone-iodine** (**Betadine**, etc.) slowly release free iodine when applied to the skin. They also offer the advantage of producing less stinging and staining of the skin, as well as a more prolonged germicidal action than free iodine. Consequently, it is a common product in many first-aid kits. Povidone-iodine is frequently the germicide of choice for intravenous site skin preparation and when performing dressing changes for central venous access. It is important to remember that, to achieve maximum germicidal effects, povidone-iodine products must be allowed to dry to the air before a dressing is applied. Iodophors have, however, been shown to be less effective germicides than elemental iodine solutions.

CHLORINE AND CHLOROPHORS

Elemental **chlorine** is a powerful germicide used for decades to treat drinking water and swimming pools. Chlorine, itself, has no application in medical practice, because it is a gas at room temperature and because of the instability of its aqueous solutions.

Chlorophors are agents that gradually release hypochlorous acid, a substance providing germicidal activity comparable to that of chlorine. Typical chlorophors include **sodium hypochlorite solution** (**Dakin's solution**) and **oxychlorosene sodium** (**Clorpactin**). Sodium hypochlorite solution

is used to disinfect utensils and equipment; it is not suitable for application to damaged tissue. Oxychlorosene sodium solutions are employed in irrigating damaged or infected tissue.

MERCURY COMPOUNDS

Organic mercury compounds, such as **merbromin** (**Mercurochrome**) and **thimerosal** (**Mersol**), have been used for years as antiseptic agents. They are believed to act by interfering with enzymes found in bacterial and human cells. In so doing, they exert only a weak bacteriostatic action and may also be toxic to epidermal cells. Thimerosal is popularly used as a preservative in many commercial contact lens storing, cleaning, and rinsing solutions. Because many people have hypersensitivity reactions when they come into contact with mercury compounds, contact lens wearers should be advised to avoid products that contain such preservatives. With the development of more effective and safer germicides, the mercury compounds have rapidly declined in popularity.

SILVER COMPOUNDS

Like mercury, silver has been shown to interfere with bacterial enzyme systems and thereby exert an antiseptic effect. Products such as **silver nitrate** are not only used for their germicidal activity, but also as *caustics* and *astringents*. They have been widely used to prevent ophthalmic infections in newborn infants and to prevent infection in treating extensive burns. Silver compounds tend to stain the skin and become rapidly inactivated in the presence of body fluids.

SURFACE-ACTIVE AGENTS

Surface-active agents are detergent-like compounds used for many commercial applications. Several of these agents have potent wetting and germicidal activity when applied topically and when used to disinfect surgical instruments.

Wetting agents are water-soluble substances that enable spreading of a liquid on a surface or penetration into a material. **Benzalkonium chloride** (**Zephiran**) and related agents are the most popular germicides in this category. Although widely used in current practice, these compounds are rapidly inactivated by soaps and body fluids such as saliva and pus. Unlike many other germicides, the surface-active agents do not kill *spores*. They are therefore only moderately effective.

OXIDIZING AGENTS

Oxidizing agents release oxygen at the site of application and destroy critical microbial components. **Hydrogen peroxide** rapidly breaks down to oxygen and water in the presence of catalase, an enzyme commonly found in living tissue. When applied to a wound, therefore, considerable agitation and *effervescence* happens as oxygen gas is liberated. This mechanical action facilitates debris removal from the site and is very effective when used as a germicide in the presence of anaerobic microorganisms frequently found in puncture skin wounds.

Hydrogen peroxide is frequently used as an ingredient in toothpaste for its whitening potential. It is also used as a vaginal rinse for yeast infections because it is naturally produced by the bacteria in the vagina to kill yeast. It is advertised to help treat acne and as an effective treatment for canker sores in the mouth. Considering the wide diversity of its uses, hydrogen peroxide is one of the most frequently used oxidizing agents.

Benzoyl peroxide, an oxidizing agent, slowly releases oxygen when applied to the skin. It is also a local irritant and keratolytic agent that causes peeling, burning, and reddening of the skin. Benzoyl peroxide is used almost exclusively for the treatment of acne. It is believed to be beneficial because of its combined germicidal and skin-peeling properties.

CHLORHEXIDINE (HIBICLENS, HIBISTAT, EXIDINE)

This agent is chemically unrelated to the compounds previously described. It is effective against both gram-positive and gram-negative organisms. Because of its characteristic of persisting on the skin to provide continuous antibacterial effects, **Hibiclens** is one of the most popular solutions for preoperative skin scrubs of clients. It appears to have the ideal characteristics of potent antimicrobial activity and low toxicity.

Chlorhexidine is also available as an oral rinse (**Peridex**) for use in the treatment and prevention of gingivitis as well as in the treatment and prevention of stomatitis in clients receiving chemotherapy cancer treatment.

APPLYING THE NURSING PROCESS

The nurse will be in contact with antiseptics and disinfectants in all clinical settings. In some cases, the agent to be used will be determined by someone else; in other cases, the nurse will be expected to select an appropriate agent for use. The situations that may arise requiring the use of these agents are many and varied. They may include disinfection of the hospital or home environment of a person with a *communicable* disease, prevention of infection in a wound, or cleansing the hands of care providers. To make the appropriate selection of an agent or properly use a previously selected agent, the nurse must consider:

- the nature of the tissue or substance to which the antiseptic or disinfectant will be applied.
- the history of allergy or sensitivity presented by the provider and/or recipient of care.
- the nature of the organisms to be destroyed.
- the presence of foreign matter—particularly organic matter—that might affect the action of the agent.
- the nature of the antiseptic or disinfectant, including the concentration, duration of use, and environmental conditions associated with optimal effectiveness.
- the cost, availability, and storage requirements of the agent.

The nurse must become familiar with agents in common use and must obtain and read literature about newer agents being introduced. The manufacturer's suggestions for proper use must be followed. In addition, care must be taken in storing antiseptics and disinfectants. Storage is important, not only to preserve usefulness, but also for protection from the agent's harmful effects. All storage containers must be labeled. Labels must include information regarding strength, dilution, and limitations of usage—that is, whether the agent is safe for internal use or restricted to external use. Storage must be in a safe place away from children and other individuals who might accidentally or purposefully ingest these substances. The client or family should be taught the proper storage of such materials in the home and what action must be taken if accidental poisoning or sensitivity occurs.

Although it would be time-consuming to examine specific nursing actions related to each agent previously discussed, guidelines are suggested for using some of the more commonly employed agents. As previously noted, when using hexachlorophene, special care must be taken in cases where *systemic* absorption with resulting toxicity is likely to occur; for example, in infants (especially premature infants) and when large body surfaces are exposed to repeated applications.

Regarding the use of alcohol as a germicide, isopropanol may promote bleeding at incision and injection sites. Still, isopropanol is frequently used to prepare the skin before an injection and following removal of the needle. If there is client bleeding after needle insertion or on removal of intravenous infusion apparatus, a dry sterile sponge—rather than an alcohol sponge—should be used for massage or to maintain pressure on the injection site. In many facilities, povidone-iodine (Betadine) is used for skin preparation before a venipuncture.

When iodine preparations are used on the client's skin and removal of the resulting stain is desired, alcohol can be used for decolorizing. A second and more critical factor related to iodine use is its potential for producing sensitivity reactions. The nurse must be alert for the development of such reactions and must discontinue use of the iodine preparation if such a reaction is suspected. In addition, when sensitivity is confirmed by the physician, the nurse must be certain that the client understands that iodine must be avoided in the future. Clients are instructed to report their sensitivity to iodine whenever asked about allergies by health personnel; iodine may be a component of drugs used in the treatment of various conditions (e.g., hyperactivity of the thyroid gland) and media used for diagnostic X rays.

KEY NURSING IMPLICATIONS 9–1

Disinfectants

1. Always follow the manufacturer's directions for proper use.
2. Properly label and safely store disinfectants.
3. Instruct others about safe storage of these agents in the home.

The use of silver nitrate drops to prevent gonococcal infection of the eyes of newborns has been decreasing over the years. In some places, ophthalmic antibiotic ointment is used. When silver nitrate is used, 1–2 drops of a 1% solution are instilled in both eyes as soon as possible after delivery. A note concerning the performance of this procedure must always be made on the clinical record.

Recently, Dakin's solution has become popular once again as an important agent in wound care. Some controversy surrounds the use of this agent. It is effective against bacteria, spores, amebas, fungi, protozoa, and viruses, making it a useful agent. However, it has been shown to delay the clotting process, may delay healing, and can injure healthy tissue. To protect healthy tissue, the nurse can apply a thin layer of oil-based ointment, such as petroleum jelly, around the edges of a wound before irrigating or packing a wound with gauze sponges soaked in Dakin's solution. It is important for the nurse to assess the effects of this treatment on the wound and surrounding tissue and to record observations on the client's record.

The final agent discussed is hydrogen peroxide, which is often used for its antiseptic and effervescent actions. Special care must be taken in storing hydrogen peroxide if it is to retain its potency. It must be stored in a dark, tightly capped container and kept in a cool environment. As hydrogen peroxide deteriorates on exposure to the air, all solutions must be prepared immediately before use; for example, hydrogen peroxide and saline that may be used for mouth care. In preparing for wound irrigations and sterile dressings, the nurse avoids pouring hydrogen peroxide into any container or irrigation syringe until just before the procedure begins. Because of its effervescent action, hydrogen peroxide has been used to cleanse the inner cannula of *tracheostomy* sets. However, the hydrogen peroxide must be poured into a container immediately before the inner cannula is removed for cleansing. An open container of hydrogen peroxide by the bedside will rapidly lose its ability to remove secretions from the cannula.

Before soaking instruments in disinfectant, they must be thoroughly washed in soapy solution while using friction. They must then be rinsed and dried before disinfection. This preliminary cleaning removes organic matter that can interfere with thorough disinfection. This principle also applies when germicides are to be applied to skin or wounds; organic matter, such as blood, pus, or drainage, should be removed by cleansing or irrigation before application of the germicide.

KEY NURSING IMPLICATIONS 9–2

Antiseptics

1. After using hexachlorophene on skin or body tissue, always rinse the area thoroughly with water or normal saline.
2. Because it causes vasodilation, isopropanol may promote bleeding at injection sites.
3. Alcohol may be used to decolorize skin stained by iodine preparations.
4. Always ask clients about hypersensitivity to iodine before using any iodine preparation.
5. Use a thin layer of petroleum jelly to protect healthy skin around wounds packed with Dakin's solution.
6. Preparations of hydrogen peroxide and saline must be prepared immediately before use as hydrogen peroxide will deteriorate upon exposure to air.
7. Always thoroughly clean or irrigate skin or wounds to remove organic matter before applying germicide.

HANDWASHING

Every health care professional knows the importance of handwashing in preventing the transmission of infection. However, few practice handwashing as often and as thoroughly as they should. Handwashing is important in preventing nosocomial infections, transmission of infection to clients who are immunocompromised, and transmission of resistant organisms. **Note:** Wearing gloves does not substitute for handwashing. In fact, because organisms rapidly multiply inside gloves, and because bacteria and viruses can leak through gloves, handwashing is always necessary after removing gloves.

The agent used for handwashing is less important than the frequency, duration, and technique used in washing and the amount of the agent used. Briefly, the frequency and duration of handwashing have a direct effect on the types and numbers of organisms on the hands. It is

NURSING CARE PLAN

A Client with a Stage III Pressure Ulcer

Amanda Derstine is an obese 87-year-old woman being cared for at home by a niece. She spends much of her day quilting and has developed a stage III pressure ulcer on her left buttock. The physician has prescribed a wound care regimen that includes cleansing with a ½ strength solution of hydrogen peroxide followed by the application of **Duoderm Granules** and a dry sterile dressing. Wound care is ordered twice a day. A community health nurse develops the following nursing care plan.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Nutritional status, food intake.	Imbalanced nutrition: more than body requirements. Related to intake of in excess of metabolic requirements.	Client will lose 1–2 pounds per week and demonstrate progressive wound healing.	Plan with niece a low-calorie diet high in protein and vitamin C to promote wound healing and foster weight loss.	Client experiences weight loss of 1–2 pounds per week. General nutritional status improves and wound healing occurs.
Daily activity schedule.	Self-care deficit syndrome related to muscle weakness and obesity.	Client will participate in activities of daily living (ADLs). Muscle strength improves. Client walks around the house 3 times a day within 1 week following discharge.	With niece, plan a daily schedule that involves client in activities of daily living and other activities designed to strengthen muscles, e.g., walking and muscle-strengthening exercises.	Client participates in ADLs and other muscle-strengthening exercises, and walks around the house three times a day.
General physical condition, activity level.	Ineffective tissue perfusion related to obesity and sedentary life-style.	Client will state understanding of the need for an activity schedule and skin care to prevent future pressure ulcers prior to discharge.	Develop an activity schedule and skin care routine with niece.	Client verbalizes understanding of activity schedule and routine skin care. Skin remains intact in unaffected areas.
Observation of wound and surrounding tissue. Monitor body temperature.	Risk for infection related to inadequate primary defenses.	Client will be free of wound and systemic infection during hospitalization.	Cleanse wound with 50/50 solution of povidone-iodine and saline; apply Duoderm Granules and dry sterile dressing BID. Take body temperature twice a day. Advise niece to report elevations. Observe wound for purulent drainage and foul odor. Advise niece to report these developments. Reinforce need for diet high in protein and vitamin C. Reinforce need for good skin care.	Client maintains a normal body temperature. Client demonstrates progressive healing of dermal ulcer. Dermal ulcer demonstrates no signs and/or symptoms of infection. If signs and symptoms of infection occur, niece seeks professional assistance.

Observation of wound and surrounding tissue. Medication history.	Risk for injury related to allergic reaction to iodine.	Client will be free of allergic reaction.	Ask niece about previous allergic reactions to iodine. Observe wound and surrounding skin for indications of allergic reactions to povidone-iodine. Teach niece to observe for allergic reactions (rash, changes in inflammation) in area around wound. Demonstrate procedure for wound care and have niece assume responsibility for wound care under nurse's supervision.	No allergic reaction develops, or, if a reaction develops, niece stops treatment and seeks appropriate professional assistance.
Niece's knowledge of factors related to preservation of skin integrity and care of wound.	Deficient knowledge (skin integrity, care of wound at home, and promotion of skin integrity).	Niece will demonstrate the correct procedure for wound care. Niece will state the steps to promote wound healing and prevent the development of pressure ulcers prior to discharge.	Discuss and demonstrate skin care; discuss importance of nutrition and position changes in promoting healing and preventing development of pressure ulcers.	Client will demonstrate progressive healing of dermal ulcer without signs and symptoms of infection; skin remains intact in unaffected areas.

recommended that the hands be washed before and after each client contact and that the agent be in contact with the skin for at least 10 seconds. Further, handwashing must be thorough, with special attention given to parts of the hand often missed, e.g., thumbs, knuckles, and nails. Nails should be kept short, and rings should not be worn, as they interfere with proper handwashing and harbor organisms. Finally, the amount of the agent also is important. Studies have shown that bacterial counts are lower on the hands of persons using 3–5 mL of antimicrobial products than on those using less of the product. For your safety and that of your clients, it is important to remember to wash often and wash well.

KEY NURSING IMPLICATIONS 9–3

Handwashing

1. Wash your hands before and after client contact and after removing gloves.
2. The frequency, duration, technique, and amount of the agent used in handwashing are more important than the nature of the agent used.
3. For maximum safety, wash your hands often and thoroughly.

CASE STUDY

George Sanders, 28, is seen in the emergency suite by Dr. Burris. Mr. Sanders has been complaining of severe abdominal pain for approximately 4 hours. The history and physical examination, which indicates localized right-sided abdominal pain, suggests acute appendicitis. Surgical permission forms are signed, the client's abdomen is shaved and routine preoperative care is given. Before the client leaves the emergency suite, an intravenous infusion of 5% dextrose in water is begun.

In the operating room, the anesthetist prepares to administer anesthesia through the intravenous line previously established. Before puncturing the diaphragm on the IV tubing, the injection site of the tubing is cleaned with 70% isopropanol.

Following loss of consciousness, the client is given a general anesthetic by inhalation. As anesthesia progresses, the client's abdomen is prepared with 2% povodine-iodine solution. When this has dried, the abdomen is then draped.

The surgery progresses without complications and an appendectomy is performed. Several days following the operation, during a dressing change, the physician notes that a small area of the incision has become infected. A bacterial culture is taken and the following order is written:

Irrigate wound BID with a 50/50 solution of NSS (normal saline solution) and H_2O_2 (hydrogen peroxide).

Following identification of the infecting organism, the client is placed on an antibiotic. Recovery occurs without further complications.

Questions for Discussion

1. In preparing to insert the needle to initiate the intravenous infusion, the technician has a choice of two agents for disinfection of the skin. The two agents are 70% isopropanol and povidone-iodine (Betadine). What are the advantages and disadvantages of each agent?
2. Is the 70% isopropyl alcohol, which is applied to the injection site on the IV tubing, likely to be an effective disinfectant? Why or why not?
3. What advantage could be gained by using hexachlorophene (pHisoHex) or chlorhexidine (Hibiclens) as an abdominal preparation, rather than iodine and alcohol?
4. In preparing to irrigate the wound with hydrogen peroxide and saline, what factors must the nurse consider concerning the use of hydrogen peroxide?

HOME CARE / CLIENT TEACHING

1. Always take the opportunity to discuss the safe storage and use of antiseptics and disinfectants in the home.
2. Stress the importance of handwashing before and after a caregiver cares for a wound.
3. Clients (or significant others) should learn how to properly apply antiseptic medications and dressings and how to change any dressings that need to be changed at home.
4. Clients should receive written as well as verbal and demonstration instructions and should perform the dressing change at least once prior to discharge, so the nurse can evaluate the client's technique.
5. Clients should be provided with supplies needed at home to apply the antiseptics, including medication, dressing, and tape.
6. Clients need to be instructed to follow the physician's directions for applying the medication and dressing, including how often the dressing is to be changed.
7. Client instructions should include that medication should be applied firmly but gently and that tongue blades or cotton-tipped applicators can be used to apply medication.
8. Clients should be instructed to note any unusual color, odor, or drainage from wound.
9. Provide poison control information and phone number for poison control centers for all homes with children.
10. Contaminated linens should be washed separately from other household laundry. Hot water (160°F for 25–30 minutes) should be used, and a cup of bleach plus detergent should be added to every load of contaminated linens.

CRITICAL THINKING EXERCISES

1. Make a list of all the disinfectants and antiseptics used in the clinical setting where you are working. Describe the situations in which they are most frequently used.
2. Visit a local pharmacy and note the preparations available for use without a prescription to treat minor lacerations and abrasions. List the contents of these preparations and describe how they work.
3. Review the preoperative surgical scrub procedure in use in your clinical area.
4. Prepare an instruction sheet on effective handwashing for use in the home of a person with an infectious disease.
5. What is/are the main purpose(s) for using antiseptics and disinfectants?
6. What government agency oversees the disinfectants?

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SECTION 3

Agents Used to Control Pain and Inflammation

MAJOR NURSING DIAGNOSES

- Pain: Acute
- Pain: Chronic
- Deficient Knowledge (Illness and Its Treatment)
- Risk for Poisoning
- Risk for Aspiration
- Activity Intolerance Related to Inflammatory Disease
- Impaired Physical Mobility Related to Connective Tissue Disease
- Risk for injury
- Fear/Anxiety
- Hypothermia

10 Analgesics and Antipyretics

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify the major therapeutic actions and adverse effects of each class of analgesics and antipyretics
- Apply the nursing process for clients receiving each of the classes of analgesics and antipyretics
- Describe the gate theory of pain
- Apply the nursing care for a client receiving analgesic drugs via an epidural catheter
- Apply nursing interventions for a client receiving a placebo
- Identify client behaviors indicative of pain and the nursing actions which might be associated with pain control
- Define client-controlled analgesia (PCA) and identify appropriate nursing interventions for clients using PCA

Pain is a sensation that causes discomfort, disturbs sleep, and may interfere with normal daily activities. It is a symptom of an underlying physical or emotional disease process and/or a warning of impending danger. Pain may be difficult for the client to describe in quantitative terms. Most clients generally resort to terms such as burning, piercing, sharp, throbbing, and dull to describe their pain in some way.

Because of the difficulty in describing and measuring pain, and because there can be wide variations in individual responses to pain stimuli, success of treatment is often difficult to predict and assess.

PAIN

When a stimulus is applied to the body, electrical impulses are initiated in the central nervous system. These impulses are perceived by the individual and interpreted by the brain. Pain is generally measured in two ways, by its threshold and by its intensity. The *pain threshold* is the level of stimulus resulting in the perception of pain. As this is a measure of a physiological response of the nervous system, it tends to be about the same for most individuals. *Pain tolerance* is defined as the amount of pain an individual can withstand without disrupting normal function and without requiring analgesic treatment. Pain tolerance is not a physiological function, but rather a response to pain, e.g., anguish, crying, nausea, based on client's environment, culture, ethnic origins, and personality. Unlike pain threshold, pain tolerance may vary widely from individual to individual.

The most popular current theory regarding pain is the "gate theory." According to this theory, painful stimuli that result in tissue injury cause the release of substances such as potassium, *histamine*, *serotonin*, *bradykinin*, *prostaglandins*, and

others that initiate an action potential along a sensory nerve fiber and/or sensitize pain receptors. Several different types of nerve fibers are thought to exist, the two most important being the "A" and "C" fibers. "A" fibers tend to be large and covered with a myelin sheath. These are further subdivided according to their size and conduction rate as alpha, beta, gamma, and delta fibers, "A alpha" being the largest and "A delta" being the smallest. "A" fibers tend to transmit impulses rapidly and appear to be involved in sharp, well-localized types of pain, particularly from peripheral areas of the body. "C" fibers tend to be small and unmyelinated and to transmit impulses relatively slowly. These fibers are generally associated with dull, nonlocalized types of pain. The relative proportion of "A" and "C" fibers in a particular area of the body is believed to account for the different types of pain experienced.

Pain and other sensory fibers enter the spinal cord and ascend to the brain. The "gate theory" suggests that cells in the substantia gelatinosa of the dorsal horn of the spinal cord act as "gates" to regulate the flow of sensory impulses, stopping some before they are transmitted to higher centers of the brain where impulses are consciously perceived by the client.

Nerve impulses that emanate from pain receptors in the periphery of the body (e.g., the skin) are transmitted to three systems (Figure 10–1):

- the cells of the substantia gelatinosa (SG) in the spinal cord
- the dorsal column fibers that carry impulses to the brain
- the spinal cord transmission (T) cells that control information flow to the brain

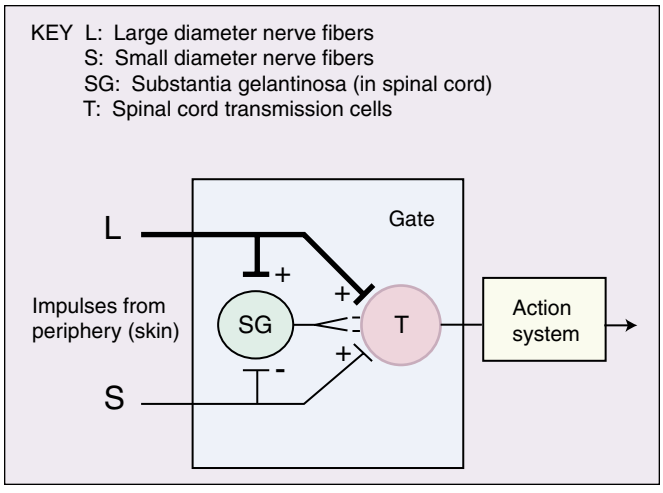


Figure 10–1 Gate theory of pain perception.

Transmission of nerve impulses to the spinal cord T cells is controlled by a gating mechanism in the substantia gelatinosa. The gating mechanism is influenced by the relative amount of activity in large diameter (L) and small diameter (S) fibers. Activity in large fibers tends to inhibit (–) transmission of impulses to the spinal cord T cells (i.e., it closes the gate). Activity in small fibers tends to facilitate (+) transmission of impulses to spinal cord T cells (i.e., it opens the gate). The spinal gating mechanism is also influenced by nerve impulses from the brain. These enable the brain to identify, evaluate, and localize the pain and control the gate before the action system is activated. When the output of the spinal cord T cells exceeds a given threshold, it activates the action system that permits pain perception.

Once perceived, interpretation of the impulse occurs in the cortex and appropriate autonomic and reflex responses occur to deal with the pain. Interpretation of pain by the cortex seems to be a learned response and is based on a person's previous experiences with pain, as well as on sociocultural influences that have shaped an individual's personal beliefs and behaviors. Recent theories link such learned responses to pain to the opening of the "gate," which allows pain impulses to reach the cortex. This may explain why emotions, such as intense anxiety, can influence the level of pain perceived by a client.

The gate theory helps explain why rubbing of a painful area with massage or applying liniments helps soothe localized pain. When rubbing of a painful area, large sensory fibers from peripheral receptors carry impulses to the substantia gelatinosa, causing inhibition of impulse transmission and a "closing of the gate." This reduces the recognition of pain impulses arriving via the small fibers.

During the past few years, increasing evidence has emerged relating the transmission of pain impulses to the actions of certain endogenous neurotransmitters that seem to be concentrated in various parts of the central nervous system (CNS). These neurotransmitters, known as endorphins and enkephalins, seem to be capable of binding with opioid receptors in the central nervous system and thereby inhibit the transmission of pain impulses, producing an analgesic effect. These endogenous analgesic compounds are released when painful stimuli affect the body. Their release may account for the ability of most individuals to tolerate higher levels of pain with repeated painful

stimuli than with a single stimulus and may also explain the phenomenon of runner's high experienced by long-distance runners.

Management of pain is generally based on:

- treatment of the cause or other underlying factors.
- selection of the safest and most effective analgesic for the pain to be treated.
- provision of psychological support to promote full potenial of emotional and placebo factors.
- use of measures, such as position changes and backrubs.

Analgesics

Analgesics are drugs that relieve pain without causing loss of consciousness. Although the proper analgesic may be extremely valuable in pain treatment, it is important to remember that complete masking of a pain symptom may not be desirable; masking can eliminate an important means of monitoring the progress of the underlying disease.

Selection of the proper analgesic is generally based on six factors: effectiveness of the agent, duration of action, desired duration of therapy, ability to cause drug interactions, hypersensitivity of the client, and available routes of drug administration.

Effectiveness of the agent. It is necessary to know whether or not a specific drug will reduce a particular type of pain. Mild-to-moderate pain, such as headache or skeletal muscle pain, is often responsive to relatively safe drugs, such as aspirin and acetaminophen (Tylenol). More severe pain might require the use of potent analgesics, such as opioid analgesics. Some agents with analgesic activity may also have good *anti-inflammatory* activity and would be useful in treating the inflammatory pain that accompanies rheumatoid arthritis and other inflammatory conditions. Other agents might have *antipyretic* activity, which makes them logical choices for treating pain associated with fever.

Duration of action. For minor surgery, an analgesic product with a short duration of action (e.g., **fentanyl citrate**) may be sufficient, while moderate-to-severe chronic pain may require the use of an analgesic with a relatively long duration of action (e.g., morphine). Likewise, sustained-action products containing analgesics can provide prolonged action for clients who would otherwise need to awaken during the night for an analgesic dose.

Desired duration of therapy. Drugs that may be highly effective, but potentially harmful with prolonged use (e.g., *opioid analgesics*), may be used to control pain of short duration, such as for toothache or surgery. In clients with chronic pain (such as with rheumatoid arthritis) the analgesic agent to be used must be chosen not only for its effectiveness, but also its long-term safety and low potential for causing drug dependency.

Ability to cause drug interactions. Clients using analgesics in combination with other drugs may be susceptible to a wide variety of drug interactions. For example, aspirin may *potentiate* the action of oral *anticoagulants* such as warfarin and cause excessive bleeding; taking aspirin with oral antidiabetic agents, such as **tolbutamide** can result in loss of diabetic control. Analgesics with CNS depressant activity, such as opioid and some potent nonopioid agents, may potentiate CNS depression already caused by sedatives, antihistamines, and/or alcoholic beverages the client may be using.

Hypersensitivity of the client. Selection of the proper analgesic drug should also be based on the medical and drug history of a client, with specific consideration given to the client's prior response to analgesics. Clients may be allergic to aspirin, opioid analgesics, and other drugs chemically related to them.

Available routes of drug administration. Whenever possible, oral therapy with analgesics is preferred. However, some individuals, such as preoperative clients and clients with surgical pain who cannot tolerate oral medications, may require parenteral or rectal administration of analgesics.

Several different theories have been proposed to explain how analgesics work. Opioid and opioid-like analgesics are believed to bind onto opioid receptors found in the central nervous system and thereby act to inhibit the transmission of pain impulses and alter pain perception. The variation in potency of different opioid analgesics is believed to be related to their varying affinity for these opioid receptors; the greater the affinity, the more potent the analgesic effect. As opioid antagonists, such as naloxone (**Narcan**), are also capable of binding with opioid receptors, they act to block the binding of opioid and opioid-like drugs, endorphins, and enkephalins.

Nonopioid analgesics, such as the salicylates, appear to exert their analgesic effects both peripherally and centrally. Peripherally, they appear to inhibit the synthesis of prostaglandins in inflamed tissue and thereby prevent the sensitization of pain receptors to mechanical or chemical stimulation. Centrally, the salicylates and other nonopioid analgesics appear to produce an analgesic effect by affecting the *hypothalamus*.

In no other type of drug therapy is the placebo effect as prominent as it is with the use of analgesics. It has been demonstrated that this effect plays a role in at least one-third of all pain treatment situations. Studies to determine the clinical effect of an analgesic must generally be done, therefore, by comparing the action of the analgesic with that of a placebo.

OPIOID ANALGESICS

Among the most potent analgesics now available are those derived from opium, a substance which is secreted from the unripe seed capsules of a species of poppy grown mostly in Turkey, India, China, and Iran. Opium has been used for thousands of years to alleviate pain and produce a sense of detachment and well-being (*euphoria*). However, it was not until the sixteenth century that opium's major component, morphine, was isolated. In the following years, many additional analgesics were naturally or synthetically derived from opium or were designed to mimic the pharmacological actions of *opiate* compounds. All of these agents became collectively known as the opioids or opioid analgesics.

Opioid analgesics, of which morphine is usually considered to be the prototype drug, exert a number of pharmacological actions. They are employed clinically primarily for their ability to produce analgesia. Opioids are primarily used in the treatment of moderate-to-severe pain originating from visceral sources (i.e., from the GI tract and other internal organs). Morphine sulfate is the drug of choice for moderate-to-severe pain in children, such as postoperative pain. Some of these agents are also employed as cough suppressants and in suppressing the motility and secretion-forming ability of the gastrointestinal tract. All of the narcotic analgesics are capable of causing dependence with regular use and are classified as controlled substances by the federal government.

The analgesic effect of the opioid analgesics has been attributed to a number of pharmacological actions. As described earlier in this chapter, these agents appear to combine with opioid receptors in the CNS and interfere with the transmission of pain impulses.

Five major types of opioid receptors have been identified. These include the mu (μ), kappa (K), sigma (σ), delta (δ), and epsilon (ε) receptors. The action of the opioid analgesics seems to be centered at the μ, K, and σ receptors. The μ receptors appear to control morphine-like effects, such as analgesia, euphoria, and respiratory depression. The K receptors seem to control spinal analgesia, sedation, and *miosis*, with the σ receptors appearing to control hallucinatory activity, as well as respiratory and vasomotor stimulation.

Morphine-like drugs (e.g., codeine, **oxycodone**) that are opioid agonists, i.e., they combine with opioid receptors to produce an analgesic response, primarily affect μ and K receptors, while drugs having agonist-antagonist activity, (e.g., **naltrexone** and **nalbuphine**), have agonist activity at some receptors and antagonist activity at others. Pure opioid antagonists (e.g., naloxone) do not produce agonist activity at any of the opioid receptor sites. Table 10–1 lists the receptor activity of several analgesic drugs.

The cough suppressant action of some of the opioid analgesics is attributed to their ability to suppress medullary cough centers. Codeine, a close chemical relative of morphine, is the opioid analgesic most commonly used as a cough suppressant. The suppressant effect of these agents on the motility of the GI tract is employed therapeutically in the treatment of diarrhea. **Camphorated opium tincture** (**paregoric**), and **diphenoxylate** (**Lomotil**) are the most popular opioid drugs in treating diarrhea.

TABLE 10–1

Receptor Activity Related to Some Analgesic Drugs

DRUG	RECEPTOR		
	μ	K	σ
morphine	agonist	agonist	—
pentazocine	antagonist	agonist	agonist
naloxone	antagonist	antagonist	antagonist

Several adverse effects are frequently associated with the use of opioid analgesics. Some of these (e.g., nausea, vomiting, and constipation) are not generally serious. Of major importance, however, is the respiratory depression caused by most opioid analgesics. This may be life-threatening if experienced by clients with a history of impaired respiratory function (e.g., those with bronchial asthma). The use of opioid analgesics needs to closely monitored in clients with known or suspected head injuries, as it would be difficult to determine in these clients if decreased awareness, changes in respirations, and other signs were due to the injury or to the drug. However, providing adequate pain control in these clients is very important, because clients with head injuries will experience ongoing increase in intracranial pressure if their pain is not controlled.

Opioid analgesic use is also associated with the development of tolerance and dependence. With *continued* long-term use, tolerance develops rapidly to the *euphoric* and analgesic effects of these agents. The dose may need to be raised regularly to maintain a specific level of clinical effectiveness. Dependence on these agents may occur with regular use and may be characterized by the development of *abstinence syndrome* when the administration of the drug is abruptly discontinued. This syndrome is a physiological response to the removal of a drug from the body and is characterized by the development of signs and symptoms such as sweating, restlessness, and diarrhea, which are often related to the body's overcompensation to the discontinuation of the drug. Symptoms associated with abstinence syndrome are generally more pronounced if high narcotic doses have been used for long periods.

Although most opioid analgesics exert similar pharmacological actions when used in equivalent doses, differences in their duration of action, possible routes of administration, and other factors may make one agent more desirable to use for a given client. Table 10–2 compares the properties of the opioid analgesic agents. Table 10–3 lists the equianalgesic doses of the opioid analgesics.

Mixtures of opioid narcotics and other agents (e.g., **Brompton's mixture**, **MS Contin**) are used for the treatment of pain in terminally ill clients with severe pain. These mixtures, which may contain morphine, cocaine, **dextroamphetamine**, alcohol, and other agents, help to control severe pain; they also frequently produce a euphoric state. Although dependence is likely to occur with the regular use of such mixtures, this is rarely an important consideration in the treatment of such clients, as providing comfort is usually more important than the possibility of causing dependence.

OPIOID ANTAGONISTS

Several compounds have been developed capable of competing with opioid analgesics for the same receptor sites and can, therefore, reverse or prevent many of the actions of the opioid agents. They are employed in reversing respiratory depression caused by the narcotic analgesics or in diminishing other clinical manifestations of opioid use or overuse.

Naloxone HCl (Narcan) and **naltrexone HCl** (**Trexan**) are considered to be pure opioid antagonists, as they exert little, if any, pharmacological action of their own, yet antagonize virtually all actions of morphine and most other opioid analgesics. If administered to a client who is dependent on an opioid or opioid-like drug, these agents will rapidly produce withdrawal symptoms. They must, therefore, be administered with great care to such clients. Although naloxone may be administered orally or by a variety of parenteral routes, the IV route is usually preferred for reversing opioid-induced effects, as this route provides the most rapid action and permits the closest dosage control. Naloxone is generally considered to be the drug of choice in reversing respiratory depression caused by opioid analgesic drugs, as it will not exert any further respiratory depressant effect of its own. Special care should be taken in administering naloxone to infants of drug dependent mothers, as it may cause withdrawal symptoms in the baby.

Naltrexone (Trexan) is currently available only for oral administration. It is indicated for use as an adjunct to the maintenance of the opioid-free state in detoxified, formerly opioid-dependent individuals. This indication is based on naltrexone's pure opioid antagonist activity and its long duration of action (24–72 hours depending on the dose administered) when administered orally. Table 10–4 compares the properties of the opioid antagonists.

TABLE 10–2

Opioid Analgesics

Note: Do not administer opioid analgesics to clients with depressed respirations. Severe respiratory depression that results from opioid use can be treated with naloxone (Narcan) given IV.

Instruct client to avoid activities requiring mental alertness.

Routinely evaluate the effectiveness of opioid analgesics in relieving pain. Supportive nursing measures should be used to enhance the effectiveness of opioid analgesics (e.g., massage, positioning, emotional support, diversion, guided imagery).

Assess pain for type, location, and intensity before and 10–45 minutes after administration.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION (IM OR SC)	DURATION OF ACTION	NURSING IMPLICATIONS
codeine phosphate, codeine sulfate *(**KOH**-deen **FOS**-fayt, **KOH**-deen **SUL**-fayt)* (Paveral ✱)	oral, IM, IV, SC	*Adults:* 15–60 mg every 4–6 hours *Children:* 0.5 mg/kg every 6 hours	15–30 min	4–6 hr	Used in smaller doses as an antitussive agent. Administer with food or milk to minimize GI upset. May cause constipation. Avoid use in care of persons with head injuries or increased intracranial pressure. Do not administer intravenously in children. Protect codeine injectable solutions from light.
fentanyl citrate *(**FEN**-tah-nil **SIH**-trayt)* (Sublimaze, Duragesic)	IM, IV, transdermal, epidural	IM, IV: *Adults:* 0.02–0.1 mg as needed *Children from 2 to 12:* 2–3 mcg/kg Transdermal: one patch every 48–72 hours 25 mcg/hr	7–8 min 2–8 hr	1–2 hr 72 hr	Commonly used in short surgical procedures and as a preoperative and postoperative medication because of its short duration of action. Often used with droperidol (see Chapter 11). Contraindicated in clients with myasthenia gravis and in those who have taken MAO inhibitors within 14 days. Carefully monitor circulatory and respiratory status. Transdermal patch is used to treat chronic pain. It should be applied to a flat surface on the upper torso. Dispose of used patches by folding patch so that adhesive side adheres to itself. Then flush patches down the toilet. Increasingly used for epidural pain control.
heroin *(**HAIR**-oh-in)*	not legally used in the U.S. except as investigational drug		15–30 min	3–4 hr	Most commonly abused opioid. Highly addictive.
hydrocodone *(**hy**-droh-**KOH**-dohn)* (Hycodan)	oral	*Adults:* 5–10 mg every 4–6 hours *Children:* 0.2 mg/kg every 3–4 hours		4–6 hr	Assess type, location, and intensity of pain before and 30–45 minutes after administration.

continues

TABLE 10–2 *continued*

See **Note** at beginning of Table 10–2, page 221

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION (IM OR SC)	DURATION OF ACTION	NURSING IMPLICATIONS
hydrocodone bitartrate with acetaminophen *(ah-**seat**-ah-**MIN**-of-fen)* (Vicodin)	oral	*Adults:* 2.5–7.5 mg hydrocodone/ acetaminophen every 4–6 hours		4–6 hr	Monitor for adverse effects.
hydrocodone with aspirin (Lortab-ASA)		*Adults:* 5 mg hydrocodone/ 500 mg aspirin every 4–6 hours		4–6 hr	Encourage fluid intake to prevent constipation.
hydrocodone with ibuprofen (Vicoprofen)		*Adults:* 7.5 mg hydrocodone/ 200 mg ibubrofen		4–6 hr	Assess bowel function.
hydromorphone HCl *(hy-droh-**MOR**-fohn **hy**-droh-**KLOR**-eyed)* (Dilaudid)	oral, IM, slow IV, SC, rectal	*Adults:* IV, IM, SC: 1–4 mg every 4–6 hours Rectal: 3 mg every 6–8 hours Oral: 2.5–10 mg every 4–6 hours	15–30 min	4–5 hr	Suppository form provides long duration of action which is useful for nighttime pain control. Suppositories should be refrigerated. Rotate sites of injection. Avoid use with clients who have head injuries, increased intracranial pressure or chronic pulmonary disease. Useful with chronic pain. Is 7-10 times analgesic than morphine with a shorter duration.
levorphanol tartrate *(lee-**VOR**-fah-nohl **TAR**-trayt)* (Levo-Dromoran)	slow IV	*Adults:* 1–3 mg as needed 2 mg or fraction thereof over 4–5 minutes	30–90 min	3–6 hr	Often used preoperatively. Monitor circulatory and respiratory status. May cause constipation. Contraindicated in clients during labor and delivery.
meperidine HCl, pethidine *(meh-**PER**-ih-deen **hy**-droh-**KLOR**-eyed, **PETH**-ih-deen)* (Demerol)	oral, IM, IV, SC	*Adults:* 50–100 mg every 3–4 hours *Children:* 1–2 mg/kg every 3–4 hours IV: 1–10 mg/hr	10–45 min	2–4 hr	Oral syrup should be taken in ½ glass of water to avoid topical anesthesia of GI mucous membranes. Less effective by oral route than parenteral. Irritating to subcutaneous tissues. Monitor carefully for toxic effects in clients with poor renal function. Check compatibility before mixing meperidine with any other drug in syringe. Monitor cardiac and respiratory status. Not appropriate for chronic pain.

continues

TABLE 10–2 *continued*

See **Note** at beginning of Table 10–2, page 221

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION (IM OR SC)	DURATION OF ACTION	NURSING IMPLICATIONS
methadone HCl *(**METH**-ah-dohn **hy**-droh-**KLOR**-eyed)* (Dolophine HCl)	oral, IM, SC	*Adults:* 2.5–10 mg every 3–4 hours Narcotic withdrawal: 15–120 mg/day *Children:* 0.1 mg/kg every 6–8 hours	30–60 min	4–6 hr	Twice as potent when given parenterally than orally. Commonly used for treatment of opioid addiction, because of its extended duration of action in suppressing withdrawal symptoms in opioid-dependent persons. When used for treatment of addiction, administer the dissolved drug in citrus juice. Because of its cumulative effect, marked sedation can occur after repeated doses. Constipation may become a serious problem. Rotate injection sites.
morphine sulfate *(**MOR**-feen **SUL**-fayt)* (Roxanol, Duramorph, M.O.S, Statex)	oral, IM, IV, SC, rectal	*Adults:* Oral: 10–30 mg every 4 hours SC or IM: 5–20 mg every 4 hours IV: 2.5–15 mg *Children:* IV, SC, IM: 0.1–0.2 mg/kg every 1–2 hours, depending on route Rectal: 10–20 mg every 4 hours	10–60 min	3–7 hr	Parenteral administration is more reliable than oral administration. IV injections should be administered slowly over a 1–2-minute period. Analgesic of choice to relieve the pain of acute myocardial infarction. May result in drop in blood pressure. Monitor circulatory and respiratory status carefully. Useful in the intractable pain of cancer.
MS contin	oral	15–200 mg every 3–4 hours			See morphine.
opium *(**OH**-pee-um)* (Pantopon, paregoric, etc.)	oral, IM, SC	varies widely depending on form used	See morphine.	See morphine.	Opium products are most commonly used to treat diarrhea. Specific pure opium derivatives (e.g., morphine) have mostly replaced opium as an analgesic.
oxycodone HCl *(ox-ee-**KOH**-dohn **hy**-droh-**KLOR**-eyed)* (Roxicodone, Supeudol)	oral	*Adults:* 5–10 mg every 4–6 hours as needed	15–30 min (orally)	4–6 hr	Monitor for constipation.
oxymorphone HCl *(ox-ee-**MOR**-fohn **hy**-droh-**KLOR**-eyed)* (Numorphan)	IM, IV, SC, rectal	*Adults:* Parenteral: 0.5–1.5 mg every 4–6 hours as needed. Rectal: 5 mg every 4–6 hours	5–10 min	3–6 hr	Not recommended for persons under 12 years of age. Use carefully in debilitated or elderly clients. Monitor circulatory and respiratory status carefully. Contraindicated in care of clients with paralytic ileus. Suppositories should be refrigerated.

continues

TABLE 10–2 *continued*

See **Note** at beginning of Table 10–2, page 221

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION (IM OR SC)	DURATION OF ACTION	NURSING IMPLICATIONS
propoxyphene HCl *(proh-**POX**-ih-feen **hy**-droh-**KLOR**-eyed)* (Darvon, Dolene, etc.)	oral	65–100 mg every 4 hours	30–60 min (orally)	4–6 hr	Total daily dosage should not exceed 390 mg. Not for use in children. Advise client to avoid alcohol while taking drug.
propoxyphene napsylate *(proh-**POX**-ih-feen **NAP**-sih-layt)* (Darvon-N)	oral	50–100 mg every 4 hours	30–60 min (orally)	4–6 hr	Total daily dosage should not exceed 600 mg. Not for use in children. Available as a liquid for oral use.
propoxyphene napsylate (50–100 mg) with acetaminophen (325–650 mg) (Darvocet-N)	oral	50–100 mg every 4 hours		4–6 hr	Major adverse effects: Constipation, sedation, confusion. Reduce dose in impaired renal/hepatic function. May be used if fever present.
sufentanil citrate *(soo-**FEN**-tah-nil **SIH**-trayt)* (Sufenta)	IV	*Adults:* 10–50 mcg *Children:* 10–25 mcg/kg with 100% oxygen	1.3–3 min	—	Used as an adjunct to general anesthesia. Use with oxygen.

TABLE 10–3

Equianalgesic Doses of Opioid Analgesics*

DRUG	IM (mg)	ORAL (mg)
Alfentanil (Alfenta)	ND	NA
Codeine	120	200
Fentanyl (Sublimaze)	0.1	NA
Hydrocodone	NA	ND
Hydromorphone (Dilaudid)	1.5	7.5
Levorphanol (Levo-Dromoran)	2	4
Meperidine (Demerol)	75	300
Methadone (Dolophine)	10	20
Morphine	10	60
Oxycodone (Roxicodone)	NA	30
Oxymorphone (Numorphan)	1	10 (rectal)
Propoxyphene HCl (Darvon)	ND	130
Propoxyphene Napsylate (Darvon-N)	ND	200
Sufentanil (Sufenta)	0.02	NA

*Based on acute, short-term use. With chronic administration, tolerance may develop and the oral:IM dose ratio may decrease. NA = not applicable; ND = no data available.

NONOPIOID ANALGESICS

Buprenorphine HCl (**Buprenex**), **butorphanol tartrate** (**Stadol**), **nalbuphine hydrochloride** (**Nubain**) and **pentazocine hydrochloride** (Talwin) were also developed to provide effective analgesic action without the abuse potential of the opioid analgesics. It has become evident that all of these agents exert some opioid antagonist activity. If they are administered to an opioid-dependent client, therefore, they may induce the development of withdrawal symptoms. Although none of these agents were initially believed to be capable of being abused, abuse of pentazocine has been frequently reported in recent years. As a result, this agent has been classified as a controlled substance by the federal government.

In an attempt to discourage abusers from injecting solutions of pentazocine made from Talwin tablets, these tablets were reformulated by the manufacturer to combine pentazocine and naloxone into an oral product, **Talwin NX**, which produces narcotic withdrawal symptoms if injected by an abuser, but is still an effective oral analgesic. Table 10–5 reviews the properties of the nonopioid analgesics.

TABLE 10–4

Opioid Antagonists

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
naloxone HCl *(nal-**OX**-ohn **hy**-droh-**KLOR**-eyed)* (Narcan)	IM, IV, SC	*Adults:* 0.1–2.0 mg as needed *Pediatric:* 0.01 mg/kg IM, IV or SC *Children:* 0.01 mg/kg	Pure opioid antagonist. Used in neonatal care to counteract respiratory depression induced by opioid intake of mother. May cause acute withdrawal symptoms in drug-dependent individuals. Given intravenously as opioid antagonist for clients with respiratory depression from use of opioid analgesics.
naltrexone HCl *(nal-**TREX**-ohn **hy**-droh-**KLOR**-eyed)* (Trexan)	oral	25–150 mg every 24–72 hours	Pure opioid antagonist. Used only for treating detoxified, formerly opioid-dependent individuals. Treatment should not be attempted until client has been opioid-free for at least 7–10 days. Initial test dose of 25 mg may be given to see if withdrawal symptoms develop.

ANALGESIC ANTIPYRETICS

Although the opioid and nonopioid analgesic agents discussed exert their analgesic effect by directly acting on the CNS, there are a number of useful analgesic drugs that exert relatively weak action on the CNS. These agents appear to provide their analgesic effects by acting peripherally to interfere with the synthesis and action of prostaglandins, chemical substances released by damaged tissue that increase the sensitivity of nerve endings. Pain emanating as a result of peripheral nerve stimulation is, therefore, blocked and symptoms are relieved. Virtually all of the analgesics that act peripherally also exert an antipyretic effect—that is, they reduce fever by a direct action on the thermostat of the body, the hypothalamus.

Salicylates are, perhaps, the oldest of the analgesic antipyretic agents. They have been widely used for more than one hundred years. Aspirin (**acetylsalicylic acid**) is the most popular member of this group and is the most widely used analgesic ever developed. It is useful in treating mild-to-moderate pain, such as headache and skeletal muscle pain. When used in relatively moderate doses, such as 1.2 g (1,200 mg or 18 gr) daily, aspirin produces an effective analgesic and antipyretic response. When higher doses are employed (3–6 g daily), aspirin exerts an anti-inflammatory effect useful in treating rheumatic disorders, as is discussed in more detail in Chapter 12.

Even though aspirin is an excellent and useful drug, it does produce a variety of adverse effects. The most important of these is irritation of the gastrointestinal tract to the point of causing nausea and vomiting, gastric ulceration, and hemorrhage. Salicylate-induced GI bleeding is often painless and may continue for an extended time without detection. The use of enteric-coated aspirin tablets may reduce the incidence of gastric distress associated with long-term aspirin use. Salicylates may also interfere with blood clotting and may stimulate respiration to the point of respiratory *alkalosis*. High doses may cause CNS stimulation, tinnitus, and/or hearing loss, which are reversible on discontinuing therapy. To avoid serious adverse effects, salicylates must be used with caution in clients with GI ulcers or *anemia* or in those taking drugs that can interact with them (e.g., warfarin, tolbutamide, probenecid, etc.) A higher than normal incidence of *Reye's syndrome* has been reported in children and teenagers who have received

TABLE 10–5

Nonopioid Analgesics

Note: Administer before pain becomes severe.
Assess client's response to drug.
Be aware of possibility of dependency.
Supportive nursing measures (e.g., positioning, emotional support) should be used to enhance the effectiveness of these drugs.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION (IM OR SC)	DURATION OF ACTION	NURSING IMPLICATIONS
buprenorphine HCl *(byou-pren-**OR**-feen hy-droh-Klor-eyed)* (Buprenex)	IM, IV	*Adults:* 0.3 mg every 6 hours *Children 2–12 years:* 2–6 mcg/kg every 4–6 hours	15 min	6 hr	Has some opioid antagonist activity. Monitor client for development of sedation, dizziness, hypotension, and hypoventilation. Avoid the use of alcohol and benzodiazepines in clients using this drug.
butorphanol tartrate *(byou-**TOR**-fah-nohl **TAR**-trayt)* (Stadol, Stadol NS)	IM, IV, intranasal	*Adults:* 0.5–4 mg every 3–4 hours	5–10 min	3–4 hr	Has some opioid antagonist activity. Not for use in children under 18. Intranasal administration has been shown to be effective for the treatment of postoperative pain and migraine headaches.
dezocine *(**DEZ**-oh-seen)* (Dalgan)	IM, IV	*Adults:* 5–20 mg every 3–6 hours IM: 5–20 mg every 6 hours IV: 2.5–10 mg every 2–4 hours with usual dose being 5 mg	15–30 min	2–4 hr	Has some opioid antagonist activity. Not for use in children under 18.
nalbuphine HCl *(**NAL**-byou-feen **hy**-droh-**KLOR**-eyed)* (Nubain)	IM, IV, SC	*Adults:* 10–20 mg every 3–6 hours	10–15 min	3–6 hr	See butorphanol tartrate.
pentazocine HCl *(pen-**TAZ**-oh-seen **hy**-droh-**KLOR**-eyed)* (Talwin, Talwin NX)	oral, IM	*Parenteral:* 30 mg every 3–4 hours *Oral:* 50–100 mg every 3–4 hours	15–20 min	3–4 hr	Has some opioid antagonist activity. Not recommended for use in children under 12 years of age. May cause tissue necrosis at injection site. Contraindicated in drug abusers, persons with head injuries, or with hepatic or renal disease. Not absorbed well orally. Psychological and physiological dependence possible. Do not mix in same syringe with barbiturates. Respiratory depression can be reversed with intravenous naloxone. Pentazocine combined with naloxone (Talwin NX) is an oral form of pentazocine that produces no euphoric effect if administered by injection.

aspirin while having fever associated with viral infections of the upper respiratory tract or chickenpox. It has been suggested, therefore, that aspirin use be avoided in treating children with such conditions.

Several drugs that are not salicylates are also used as analgesics and antipyretics. Acetaminophen is somewhat less irritating to the gastrointestinal tract than aspirin, yet it has comparable analgesic and antipyretic effects. It does not appear to alter blood clotting or respiration. Unlike aspirin, acetaminophen is available as a stable liquid dosage form, making it more suitable than aspirin for administration to children and other clients who have difficulty in taking solid forms. Acetaminophen can cause *hepatotoxicity* and nephrotoxicity after ingestion of high doses. In addition, unlike the salicylates, acetaminophen exerts virtually no anti-inflammatory action, making it a poor substitute for aspirin in the treatment of inflammatory disorders, such as rheumatoid arthritis.

Phenacetin (**acetophenetidin**) is chemically related to acetaminophen and is actually converted, in part, to acetaminophen in the body. Phenacetin and some of its metabolites have been associated with the development of hemolytic anemia, nephrotoxicity, and other disorders, particularly when used in high doses for long periods of time. For this reason, phenacetin has been removed from many commercial products and is no longer an official drug in the United States.

Salicylamide is not a salicylate, nor is it chemically related to acetaminophen. It does possess analgesic, antipyretic, and anti-inflammatory properties, but is metabolized so rapidly at normal doses that its action is unpredictable.

Most nonsteroidal anti-inflammatory agents (see Chapter 12) also exert analgesic and antipyretic effects that make them useful agents for the treatment of postextraction dental pain, primary *dysmenorrhea*, and other painful disorders. These agents are more expensive than aspirin, acetaminophen, and similar drugs, and may cause gastrointestinal upset or bleeding, particularly in the elderly. Although their precise mechanism of action is still unclear, inhibition of prostaglandin synthesis appears to be a part of their analgesic action. With the move of ibuprofen (Motrin, **Actiprofen** ✱) and naproxen (**Naprosyn**, **Anaprox**) from prescription to over-the-counter (OTC) status in the United States, the use of nonprescription forms of ibuprofen (**Advil**, **Haltran**, **Medipren**, **Nuprin**) and naproxen (**Aleve**) has widened the use of these drugs by the general public for the treatment of mild-to-moderate pain and fever. These drugs should not be used with aspirin, as aspirin will diminish their action and will increase the likelihood of gastrointestinal distress. Alternating acetaminophen and ibuprofen has produced good antipyretic results in children.

Many OTC analgesic antipyretic products contain combinations of the mild analgesics, as well as therapeutic and nontherapeutic adjuncts meant to enhance the efficacy or reduce the adverse effects of the analgesic component. Aspirin-containing products, for example, often contain antacids or buffers, such as **aluminum** and/or **magnesium hydroxide**, which presumably reduce GI irritating action. In addition, they increase the rate of absorption of aspirin by increasing its solubility in gastric fluids. **Caffeine** is included in many analgesic mixtures because of its CNS-stimulating action, as well as its apparent ability to relieve headache pain in some clients. The use of analgesic combination products (e.g., aspirin and caffeine) may increase the likelihood of adverse effects.

Combinations of opioid analgesics with less potent antipyretic analgesic agents such as aspirin or acetaminophen are quite popular. The combinations are less likely to produce adverse effects than higher doses of opioid analgesics used alone and a combined analgesic effect on the CNS and on peripheral nerves can be obtained. Such agents may also be useful in situations in which severe pain is accompanied by fever and/or inflammation. Table 10–6 lists the components of some popular products that contain combinations of opioid analgesic and antipyretic analgesic drugs.

Analgesics Used to Treat Headaches

Headache is one of the most common afflictions. Many different types of headache have been identified, the most common being tension, or muscle contraction, headaches and vascular headaches. Tension headaches are generally recurrent and often begin in early afternoon or evening. They are most common in women, in persons who are anxious, and in those whose work or posture involves the sustained contraction of posterior cervical, frontal, or temporal muscles.

TABLE 10–6

Some Popular Opioid Analgesic Combination Products

Note: All of the products in this table are controlled substances and may cause drug dependence if misused. Withdrawal symptoms may emerge on discontinuing therapy. These products should be used with extreme caution in clients with head injuries or respiratory impairment.

BRAND NAME (TABLETS)	OPIOID ANALGESIC COMPONENT(S)	ANTIPYRETIC ANALGESIC COMPONENT(S)
Empirin w/ Codeine No. 3	codeine phosphate 30 mg	aspirin 325 mg
Empirin w/ Codeine No. 4	codeine phosphate 60 mg	aspirin 325 mg
Fiorinal w/ Codeine	codeine phosphate (7.5, 15, or 30 mg)	aspirin 325 mg
Percodan	4.5 mg oxycodone HCl 0.38 mg oxycodone terephthalate	aspirin 325 mg
Percocet-5	5.0 mg oxycodone HCl	acetaminophen 325 mg
Tylenol w/ Codeine No. 1	codeine phosphate 7.5 mg	acetaminophen 300 mg
Tylenol w/ Codeine No. 2	codeine phosphate 15 mg	acetaminophen 300 mg
Tylenol w/ Codeine No. 3	codeine phosphate 30 mg	acetaminophen 300 mg
Tylenol w/ Codeine No. 4	codeine phosphate 60 mg	acetaminophen 300 mg
Phenaphen w/ Codeine No. 2	codeine phosphate 15 mg	acetaminophen 325 mg
Phenaphen w/ Codeine No. 3	codeine phosphate 30 mg	acetaminophen 325 mg
Phenaphen w/ Codeine No. 4	codeine phosphate 60 mg	acetaminophen 325 mg
Phenaphen-650 w/ Codeine	codeine phosphate 30 mg	acetaminophen 650 mg
Tylox	oxycodone HCl 5 mg	acetaminophen 500 mg
Vicodin	hydrocodone bitartrate 5 mg	acetaminophen 500 mg
Vicoprofen	hydrocodone bitartrate 7.5 mg	ibuprofen 200 mg

Tension headaches are characterized by pressure or tightness, most often at the back of the neck, that intensifies in pain as the day progresses. Such headaches generally respond to the use of aspirin, acetaminophen, or ibuprofen, although the antiprostaglandin action of aspirin or ibuprofen seems to make them more effective in many clients. In some persons with regularly recurring tension headaches, the administration of antianxiety agents, such as diazepam (Valium), may be useful.

Vascular headaches are a group of related symptoms characterized by dilation of one or more branches of the carotid artery. This increases the sensitivity of nerve endings supplying the artery and appears to result in the release of substances, such as bradykinin, serotonin, histamine, and/or prostaglandins, all tending to increase the severity of pain experienced by the client. Migraine headaches are the most common form of vascular headache. These usually begin in childhood and continue through adulthood.

In most migraine clients, there is a family history of the disease.

Migraine headaches are usually recurrent and severe. They generally begin unilaterally and, unlike tension headaches, are generally accompanied by nausea, vomiting, and *photophobia*. Some migraine clients, particularly those with "classic migraine," may experience a *prodromal* phase beginning about 24 hours before their headache. During this period, the client may feel euphoric or depressed and may experience increased hunger or thirst. Some migraine clients experience neurological symptoms just before the beginning of a headache. Such symptoms may include the perception of flashing lights or other altered sensory perception. In many clients, migraine headaches tend to be debilitating and may persist for 4 to 6 hours. Frequently, certain factors can be identified that precipitate an individual's migraine attacks. These may include menstrual periods, consumption of certain foods (particularly red wine, aged cheeses, and chocolate), viewing bright lights, or undergoing emotional distress.

Several approaches may be employed to manage a client with migraine headaches. Prevention of headaches may be attempted by avoidance of foods or situations known to precipitate attacks. Drugs, such as the beta-adrenergic blocking agents and the calcium-channel antagonists (see Chapter 28), have been used successfully in some clients to prevent attacks. Ergot and ergot-like drugs have also been used for many years in treating migraine headaches. These agents, which are derived or synthesized from extracts of a fungus disease of rye grain, are potent vasoconstrictors that rapidly diminish migraine pain by decreasing the pulsations of cranial arteries. They also act to antagonize the action of serotonin, an agent believed to contribute to the development of migraine attacks.

Ergotamine tartrate (**Ergostat**, **Gynergen** ✤) and **dihydroergotamine mesylate** (**D.H.E. 45**) are ergot derivatives administered as soon as possible after the first symptom of an attack. The earlier the drug is taken, the smaller the dose needed and, generally, the more rapid the effect. After the drug has been administered, the client should seek bedrest in a darkened, quiet room for 1 to 2 hours. Ergotamine tartrate, which is an alpha-adrenergic blocking agent, is available in sublingual or inhalational products that permit convenient administration and rapid therapeutic response. **Dihydroergotamine mesylate** may be administered intramuscularly or intravenously to control attacks. Although oral ergotamine therapy is generally effective, some clients may respond better to sublingual, inhalational, or rectal dosage forms. **Methysergide maleate** (**Sansert**) is a semisynthetic ergot derivative which is not used to manage acute attacks but is used to prevent their onset.

All ergot derivatives may produce toxicity because of their ability to accumulate in the body. The symptoms of ergot toxicity (ergotism) include muscle pain and weakness, tingling, numbness and weakness of the extremities, and blindness. Because ergot toxicity is more likely to occur in clients with a prior history of peripheral vascular disease or diabetes mellitus, these drugs should be avoided in such clients. Ergot derivatives should also not be used during pregnancy.

The use of methysergide maleate is associated with a number of serious adverse effects. These include retroperitoneal fibrosis, fibrotic thickening of vascular walls and heart valves, vascular insufficiency, and gastronintestinal upset. To reduce the likelihood of developing serious side effects with this drug, methysergide administration may be discontinued for 1 month after every 4–6 months of therapy.

Sumatriptan succinate (**Imitrex**) is a relatively new drug used to treat migraine headache. It is administered subcutaneously at the first sign of a developing migraine headache. The drug may be administered directly using the prefilled syringes containing the drug solution or the client may use an autoinjector device that is also available. Clients using sumatriptan must be advised that the drug is used only to treat a migraine attack, not to prevent them from occurring. In addition, because sumatriptan produces vasoconstriction, clients using the drug should be monitored for the development of elevated blood pressure, angina, or other cardiovascular effects.

A number of combination drug products are widely used to treat migraine headache. These are generally combinations of ergotamine tartrate and caffeine. Caffeine is employed as a cranial vasoconstrictor which enhances the vasoconstrictor properties of the ergotamine. Table 10–7 lists some popular drug products used to treat migraine headache.

TABLE 10–7

Drug Products Used to Treat Migraine Headaches

Note: Therapy with drugs other than methysergide maleate should be initiated at first sign of an attack.
Bed rest in a darkened room is advised for 1–2 hours after taking these drugs.
Assess the effectiveness of the drug in relieving migraine symptoms.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
dihydroergotamine mesylate *(die-**hy**-droh-er-**GOT**-ah-meen **MES**-ih-layt)* (D.H.E. 45) (Migranal)	IM, IV, nasal spray	*IM:* 1 mg injected at first sign of headache; repeat at 1-hour intervals to a total of 3 mg *IV:* up to a maximum of 2 mg may be administered to relieve an attack, weekly dosage not to exceed 6 mg *Nasal:* 0.5 mg spray	Notify prescriber if signs of toxicity develop, i.e., nausea, vomiting, numbness, pain or weakness of extremities. Not recommended for children.
divalproex sodium *(die-val-**PROH**-ex)* (Depakote)	oral	250 mg a day in two divided doses; some may require as much as 1,000 mg/day	Monitor for CNS symptoms that indicate possible overdose. Multiple drug interactions. Most frequent side effects are gastrointestinal—nausea and vomiting, indigestion, abdominal pain
ergotamine tartrate *(er-**GOT**-ah-meen **TAR**-trayt)* (Ergostat, Medihaler, Ergotamine, Gynergen ✱, etc.)	inhalation, sublingual	*Sublingual:* one 2 mg tablet is placed under tongue at first sign of attack; additional doses may be administered, if required, at ½-hour intervals, not more than 6 mg to be used in any 24-hour period and not more than 10 mg to be used per week *Inhalation:* one inhalation (approximately 0.36 mg) initially; may be repeated at 5-minute intervals if necessary; not more than 6 inhalations to be used in any 24-hour period and not more than 15 inhalations to be used per week	See dihydroergotamine mesylate.
ergotamine tartrate and caffeine *(er-**GOT**-ah-meen **TAR**-trayt and **KAF**-feen)* (Cafergot tablet, Wigraine tablets, etc.)	oral	*Tablets:* 2 tablets at first sign of attack; follow with 1 tablet every ½-hour, if needed; maximum dose is 6 tablets per attack and 10 tablets per week	See dihydroergotamine mesylate.
methysergide maleate *(**meth**-ee-**SIR**-jide **MAL**-ee-ayt)* (Sansert)	oral	4–8 mg (2–4 tablets) daily; drug-free-period of 3–4 weeks should be provided after every 6-month course of therapy	Administer with food to reduce gastrointestinal upset. Notify prescriber if signs of toxicity develop, i.e., cold, numb, or painful extremities; leg cramps; chest pain; shortness of breath; or painful urination.

continues

TABLE 10–7 *continued*

See **Note** at beginning of Table 10–7, page 230

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
rizatriptan benzoate *(rize-ah-**TRIP**-tan)* (Maxalt, Maxalt-MLT)	oral	*Adults:* 5-10 mg as a single dose not to exceed 30 mg in 24 hours	In form of disintegrating tablets. Monitor for serious cardiovascular adverse effects, including MI, arrhythmias, cardiac artery vasospasms. Not approved for use in children.
sumatriptan succinate *(**soo**-mah-**TRIP**-tan)* (Imitrex)	SC, oral, nasal spray	6 mg	A second 6-mg dose may be administered, if required, at least 1 hour after the first dose. Not more than 24 mg of drug should be administered within a 24-hour period. Client must be advised that drug is only for use in treating an existing migraine attack, not for preventing one. Monitor client for signs of hypersensitivity or adverse cardiovascular effects.

APPLYING THE NURSING PROCESS

ASSESSMENT

Pain is universal. The nurse will encounter people experiencing pain in every type of clinical and community setting. A variety of pain-relieving tools is available. These include positioning, massage, and distraction, as well as medication. Use of the nursing process can assist the nurse in determining what pain-relieving tools are most effective for a particular client. An assessment of the pain experience must precede selection of any pain-relieving measures. When assisting a client in pain or one who is likely to experience pain because of injury, disease, or surgery, the nurse assesses the nature of the pain and may rate the pain on a scale from 1 to 10. This is known as developing a pain history. Inquiries are made about the onset, location, duration, intensity, and nature of the pain (cramping, stabbing, shooting, throbbing, etc.), as well as other symptoms (such as nausea) that may be associated with the pain. The nurse should ask about predisposing factors, such as position and activity, that preceded the onset of pain. Past experience with pain often affects how a client responds to recently perceived pain or threat of pain. Clients with chronic pain should be questioned about their usual means of pain relief; techniques proven to have been useful in the past should be used whenever possible.

Some clients are unable to describe the pain experience. Other clients who are unable to communicate include infants and young children, persons not fully conscious, those who are confused, and persons with communication barriers. In such cases, the nurse must depend on someone else, such as a family member, to aid in pain assessment. Providing a list of adjectives from which the client can select may be helpful with conscious adults who are able to communicate.

The assessment also includes observations for signs of pain. Indicators of pain include perspiration, nausea, anxiety, restlessness, tension, and changes in vital signs. Pain is often undertreated in children, perhaps because health professionals are not familiar with the common indicators of pain demonstrated by children of different ages. Pain scales have been developed for assessing pain in children. Pediatric nurses use the Oucher Scale or the Wong-Baker Faces Scale for assessment of pain in young children. It is important to be sure that the pain assessment tool used provides an objective and consistent measurement of client pain. Such scales use standardized facial expressions.

KEY NURSING IMPLICATIONS 10–1

Pain

1. Pain-relieving measures include positioning, massage, distraction, and use of analgesics.
2. Assess the onset, location, duration, intensity, and nature of pain, as well as other symptoms associated with the pain.
3. If the client is unable to provide information about pain, obtain information from the family and observe the patient for such signs of pain as anxiety, restlessness, and changes in vital signs.
4. Response to pain depends on the client's developmental level, sex, ethnic group membership, early childhood socialization, and past experiences with pain.
5. Analgesics are most effective when given before pain becomes severe.
6. Do not undertreat pain because of a fear of producing drug addiction.

Indications of pain in the neonate depend on how close to term the child was when born. Children born preterm often show no signs of discomfort and little movement with invasive procedures, such as the insertion of catheters and needles. Near-term neonates, on the other hand, may respond with general body movement and crying. Other indicators of pain in neonates include eye rolling, breath holding with cyanosis, seizures, slow heart rate, and vomiting. Infants through 12 months show pain through body movements, crying, coughing, and withdrawing the affected area. Toddlers from 1 to 3 years may indicate pain by aggressive behavior, such as biting, by quiet withdrawal, and by regression, for example, rocking. Once language skills are mastered, children can begin to express pain using their own words for discomfort. In addition, children often exhibit guarding of the painful area. If the child shows one or more indications of pain, the nurse may administer a PRN analgesic that has been ordered for the child. The child's response is assessed carefully. If pain relief occurs and the child becomes less anxious and restless, a note should be made on the care plan about the response to pain and pain relief measures.

Clients react to pain in different ways, based on their age, sex, ethnic group membership, early childhood socialization, and past experiences with pain. For example, older persons often tolerate chronic pain because they believe it is a natural occurrence in growing older. These factors must be taken into account when assessing pain.

NURSING DIAGNOSES

Including but not limited to:

- Pain related to health alteration
- Chronic pain related to disease process
- Risk for injury related to adverse effects of medication regimen
- Deficient knowledge related to individual pain control needs, disease process, medication regimen

PLANNING/GOALS

- Pain will be controlled at a level of 0–3/10 as evidenced by verbalization/actions.
- Chronic pain will be controlled at a level of 0–3 as evidenced by verbalization/actions.
- Client will demonstrate a proactive approach to own pain management.
- Client will not sustain any injuries from adverse effects of pain management regimen.
- Client will verbalize understanding of own pain management needs, disease process, and medical regimen for pain management.

IMPLEMENTATION

The goal of pain management should be to improve the client's psychological and physical welfare and to permit optimal functioning of the individual. In working toward this goal, the nurse does not rely solely on drugs to relieve pain. Alternative comfort measures, including positioning, offering information and reassurances, and demonstrating interest and concern, should be used. The client should be assisted in learning to relax, because anxiety and muscle tension may intensify the pain experience. The effectiveness of analgesics in children, in particular, may be enhanced by holding the child or by other bodily contact and through efforts to encourage sleep.

Most medication orders for analgesics are PRN orders. The nurse must often use a great deal of discretion in determining when and how

(route of administration) to administer analgesics. A frequent nursing care problem is that of unrelieved pain, caused, in part, to the tendency of nurses to withhold analgesics, particularly opioids. Nurses may be concerned about causing drug addiction or masking symptoms. Studies have shown that analgesics are most effective when pain first begins. After major surgery, clients who are adequately medicated for pain during the first 2 days postoperatively usually have a reduced need for pain medication later in the recovery period. Also, very few clients with acute pain treated in a hospital setting will become addicted to their pain medication. The behaviors often interpreted as addiction, such as requesting pain medication as soon as a specified amount of time has passed, are often indications of undermedication and unrelieved pain. The problems of those clients with chronic pain should be discussed in nursing and interdisciplinary conferences to determine the best approaches for pain management.

In addition to charting the measures used for relief of pain, the nurse should note the effectiveness of such measures. This information must be available to nursing staff on all shifts since the management of a client's pain is a team effort. Such a team effort involves consultation with the physician and pharmacist to determine what drugs, or combinations of drugs, and what routes or drug delivery systems are most effective in relieving the client's pain.

KEY NURSING IMPLICATIONS 10–2

Nursing Intervention

1. Nursing measures, such as positioning and bodily contact, should always be used to provide pain relief, even when analgesics are also used.
2. Record the effectiveness of all pain-relieving measures on the client's chart.

NONOPIOID ANALGESICS

Implementation

In addition to general nursing measures, specific nursing actions are associated with use of the various analgesics. An examination of the frequently used analgesics, beginning with aspirin, reveals some of these specific nursing measures. Because of its availability, aspirin is one of the most frequently used analgesic, antipyretic, and anti-inflammatory agents. The availability of aspirin without a prescription, however, may encourage the misconception that aspirin is harmless. The nurse should help to educate the public about the beneficial and harmful effects of aspirin and about its proper use. Aspirin should be avoided by persons taking anticoagulants because the interactive effects of these drugs may produce bleeding. Clients with gastric ulcers must also avoid aspirin and other oral salicylates because they cause gastric irritation and bleeding. Pregnant women should use aspirin carefully, as the drug crosses the placental barrier and may cause neonatal bleeding. As aspirin may result in hemorrhage, the nurse assesses the regular aspirin user for bleeding from the gums, easy bruising, *hematuria*, and tarry stools.

Some persons must avoid aspirin because of allergy. A notation of aspirin allergy must be prominently displayed on a client's chart and medication record. Persons who must avoid aspirin should be informed about aspirin substitutes, for example acetaminophen. They should be instructed to read the labels of OTC drugs, as many preparations for pain relief and colds and even some sleep aids contain aspirin or other salicylates.

Clients taking aspirin are instructed to follow the label regarding its proper use. Aspirin is sometimes used in children to decrease fever. The general rule regarding children's dosage is to give 1 grain (65 mg) of aspirin for each year of age up to 10 years of age. More accurate measurement of the dose can be obtained through the use of children's aspirin. Aspirin is less frequently used for its antipyretic effect in children than it once was because of its association with the development of Reye's syndrome. Because some people, particularly children, may experience gastric upset and nausea when taking aspirin, the dose should be taken with food or after meals. Clients with rheumatoid arthritis often take large doses of aspirin. Because of the possibility of gastric mucosal damage, it is important that the aspirin tablets that they use dissolve quickly in the stomach. The client can be taught to drop a tablet into a glass of room temperature water and time how long it takes for

the aspirin to dissolve. Brands of aspirin that dissolve within one minute are recommended for these clients. Clients should always be instructed to take sufficient fluid with aspirin to ensure that the tablets reach the stomach and dissolve readily. A full glass of water is recommended for adults. Antacids may be taken with the aspirin if the client experiences gastric discomfort. Buffered or enteric-coated preparations may also help to decrease gastric upset. However, antacids should not be taken with enteric-coated products.

Clients with diabetes mellitus who take aspirin frequently should inform health care providers of their drug use when having urine tested for *glycosuria*, as a false-positive reading may result with aspirin use.

At high doses or with continued use, aspirin may cause tinnitus (ringing in the ears) and vertigo. If these do occur, reducing the dose will reverse the adverse side effects.

A few words about the storage and safe use of aspirin are essential, as hardly a household is without this useful drug. Aspirin should be kept in closed containers and protected from moisture. This makes the family medicine cabinet in the bathroom an undesirable storage area. Also, and very importantly, aspirin must be kept in child-resistant containers and out of the reach of children. Accidental ingestion of aspirin is one of the leading causes of poisoning in children. Flavored children's aspirin is particularly attractive, but should never be given to a child with the message that it is candy. Indications of aspirin toxicity include faintness, tinnitus, hearing loss, disturbed vision, nausea and vomiting, sweating, dehydration, and rapid breathing. Parents should be advised to call the nearest poison control center if ingestion has recently occurred. If some time has passed since ingestion, the child should be immediately taken to an emergency room.

In recent years acetaminophen (e.g., Tylenol and **Datril**) has become increasingly popular as an aspirin substitute. It has overtaken aspirin as the most frequently used analgesic and antipyretic in part due to the increase in allergies to aspirin, as well as that acetaminophen causes little gastric upset and has no effect on the blood clotting process. It is useful as an analgesic and antipyretic, but not as an anti-inflammatory agent. Individuals who have been taking aspirin primarily for its anti-inflammatory effects, for example those with rheumatoid arthritis, must be told that they cannot switch to acetaminophen. The liquid preparations of acetaminophen (e.g., **Liquiprin**, **Tempra**) are frequently used to decrease fever and discomfort in infants and young children. Users of acetaminophen should be instructed to follow carefully the directions on the label. Increased use of acetaminophen has brought with it an increase in the reported number of overdosages. Safety factors discussed for aspirin also apply to acetaminophen. Indications of poisoning in the first 24 hours include nausea, vomiting, profuse perspiration, pallor,

KEY NURSING IMPLICATIONS 10–3

Aspirin and Acetaminophen

1. Aspirin is contraindicated in persons taking anticoagulants, those with gastric ulcers, pregnant women, and children with febrile illness, such as flu.
2. Aspirin allergy must be noted on the client's chart and medication record, and the client is instructed to avoid nonprescription drugs containing aspirin.
3. Use of aspirin in children has dramatically declined because of its most frequent use as an antipyretic, and it has been determined that aspirin should not be given with febrile illness caused by viruses.
4. Instruct the client to take sufficient fluid with aspirin to ensure that the tablets reach the stomach.
5. If gastrointestinal upset is experienced, aspirin can be taken with food or after meals. A readily soluble aspirin preparation should be used and a full glass of water should be taken with the aspirin. Also, an antacid may be taken or a buffered or enteric-coated product may be used.
6. Aspirin use may result in a false-positive reading for glycosuria.
7. Tinnitus and vertigo may occur with high doses or continued use of aspirin. Reducing the dose will reverse these side effects.
8. Aspirin should be stored in closed, child-resistant containers and kept out of the reach of children.
9. Overdoses with aspirin or acetaminophen must be treated promptly.

and malaise. Right upper quadrant pain may occur during the 24–48 hours following ingestion, while serious effects such as hepatotoxicity (which may appear as jaundice, *hypoglycemia* and blood coagulation defects) and renal failure may occur after as long as 48 hours. If hepatotoxicity develops, it may be treated successfully with **N-acetylcysteine** (**Mucomyst**). If the nurse is administering Mucomyst orally, there are several ways to encourage clients to take the drug, despite its unpleasant odor and taste. It can be chilled; in addition, it can be added to liquids in which its stability is maintained. Such liquids include cola beverages and citrus juices.

Propoxyphene HCl (**Darvon**) and **propoxyphene napsylate** (**Darvon-N**) are analgesics frequently used in combination with aspirin (**Darvon with ASA**), with acetaminophen (**Darvocet-N**), or with aspirin and caffeine (**Darvon Compound**). Most of the side effects noted in individuals taking propoxyphene preparations are mild. These include dizziness, sedation, nausea, and vomiting. If dizziness or sedation occur, clients should be advised to rest and to avoid changing positions rapidly. Outpatients should be cautioned against driving and the use of machinery. Serious problems can arise as a result of propoxyphene therapy; psychological and sometimes physical dependency can occur. In addition, toxic overdosages are possible, particularly when propoxyphene is ingested with CNS depressants, such as alcohol, barbiturates, and tranquilizers. For these reasons, clients should be evaluated carefully before propoxyphene compounds are prescribed. Clients who are known drug abusers or suicide-prone should be monitored carefully. The capsules or tablets should be prescribed in small quantities. All clients should be cautioned to avoid CNS depressants while taking propoxyphene. Signs of overdosage include respiratory depression, increasing drowsiness, miosis, and circulatory collapse. Treatment includes the use of naloxone (Narcan). Some clients may develop convulsions. A safe environment, including padded siderails and a safety belt for stretcher clients, must be provided. In all cases of propoxyphene overdosage, the nurse should try to obtain information about the specific product taken, so that treatment can also be initiated for the other substances ingested—for example, aspirin or acetaminophen.

Pentazocine HCl (Talwin) is a drug sometimes used by both hospitalized and outpatients for the control of mild-to-severe pain. The nurse caring for a client receiving pentazocine should be aware that respiratory depression may occur, particularly in newborns. Clients with chronic obstructive respiratory conditions must be observed carefully for respiratory distress. If respiratory depression occurs, naloxone (Narcan) will probably be ordered as an antagonist. Other adverse side effects of pentazocine may include nausea and vomiting, sedation, and decreased gastric motility with resulting constipation. Some clients may experience orthostatic hypotension, and clients should be advised not to rise or change positions too rapidly. Assistance with ambulation should be provided for clients experiencing sedation or hypotension. Outpatients should be cautioned not to drive or operate machinery.

The use of butorphanol tartrate (Stadol), buprenorphine HCl (Buprenex), **dezocine** (**Dalgan**), pentazocine (Talwin), or nalbuphine HCl (Nubain) may result in respiratory depression that can be reversed by using naloxone. Careful nursing assessment of the client's respiratory status is advised when these drugs are used, especially in clients with a history of respiratory problems.

OPIOID ANALGESICS

Implementation

Opioid drugs are some of the most effective agents used to relieve pain. In the course of their education, many nurses become concerned with producing drug-addicted clients, and become reluctant to administer opioids for the relief of pain, particularly chronic pain. Some clients are also concerned about the use of opioids for pain relief. Both nurse and client should know that drug addiction does not occur frequently with the therapeutic use of opioids. When opioid intake is tapered off gradually, as is usually the case, most clients will not experience withdrawal symptoms. For those individuals who have been taking opioids regularly over a period of time and who do notice withdrawal symptoms, **methadone** (**Dolophine**) can be given over about a 10-day period. In addition to relieving withdrawal symptoms, the methadone provides relief of pain the client may be experiencing.

KEY NURSING IMPLICATIONS 10–4

Opioid Analgesics

1. Be proactive with pain control. Offer pain medication on a routine schedule when, in the nurse's judgment, it is warranted.
2. Drug addiction does not occur frequently when opioids are used therapeutically.
3. Withdrawal symptoms can be prevented or treated by withdrawing the opioid slowly or by using methadone.
4. Assess all clients receiving opioids for respiratory depression. Do not administer opioid analgesics to clients with 12 or fewer respirations per minute. Notify the prescriber of respiratory depression.
5. Respiratory depression can be treated by the use of intravenous naloxone and other measures to support respiration.
6. Observe clients receiving opioids for hypotension, nausea, vomiting, and constipation.
7. To avoid constipation in clients receiving opioid analgesics, increase the client's intake of fluid and dietary fiber, unless such measures are contraindicated by the client's treatment plan.

To use opioids effectively, the nurse should be familiar with the usual dosage, duration of action, and side effects associated with opioid preparations (refer to Table 10–2). There are several implications of importance to nursing. One of the most significant of these is the need to act proactively when using opioid analgesics. The pain should be treated before it becomes moderate-to-severe for the opioids to be the most effective. Offering pain medication to postoperative clients on a routine schedule for the first 24–48 hours provides better pain management than administering it on a PRN basis. Respiratory depression may occur with the use of any opioid analgesics. Sleep, chronic lung disease, and interaction with other drugs, particularly CNS depressants, can intensify the respiratory depression produced by opioids. As a general rule, opioids should not be administered to clients with less than 12 respirations per minute. The physician should be immediately informed of the slow respiratory rate. Respiratory depression most frequently occurs within 30 minutes of intramuscular injection and 90 minutes of the subcutaneous injection of morphine. It may occur within 1 hour after a meperidine injection. Depressed respirations may be accompanied by hypotension, constricted pupils, and cold, clammy skin.

The treatment of respiratory depression and other toxic symptoms related to opioid overdose is relatively straightforward. The nurse should try to arouse the client and ask him/her to breathe 10–12 times per minute. If the client cannot be aroused or does not respond to these instructions, a physician should be called immediately. Currently, the most effective treatment for respiratory depression caused by opioids is the use of intravenously administered naloxone (Narcan). In addition, a respirator might be used to keep the effective dosage of naloxone relatively small. The nurse should continue to observe the client carefully after the use of naloxone as respiratory depression and/or pain may return.

Other opioid side effects with implications for nursing care include sedation and orthostatic hypotension. Hypotension is more common following meperidine administration than morphine. Hospitalized clients should ambulate with care and supervision following the administration of opioids. Siderails are recommended for use, particularly with children, elderly clients, those on stretchers, and confused clients. Clients should be instructed not to rise or change position rapidly. In addition, slight elevation of the client's legs when opioids, particularly morphine, are administered may decrease the likelihood of orthostatic hypotension. Outpatients should be cautioned against engaging in hazardous activities such as driving.

Finally, nursing intervention can prevent or alleviate the effects of opioids on the gastrointestinal tract. Nausea and vomiting occur in some clients following administration of opioids. Relief can often be obtained by encouraging rest and decreasing ambulation. Constipation occurs with the regular use of opioids. To decrease the severity of this problem, increasing the client's fluid intake and dietary fiber are suggested, unless these measures are contraindicated by the client's treatment plan.

PARENTERAL ADMINISTRATION

The nurse should be aware of several factors related to parenteral administration of analgesics. First, although pentazocine may be ordered to be given with barbiturates, these drugs should not be mixed in the same syringe. To do so can cause precipitation. Secondly, an infrequent but striking adverse side effect of pentazocine administration is the development of *sclerotic* skin lesions at the site of injection. If this occurs with subcutaneous injection, a switch to intramuscular injection or oral administration may be advisable. Rotation of injection sites should always be practiced when pentazocine is administered.

Whenever opioids are given parenterally, the nurse carefully assesses the client for respiratory depression. If a child has been given an opioid intravenously, the nurse monitors the vital signs closely for at least 30 minutes following administration. Emergency equipment to support respiration must always be available when opioids are given intravenously. Children who have received parenteral opioids should not be discharged from a health care setting until at least 2 hours following drug administration.

Whenever a parenteral analgesic has been ordered, the nurse should not change to the use of an oral dosage form of the analgesic without discussing this with the prescriber. Switching to an oral dosage form may result in a lower serum level of the analgesic, and thus, in unrelieved pain.

KEY NURSING IMPLICATIONS 10–5

Parenteral Analgesics

1. Do not mix pentazocine and barbiturates in the same syringe.
2. If sclerotic skin lesions develop with the use of pentazocine, a switch to intramuscular or oral administration is advised.
3. Be certain that all clients, but especially children, are monitored for respiratory depression following the use of parenteral opioids.
4. Do not switch dosage forms without discussing this with the prescriber.

OPIOID DRUGS AND THE LAW

Because opioid drugs are substances whose use is strictly regulated by law, special procedures are followed in their use. Such agents are kept securely locked, with two locks. Each dose must be recorded on a special record at the time it is removed to be administered to a client. Lost or contaminated doses must be accounted for on this record and signed by two nurses. Also, a check is generally made on the supply of controlled substances by two nurses at the change of each shift. Both nurses then sign the record.

When administering an opioid drug, the nurse must carefully check the physician's order. Specific laws, as well as hospital policies, govern use of these drugs. Such laws and policies define the length of time a physician's order is valid. For example, an opioid order for a client might only be valid for 48 hours. After this period, the order must be renewed by the physician before the nurse can administer the drug. When administering an opioid, the nurse checks for a valid order, and records on the special record the amount of the drug taken and the name of the person for whom it is intended. The drug, dosage, route, and time of administration are also recorded on the client's record.

KEY NURSING IMPLICATIONS 10–6

Opioid Drugs and the Law

1. All opioids are kept under double locks.
2. The use of all opioid drugs must be recorded on a special record and on the client's record.
3. Lost or contaminated doses must be signed for by two nurses.
4. Opioids are counted by two nurses, one from the oncoming shift and one from the departing shift. Both nurses sign the record.
5. The nurse must be aware of the hospital policy for stop time on opioid orders.

PATIENT-CONTROLLED ANALGESIA

Recently, there has been a dramatic increase in use of patient-controlled analgesia (PCA). This term usually means the self-administration of intravenous doses of opioid analgesics using a special infusion pump. It is often used in the relief of acute pain, for example, following surgery. PCA can be defined more broadly, however, to encompass any analgesic drug administration method that allows an individual to exercise control over self-administration. As such, PCA includes the use of oral drugs, drugs administered subcutaneously, drugs administered by the epidural or intrathecal routes, and drugs administered intravenously. PCA has been used successfully in older children and adults and represents a philosophy of treatment, rather than a single method of drug administration.

In this section, the focus is on use of a pump to administer IV bolus doses of analgesics. The section on chronic pain, which follows, will discuss other routes commonly used for PCA.

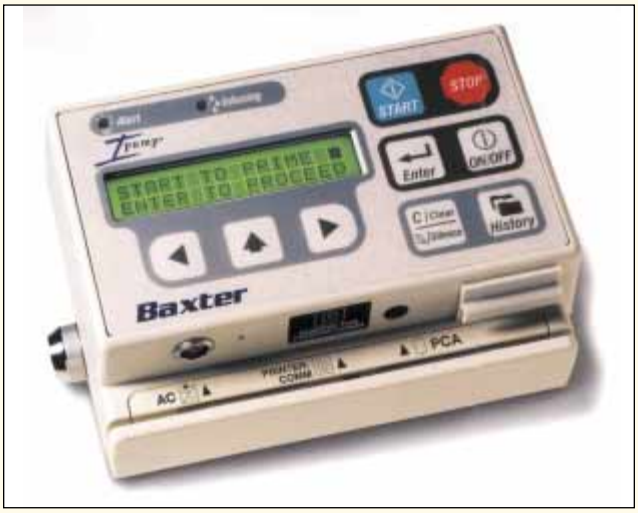
As pain is subjective, PCA has the advantage of allowing clients to assess and treat their pain continuously. Currently, the system for intravenous PCA consists of a small unit that sits on the bedside table or attaches to an IV pole and a hand-held button, similar to a call light, that the client presses to administer the medication. The unit itself consists of an infusion pump, a timing device, and a small computer. Figure 10–2 shows the Life Care PCA Infuser (Abbott Laboratories, North Chicago, IL), one of the infusers most commonly used. The pump is programmed to allow multiple doses of a drug to be delivered until a predetermined maximal dose is reached. At that point, a minimal interval period is activated, and the client is unable to administer additional analgesic until the interval

KEY NURSING IMPLICATIONS 10–7

Patient-Controlled Analgesia

1. Patient-controlled analgesia is a philosophy of treatment, rather than a single method of drug administration.
2. A pump infuser can be used to administer intravenous bolus doses of analgesics for the relief of acute pain.
3. When patient-controlled analgesia is used, the nurse retains responsibility for assessing the patient's level of comfort and for addressing the deficient knowledge related to this method of pain relief.
4. Patient-controlled analgesia has been shown to be both safe and effective in relieving pain.

A.



B.

Figure 10–2 (A) The PCA infusion pump is an example of a device that permits the client to administer a dose of analgesic drug whenever needed. *(Courtesy of Abbott Laboratories.)* (B) Ipump is a PCA infusion pump, which is an example of a device that permits the client to administer a dose of analgesia as needed. *(Photo courtesy of Baxter Healthcare Corporation, IV Systems)*

period has expired. This prevents the client from administering an overdose of the medication. Meanwhile, the unit records the number of attempts the client has made to administer a dose of analgesic and the number of doses actually delivered. The information on dosage administered is recorded in the client's chart and on a flow chart sent to the pharmacy to track analgesic use. Nurses are responsible for setting up the infusion, programming the pump as ordered, and addressing any client questions about when and how to use the PCA device. The nurse continues to assess the client's level of comfort and discusses the effectiveness of the PCA with the prescriber.

The advantages of PCA include increased client independence, improved pain control, improved pulmonary function, and early ambulation following surgery because of improved pain control. Research has shown PCA to be both safe and effective in relieving pain. Also, it has been shown to often decrease the total amount of analgesic used by the client.

Clients may also receive PCA pain control by means of an epidural catheter. This is defined as epidural analgesia. This is usually used for postoperative pain control, especially with clients who had an epidural anesthesia block during surgery or back surgery or when the client's physician believes this is the best route for pain control. **Bupivacaine**, morphine sulfate, and **hydromorphone** (**Dilaudid**) are the most common drugs used for epidural analgesia. See Table 10-8. Children using opiods via PCA pump should be placed on an apnea monitor.

CONTROL OF CHRONIC PAIN

The control of chronic pain may involve the simultaneous use of several drugs as a mixture. These drugs are usually given on a schedule, rather than on a PRN basis. Nurses who work with clients experiencing chronic pain and those who are terminally ill may have occasion to administer medications such as Brompton's mixture or similar products. Nurses should be aware of the constituents of the mixture and familiar with the adverse side effects and interactive effects of each of the ingredients. Nursing measures should be employed to reduce unpleasant side effects and to provide both comfort and emotional support to the client and family. The greatest difficulty stemming from the use of these drugs has been staff attitudes, resulting in undermedication and unrelieved pain.

Some clients, particularly those who are terminally ill, may use an infusion pump to administer intravenous opioid analgesics. These pumps are lightweight and operated by rechargeable batteries. The pump can be worn in a harness or on a belt. Its use provides analgesic administration at a continuous, predetermined rate. Most often such pumps are used in clients with a Hickman catheter inserted into the vena cava at the entrance to the right atrium. The client and family will need instruction on use of the catheter and in the procedure for heparin flush to keep the catheter patent.

Two other methods used for the relief of chronic pain include subcutaneous infusion of opioids and intraspinal opioid administration. Continuous subcutaneous infusion offers pain relief for clients who are not able to tolerate oral analgesics and who do not have suitable intravenous access. Administration of opioid analgesics is accomplished by insertion of a special subcutaneous infusion set or small gauge pediatric butterfly needle (27 G) into suitable subcutaneous tissue. Commonly used infusion sites include the outer aspect of the upper arms, abdomen, and thighs. Tubing connects the needle to an infusion device that is programmed to deliver medication at a set rate. Hydromorphone HCl (Dilaudid) is an example of a drug administered as a subcutaneous infusion for clients with pain associated with terminal cancer. Meperidine (Demerol) is not recommended for administration by this route, as it is irritating to the tissues and may cause CNS excitation. When analgesics are administered by this method, the nurse instructs the client to inspect the site at least twice a day for signs of irritation or infection. The administration site is changed weekly or more often, as needed. Recurrence of pain, once pain relief has been established, may be an indication that the narcotic is not being well absorbed. Another site should be tried before increasing the dosage or changing medications.

The two intraspinal routes used for intermittent or continuous administration of opioid analgesics are epidural (administration into the epidural space) and intrathecal (administration into the subarachnoid space). These methods block pain at the spinal cord level rather than at the brain, leaving the client's sympathetic, motor, and

TABLE 10–8

Drug Products Used for PCA

Note: Monitor the effectiveness of pain management.
Monitor respiratory status with epidural analgesia.
Monitor the insertion site for epidural to insure that the catheter does not become dislodged.

DRUG	ROUTE(S)	ADVERSE EFFECTS	NURSING IMPLICATIONS
bupivacaine (*bu-**PIH**-vah-kane*)	epidural	respiratory depression	Assess epidural catheter site every 4 hours. Monitor client's respiratory status hourly during initial therapy.
duramorph (*dur-a-morf*)	epidural	respiratory depression	See bupivacaine
Hydromorphone (*high-dro-**MOR**-fone*) HCl (Dilaudid)	IV, SC	respiratory depression	Used primarily for chronic pain associated with cancer after client has developed tolerance for morphine sulfate.
morphine sulfate (*mor-feen sul-fate*)	IV, epidural	urticaria, itching, nausea and vomiting, respiratory depression	If epidural, see bupivacaine. If IV, monitor IV site for pain (infiltration). Monitor for effectiveness.
Meperidine HCl (*meh-**PARE**-ih-deen*) (Demerol)	IV	nausea, vomiting	Usually used only if client exhibits allergy to morphine sulfate.

sensory functions intact. Figure 10–3 shows common areas of placement for an epidural catheter.

When this route initially was used to provide pain relief, external catheters were used. CNS infection is an important concern, however, and strict aseptic technique is required whenever an external catheter is used. Dressings over the site are changed every 72 hours or more often, if necessary, and the tubing and 0.22 micron filter, if used, are changed every 48 hours. Because of concerns about CNS infections, implantable drug delivery systems have been developed. The system includes a catheter implanted into the epidural or intrathecal space and a reservoir implanted in subcutaneous tissue, usually in the flank or abdominal wall. Morphine, the drug of choice, can easily be injected into the reservoir through a self-sealing membrane. **Note:** All opioid analgesics used for epidural or intrathecal administration must be preservative-free to avoid nerve tissue damage.

When an external catheter is used, the nurse must label the tubing, infusion bag, and pump with "EPIDURAL" or "INTRATHECAL" to avoid accidental injection of fluids or medications meant for other sites into the intraspinal site. Tape is placed on all injection ports connected to the epidural line to avoid accidental injection.

Following insertion of the catheter or implanted pump, the nurse monitors the client for effectiveness of pain control, headache, fever, hypotension, respiratory depression, urinary retention (which is usually temporary and may be treated with subcutaneous **bethanechol chloride** [**Urecholine**] or catheterization), and numbness or tingling in the lower legs that may indicate that the catheter is rubbing against neural tissue and needs to be repositioned by the physician. Clients receiving opioid drugs are carefully monitored, especially for respiratory depression. In some settings, an apnea monitor is used to assess respiratory status for the first 24 hours after the placement of the catheter. If a monitor is not used, the nurse assesses the ease and rate of respiration hourly for 24 hours and periodically thereafter. Raising the head of the bed 30° prevents upward migration of the drug in the spinal cord and helps prevent respiratory depression. Naloxone (Narcan) must be available to reverse respiratory depression.

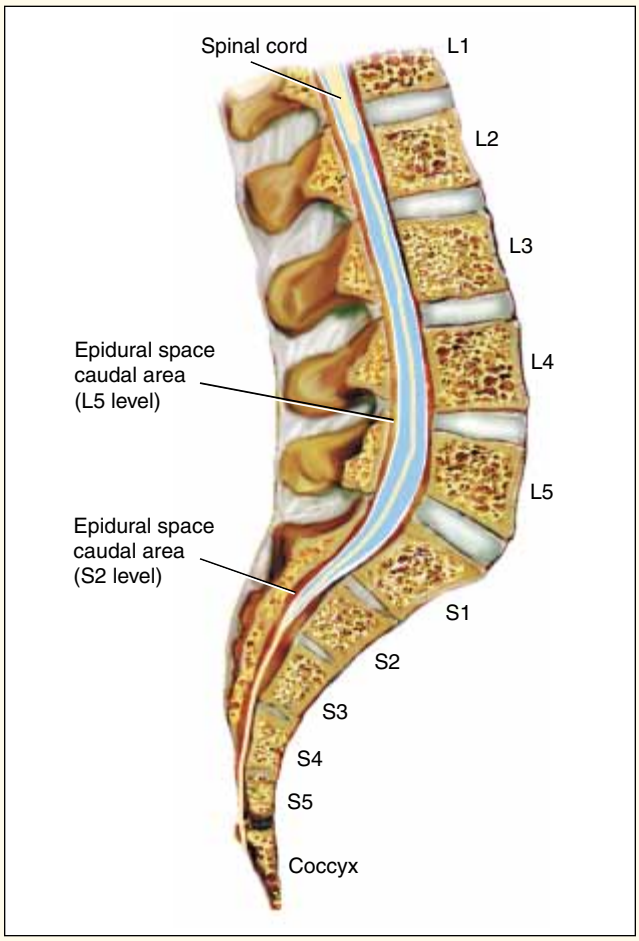


Figure 10–3 An epidural catheter is frquently inserted in one of the two sites indicated.

Opioids given by intraspinal routes may cause pruritus that can be relieved through the administration of **diphenhydramine HCl** (Benadryl). Pruritus usually ceases within a day or two. Nausea and vomiting also may occur and usually remit with continued use.

Discharge teaching for clients with implantable pumps focuses on resolution of their dificient knowledge. Clients are instructed to report expected changes in altitude, such as a prolonged vacation in the mountains, as this may alter the rate of drug infusion. They must also avoid exposure to extreme heat or cold and avoid rough physical activity that could damage the pump. Prolonged fever must be reported to the physician. In addition, clients are taught how to keep a daily record of supplemental analgesic use. They are instructed to carry a card concerning their pump, so other health professionals will be aware of it in an emergency situation. Finally, clients are told that the pump may activate metal detection devices. See Nursing Care Plan 10–B for additional information about the care of a client with an epidural catheter.

In some clients experiencing pain, especially those with chronic pain, placebos may be used to provide analgesia. Placebos are generally used when there is no specific treatment for the client's pain or illness or when there are significant disadvantages to using available treatments. Disadvantages might include the development of respiratory depression in clients with chronic respiratory disease, for example. Placebos are sometimes used in clients who have not responded to other pain relief measures. A trusting relationship should exist between the client and staff, particularly the prescriber, whenever a placebo is used. It is important that the staff be prepared to discuss the use of the placebo when —not if—the client learns the nature of the medication. The message given to the client is that there is no particular drug useful in treating the pain they have been experiencing. In addition, it has been the staff's experience that the body can often heal itself and that placebos may be helpful in starting that process.

Whenever analgesics are used, the nurse should take advantage of the placebo effect. It is often helpful, after administering the medication and providing comfort measures, for the nurse to reassure the client by indicating confidence in the effectiveness of the treatment to relieve pain.

KEY NURSING IMPLICATIONS 10–8

Chronic Pain

1. Chronic pain may be controlled through the regular basis use of single or a combination of analgesics.
2. Infusion pumps may be used to administer intravenous or subcutaneous opioid analgesics to outpatients with chronic pain.
3. Intraspinal routes can be used for the intermittent or continuous administration of opioid analgesics. Analgesics administered this way must be preservative-free.
4. Placebos may be used, if there is no specific treatment for the client's problem or if there are significant disadvantages to using available treatments.
5. Whenever analgesics are used, the nurse should take advantage of the placebo effect.

NURSING CARE PLAN 10–A

A Client Receiving Morphine Sulfate Following Cholecystectomy

Patricia Patterson, age 42, was admitted to the hospital after several attacks of lower right quadrant pain. The preoperative testing indicated that Ms. Patterson had appendicitis and an appendectomy was performed this morning. Her pain medication is morphine SO_4 IV via PCA (patient-controlled analgesia). The order reads: Morphine sulfate 1 mg/hour continuous and 0.5 mg, every 8 minutes PCA with a 4-hour lockout interval. With this order, Ms. Patterson cannot self-administer (PCA) more than 15 mg morphine sulfate in a 4-hour period. Ms. Patterson has spent 2 hours in the recovery room following surgery. When she arrives in her room postoperatively, she is awake and moaning with pain. The nurse assesses vital signs and reminds her to use the PCA for pain relief.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Ask client to describe severity (scale 1 to 10; 10 most severe), location, and type of pain. Observe for restlessness, diaphoresis, tachycardia.	Pain: acute: related to tissue trauma secondary to surgical procedure.	Client will verbalize understanding of pain control with the use of PCA. Client will demonstrate the proper use of PCA by first post-operative day.	Provide analgesia via PCA. Before surgery instruct client in the use of the PCA device. Instruct client to push button to receive a premeasured dose of IV morphine sulfate. When dose is delivered the machine will not permit client to have another dose within 10 minutes. Remind client that controller is set so overdose cannot occur.	On a scale of 1 to 10, client verbalizes adequate relief from pain at a level of 0 to 3.
Assess skin areas for signs of irritation and breakdown. Assess wound healing.	Impaired skin integrity related to tissue trauma secondary to surgical procedure.	Client will demonstrate progressive wound healing with no signs or symptoms of infection during hospitalization.	Check dressings and change as needed. Inspect wound for intact sutures and approximated wound edges. Maintain sterile technique to prevent wound infection.	Client demonstrates progressive wound healing, with no signs of redness or infection. Skin clear and intact. Incision intact; edges well approximated.
Respiratory rate and rhythm. Breath sounds.	Risk for ineffective breathing pattern related to pain and effects of anesthesia.	Client will have respirations within normal limits within 24 hours of surgery.	Implement preoperative teaching for coughing and deep breathing. Turn, cough, and deep breath q2h. Position in semi-Fowler's. Monitor blood gases.	Client demonstrates an effective breathing pattern, clear breath sounds, and maintains blood gases within normal limits (WNL).
IV site, body temperature.	Risk for infection related to intravenous administration of fluid and medications.	Client will not develop infection or inflammation at the IV site during hospitalization	Assess integrity of IV site every shift. Use sterile technique when changing site dressing or discontinuing IV. If redness, pain, or swelling occur, change IV site.	Client demonstrates no signs and symptoms of infection. IV site is changed if pain, redness, or swelling occurs.

Heart rate, blood pressure, normal skin turgor, moist mucous membranes, intake and output weight.	Risk for deficient fluid volume related to inadequate fluid intake/active fluid loss.	Client will stabilize vital signs within 2 hours after surgery and will not show signs of fluid loss.	Medicate for nausea to prevent vomiting. Monitor laboratory tests for electrolytes and complete blood count. Monitor vital signs. Report drops in blood pressure or increases in heart rate. Monitor intake and output. Monitor skin turgor.	Client demonstrates adequate fluid volume and electrolyte balance as manifested by urine output above 30 mL/hr, vital signs within normal limits, consistency of weight, and normal skin turgor.
Learning needs for care of client following discharge.	Risk for fluid volume excess related to excessive fluid intake/stress. Deficient knowledge (postoperative home care).	Client will stabilize vital signs within 2 hours after surgery and will not show signs of fluid excess. Client will demonstrate understanding of discharge instructions regarding wound care, diet, activity, need for follow-up, and signs and symptoms of complications prior to discharge.	Monitor IV rate, use an IV pump for hypertonic solutions. Monitor laboratory tests for electrolytes and CBC. Monitor vital signs, report increase in BP, bounding heart rate, dyspnea, and jugular vein distension. Monitor breath sounds for presence of rales; assess for edema. Teach client principles of infection control. Teach wound care with return demonstration. Teach importance of keeping appointments and notifying physician if unusual symptoms develop. Provide instruction regarding diet, activity, and signs and symptoms of infection.	Client demonstrates adequate fluid volume and electrolyte balance as manifested by vital signs within normal limits, consistency of weight, absence of edema, and normal breath sounds. Client has a plan for follow-up care that includes diet, allowed activities, and when to call physician. Client demonstrates wound care.

NURSING CARE PLAN 10–B

A Client Receiving Morphine via Epidural Catheter Following Hysterectomy

Geraldine Coats, age 44, is admitted to the hospital and scheduled for an abdominal hysterectomy. She has elected to have epidural anesthesia rather than inhalation anesthesia. Her physician informs her that the epidural catheter will be left in place following surgery to permit her to receive analgesic medication by this route. Following 1 hour in the postanesthesia care unit, Ms. Coats is returned to the client unit with an order for morphine. In the recovery room, she receives morphine (Astramorph/ PF) 5 mg via epidural catheter. On return to the client unit, she may receive Astramorph/PF 1 mg q4h, dosage not to exceed 10 mg in 24 hours.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Understanding of epidural anesthesia and analgesia.	Deficient knowledge (use of epidural catheter for anesthesia and postoperative pain control).	Client will demonstrate understanding of epidural catheter use and postoperative pain control by first postoperative day.	Before surgery, describe placement of catheter, use of apnea monitor, and postoperative pain control by first postoperative day. Reinforce information after surgery.	Client verbalizes understanding of catheter use and postoperative pain control.
Placement of catheter, pain, movement of extremities, headache, sensorium.	Risk for injury related to displacement of catheter and use of inappropriate medications.	Client will not experience injury during use of epidural catheter.	Assess for headache, level of pain, ability to use extremities, changes in level of consciousness, security of catheter. Negative aspiration before injecting medication. Use only preservative-free morphine. Administer no other medication or fluids through the epidural catheter. Clearly mark the catheter for epidural medication only.	Catheter remains in place, and client experiences no injury.
Catheter site. Body temperature. White blood cell count. Nuchal rigidity. Headache.	Risk for infection at catheter site or in central nervous system (CNS) related to epidural catheter.	Client will be free of infection during hospitalization.	Monitor catheter insertion site q8h for redness, edema, and drainage. Use sterile technique in administering morphine and in dressing changes. Assess vital signs and question client about nuchal rigidity and headache. Assess ability to move extremities.	Client demonstrates no signs and symptoms of local or CNS infection.
Ease and rate of respiration. Level of sedation.	Risk for ineffective breathing pattern (respiratory depression) related to epidural analgesia.	Client will maintain adequate oxygenation during use of epidural analgesia.	Monitor respirations and level of sedation every hour for the first 24 hours and then every 4 hours until 24 hours after epidural analgesia has been discontinued. Administer no other opioids or CNS depressants. Have naloxone (Narcan) 0.4 mg and emergency equipment available for emergency use.	Client maintains nonlabored respiratory rate above 6/min and is easily aroused during epidural analgesia.

Skin integrity.	Altered comfort (pruritus): Related to morphine-induced histamine release.	Client will have minimal discomfort from pruritus during use of epidural analgesia.	Assess for signs and symptoms of pruritus. Request a PRN order for antipruritic medication. Prevent excessive perspiration by maintaining comfortable room temperature. Provide soothing skin care with tepid water.	Client reports signs and symptoms of pruritus immediately. Client verbalizes relief from pruritus 15 minutes following an intervention.
Urinary output.	Risk for urinary retention related to atony of bladder secondary to epidural analgesia.	Client empties bladder completely during use of epidural analgesia.	Measure intake and output q4h for 24 hours and q8h thereafter. Palpate bladder for distension. Inquire about discomfort q8h. Teach client to report any discomfort.	Client maintains adequate urinary function without bladder distention.
Blood pressure.	Risk for decreased cardiac output related to vasomotor disturbance secondary to epidural analgesia.	Client will not experience hypotension during use of epidural analgesia.	Take blood pressure and pulse q4h. Provide adequate fluid intake. Dangle legs before getting out of bed. Elevate legs above heart level if hypotension occurs. Teach client to report any sensation of dizziness or light-headedness.	Blood pressure remains at client's normal level.
Nutritional status. Gastrointestinal comfort.	Risk for deficient fluid volume related to nausea and vomiting secondary to epidural analgesia.	Client will demonstrate no signs and symptoms of dehydration during hospitalization.	Assess for nausea and vomiting every 4 hours. Gradually increase activity. Introduce fluids and food in small quantities. Request a PRN order for an antiemetic.	Vital signs remain within normal limits, mucous membranes moist, skin turgor normal.
Pain level (scale 0 to 10; 10 severe).	Alteration in comfort: pain: Acute: Related to tissue trauma secondary to surgery.	Client will verbalize control of incisional pain after intervention.	Measure pain level on a scale of 0 to 10 q4h. Administer medication PRN. Ensure continued placement of catheter.	Client verbalizes pain relief on a scale of 0 to 10 within 15 minutes of pain relief interventions at a level of 0 to 3.
Vital signs.	Risk for decreased cardiac output related to autonomic blockade secondary to epidural analgesia.	Client will maintain adequate cardiac output and VS WNL during use of epidural analgesia.	Take vital signs q2h for 8 hours, then qid or more often as indicated. Advise client to change position gradually. Assess tissues for adequate perfusion.	Client demonstrates no signs and symptoms of decreased cardiac output such as hypotension, tachycardia, restlessness, dysrhythmias, and vertigo.

PAIN MANAGEMENT IN END-OF-LIFE CARE

Pain management in end-of-life care has become an increasingly significant issue for health care providers. For decades, clients and their families have had overwhelming concern about pain relief during the terminal stages of such diseases as cancer. As a result, some state boards of nursing in conjunction with medical and pharmacy boards have issued statements concerning pain management in end-of-life care to use as guidelines for doctors, nurses, and pharmacists to better ensure that palliative care be focused on controlling discomfort.

Pain management for terminally ill clients has been the major focus for *hospice* for more than 20 years. The hospice movement was founded by Dame Cicely Saunders who said, "You matter until the last moment of your life, and we will do all we can, not only to help you die peacefully, but to live until you die" (National Hospice Foundation, 2001). That philosophy has been the goal of all local, state, and national hospice organizations. At the center of hospice is the belief that each of us has the right to die pain-free and with dignity. The focus is on caring, not curing. The National Hospice Foundation was established as a charity organization in 1992; however, local and state organizations have been actively supporting clients and their families—physically, emotionally and spiritually—for more than two decades. Hospice has been a major force in changing attitudes about opioid dosing, by helping health care professionals understand that the dose of opioid required for management of the intractable pain of cancer frequently far exceeds the dose needed to control other more temporary causes of pain, such as surgery. Hospice care is recognized by government health insurance carriers (Medicare, Medicaid), as well as private insurance companies and health maintenance organizations. Hospice care is available 24 hours a day, 7 days a week for those clients who have a terminal illness and who are no longer actively pursuing treatment. Hospice provides care in the home, in hospitals, and in other health care facilities, as well as at inpatient hospice facilities.

EVALUATION

- Pain is controlled at a level of 0–3/10 as evidenced by verbalization/actions.
- Chronic pain is controlled at a level of 0–3 as evidenced by verbalization/actions.
- Client demonstrates a proactive approach to personal pain management.
- Client does not sustain any injuries from adverse effects of pain management regimen.
- Client verbalizes understanding of own pain management needs, disease process, and medical regimen for pain management.

Nursing interventions for clients experiencing alterations in comfort due to acute or chronic pain are varied. Nurses use both pharmacological and nonpharmacological measures to ease pain. In evaluating the effectiveness of these interventions, it is important to regularly assess the client's level of comfort. This assessment was discussed earlier in this chapter. It is important, however, to stress measurement of pain in discussing evaluation of care. Techniques used to assess pain must be appropriate for the client's developmental level, language and communication skills, and level of consciousness. Pain can be assessed in children through measurement of physiological or behavioral responses to pain. A child's drawings may indicate unalleviated pain. Children with language skills can be asked to indicate pain in using a color chart with red, for example, being severe pain. In measuring pain in adults, the nurse can use a 10-point scale with 1 being pain-free and 10 being the worst pain imaginable. This assessment can be done before and after administration of analgesics. The outcomes of this evaluation are then used in modifying the client's plan of care.

KEY NURSING IMPLICATIONS 10–9

Evaluation of Interventions to Relieve Pain

1. Regularly assess the client's level of comfort.
2. Methods of measuring pain must be appropriate for the client's developmental level, language skills, and level of consciousness.
3. The outcomes of evaluating level of comfort before and after pharmacologic and nonpharmacologic interventions are used in modifying the plan of care.

CASE STUDY

Susan Mason is a 52-year-old woman with a history of chronic bronchitis and metastatic breast cancer involving multiple osseous sites. She suffers from constant excruciating pain, which is intensified by ambulation. Regular doses of 600–1,200 mg of aspirin or acetaminophen provide only minimal relief, so the physician prescribes oxycodone with acetaminophen (Percocet) tablets ii, q4h. After 2 days of Percocet therapy, the client experiences severe breathing difficulty which is relieved by the use of a mechanical respirator. Because Percocet does not completely control her pain, the client is placed on a regimen of Roxonal 10 mg solution and **promethazine** (**Phenergan**) 25 mg IM q4h, as well as **docusate sodium** (**Colace**) 100 mg BID, a stool softener.

Questions for Discussion

1. Would the use of higher aspirin or acetaminophen doses have been justified in treating this client?
2. What aspect of this client's drug therapy could have been responsible for her breathing difficulty?
3. What is the purpose of using promethazine with each Roxonal administration?
4. Why is the use of a stool softener indicated for this client?
5. Would the use of the opioid analgesics on a PRN basis be preferable to their regular q4h administration for this client?
6. What nursing action would be appropriate in monitoring Mrs. Mason's response to the Roxonal?

HOME CARE / CLIENT TEACHING

1. Analgesics, like all medications, must be kept out of the reach of young children.
2. Teach parents to never use aspirin for a young child or teenager who has a viral infection.
3. Encourage client to keep a journal of pain experience, including pain management, both pharmacologic and nonpharmacologic.
4. Client should follow directions for taking any pain medication as prescribed and should be informed about adverse effects, especially nausea and vomiting by health care provider.
5. Client should be aware of risk of constipation and be informed to drink at least 2,400–3,000 ml/day, unless contraindicated.
6. Clients should be instructed to change positions slowly to prevent orthostatic hypotension.
7. Clients with implanted pumps for continuous administration of analgesics are instructed to keep a daily record of supplemental analgesic use. They are also advised to report expected changes in altitude to the physician and to avoid exposure to extremes in temperature and rough physical activity. Prolonged elevation of body temperature must be reported to the physician.
8. Clients with central venous accesses for infusion of analgesics should be instructed about aseptic technique during dressing changes and to be sure to report fever to health care provider.
9. Hospice care is becoming increasingly common in homes. Pain management is one aspect of a holistic approach to caring for the client and family. Related aspects of care include providing for comfort through symptom management, assisting with general hygiene, and openly discussing the approaching death with the client and family.

CRITICAL THINKING EXERCISES

1. Prepare a chart with the following information: (1) a list of the major classes of analgesics and antipyretics, (2) an example of each class, (3) the major therapeutic actions of each class, and (4) adverse effects of each class. Upon completion, study the chart and be able to recommend nursing interventions applicable to clients taking the drugs given as your examples.
2. Visit a local pharmacy and make a list of the over-the-counter preparations containing aspirin.
3. Design and evaluate a technique that might be useful in assessing pain (for example, a play, chart, questionnaire, etc.).
4. Talk with a pediatric nurse about the measures he/she has found most helpful in relieving the pain of young children.
5. Initiate a class discussion on attitudes relating to pain relief with drugs, particularly opioid drugs.
6. Examine the recordkeeping systems for opioid drugs used in your clinical facility. Observe the opioid-controlled substances count at change of shifts.
7. Practice programming a patient-controlled analgesia infuser.
8. Make a home visit with a hospice nurse and observe how pain management interventions are implemented in the home.

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Anesthetics

11

OBJECTIVES

After studying this chapter, the student will be able to:

- Differentiate the characteristics of the four stages of general anesthesia
- Identify major therapeutic actions and adverse effects of the most commonly used preanesthetic drugs
- Identify major therapeutic actions and adverse effects of the most commonly used anesthetic agents
- Describe the procedure for using tetracaine-adrenaline-cocaine solution as an anesthetic agent for repair of lacerations
- Apply the nursing process for clients receiving each of the major classes of anesthetic and preanesthetic drugs
- Identify the nursing needs and appropriate intervention for a client with malignant hyperthermia

Anesthetics are agents that interfere with nerve conduction and thereby diminish pain and sensation. There are two major classes of anesthetic agents, general anesthetics and regional anesthetics. *General anesthetics* are drugs causing a partial or complete loss of consciousness. They may also produce analgesia and muscle relaxation. Such anesthetics are used when profound muscle relaxation and loss of consciousness are desirable—for example, during abdominal surgery such as removal of the gallbladder. *Regional anesthetics* block nerve conduction only in the area to which they are applied and do not cause a loss of consciousness. They are employed in situations in which loss of consciousness and/or widespread muscle relaxation are not necessary or desirable, for example during childbirth.

GENERAL ANESTHESIA

The relief of surgical pain has been an objective of medical science for thousands of years. Many ancient documents have revealed ingenious and often cruel techniques used to render surgical clients temporarily unconscious. Such procedures ranged from asphyxiation to cerebral concussion and frequently caused more pain and suffering than the actual surgical procedure. In later years, the use of narcotics such as opium (**laudanum** [**tincture of opium**]) as well as **hashish** and alcohol was commonplace and represented the only means for reducing the pain of surgery. Although the anesthetic properties of nitrous oxide gas were first described in the middle of the eighteenth century, it was not until the mid-nineteenth century that gaseous anesthetics, namely **nitrous oxide** (laughing gas), **ether,** and **chloroform** became popular. In the one hundred years to follow, many general anesthetics were developed.

A number of theories have been proposed to describe the mechanism of action of the general anesthetics. Many of these have contributed to the understanding of anesthesia, but none has been able to completely unravel all aspects of general anesthetic action. Overton and Meyer in 1901 proposed one of the earliest and most popular theories. They suggested that the more fat soluble an anesthetic drug is, the more rapidly it will enter the central nervous system (CNS) (via the reticular activating system) and the more pronounced its CNS-depressant action will be. This theory describes why anesthetics rapidly enter the brain, but does not explain why all lipid-soluble substances do not exert anesthetic activity. It is currently believed that general anesthetics inhibit nerve conduction by altering the movement of ions in and out of nerve cells, thereby interfering with the conduction of nerve impulses either along the nerve fiber or across the synaptic space.

Although a complete understanding of anesthetic activity still does not exist, many of its effects on the body have been well established. It has been determined, for example, that clients receiving general anesthesia pass through a progression of several stages of anesthesia. Stage 3 (surgical anesthesia) is divided into four planes. These planes represent the gradual progression of this stage from Plane 1 to Plane 4. (Plane 4 should not be reached, as this represents extreme hemodynamic and respiratory compromise.) During Plane 1, muscle tone decreases: eyelid, gag, and swallow reflexes are lost. This plane is appropriate for such surgeries as craniotomies, reduction of small fractures, and mastectomies. During Plane 2, muscle tone continues to decrease, pauses occur between respirations, and there is a slight change in the pupils. This plane is used for large-bone surgeries, amputations, and thoracic surgeries. Plane 3 results in markedly decreased muscle tone and pupil dilation. Rectal surgeries, upper abdominal surgeries, and hernioplasties are performed in this plane. Finally, during Plane 4, which should not be reached, pupils are widely dilated and do not respond to light, intercostal muscles are paralyzed resulting in respiratory paralysis, and pulse and blood pressure decrease. This plane is quickly followed by Stage 4—medullary paralysis—in which the client is near death. All stages are summarized in Table 11–1. By observing the client for the characteristics of these stages, the anesthetist can gauge the proper time for surgery to begin and the point at which overdosage takes place. The nurse uses this knowledge to prepare the client by providing information in response to inquiries, reducing anxiety and promoting quality care through client education and nursing intervention.

General Anesthetics Administered by Inhalation

Certain drugs that are gases or volatile liquids at room temperature are administered by inhalation in combination with air or oxygen. They may be administered in two ways: semiclosed method and closed method.

Semiclosed method. A gas mixture from a reservoir containing the anesthetic is provided through a mask that is connected to it. Exhaled gases escape through a system of valves to the environment, so that rebreathing of the anesthetic gas mixture is prevented. Although this technique does provide good control of the anesthetic dose, the expulsion of exhaled gases into the environment may create a hazardous situation.

Closed method. This method can be used with volatile liquids or gases. It consists of a completely closed system, generally as part of an anesthetic machine that fits over the face of the client and provides an anesthetic gas mixture that can be carefully regulated by the anesthetist by the use of accurate flowmeters. By a complex process, carbon dioxide and moisture can be removed from exhaled gases and may be rebreathed. Such a closed system enables the anesthetist to monitor the client carefully and control the anesthesia, while preserving the safety of those working around the client as well.

General anesthetics administered by inhalation, because of their action on many organ systems, may produce a number of adverse effects. Some of these effects are minor, but others may be serious. Many gaseous anesthetics may produce nausea and vomiting because of their action on the CNS. In addition, some agents produce alterations of cardiac rhythm, alter respiration rate and cardiac output, and lower blood pressure. Several anesthetics may alter liver function and may cause the development of hepatotoxicity.

Table 11–2 provides a comparison of the properties of general anesthetics administered by inhalation.

TABLE 11–1

Changes in Body Function During Stages and Planes of Anesthesia*

BODY FUNCTION	STAGE 1 (ANALGESIA)	STAGE 2 (EXCITEMENT OR DELIRIUM)	STAGE 3 (SURGICAL ANESTHESIA)				STAGE 4 (MEDULLARY PARALYSIS)
			Plane 1	*Plane 2*	*Plane 3*	*Plane 4*	
Consciousness	conscious	lost	unconscious	—	—	—	—
Respiration	normal or slightly increased	rapid and irregular	regular	normal	deep and diaphragmatic	depressed	respiratory paralysis
Pupil size	moderately dilated	widely dilated	somewhat constricted	normal or slightly dilated	moderately dilated	very dilated	completely dilated
Eye movement	normal	rapid	rapid	absent	—	—	—
Corneal reflex	present	present	present	absent	—	—	—
Pharyngeal (gag) reflex	present	present	absent	—	—	—	—
Heart rate	increased	increased	decreased or normal	normal	increased	decreased	—
Blood pressure	normal or slightly elevated	elevated	normal	normal	decreased	decreased	extremely low
Skeletal muscle response	normal tone	increased tone	some muscle relaxation	moderate muscle relaxation	complete muscle relaxation	complete muscle relaxation	flaccid
Note:	This stage suitable for some dental procedures and second stage of labor.	Incontinence, laryngospasm, and other reflex responses may occur.	Most surgical procedures are done while the patient is in plane 2 or just passing into plane 3.				This is the toxic stage of anesthesia. Respiratory collapse is followed by complete circulatory collapse.

*Some characteristics may be different when using different anesthetics.

General Anesthetics Administered by Injection

These agents are generally used for induction of anesthesia before using inhaled agents. They provide a sedative action for clients who might become apprehensive when a mask is placed over their face and also permit the administration of lower concentrations of inhalational anesthetics. Anesthetic induction with these agents occurs rapidly (generally in less than 30 seconds).

A commonly used class of injectable anesthetics are the ultrashort-acting barbiturates, such as **thiopental sodium**, **ketamine**, **methohexital sodium**, and **thiamylal sodium** (discussed in more detail in Chapter 17). Because of their brief duration of action, these agents are frequently used for minor surgical procedures. When administered

TABLE 11–2

General Anesthetics Administered by Inhalation

Note: Carefully monitor vital signs of all postanesthesia clients.
Inhalational anesthetics may trigger malignant hyperthermia. Dantrolene has been used to prevent and treat this condition (see Chapter 20).
Ensure the physical safety and patency of airway in all persons who are receiving or who have received anesthetic agents.

DRUG	PHYSICAL STATE AT ROOM TEMPERATURE	NURSING IMPLICATIONS
cyclopropane *(**sigh**-kloh-**PROH**-payn)*	gas	Mixtures of cyclopropane and oxygen are explosive. Cylinders containing cyclopropane are always orange. Nausea, vomiting, headaches, hypotension, and/or delirium may occur. Small doses of narcotics given just before completion of surgery may lessen nausea and confusion.
desflurane *(**DESS**-floo-rayn)* (Suprane)	volatile liquid	Avoid use in clients in whom increases in heart rate or blood pressure are not desired. Not for use in pediatric clients. Administer only using special vaporizer designed for desflurane administration.
enflurane *(**EN**-floo-rayn)* (Ethrane)	volatile liquid	May provide moderate muscle relaxation. Can sensitize heart to action of sympathomimetic agents (e.g., epinephrine). May cause renal damage or may damage impaired kidneys due to release of fluoride from drug. Not flammable.
halothane *(**HAL**-oh-thayn)* (Fluothane, Somnothane ✱)	volatile liquid	Most metals are corroded or tarnished by halothane. Halothane is a poor analgesic and must often be supplemented with analgesics during surgery. Not flammable. May cause changes in heart rate and rhythm. May induce hepatic dysfunction. Atropine may be used to reverse bradycardia. Provide for warmth as shivering is common during recovery period.
isoflurane *(eye-soh-**FLUR**-ayn)* (Forane)	volatile liquid	Monitor respiration carefully while client receives this drug. Produces rapid onset and recovery.
methoxyflurane *(meh-**thock**-see-**FLUR**-ayn)* (Penthrane)	volatile liquid	Provides both anesthetic and analgesic action. Has a slow onset and a long duration of action. May cause renal failure or damage. Not explosive in anesthetic concentrations. Seldom causes nausea or vomiting. May enhance the adverse effects of some antibiotics (e.g., kanamycin, gentamicin, tetracycline).
nitrous oxide *(**NIGH**-trus **OX**-eyed)* (laughing gas)	gas	Most popular anesthetic gas. Since it is a weak anesthetic, nitrous oxide is generally used in combination with other anesthetics. Oxygen should be administered for several minutes after anesthesia to prevent development of hypoxia. Cylinders containing nitrous oxide are always blue. Not explosive.

intravenously, they are excellent for the induction and maintenance of surgical anesthesia. They are, however, poor analgesics and must generally be used in combination with inhaled anesthetics. Barbiturates tend to depress the circulatory and respiratory system as well as the CNS. This may be hazardous for clients with preexisting cardiovascular or respiratory disease.

Ketamine HCl (**Ketalar**) is a nonbarbiturate, injectable general anesthetic, which, unlike the barbiturates, does produce both general anesthesia and extensive analgesia. It has found wide acceptance for use in diagnostic and/or surgical procedures that do not require skeletal muscle relaxation. It may be used either intramuscularly or intravenously prior to the administration of inhaled anesthetics to permit smoother anesthetic induction and to supplement low-potency inhaled anesthetics such as nitrous oxide. Some clients may experience emergence reactions consisting of hallucinations, confusion, excitement, and irrational behavior. Such reactions may last a few hours but may recur up to 24 hours postoperatively. The use of lower dosages and IV **diazepam** may reduce the severity of such reactions.

Etomidate (**Amidate**) is also a nonbarbiturate injectable anesthetic. It acts like the injectable barbiturates to produce rapid induction of anesthesia. It does not, however, produce significant cardiovascular or respiratory depressant effects.

Midazolam HCl (**Versed**) is an injectable benzodiazepine chemically related to diazepam (Valium) and other benzodiazepines. When administered intravenously, midazolam HCl induces anesthesia within 1.5 to 2.5 minutes, depending on whether a narcotic drug has been administered at the same time. The drug may be administered intramuscularly or intravenously to produce preoperative sedation or intravenously to produce conscious sedation prior to short diagnostic or *endoscopic* procedures.

Propofol (**Diprivan**) is a drug administered intravenously in conjunction with other anesthetics to induce and maintain general anesthesia. A hypnotic effect is generally produced within 40 seconds after administering a rapid IV bolus dose of the drug. Anesthesia can be maintained by administering propofol by infusion or intermittent IV bolus injection. As propofol is an emulsion, it must not be used if there is evidence of separation of the phases of the emulsion. Although the drug is compatible with many IV diluting fluids, it should only be administered into a running IV catheter. Its compatibility with blood, serum, or plasma has not been established.

The greatest advantages in the use of intravenous anesthetics include their:

- rapidity and ease of action
- relative inability to stimulate salivation or emesis
- nonexplosive nature

Their major disadvantages include:

- ability to cause *apnea*, coughing, *laryngospasm*, and bronchospasm
- difficulty in controlling their adverse effects, as it is impossible to remove the drug from the body once it has been introduced into the bloodstream

Table 11–3 lists the properties of the injectable anesthetics used in the United States.

Adjuncts to General Anesthesia

Most clients can be anesthetized quickly and safely without passing through each of the stages previously described. This is done by the judicious use of medications before, during, and following anesthesia, as well as by the proper combination of general anesthetics.

Preanesthetic medications are used prior to the administration of an anesthetic to facilitate induction of anesthesia and to relieve anxiety and pain. They may also be used to minimize some of the undesirable aftereffects of anesthetics, such as excessive salivation, *bradycardia*, and vomiting. To accomplish these objectives, several drugs are often used at the same time. The following drugs are commonly used as preanesthetic medications: sedative-hypnotics, antianxiety agents, opioid and nonopioid analgesics, antiemetics, and anticholinergics.

Sedative-hypnotics (e.g., pentobarbital, secobarbital). These provide sedation and relieve preoperative anxiety, while having little depressant effect on respiration. **Hydroxyzine** is an antihistamine that is particularly useful, as it not only causes sedation but also reduces salivation and acts as an antiemetic.

Antianxiety agents (e.g., **promethazine**, diazepam, hydroxyzine). These produce sedation, reduce apprehension, and provide a feeling of detachment without causing loss of consciousness. Promethazine and hydroxyzine also exert

TABLE 11–3

General Anesthetics Administered by Injection

Note: Carefully monitor vital signs.
Ensure physical safety and patency of airway.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
fentanyl citrate and droperidol *(**FEN**-tah-nil **SIH**-trayt* and *droh-**PER**-ih-dohl)* (Innovar)	IV	0.1 mL/kg of body weight, injected over a period of 5–10 minutes of concentration of 2.5 mg droperidol and 0.05 mg fentanyl/mL	Although technically not an anesthetic, this combination provides potent analgesic and tranquilizing action without resulting in loss of consciousness. If postoperative analgesia is required, the dosage of the analgesic should be decreased. Postanesthesia effects may include hypotension, emergence delirium, nausea, vomiting, and shivering.
ketamine HCl *(**KEET**-ah-meen **hy**-droh-**KLOR**-eyed)* (Ketalar)	IM, IV	IM: 5–10 mg/kg IV: 1–2 mg/kg/dose or 0.5 mg/kg/min	Indicated for procedures that do not require skeletal muscle relaxation. May produce an increase in blood pressure. Incompatible with barbiturates; use separate syringes. May result in emergence reactions with delirium and excitement up to 24 hrs post-anesthesia. To minimize, place clients in quiet environment and disturb as little as possible during emergence, use benzodiazepines.
methohexital sodium *(**meth**-oh-**HEX**-ih-tal **SOH**-dee-um)* (Brevital Sodium, Brietal 🍁)	IV	Induction: 1–2 mg/kg Maintenance: 0.25–1 mg/kg of 0.2% solution	Solutions of drug may be used as long as they are clear and colorless. Do not mix solutions of the drug with acidic solutions. Reconstituted solution is stable for 24 hours at room temperature.
midazolam HCl *(mid-**AZ**-oh-lam **hy**-droh-**KLOR**-eyed)* (Versed)	IM, IV	IV: 0.15–0.35 mg/kg IM: 0.07–0.08 mg/kg	Do not use in clients with open-angle glaucoma unless the client is receiving appropriate glaucoma therapy. Administer drug slowly.
propofol *(**PROH**-poh-fohl)* (Diprivan)	IV	Induction: 100–150 mcg/kg/min Maintenance: 50–200 mcg/kg/min	Product is an emulsion. Shake well before use. If phase separation is evident, discard product. Protect from light. Monitor client for apnea bradycardia.
thiamylal sodium *(thy-**AM**-ih-lal **SOH**-dee-um)* (Surital)	IV	Titrate according to individualized response	Solutions of drug should be refrigerated and discarded after 6 days. If stored at room temperature, use within 24 hours. Only clear solutions should be used. Incompatible with lactated Ringer's solution.
thiopental sodium *(thy-oh-**PEN**-tal **SOH**-dee-um)* (Pentothal)	IV, rectal	IV: 3–5 mg/kg administered at 20–40 second intervals as needed	Hypnosis produced 30–40 seconds after IV injection or 8–10 minutes after rectal administration. Solutions for IV administration must be used within 24 hours of preparation and should be refrigerated. Test dose should be given to assess client response to drug.

antihistaminic actions and thereby help to dry secretions and prevent postanesthetic nausea and vomiting. They also potentiate the action of many opioid and nonopioid analgesics, thereby permitting a lower dosage of these agents to be used.

Opioid and nonopioid analgesics (e.g., morphine, **fentanyl**, pentazocine, meperidine). These provide analgesia to counteract preoperative and operative pain that would interfere with smooth induction of anesthesia. They also reduce the amount of anesthetic required to produce surgical anesthesia. Fentanyl is particularly useful in brief procedures, because of its short duration of action (1–2 hours). Morphine and meperidine provide 4–6 hours of analgesic effect.

Antiemetics (e.g., promethazine, hydroxyzine, droperidol). These agents are discussed in this text under other categories because of their diversity of action.

Anticholinergics (e.g., atropine, scopolamine). These belladonna alkaloids diminish salivation and can prevent laryngospasm and reflex slowing of the heart (bradycardia) during general anesthesia. Although they must be used with great caution in clients with fever, because they depress the sweating mechanism, anticholinergics have been found to be relatively safe to use in most surgical clients. They are discussed in more detail in Chapter 15.

A number of drugs may be used in conjunction with general anesthetics to enhance the action of the anesthetic (e.g., Fentanyl) or to provide another useful pharmacological action. Some of these (e.g., sedatives, anticholinergics, and analgesics) may be used before, during and after surgical procedures, as their actions facilitate the induction and maintenance of the anesthetized state and help prevent unpleasant side effects as the client enters the recovery stage. Neuromuscular blocking agents (e.g., **succinylcholine chloride**, **tubocuranine chloride**) may be employed during general anesthesia to produce temporary skeletal muscle paralysis. These agents are often employed when complete relaxation of abdominal muscles is desirable. As muscles controlling respiration are generally paralyzed during such surgery, some means of artificially ventilating the client must be provided.

Table 11–4 lists the drugs commonly used as adjuncts to general anesthesia currently in clinical use. Chapter 20 reviews the properties of the neuromuscular blocking agents.

REGIONAL ANESTHESIA

Regional anesthetics are drugs that reversibly block nerve conduction when applied locally to nerve tissue. The extent of their action is dependent upon the area to which they are applied, the drug concentration used, and the duration of contact with nerve tissue. A number of different types of regional anesthesia are currently used. The most common of these are summarized in Table 11–5. Figure 11–1 illustrates the application of Tegoderm over EMLA application.

Cocaine, an agent extracted from the leaf of the coca plant, was the first *local* anesthetic to be discovered. Because of the addicting properties of cocaine, many synthetic substitutes have been introduced since its use was first advocated in the nineteenth century.

Regional anesthetics appear to act by preventing the generation and the conduction of the nerve impulse. They do so by changing the permeability of a nerve's cell membrane to sodium, potassium, and calcium, and thereby altering the nerve's ability to conduct an electrical impulse. Although ideally these drugs should only provide a regional anesthetic action, many of these agents affect other organs in which conduction of nerve impulses occur. Regional anesthetics are capable, therefore, of causing CNS stimulation, resulting in restlessness, tremors, and/or clonic convulsions. This effect may be followed by CNS depression, respiratory depression, and death.

If significant amounts of regional anesthetic enter the systemic circulation, cardiovascular collapse may occur. A small percentage of the client

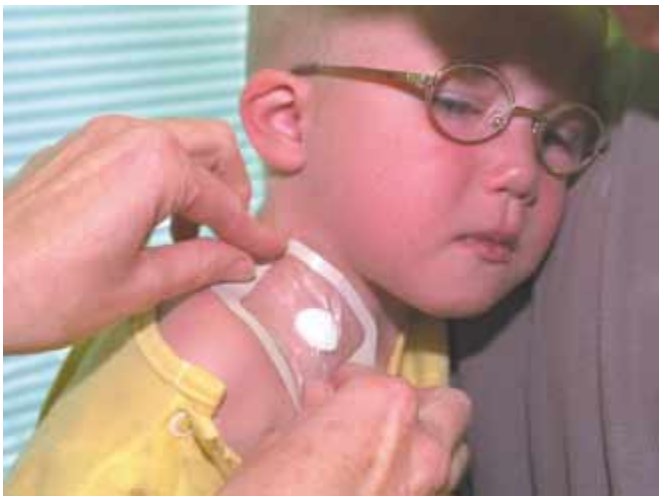

Figure 11–1 Tegaderm is being applied to a young child's arm to cover the EMLA application.

TABLE 11–4

Drugs Used as Adjuncts to General Anesthesia

Note: Always record name and amounts of preanesthetic drugs given to the client.
Provide for the safety of clients who have received these drugs (side rails up, bed in low position if preoperative).
Monitor vital signs.

DRUG	PHARMACOLOGICAL CATEGORY	USUAL PREANESTHETIC DOSE	NURSING IMPLICATIONS
alfentanil HCl *(al-**FEN**-tah-nil **hy**-droh-**KLOR**-eyed)* (Alfenta)	opioid analgesic	*Adults*: 8–245 mcg/kg IV	Dose may vary considerably depending on use. Do not use in children under 12. Multiple drug interactions.
atropine sulfate *(**AT**-roh-peen **SUL**-fayt)*	anticholinergic	*Adults*: 0.4–0.6 mg *Children*: 0.1–0.4 mg	Monitor body temperature of client to avoid serious hyperthermia. Use with caution in elderly clients as they may react with excitement, agitation and/or other symptoms. Monitor for tachyarrhythmias. May cause flushing.
diazepam *(die-**AZ**-eh-pam)* (Valium, E-Pam ✱, Meval ✱)	antianxiety agent	*Adults*: 2–15 mg, PO IM, or IV before surgery *Children:* 0.2–0.6 mg/kg every 2–4 hours	If used by IV route, drug should not be mixed with other solution or IV fluids. IV injection should be made slowly to avoid local irritation and vascular complications. Provides surgical amnesia if IV.
droperidol *(droh-**PER**-ih-dohl)* (Inapsine)	antianxiety agent; antiemetic	Give IV 2.5–5 mg 30–60 minutes preoperatively. *Adults*: 2.5–10 mg *Children*: .75–150 mcg/kg	May cause hypotension and/or tachycardia. Commonly used in combination with fentanyl citrate.
fentanyl citrate *(**FEN**-tah-nil **SIH**-trayt)* (Sublimaze)	opioid analgesic	Give IV 30–60 minutes preoperatively. *Adults*: 20–50 mcg/kg *Children 2–12 yrs*: 1–3 mcg/kg/dose	May cause respiratory depression and muscle rigidity. Commonly used in combination with droperidol. Protect from light.
glycopyrrolate *(**gly**-koh-**PIR**-roh-layt)* (Robinul)	anticholinergic	Give IV 30–60 minutes prior to anesthesia. *Adults*: 0.1 mg *Children under 12*: 200–400 mcg/kg	May also be used IV during surgical procedures. Monitor for anticholinergic adverse effects.
hydroxyzine HCl *(hy-**DROK**-sih-zeen **hy**-droh-**KLOR**-eyed)* (Atarax, Vistaril, Multipax ✱, Novohydroxyzine ✱)	sedative-hypnotic	Give IM prior to surgery. *Adults*: 25–100 mg *Children*: 0.5 mg/kg	May potentiate the action of CNS depressants, such as opioid analgesics and barbiturates. Reduce dose of such drugs up to 50% when using hydroxyzine. Should only be injected into a large muscle.

continues

TABLE 11–4 *continued*

See **Note** at beginning of Table 11–4, page 256.

DRUG	PHARMACOLOGICAL CATEGORY	USUAL PREANESTHETIC DOSE	NURSING IMPLICATIONS
meperidine HCl *(meh-**PER**-ih-deen **hy**-droh-**KLOR**-eyed)* (Demerol HCl)	opioid analgesic	Give IM or SC 30–90 minutes preoperatively. *Adults*: 50–100 mg *Children*: 1–2.2 mg/kg	May cause constipation, respiratory depression, hypotension, nausea, and vomiting. Often given with local anesthetics to prolong their effects. Do not administer in same syringe with barbiturates. Do not use with MAO inhibitors.
morphine sulfate *(**MOR**-feen **SUL**-fayt)* (M.O.S ✱, Epimorph ✱)	opioid analgesic	Give IV, IM, or SC 30 minutes prior to anesthesia. *Adults*: vary/route *Children*: 0.1–0.2 mg/kg IV	May cause constipation, respiratory depression and/or hypotension. Monitor vital signs.
pentazocine lactate *(pen-**TAYZ**-oh-seen **LACK**-tayt)* (Talwin)	opioid analgesic	*Adults*: 30 mg IM, SC or IV	Not recommended for pediatric use. Parenteral doses of 30–60 mg of pentazocine are equivalent in analgesic action to about 10 mg of morphine or 75 mg to 100 mg of meperidine. May cause tissue necrosis at injection site. Must dilute.
pentobarbital sodium *(pen-toh-**BAR**-bih-tal **SOH**-dee-um)* (Nembutal Sodium)	sedative-hypnotic	*Adults*: 1.5–10 mg/kg IV over 30 nyn 20 mg 3–4 times daily by oral route: Preop 100 mg *Children:* 1–3 mg/kg	Do not use solutions of pentobarbital sodium if they contain a precipitate. Avoid extravasation at injection site, as solutions are irritating. May also be given by mouth the night before surgery.
promethazine HCl *(proh-**METH**-ah-zeen **hy**-droh-**KLOR**-eyed)* (Phenergan, Histantil ✱, etc.)	sedative-hypnotic	*Adults*: 25–50 mg IV *Children:* 0.5–1.1 mg/kg	May discolor urine pink or reddish brown. May cause photosensitivity. May be combined with reduced dose of opioid analgesic.
scopolamine HBr *(skoh-**POL**-ah-meen **hy**-droh-**BROH**-myd)*	anticholinergic	*Adults*: 0.3–0.6 mg SC, IM, IV *Children:* 0.1–0.3 mg SC, IM, IV	See atropine sulfate.
secobarbital sodium *(**see**-koh-**BAR**-bih-tal **SOH**-dee-um)* (Seconal Sodium, etc.)	sedative-hypnotic	*Adults*: IM or P.O.: 100–200 mg IV: 100–250 mg, 2 mg/kg depending on degree of hypnosis required IV not to exceed rate of 50 mg per 15 seconds	IM injection given deeply to avoid sterile abscess and pain. Do not use if solution is turbid or precipitate is present. May also be given by mouth the night before surgery.
sufentanil citrate *(soo-**FEN**-tah-nil **SIH**-trayt)* (Sufenta)	opioid analgesic	*Adults and Children*: 1–8 mcg/kg IV	May be administered in higher doses for induction and maintenance of anesthesia. Administer with nitrous oxide and oxygen.

TABLE 11–5

Common Types of Regional Anesthesia

TYPE	DESCRIPTION
Topical Anesthesia	Topical anesthesia is performed by applying an anesthetic agent directly onto the surface of the skin, mucous membranes, or eye to prevent or relieve pain. It is frequently employed in relieving pain associated with minor skin irritation or in permitting easy examination of the eye.
Infiltration (Local) Anesthesia, Regional	This form of anesthesia is employed in situations in which superficial anesthesia is required, e.g., suturing wounds or in dental surgery. It is accomplished by the injection of small amounts of anesthetic solution into tissue surrounding the operative site. As only small amounts of anesthetic are required for such procedures, there is generally little danger of systemic toxicity developing with its use.
Nerve Block Anesthesia	Such anesthesia is accompanied by injection of anesthetic solution along the course of a nerve before the nerve reaches the tissue to be anesthetized. Such anesthesia permits an area of the body (e.g., a leg) to be anesthetized by injection into a single site.
Spinal Anesthesia	In spinal anesthesia, an anesthetic solution is injected into the subarchnoid space or into the epidural space surrounding the spinal cord. Depending on the location of the injection, a variety of different nerves may be anesthetized, e.g., if the anesthetic is administered at the base of the spine (caudal or sacral anesthesia), anesthetic effects may be evident only in the pelvic region and legs. Such an action may be desirable in performing obstetrical procedures or during surgery involving the rectum. If the anesthetic solution is injected into the lower spinal area while the client is seated, only those portions of the body that would be in contact with a saddle would be affected, hence the name *saddle block*. If the anesthetic is administered at higher areas of the spinal column, anesthetic effects will be evident in wider areas of the body. This may be appropriate for abdominal surgery.

population will also exhibit a hypersensitivity to these agents. This effect may appear as allergic dermatitis, respiratory distress, or anaphylaxis.

To minimize the likelihood of a toxic effect caused by regional anesthetics, several precautions should be taken. It is important to administer the smallest dose that will be effective in a client. Several small doses of these agents are generally less likely to result in adverse effects than one large dose. Epinephrine may be used with regional anesthetics to promote local vasoconstriction and thereby delay their systemic absorption. Epinephrine may, however, cause restlessness, tachycardia, and anxiety, which can be misinterpreted as being a toxic effect of the regional anesthetic.

Systemic toxicity of the local anesthetics requires aggressive and immediate treatment. Drug-induced convulsions can be treated by the administration of an intravenous dose of a barbiturate or sedative with anticonvulsant action, for example phenobarbital or diazepam (Valium). Respiratory depression may be treated with artificial ventilation, and cardiovascular collapse may require the use of closed-chest cardiac massage, drugs to raise blood pressure (pressor drugs), and/or equipment delivering an electric current to the heart to reestablish normal heart rhythm (defibrillation).

Because of the wide variety of regional anesthetics available, the selection of the proper agent should be based on the:

- area to be anesthetized
- agent's duration of action
- client's history of allergies
- physician's prior experience with the drug

Table 11–6 compares the properties of regional anesthetics in common use.

TABLE 11–6

Regional Anesthetic Agents

Note: All clients receiving these agents should be asked about drug hypersensitivity. Vital signs should be carefully monitored.

DRUG	ROUTE(S)	USUAL DOSE OR STRENGTH USED	NURSING IMPLICATIONS
benoxinate HCl* *(ben-**OK**-sih-nayt **hy**-droh-**KLOR**-eyed)*	ophthalmic	0.4% solution	Prolonged use may lead to vision loss because of corneal opacity.
benzocaine, ethyl aminobenzoate *(**BEN**-zoh-kayn, **ETH**-ill ah-**mee**-noh-**BEN**-zoh-ayt)* (Americaine, Solarcaine)	topical	5–20% ointment or cream	May cause hypersensitivity reaction. Not for ophthalmic use.
bupivacaine HCl *(byou-**PIV**-ah-kayn **hy**-droh-**KLOR**-eyed)* (Marcaine HCl, Sensorcaine)	injection	25–150 mg as a 0.75% solution	Relatively long-acting (4–5 hours). Not for use in children under 12. Available with and without epinephrine. Monitor respiratory status hourly when used as epidural analgesia.
butamben picrate *(byou-**TAM**-ben **PIE**-krayt)* (Butesin Picrate)	topical	1% ointment	See benzocaine.
chloroprocaine HCl *(**klor**-oh-**PROH**-kayn **hy**-droh-**KLOR**-eyed)* (Nesacaine)	injection	1–3% solution	Discard partially used vials. Keep resuscitation equipment on hand.
cocaine, cocaine HCl *(**KOH**-kayn, **KOH**-kayn **hy**-droh-**KLOR**-eyed)*	topical	1–2% solution	May cause addiction and tolerance if taken internally.
dibucaine *(**DIE**-byou-kayn)* (Nupercaine HCl, Nupercainal)	injection, topical	0.5–1% solution, ointment, cream	See benzocaine.
dyclonine HCl *(**DIE**-kloh-neen **hy**-droh-**KLOR**-eyed)* (Dyclone)	topical	0.5% solution	Used primarily to anesthetize mucous membranes.
etidocaine HCl *(eh-**TIH**-doh-kayn **hy**-droh-**KLOR**-eyed)* (Duranest HCl)	injection	1–1.5% solution	Available with and without epinephrine. Relatively long-acting agent (5–10 hours).

continues

TABLE 11–6 *continued*

See **Note** at beginning of Table 11–6, page 259.

DRUG	ROUTE(S)	USUAL DOSE OR STRENGTH USED	NURSING IMPLICATIONS
levobupivacaine *(**levo**-byou-**piv**-ah-kayn)* (Chirocaine)	injection	50–150 mg as a 75% solution	See bupivacaine.
lidocaine HCl *(**LYE**-doh-kayn **hy**-droh-**KLOR**-eyed)* (Xylocaine HCl)	topical, injection	0.5–5% ointment, cream, solution, jelly	Injection available with and without epinephrine.
Lidocaine 2.5%/ prilocaine 2.5% (eutectic mixture of local anesthetics) (EMLA)	topical	2.5 grams	Adverse effects: Blanching, erythema Indicated for peripheral, midline, or PICC (peripherally inserted central catheter) lines, venipuncture, groin preparation for cardiac catheterization, lumbar puncture, circumcision. Apply to intact skin under occlusive dressing (Tegaderm) ***1-2 hours*** prior to procedure. Provides local dermal analgesia to 0.5 mm depth. Not approved for infants <1 month of age. Monitor for effectiveness.
mepivacaine HCl *(meh-**PIV**-ah-kayn **hy**-droh-**KLOR**-eyed)* (Carbocaine HCl) (Polocaine)	injection	1–2% solution	Monitor fetal heart rate when used for paracervical block during delivery. Used for epidural analgesia—monitor respiratory status.
pramoxine HCl *(pram-**OK**-seen **hy**-droh-**KLOR**-eyed)* (Tronothane, etc.)	topical	1% cream, jelly	May be safely used in many clients who are allergic to other local anesthetics.
procaine HCl *(**PROH**-kayn **hy**-droh-**KLOR**-eyed)* (Novocain)	injection	1–10% solution	Often used with epinephrine.
tetracaine HCl *(**TET**-rah-kayn **hy**-droh-**KLOR**-eyed)* (Pontocaine)	injection, topical, ophthalmic	0.5–2% solution, ointment, cream	Ophthalmic solution should not be used with products containing silver or mercury salts.

*available only in combination with fluorescein sodium as Fluress.

APPLYING THE NURSING PROCESS

ASSESSMENT

Nurses are actively involved in the care of clients requiring anesthesia, from just before administration of the anesthetic to full recovery from anesthesia. Before clients receive anesthesia, the nurse is responsible for checking vital signs. This check provides information on preexisting conditions, such as infection or hypertension, that might affect the decision to carry out the surgical procedure and the agent to be used. It also alerts others to possible problems that could result from anesthetizing the client. In addition, the preanesthetic vital signs provide a baseline against which the client's vital signs may be compared during and following anesthesia. The client's weight should be measured, as some drug dosages are based on weight. The nurse also questions the client and/or family about a history of allergy to any substances, but particularly to drugs. Clients should also be questioned about whether they are taking any drugs for the treatment of mental or physical health problems. **Note:** All allergies and the names of drugs the client takes at the time, particularly antihypertensives, sedatives and tranquilizers, corticosteroids, and cardiac drugs, should be prominently displayed on the chart that accompanies the client. Such notations are frequently made on a preanesthetic checklist. Allergies are frequently listed in bold red letters on the front cover of the client's treatment record.

NURSING DIAGNOSES

Including but not limited to:

Preoperative:

- Risk for injury related to central nervous depressive effects of preanesthetic agents
- Fear/anxiety related to the unknown, risks of surgery, and new experience
- Deficient knowledge related to preanesthetics agents and safety precautions

Intraoperative:

- Risk for injury related to adverse effects of anesthesia
- Hypothermia related to decreased metabolic rate and exposure to cool environmental temperature
- Risk for injury, malignant hyperthermia
- Refer to care plan for postoperative care

PLANNING/GOALS

- Client will not sustain any injuries resulting from depressive effects of preanesthetic agents.
- Client will demonstrate use of coping mechanisms when dealing with fear/anxiety.

BOX 11–1
Preoperative Client Teaching

- Complete a list of all medications—prescription and over-the-counter OTC—that the client is taking and when each medication was last taken.
- Identify and report any factors that would increase the risks of anesthesia—obesity, smoking, respiratory disease, heart disease, diabetes.
- Explain the procedure and what to expect before, during, and after the procedure. This will help decrease anxiety.
- Complete client teaching (and return demonstration) of postoperative exercise, such as turning, coughing, deep breathing, and use of incentive spirometry, which are designed to prevent respiratory complications of surgery.
- Explain to the client such surgical routines as NPO status, preanesthetic medications, time the client will spend in the presurgical (hold area) area before surgery, tubes and equipment (and the rationales for their use) that the client may see and/or feel.
- Stress to client and family the importance for the client to be proactive about need for analgesics, as well as address any unfounded concerns they may have about "becoming addicted to pain killers."
- Ask clients regarding any food or drug allergies and explain why this information is important for health care team to know prior to surgery.
- Stress importance of safety measures after preanesthetic agents are given.

KEY NURSING IMPLICATIONS 11–1

Preanesthetic General Nursing Care

1. Measure vital signs to be used as a baseline.
2. Record on the client's chart all allergies and drugs the client currently takes.
3. Dentures, eyeglasses, contact lenses, jewelry, and hairpins are removed. Makeup is also removed.
4. Meperidine HCl and barbiturates cannot be mixed in the same syringe.
5. After preanesthetic medications are given, the nurse ensures the client's safety and arranges for safekeeping of the client's possessions.
6. Clients who have received anticholinergics may experience an atropine flush, urinary retention, excitement, delirium, or hallucinations.
7. Client should void prior to administration of preanesthetic medication.

- Client will verbalize understanding of preoperative instructions.
- Client will not sustain any injuries resulting from anesthetic agents.
- Client's temperature will be maintained within normal limits (WNL) for surgical experience.

IMPLEMENTATION

The nurse is often responsible for administering preanesthetic medications. In hospitalized clients, a sedative or hypnotic is often ordered to be given at bedtime the evening before anesthesia is scheduled. The purpose of these drugs is to reduce anxiety and to promote rest and sleep. In the morning of the scheduled procedure, the nurse may administer other drugs ordered by the physician. The purpose is to prepare the client for anesthesia by reducing anxiety, decreasing respiratory secretions and salivation and providing pain relief, thereby reducing the amount of anesthetic that must be administered. Of the commonly ordered preanesthetic medications, morphine sulfate and atropine sulfate may be mixed in the same syringe. **Meperidine HCl** and promethazine HCl may also be mixed in one syringe, however diazepam must not be mixed in the same syringe with any other drug.

At the time that these preanesthetic medications are given, the nurse takes measures to provide for the client's personal safety and the safekeeping of the client's possessions. The nurse explains in simple language the purpose of the medications and what reaction the client can expect. (For example, "Mr. Jones, I am going to give you some medication that Dr. Greenburg wants you to have to prepare you for your surgery. It might make you feel relaxed and sleepy. It may also cause you to have a dry mouth, but do not drink anything. After I give you this medication, I am going to put up your siderails and ask you to stay in bed. If you need to go to the bathroom or need a nurse for any reason, please use your call bell.") The nurse makes certain the client is comfortable, has voided, and is appropriately dressed for the operative procedure. Dentures and eyeglasses or contact lenses must be removed for the client's safety. Jewelry and hairpins are removed. All possessions should be stored securely. Female clients should remove all makeup and fingernail polish so that accurate assessment of color and circulation can be made. Clients are allowed nothing by mouth (NPO) for about 12 hours before any anesthesia, but especially for general anesthesia. The nurse should be certain that these procedures have been carried out.

After checking vital signs, the nurse should make the client comfortable and minimize environmental distractions. Periodic checks on clients should be made to determine their response to the medication. One of the reactions a client might experience is what is often called an atropine flush or fever. In response to the administration of anticholinergics (for example atropine sulfate or **scopolamine HBr**), a client may become flushed and develop a fever because of the drug's ability to inhibit the sweat glands. Clients who have received preanesthetic anticholinergics may also experience urinary retention, as well as excitement, delirium, and hallucinations. The nurse should reassure the client that these symptoms are responses to the drug. A safe, quiet environment should be provided.

Young children may be held by their parents rather than confined to their beds following preanesthetic medication. The parents should be instructed not to provide liquids to the child and not to allow the child to walk. They should also be instructed to call for the nurse if they need assistance or have any questions.

NURSING CLIENTS WITH MALIGNANT HYPERTHERMIA

Malignant hyperthermia is an unexpected fever occurring while the client is anesthetized and possibly when exposed to intensive exercise and certain other stressors. It is a life-threatening condition. When **succinylcholine** or anesthetic agents are administered, the susceptible client rapidly develops muscle rigidity, tachycardia and elevated temperature (105°F/41°C or higher). The skin is warm and often mottled, and respiratory and metabolic *acidosis* develop. If not treated promptly, the client may develop cardiac arrhythmias and vascular collapse and may die. The cause of this condition is apparently a sudden release of calcium by the sarcoplasmic reticulum into contractile muscle causing a high level of intracellular calcium. This, in turn, increases the metabolic rate of muscle cells, increasing oxygen consumption and releases heat. This reaction occurs because of an apparent inherited defect in the membrane of skeletal muscles.

The development of malignant hyperthermia is considered an emergency and immediate measures are taken to lower the body temperature and to correct the metabolic imbalance. If the client is receiving an anesthetic agent at the time the hyperthermia develops, the anesthetic is discontinued. **Dantrolene** (**Dantrium**) is given intravenously to block the release of calcium from the sarcoplasmic reticulum. The nurse reconstitutes the dantrolene with sterile water and rotates the vial until the fluid is clear. This may take a few minutes. The nurse also obtains equipment to lower the body temperature. This may include a hypothermia blanket, ice packs, chilled intravenous fluids, and chilled fluids for irrigation of body cavities, such as gastric lavage. The client may be given a cold sponge bath. Generally, a Foley catheter is inserted for measurement of urinary output. Arterial and central venous catheters may also be inserted, and a number of drugs, such as sodium bicarbonate, will be given intravenously. The client will be attached to a cardiac monitor and arrhythmias will be treated with drugs such as lidocaine or **procainamide** (see Chapter 28).

After the client's condition has been stabilized, the nurse continues to monitor urinary output, vital signs, and general condition. Malignant hyperthermia does not always occur during surgery. It may occur hours after surgery and may recur up to 3 days after the initial episode. Usually the client receives dantrolene during this period to prevent recurrence. Because the susceptibility to developing this condition seems to be inherited, the nurse should always take a thorough client and family history regarding multiple drug allergies and any reactions the client or close family members have ever had to anesthesia. It is believed that malignant hyperthermia may be a reaction to stress, and the nurse should attempt to minimize preanesthesia stress by such means as formation of a therapeutic relationship, providing easily understandable instructions and answering questions simply, promoting confidence in the physician, and facilitating rest and sleep. Clients at risk of malignant hyperthermia receive dantrolene the night before and the morning of surgery.

Finally, family members must be taught about malignant hyperthermia and instructed to let health care personnel know of a positive family history. The Malignant Hyperthermia Association of the United States (P.O. Box 3231, Darien, CT 06820) can provide additional information.

KEY NURSING IMPLICATIONS 11–2

Malignant Hyperthermia

1. This is a life-threatening condition requiring immediate treatment.
2. Dantrolene will be given intravenously to block the release of calcium. When reconstituting dantrolene, always rotate the vial until the fluid is clear.
3. Monitor vital signs.
4. Take measures to lower the body temperature.
5. Assist with procedures such as insertion of a Foley catheter, irrigation of body cavities with chilled fluids, and administration of medications.
6. Monitor the client's vital signs carefully for 24–48 hours. Administer dantrolene as ordered.
7. Teach the client and family about malignant hyperthermia and the necessity of reporting a family history of this problem.

NURSING CARE FOLLOWING GENERAL ANESTHESIA

Assessment

After surgical intervention under general anesthesia, the client is usually transported to the postanesthesia care unit (PACU), where intensive care can be provided. When the client arrives in the PACU, the nurse checks to see that the client has an adequate airway. The nurse then receives a report from the anesthetist. This report includes information such as the client's identity, procedure done, type of anesthetic used, any problems encountered, pertinent medical history, and a review of the client's fluid and electrolyte status. The anesthetist frequently reviews the placement and function of various drainage tubes and equipment with the nurse. See Nursing Care Plan.

Implementation

Following the anesthetist's report, the nurse checks the vital signs and monitors other bodily functions (e.g., checks urinary drainage, arterial pressure, drainage from wounds). The client is usually positioned in a side-lying position, to ensure an adequate airway. Pertinent observations are recorded initially on admission and frequently thereafter.

When there are signs of regaining consciousness (e.g., restlessness, moaning, attempts to swallow), the client is told that he/she is in the recovery room or that the procedure is completed. Some clients may need to be told this information repeatedly. It is well for the nurse to remember that, in anesthetized clients, hearing is usually the last sense to fade and the first to return. Although apparently unconscious, the client may be able to hear. When the swallowing reflex returns, the airway may be removed, but attention must still be paid to the possibility of respiratory depression, vomiting with resulting airway obstruction, and the development of emergency situations (such as cardiac arrest).

Two problems frequently occurring in clients following anesthesia are pain and shivering. Pain medication may be administered as ordered, provided that the vital signs are stable. Occasionally pain medications are withheld because of low blood pressure (hypotension). The nurse should assess the client's condition carefully because the hypotension could be due to pain. In some instances, the physician will approve the administration of less than the full dose of a pain reliever to allow for assessment of its effects on blood pressure and on the pain experienced. The second problem, shivering, is due to peripheral vasodilation resulting from the anesthetic, as well as the change from the operating room, with its lights and drapes, to the PACU with its air-conditioning and lightweight covers. Clients who shiver should be provided with a warmed blanket and be reassured that the shivering will soon pass.

Clients who have received ketamine hydrochloride (Ketalar) may have emergence reactions, including delirium, hallucinations, confusion, and excitement. These reactions may occur immediately on emergence from anesthesia and may last for several hours. In some clients, a recurrence of the reaction has occurred up to 24 hours postanesthesia. **Note:** To minimize such reactions, place clients who have received this anesthetic in a quiet place and disturb them as little as possible during emergence from anesthesia. Be gentle in handling them when checking vital signs.

KEY NURSING IMPLICATIONS 11–3

Nursing Care After General Anesthesia

1. Check the client's airway when received in the postsurgical area.
2. Receive the report from the anesthetist.
3. Check the client's vital signs and wound. Monitor bodily functions.
4. Orient the client and remove the airway when the client becomes conscious.
5. Provide pain relief and warmth as necessary.
6. Monitor oxygen and intravenous fluid administration as necessary.
7. Place clients who have received ketamine hydrochloride in a quiet place and disturb them as little as possible during emergence from anesthesia.

SAFETY AND ANESTHETIC AGENTS

For many years, safety precautions have been taken in operating suites to prevent leaks and explosions of anesthetic gases. More recently, concern has been developing about the health of personnel who work in settings where anesthetic agents are regularly used. Research studies have indicated that operating suite staff may have higher rates of hepatic and renal diseases, as well as spontaneous abortion and birth defect rates in excess of the general population. Studies have shown that some anesthetic agents can be expired by the client for 10–20 days following surgery, thus exposing nursing staff to small amounts of gases over long periods of time.

The following safety precautions are indicated for nurses who are exposed to general anesthetic agents over long periods:

- Be sure the area where you work is well ventilated.
- Avoid direct exposure to the mouths of clients expiring anesthetic agents.
- Report your symptoms, such as headache, dizziness, slowed reflexes, and sleepiness to the health service.
- Personnel with high levels of exposure to general anesthetic agents should be checked every 3 months for levels of halogenated anesthetics and nitrous oxide.
- The exposure of pregnant personnel to general anesthetic agents should be limited.

KEY NURSING IMPLICATIONS 11–4

Safety and Anesthetic Agents

1. Continual exposure to anesthetic agents may result in health problems.
2. Those with continued exposure to these agents should ensure that their work area is well ventilated, that they avoid direct exposure to the mouths of clients expiring anesthetic gases, that they report indications of toxicity and are routinely monitored for levels of anesthetic agents and that, if pregnant, their exposure to these agents is limited.

NURSING CARE FOLLOWING REGIONAL (LOCAL) ANESTHESIA

The nursing care given to clients following regional anesthesia will depend on the area to which the anesthetic has been applied and the extent of the resulting anesthesia. Regional anesthetics applied to the eye, for example, are generally short-acting. The major nursing responsibility is to see that the eye is not damaged during recovery.

Few reactions except itching are noted as a result of local anesthesia confined to a limited area of the body in which the drug is placed directly around the area to be anesthetized (such as infiltration anesthesia). This procedure, useful for repair of *lacerations*, for example, may be associated with allergic reactions or with CNS stimulation if a sufficient amount of the drug enters the bloodstream. The client should be reassured that this CNS stimulation will gradually decrease over time. Following the use of a local anesthetic, the nurse checks the local circulation before dressing the wound. The client is instructed in proper care of the wound and indications of infection, which should be reported promptly.

Instead of infiltration anesthesia, some health care practitioners use a solution of tetracaine, adrenaline, and cocaine (TAC) for anesthetizing lacerations before suturing. The advantages of this solution are that it does not swell or distort wound edges as infiltration anesthesia might; it is not painful to administer and it produces a dry bloodless field. **Note:** This solution must never be used on mucous membranes (because of excess absorption), pinna of the ear, nasal openings, penis, digits, or burned or denuded skin. It is used half strength for repair of lacerations on the face, lip, or scalp. When this solution is used, the nurse inquires about a history of allergy to the components. The nurse then places a small piece of sterile gauze into the wound to act as a wick. TAC solution is dripped on the wick to saturate it. The nurse periodically assesses the client's level of anesthesia. When the wound edges blanche, the wound can be cleansed and repaired. This generally takes about 15 minutes after applying the TAC.

Regional anesthetics can also pass through the placenta, and excessive amounts may produce

NURSING CARE PLAN

A Postsurgical Client

Duncan MacDonald, age 73, has had a resection of his colon because of a tumor. In the operating room, he received thiopental sodium to induce sleep, fentanyl to block pain response, succinylcholine to permit ease of endotracheal tube insertion, and a mixture of oxygen, nitrous oxide, and halothane anesthetic agents. He is brought to the postanesthesia care unit (PACU) to recover. He is receiving intravenous fluids, has a dry sterile dressing on his abdomen, and a Foley catheter.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Intake and output. Abdominal dressing. Vital signs and skin turgor.	Risk for fluid deficient volume related to surgical loss and decreased intake.	Client will maintain fluid and electrolyte balance.	Monitor intravenous fluid administration and urinary output. Record intake and output. Check surgical site for bleeding. Monitor vital signs and tissue turgor.	Fluid and electrolyte balance maintained. No excess bleeding, nausea, or vomiting experienced. Vital signs are stable and tissue turgor is maintained.
Level of consciousness.	Disturbed thought processes related to decreased level of consciousness secondary to anesthesia and central nervous system depressant use.	Client will return to baseline state of consciousness.	Assess level of consciousness q15 minutes. Orient client to location.	Client awakened with no untoward effects. Transferred to his room 11/2 hours after arrival in PACU.
Airway patency. Skin integrity.	Risk of injury related to decreased sensations secondary to anesthesia and medications.	Client will not sustain injury during decreased consciousness.	Maintain client airway. Remove plastic airway when swallowing reflex returns. Keep siderails up until client is fully aroused. Assess skin integrity and provide position change and skin care PRN.	Client returns to consciousness without experiencing any untoward events.
Pain level.	Acute pain related to surgical procedure.	Client maintains pain control of 2–3/10 (scale) as evidenced by verbalization and assessment of nonverbal data.	Routinely assess level of pain. Administer pain medication on routine schedule to maintain pain control.	Client verbalizes pain control of 2–3/10 scale.
Position. Ease of Respiration.	Risk for injury related to increased secretions during unconsciousness.	Client will be protected from injury during decreased consciousness.	Ensure comfortable position that facilitates gas exchange and does not put undue pressure on any body part. Maintain client in head-down position or turned to side to prevent drainage of secretions. Suction secretions while client is unable to control them.	Client returns to consciousness and controls own secretions.

Body temperature. Blood pressure.	Risk for altered body temperature hypothermia: chills related to vasodilation secondary to medications and environment.	Client will be restored to body temperature within normal limits (WNL).	Take vital signs frequently (q 5–4 hrs). Provide additional blankets and keep client from contact with drafts.	Note evidence of shivering. Client's body temperature is gradually returned to normal.
Vital signs. Verbalizations.	Anxiety related to surgical procedure and hospital environment.	Client will express concerns and receive answers to control anxiety.	Provide explanations, support, and reassurances. Orient client to time and place (at completion of surgery and in PACU).	Client experiences minimal anxiety.

KEY NURSING IMPLICATIONS 11–5

Nursing Care For Regional Anesthesia

1. Before the use of a regional anesthetic, obtain a history of prior anesthetic exposure, response to local anesthetics, and/or pregnancy status.
2. Check vital signs and provide supportive care.
3. Never apply TAC solution to mucous membranes, pinna of the ear, nasal openings, penis, digits, or burned or denuded skin.
4. Supervise ambulation after caudal or spinal anesthesia has been used.
5. Report indications of systemic absorption or toxicity when the patient is receiving continuous extravascular infusion.

bradycardia (slow heart beat) in the fetus. Before regional anesthetic agents are used, therefore, the nurse should inquire whether (1) the client has received such agents before, (2) there have been any adverse responses, including allergic reactions, and (3) female clients might be pregnant.

More intensive nursing care is required for clients in whom regions of the body are anesthetized—for example, the lower extremities. An example of this type of anesthesia is epidural anesthesia, which may be used during labor and delivery; the drug is placed in the spinal canal area. Another example is spinal anesthesia in which the drug is placed in the subdural space. The latter procedure is sometimes used for clients having surgery on the lower extremities, for some types of abdominal surgery, or when clients are unable to tolerate general anesthesia. The major nursing measures following spinal anesthesia are checking vital signs, positioning the client and providing general supportive care. To prevent headaches that follow spinal anesthesia, the client is generally kept in a recumbent position for at least 12 hours and is provided with adequate fluid replacement. After recovery from spinal anesthesia, just as with recovery from general anesthesia, clients should be supervised during their first attempts to ambulate. Some clients will initially experience hypotension and dizziness.

Another type of regional anesthesia is continuous extravascular infusion (CEI). In CEI, a small amount of local anesthetic is delivered continuously over a period to a particular body part. This technique is used to treat chronic pain. A small catheter is placed in one of several body areas—for example, in the epidural space for the treatment of pain in the trunk or lower extremities or in the brachial plexus for the treatment of pain in the upper extremities. Following insertion of the catheter, a small volume of local anesthetic in an appropriate amount of normal saline is infused through the catheter. An electronic infusion device (see Chapter 3) is used to control the rate of infusion. Nursing responsibilities include monitoring the client's level of pain, limiting activity to prevent catheter displacement, preventing infection at the catheter site, and providing emotional support for the client. See Nursing Care Plan 10–B for a discussion of the care of a client with an epidural catheter. Vital signs are monitored closely, as hypotension, respiratory depression, and bradycardia may indicate systemic absorption of the anesthetic or toxicity. The nurse should stop the infusion and report client complaints of metallic taste, blurred vision, or ringing in the ears. Also, whenever epidural or caudal blocks are used, the nurse monitors the client for urinary retention, abdominal distention, or fecal incontinence.

OVERALL ASSESSMENT

Regardless of the anesthetic agent used, the nurse can play an important role in providing for the safety and comfort of the client. Whenever general anesthesia or extensive regional anesthesia has been used, the nurse observes the client for:

- *hypotension*, which may be caused by: (1) depression of the vasomotor center in the brain, (2) loss of blood and body fluids that have been inadequately replaced, or (3) narcotic drugs administered for relief of pain
- *rapid pulse rate*, which may indicate internal bleeding
- *gastrointestinal upset*, including postoperative nausea and vomiting and intestinal distention, which may occur several days after surgery
- *difficulty with urination*, including inadequate urinary output, urinary retention, and loss of bladder tone

- *body temperature*, as sudden elevations may signal the development of malignant hyperthermia
- *respiratory depression* and difficulty with gaseous exchange (e.g., hypoventilation)
- *injury to nerves* due to problems associated with regional anesthesia or to malpositioning of the client during surgery
- *pain, heat, and/or redness over a vein*, indicating possible thrombosis or formation of a blood clot
- *extreme anxiety or other behavioral changes*, which may indicate impending shock
- *changes in skin temperature and/or color*, which may indicate impending shock (particularly cold, clammy skin with pallor).

Additional observations are related to the type of surgery the client has experienced, as well as the age and general physical condition of the client. The student is referred to a medical-surgical nursing text for a more thorough discussion of the care of postoperative clients.

CASE STUDY

Carmen Alvarez, a 50-year-old truck driver, is admitted to the hospital for removal of hemorrhoids (hemorrhoidectomy). He has been bothered by hemorrhoids for the previous 2 years and has been using **Preparation H** for relief of burning and itching. In the past month, the discomfort increased and the physician suggested that surgery be scheduled.

On admission to the hospital, the following preoperative medication orders are written:

- **Flurazepam hydrochloride** (**Dalmane**) 30 mg, PRN, HS
- Versed 2.5 mg IV at 7:45 AM

Mr. Alvarez received his preoperative medications and was transferred to the operating suite about 8:15 AM. There he was strapped to the table, a blood pressure cuff was placed on his left arm, and an intravenous infusion was begun in his right arm. The anesthetist administered thiopental sodium through this intravenous line. Following loss of consciousness, the closed method of administration was used to give the client nitrous oxide gas and oxygen.

After completion of the surgery, Mr. Alvarez was transferred to the PACU, where the anesthetist gave a report to the PACU nurse.

Questions for Discussion

1. What kind of drug is Preparation H and why would it be used in the treatment of hemorrhoids?
2. Why do preoperative medication orders often contain an order for a hypnotic to be administered the night before surgery? In this case, the hypnotic has been ordered PRN. What would you, as the nurse, do about administering this drug?
3. What is the purpose for administering the Versed? To what drug group does it belong? Can these drugs be given in the same syringe? What nursing care is associated with the administration of this drug before surgery?
4. What kind of drug is thiopental sodium? Why is it used?
5. What advantages does the closed method of anesthetic gas administration have over the semiclosed method?
6. Nitrous oxide is used to achieve surgical anesthesia. What stage of general anesthesia is surgical anesthesia? What are the characteristics of this stage?
7. What information about the surgery and the client is the anesthetist likely to give the nurse as part of the PACU report?
8. What nursing care will be required for Mr. Alvarez in the PACU until he regains consciousness?

CRITICAL THINKING EXERCISES

1. Discuss the influence of an active history of smoking on a client who is to undergo general anesthesia.
2. List the information the anesthesiologist or nurse should report to the nurse in the PACU when admitting a client to the PACU.
3. Discuss the special needs of a pediatric client and family before, during, and after anesthesia. You may want to talk with a pediatric surgical nurse.
4. Discuss which of the following complications can occur as a result of anesthesia in the elderly because of physiologic changes—CNS excitation, atelectasis, polydypsia, aphasia—and why complications would occur.
5. List the various measures nurses should take at the time of the administration of preanesthetic medications to ensure client comfort and safety and safekeeping of personal belongings. Design a checklist to be used at that time to be certain that appropriate nursing tasks are completed.
6. List the major classes of anesthetic agents and give an example of each class.

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Anti-inflammatory Agents

12

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the mechanism of action of the nonsteroidal anti-inflammatory agents
- List the major adverse effects associated with the use of nonsteroidal anti-inflammatory agents
- Explain the difference between the mineralocorticoid and glucocorticoid action of corticosteroids
- Describe the mechanism of corticosteroid action in the treatment of inflammation
- List the major adverse effects associated with the use of corticosteroids
- Apply the nursing process related to the use of nonsteroidal and steroidal anti-inflammatory agents

Inflammation is a series of events triggered as part of the normal reaction of living tissue to injury. Although inflammation often produces pain and swelling of an affected area, it does represent a useful and important part of the body's defenses.

Inflammation may result as a consequence of injury by physical, chemical, and/or biological agents. Physical trauma may be caused by the simple introduction of a foreign object, such as a wood splinter, into living tissue or trauma to tissues as a result of any surgical procedure. It may also be caused by the exposure of tissue to extremes of temperature or radiation (e.g., sunburn). Chemically induced inflammation may be caused by contact of living tissue with caustic or other toxic chemical agents, such as strong acids or alkalies. Biological causes of inflammation are probably the most common and may occur with infection.

Although many different forms of injury may cause an inflammatory response, the actual nature of the response remains fairly uniform. This consistency suggests that similar regulatory mechanisms and chemical mediators initiate, sustain, and terminate inflammatory changes of tissues. In the acute inflammatory process, a biphasic response has been described. The early, or vascular, phase usually lasts for about 10–15 minutes after the injury has occurred and is characterized by vasodilation and increased capillary permeability to plasma proteins. The vascular phase is also accompanied by the release of a series of chemical mediators, such as histamine, serotonin, bradykinin, and others that promote the development of the response.

In addition to the relatively brief vascular phase there is also a delayed, or cellular, phase which is an acute inflammatory response. This phase, which may last from hours to days after an injury, is characterized by the accumulation of leukocytes (white blood cells) in the inflamed tissue, reduced blood flow, hemorrhage, and widespread tissue damage. During this phase, histamine and a number of enzymes are also released. The activity of *neutrophils*, *monocytes*, and lymphocytes also dramatically increases during this stage.

Within the last two decades it has become increasingly clear that complex chemical substances known as prostaglandins may be important mediators in the inflammatory process. These substances appear to be synthesized and released whenever cellular injury takes place. The role of prostaglandins in the development of inflammatory symptoms has been verified by the observation that injection of prostaglandins into the body will produce inflammatory-type symptoms.

The release of most of the chemical agents described tends to produce increased vascular *permeability* and leakage with accompanying erythema, edema, tenderness, and pain in the affected area. Such symptoms are observed with most types of tissue injury and particularly in conditions such as rheumatoid arthritis, *osteoarthritis*, *dermatitis*, *bursitis*, *colitis*, and other conditions with names ending in the suffix "itis."

Drugs used to treat inflammation are generally classified on the basis of whether they are steroidal or nonsteroidal agents. Steroidal agents are chemically related to **cortisone**, a hormone secreted by the adrenal cortex. Nonsteroidal agents are synthetic compounds not chemically related to substances produced in the body.

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDs)

The nonsteroidal anti-inflammatory drugs (NSAIDs) have emerged as the most important class of drugs used in the treatment of rheumatoid arthritis and related inflammatory disorders. These agents all exhibit varying degrees of analgesic and antipyretic effects and are believed to exert their anti-inflammatory effects by inhibiting the synthesis of prostaglandins. NSAIDs may be classified as salicylates or nonsalicylates.

Table 12–1 summarizes the properties of the nonsteroidal anti-inflammatory agents. Nursing implications provide guidelines for client care.

Salicylates

Salicylates are drugs chemically related to salicylic acid. Some of the salicylates (e.g., aspirin and **sodium salicylate**) are partially converted to salicylic acid in the body, although others (e.g., **diflunisal**) are not. Aspirin (acetylsalicylic acid, ASA) differs from the other agents in this group in that it is the most potent inhibitor of prostaglandin synthesis and, therefore, has the most potent anti-inflammatory effects.

Aspirin is considered to be the drug of choice for the treatment of many chronic inflammatory disorders, including virtually all forms of arthritis. It is the least expensive nonsteroidal agent and is readily available without a prescription. The use of aspirin is also advantageous as client compliance and drug absorption can be monitored by simple determinations of serum salicylate levels. This is not the case for other nonsteroidal agents.

When administered in low doses (up to 3 g/day) aspirin is an effective analgesic and antipyretic agent. When high doses (3–6 g/day) are administered, anti-inflammatory effects are also observed. When used in the treatment of an inflammatory disorder, the initial dose of aspirin is determined by the size and age of the client, with smaller doses being used in elderly clients and others who may be likely to exhibit adverse effects when large aspirin doses are administered. The dose of aspirin is gradually increased until serum salicylate levels in the range of 15–30 mg/100 mL are sustained.

The most common adverse effects experienced in the use of anti-inflammatory doses of aspirin are gastric intolerance and occult bleeding. These can often be prevented or alleviated by the administration of aspirin doses with meals or milk or by the use of buffered or enteric-coated aspirin. Buffering ingredients increase the rate at which aspirin dissolves in gastric fluids, thereby reducing the irritation that can be caused by undissolved aspirin crystals. Enteric-coated aspirin is designed to dissolve in the small intestine and, therefore, prevents gastric upset. In some clients, high aspirin doses may produce tinnitus and/or hearing loss. This is believed to be due to the inhibitory effect of aspirin on enzymes in the cochlea of the ear and is readily reversible on reducing the salicylate dose. Aspirin and other prostaglandin inhibitors also exert an inhibitory effect on platelet aggregation, which can result in prolongation of bleeding time. This effect may be beneficial in clients with thromboembolic disease, but may also make the client more susceptible to the development of hemorrhage. Aspirin is the most potent inhibitor of platelet aggregation of the nonsteroidal anti-inflammatory agents. Because aspirin strongly binds to plasma proteins, it is capable of displacing weakly bound drugs, such as warfarin, thereby affecting the action of the displaced drug.

TABLE 12–1

Nonsteroidal Anti-inflammatory Agents

Note: Administration of these products with food, milk, or antacids will reduce the likelihood of gastrointestinal upset.
Obtain history of allergic response to drugs. Assess client response to treatment.
Keep these and other drugs away from children.

DRUG	ROUTE(S)	USUAL ANTI-INFLAMMATORY DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
A. Salicylates				
aspirin *(**AS**-pih-rin)*	oral	3.2–6 g daily	GI distress, tinnitus	Monitor for gastric irritation. Contraindicated in aspirin hypersensitivity, gastric ulcers, and GI bleeding. Observe client for ringing in the ears (tinnitus) when large doses are used. Avoid use for 1 week prior to surgery to prevent postoperative bleeding. Do not give to clients on oral anticoagulants because the action of the anticoagulants will be increased. Monitor bleeding times.
choline salicylate *(**KOH**-leen sah-**LIH**-sill-layt)* (Arthropan)	oral	4.8–7.2 g daily *Children*: 107–174 g/kg/day in 4–6 divided doses	See aspirin.	Only available in liquid form. May be mixed with water or fruit juice.
diflunisal *(die-**FLEW**-nih-sal)* (Dolobid)	oral	0.5–1 g daily in 2 divided doses Not to exceed 1.5 g/day	GI distress, dizziness, headache, skin rash, tinnitus, fatigue	Avoid giving aspirin or acetaminophen to clients using this drug. Do not exceed 1.5 g daily. Use of diflunisal may increase plasma levels of aspirin, hydrochlorothiazide, and indomethacin.
salsalate *(**SAL**-sah-layt)* (Disalcid, etc.)	oral	3,000 mg daily in divided doses	See aspirin.	Administer last daily dose at bedtime.
sodium thiosalicylate *(**SOH**-dee-um **THYE**-oh-sah-**LIH**-sill-layt)* (Rexolate, Tusal)	IM, IV	50–200 mg daily	—	Administer drug until client is asymptomatic. IM route preferred.
celecoxib *(sel-eh-**KOX**-ib)* (Celebrex)	oral	200 mg once daily	GI distress	Monitor for effectiveness. Not approved for use in children.
diclofenac *(dye-**KLOE**-fen-ak)* 50–75 mg/ misoprostol 200 mcg (Arthrotec)	oral	50–75 mg 2–3 times a day	GI distress	Monitor for effectiveness. Clients who are pregnant or think they might be pregnant should not take Arthrotec because of miscarriage risk. Not approved for use in children.

continues

TABLE 12–1 *continued*

See **Note** at beginning of Table 12–1, page 273.

DRUG	ROUTE(S)	USUAL ANTI-INFLAMMATORY DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
B. Nonsalicylates				
diclofenac *(die-**KLOH**-fen-ack)* (Cataflam, Voltaren)	oral	100–200 mg daily in 2–4 divided doses	See aspirin.	Do not crush or take enteric-coated products with antacids or alkaline foods such as dairy products.
etodolac *(ee-toh-**DOH**-lack)* (Lodine)	oral	800–1,000 mg daily in 2–4 divided doses	GI distress, diarrhea	Indicated for acute or long-term use in management of pain and symptoms of osteoarthritis.
fenoprofen calcium *(fen-oh-**PROH**-fen **KAL**-see-um)* (Nalfon)	oral	300–600 mg 3–4 times daily	GI distress, dizziness, headache, drowsiness, tinnitus	Avoid giving aspirin to clients taking fenoprofen. May prolong bleeding time. Observe client for development of black stools. Maximal therapeutic effect may not be evident for 1–2 weeks or more. Avoid using in clients allergic to aspirin.
flurbiprofen *(flur-**BIH**-proh-fen)* (Ansaid, Froben ✱)	oral	200–300 mg daily in 2–4 divided doses	See aspirin.	Do not exceed 100 mg for any single dose.
ibuprofen *(eye-byou-**PROH**-fen)* (Actiprofen ✱, Motrin, Rufen, etc.)	oral	300 mg 4 times daily or 400–800 mg 3 or 4 times daily	See fenoprofen.	Monitor client for visual changes. Available in nonprescription form as Advil, Haltran, Nuprin, etc. See fenoprofen calcium. Monitor for gastric irritation.
indomethacin *(in-doh-**METH**-ah-sin)* (Indocin, Indocin SR, Indocid ✱)	oral, rectal	25–50 mg 2–3 times daily Sustained-release form, 75 mg 1–2 times daily	GI distress, headache, dizziness, drowsiness	Warn client of possible impairment of alertness. Avoid concurrent use of aspirin. Observe client for development of black stools. May result in headache within 1 hour after administration. Advise client to notify physician, if visual or hearing changes occur. May cause sodium retention. Check blood pressure in clients with hypertension, cardiac, or renal disease. Do not use sustained-release form in acute gouty arthritis. Total daily dose should not exceed 200 mg. Not for use in children 14 years of age and younger.
ketoprofen *(**kee**-toh-**PROH**-fen)* (Orudis, Oruvail, Rhodis ✱)	oral	150–300 mg daily divided into 3 or 4 doses Sustained-release: 200 mg once daily	GI distress	Oruvail is available in 200 mg sustained-release capsules.

continues

TABLE 12–1 *continued*

See **Note** at beginning of Table 12–1, page 273.

DRUG	ROUTE(S)	USUAL ANTI-INFLAMMATORY DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
ketorolac tromethamine *(**KEE**-toh-roh-lack troh-**METH**-ah-meen)* (Toradol)	IM, oral, IV	IM: Initial dose of 30–60 mg followed by 15–30 mg doses every 6 hours. Oral: 10 mg every 4–6 hours IV: 15–30 mg every 6 hours not to exceed 120 mg/day	GI distress, drowsiness	Protect drug solution from light. Drug should be used only for a brief period, i.e., less than 1 week. Provides opiate-level analgesia. Should be administered around-the-clock for best effect.
meclofenamate sodium *(mee-kloh-fen-**AM**-ayt **SOH**-dee-um)* (Meclomen)	oral	200–400 mg/day in 6–8 divided doses	GI distress	Contraindicated for use in clients with gastric ulcers. Warn client about activities requiring mental alertness. Discontinue if skin rash develops. Do not exceed 400 mg per day. Not for use in children 14 years of age and younger.
nabumetone *(nah-**BYOU**-met-ohn)* (Relafen)	oral	1,000–2,000 mg daily as a single dose or in 2 divided doses	GI upset, diarrhea	Monitor client for development of diarrhea and GI upset.
naproxen *(nah-**PROX**-en)* (Anaprox, Aleve, Naprosyn, Naxen, Sunflex)	oral	250–500 mg 2 times daily	See fenoprofen.	See fenoprofen. Aleve is available without a prescription.
oxaprozin *(ox-**AH**-proh-zin)* (Daypro)	oral	1,200 mg once daily	See fenoprofen.	Lower dose should be used in clients with low body weight.
oxyphenbutazone *(**ox**-ee-fen-**BYOU**-tah-zohn)*	oral	100–200 mg 3 times daily	GI distress, edema	Monitor hematological status if taken for more than 1 week. Aged clients are more likely to develop adverse effects with this drug. Seldom used for longer than 1 week in clients over 60 years of age. Observe client for development of dark stools, fever, sore throat, rash, and/or edema. Record intake and output, blood pressure, and daily weight. Used if arthritis is inactive.
piroxicam *(peer-**OX**-ih-kam)* (Feldene, Novo-Pirocam)	oral	20 mg as a single or divided daily dose	GI distress	Full therapeutic effects of drug may not be evident for first 2 weeks of therapy. Clients are more likely to cooperate because of its once-a-day administration.

continues

TABLE 12–1 *continued*

See **Note** at beginning of Table 12–1, page 273.

DRUG	ROUTE(S)	USUAL ANTI-INFLAMMATORY DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
rofecoxib *(roe-fe-**KOX**-ib)* (Vioxx)	oral	12.5–50 mg each day	GI distress in less than 2% of clients	Not indicated for clients with advanced renal disease. Contraindicated in clients with allergy to aspirin.
sulindac *(sul-**IN**-dack)* (Clinoril, Apo-Sulin ✱)	oral	150–200 mg 2 times daily	GI distress, skin rash, dizziness	Aspirin should not be given to clients using this medication. Notify physician if visual disturbances occur. May cause sodium retention. Monitor blood pressure, weight and intake and output.
tolmetin sodium *(**TOLL**-met-in **SOH**-dee-um)* (Tolectin)	oral	200–600 mg 3 times daily	GI distress, dizziness, light-headedness	Aspirin should not be given to clients using this medication. Observe client for development of dark stools. Administer with food, milk, or antacids to minimize GI upset See sulindac.

Nonaspirin salicylates, such as sodium salicylate, **magnesium salicylate**, **choline salicylate**, **sodium thiosalicylate**, **salsalate**, and diflunisal, produce varying degrees of anti-inflammatory activity, although they are all useful analgesic agents. All appear to produce a relatively lower incidence of GI upset than aspirin, but are not as effective in the treatment of inflammatory disorders. Most of these nonaspirin salicylate products are more expensive than comparable therapeutic doses of aspirin.

Nonsalicylates

Within the last decade, new NSAIDs have been developed with a different action and a lower incidence of GI distress. Among these are **diclofenac sodium/misoprostol** (**Athrotec**), **celecoxib** (**Celebrex**), **rofecoxib** (**Vioxx**), and the latest of these, **meloxicam** (**Mobic**). Among the differences between this new generation of NSAIDs and the ones that have been on the market for years is the mechanism of action. The newer NSAIDs are more specific in their inhibiting of prostaglandins by targeting COX-2 prostaglandins without interfering with the protective COX-1 prostaglandins. These medications were also developed with a focus of decreasing GI distress. Finally, the dosing of these new NSAIDs involves less frequent administration—either once or twice a day—than the traditional NSAIDs like the salicylates and the ibuprofens. The disadvantages to these new medications is that they are contraindicated for persons with allergies to aspirin and, being new and still under original patent, they are more expensive than the older NSAIDs.

In using any nonsteroidal anti-inflammatory agent, it is important to recognize that their anti-inflammatory effects may not be evident for at least 1–2 weeks after therapy is initiated. An adequate trial of at least 2 weeks should, therefore, be allotted before a determination of the success or failure of therapy is made.

SLOW-ACTING ANTIRHEUMATIC AGENTS

Several drugs have been found to be useful in the treatment of actively progressive rheumatic disorders and, unlike the nonsteroidal, anti-inflammatory agents, may actually halt the progression of the disease as well as reduce existing inflammatory symptoms. They are generally administered for long periods until a remission is achieved and then continued at lower dosage levels as maintenance therapy for indefinite periods ranging from months to years. Because of their relatively slow action, these agents are almost always administered with nonsteroidal anti-inflammatory agents to permit control of symptoms during the early stages of therapy, as well as during later maintenance stages. Because each of these agents is capable of producing toxic effects, their administration and client response must be carefully monitored.

Gold Compounds

Gold therapy (*chrysotherapy*) is aimed at reducing the progression of rheumatoid arthritis in both adult and juvenile types. It is most useful in the treatment of the disorder before extensive joint degeneration has occurred. Gold preparations—such as **gold sodium thiomalate** (**Myochrysine**) and **aurothioglucose** (**Solganal**)—must be administered intramuscularly, as they are poorly absorbed by the oral route. The use of gold sodium thiomalate is generally preferred, because it is an aqueous solution, whereas aurothioglucose is available only as a suspension of the drug in oil. Gold preparations are considered second-line treatment. Because of the need to administer weekly injections of gold for nearly 6 months initially, client noncompliance and toxicity may be problems.

Auranofin (**Ridaura**), a gold compound administered orally, is also available. Although virtually as effective as parenteral gold compounds, auranofin seems to produce a considerably lower level of adverse effects and is likely to result in better client compliance than is seen in the use of parenteral gold products.

The mechanism by which gold compounds exert their antirheumatic action is still unclear. They are, however, believed to inhibit antibody production as well as the release of enzymes from *phagocytizing* leukocytes at the affected site. Between 25% and 50% of clients receiving parenteral gold therapy may develop adverse side effects, with about 10% experiencing serious toxicity. The most common adverse effects associated with the use of these compounds include dermatological responses (e.g., skin rash), *proteinuria*, blood dyscrasias, and gastric irritation. In the use of the oral gold product auranofin, the most common adverse effect reported has been diarrhea.

Antimalarial Compounds

Long-term therapy (6–12 months) with the antimalarial compound hydroxychloroquine (see Chapter 8) has been employed successfully in the treatment of rheumatic disorders. Although the precise mechanism of action of this drug in alleviating rheumatic symptoms is unclear, it is believed to suppress the formation of those antigens that produce rheumatic symptoms.

Because irreversible retinal damage has been associated with the long-term use of hydroxychloroquine, baseline and periodic ophthalmological examinations should be performed before and during therapy. In addition, the client should be monitored for the development of dermatological and hematological changes while on this drug.

Penicillamine (Cuprimine, Depen)

This agent has been shown to be useful in the long-term therapy of clients with rheumatoid arthritis, particularly those with a persistently active or progressive disease that is unresponsive to aspirin or other nonsteroidal agents previously discussed. Although it is known that **penicillamine** lowers rheumatoid factor concentrations, its precise antirheumatic action is not yet clearly established. Therapy with this drug may be continued for months or even years in clients who respond favorably.

Many serious adverse effects are associated with the use of penicillamine for prolonged periods. These include GI distress, loss of taste perception, bone marrow depression, and proteinuria. It is essential, therefore, that clients receiving penicillamine be monitored with a weekly urinalysis, a complete blood count, and a platelet count during the early stages of therapy and with monthly determinations during maintenance therapy.

Table 12–2 reviews the properties of the slow-acting antirheumatic agents. Nursing implications are provided as guidelines for client care.

TABLE 12–2

Slow-acting Antirheumatic Agents

Note: Assess adverse and therapeutic responses to treatment.

DRUG	ROUTE(S)	USUAL ANTI-INFLAMMATORY DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
auranofin *(or-**AN**-oh-fin)* (Ridaura)	oral	3 mg twice daily or 6 mg once daily; may increase to 9 mg/day	diarrhea, GI distress, pruritis, nausea	Monitor client for development of thrombocytopenia, leukopenia. Not for use in children.
aurothioglucose *(**or**-oh-**thigh**-oh-**GLOO**-kohz)* (Solganal)	IM	one dose weekly beginning with 10 mg the first week, 25 mg the second and third week, and 50 mg thereafter until a total of 0.8–1 g has been given.	dermatitis, renal damage, hypersensitivity reactions, irritated tongue	Inject deep into muscle tissue. Urinalysis should be performed prior to each injection to identify presence of proteinuria and/ or hematuria. Monitor hematological status. Observe client for dermatitis and stomatitis.
gold sodium thiomalate *(gold **SOH**-dee-um thigh-oh-**MAL**-ayt)* (Myochrysine)	IM	See aurothioglucose.	See aurothioglucose.	See aurothioglucose. A vasomotor response may occur within 10 minutes of administration.
hydroxychloroquine sulfate *(hy-**drox**-ee-**KLOR**-oh-kwin **SUL**-fayt)* (Plaquenil Sulfate)	oral	200–400 mg daily	GI distress, ocular changes, hepatotoxicity, dermatological disorders	Administer with meals or milk—breakfast and dinner. Children are more likely to develop toxic effects than adults. Do not give to clients with psoriasis: may precipitate acute attack.
penicillamine *(pen-ih-**SILL**-ah-meen)* (Cuprimine, Depen)	oral	Initially 125–250 mg daily; increase daily dose by 125–250 mg at 1–3-month intervals as needed; for maintenance, 500–750 mg daily	GI distress, loss of taste perception, hematological disturbances, proteinuria, skin rash, tinnitus	Administer on an empty stomach, with water. Observe client for development of skin rash, bruises, sore throat, fever, or other signs of serious hematological adverse effects.

CORTICOSTEROIDS

Steroidal agents or corticosteroids are most commonly used for treatment of local inflammatory disorders, such as those affecting the skin. They are also employed in systemic inflammatory disorders that require potent and aggressive therapy for control (e.g., bronchial asthma). Their use in other inflammatory disorders is limited by the wide array of adverse effects they produce.

Naturally occurring steroid compounds produced in the *adrenal cortex* have both anti-inflammatory (glucocorticoid) and salt-retaining (mineralocorticoid) properties. These agents, which include cortisone and hydrocortisone, are used for replacement therapy in *adrenocortical* deficiency states and for several other conditions. Synthetic steroids such as prednisone, **prednisolone**, and **fludrocortisone** have both glucocorticoid and mineralocorticoid effects, but are used primarily for their glucocorticoid effects. Most other synthetic corticosteroids exhibit potent glucocorticoid effects, but are devoid of any significant mineralocorticoid effects. They are, therefore, popularly used in treating a wide variety of inflammatory disorders.

All corticosteroids produce a complex array of metabolic effects that have wide-ranging implications throughout the body. Most of these agents, if administered in high doses and/or over a long period, can alter carbohydrate, protein, and lipid metabolism by changing the way in which these nutrients are utilized and distributed within the body. Mineralocorticoids act on the distal tubules of the kidney to enhance reabsorption of sodium from the tubular fluid into the plasma. They also increase the urinary excretion of potassium and hydrogen ions and may dramatically affect fluid and electrolyte balance. The action of corticosteroids on body nutrients and electrolytes may produce adverse effects, such as fluid retention, altered glucose levels, and altered fat deposition (producing characteristic "moon face" and "buffalo hump"). Long-term use may result in wasting of muscle tissue in the extremities and delayed growth in children.

Most corticosteroids have the capacity to prevent or suppress the development of inflammatory symptoms, such as local heat, redness, swelling, and tenderness. This is believed to be the result of their ability to inhibit both the early phenomena (i.e., edema, capillary dilation, leukocyte migration into the inflamed area, etc.) and the later manifestations (i.e., capillary proliferation, deposition of collagen, etc.) of inflammation. Although corticosteroids suppress many inflammatory symptoms, it is important to recognize that the underlying cause of the symptoms may remain and the disease may continue to progress.

The ability of the corticosteroids to dramatically reduce the severity of inflammatory symptoms has made them valuable therapeutic agents. It has also resulted, however, in suppression of symptoms physicians can use in diagnosing disease and in evaluating the effectiveness of treatment. For example, a client using corticosteroids may have a rapidly progressing infection, yet may symptomatically appear to improve. In using corticosteroids for the treatment of inflammatory diseases, therefore, extreme caution must be exercised to avoid the development of serious adverse effects or the masking of other disease symptoms. The use of these agents should be limited to chronic conditions that cannot be treated with more conservative forms of therapy or for short-term therapy of acute inflammatory conditions.

Corticosteroids may be used systemically for the treatment of conditions such as bronchial asthma, *neoplastic* diseases, and for a wide variety of endocrine disorders. Table 12–3 compares the properties of corticosteroids employed systemically.

To avoid systemic adverse effects with corticosteroid use, it is sometimes desirable to administer these agents directly at the inflammatory site. To accomplish this, the inflammatory site must be sufficiently localized and accessible (e.g., a joint, *bursa*, or single skin lesion). Many corticosteroid products are available for local injection. Some are aqueous solutions with a rapid onset and a short duration of action. Other products may contain solid particles of corticosteroid drugs in suspension. Such formulations generally have a slow onset of action but a long duration of effect because the drug dissolves very slowly at the injection site. Table 12–4 compares corticosteroid products administered locally by injection.

The widest use of anti-inflammatory corticosteroids occurs in the topical treatment of dermatological disorders, such as dermatitis and psoriasis. These drugs, when used properly, provide an effective and relatively safe form of therapy. Many different topical corticosteroid products are available. Hydrocortisone, the least potent corticosteroid used topically, is available in some nonprescription products. Table 12–5 lists corticosteroids used in topical therapy.

TABLE 12–3

Corticosteroids for Systemic Use

Note: Systemic use may be associated with gastric ulceration, suppression of the hypothalamic-pituitary-adrenal system, hypertension, and changes in the location of body fat deposits.

Observe clients for therapeutic and adverse effects.

Routinely assess vital signs.

DRUG	ADMINISTRATION ROUTE	USUAL DOSE
betamethasone *(bay-tah-**METH**-ah-zohn)* (Celestone, Betnelsol ✱)	oral, IM, IV	Oral: 0.6–7.2 mg daily Parenteral: 0.5–9 mg daily
cortisone acetate *(**KOR**-tih-zohn **AH**-sih-tayt)* (Cortone, Acetate, etc.)	oral	25–300 mg daily
dexamethasone *(dex-ah-**METH**-ah-zohn)* (Decadron, Hexadrol, Oradexon ✱, etc.)	oral	Oral: 0.75–9 mg daily
dexamethasone acetate *(dex-ah-**METH**-ah-sohn **AH**-sih-tayt)* (Decadron L.A.)	IM	8–16 mg every 1–3 weeks
hydrocortisone *(hy-droh-**KOR**-tih-zohn)* (Cortef, Hydrocortone, etc.)	oral, SC, IM, IV	Oral: 20–240 mg daily IV: 100–500 mg 4–12 times/day *Children:* IV: 1–2 mg/kg
hydrocortisone cypionate *(hy-droh-**KOR**-tih-zohn **SIH**-pee-on-ayt)* (Cortef)	oral	See hydrocortisone
hydrocortisone sodium phosphate *(hy-droh-**KOR**-tih-zohn **SOH**-dee-um **FOS**-fayt)* (Hydrocortone Phosphate)	IM, IV, SC	15–240 mg daily, divided into 2–3 doses
hydrocortisone sodium succinate *(hy-droh-**KOR**-tih-zohn **SOH**-de-um **SUCK**-sih-nayt)* (A-HydroCort, Solu-Cortef, etc.)	IM, IV	100–500 mg/day
methylprednisolone *(meth-ill-pred-**NISS**-oh-lohn)* (Medrol)	oral	4–48 mg daily *Children:* 6–19 mg/day
methylprednisolone acetate *(meth-ill-pred-**NISS**-oh-lohn **AH**-sih-tayt)* (Depo-Medrol, etc.)	IM	40–120 mg every 1–4 weeks
methylprednisolone sodium succinate *(meth-ill-pred-**NISS**-oh-lohn **SOH**-dee-um **SUCK**-sih-nayt)* (A-Methapred, Solu-Medrol)	IM, IV	10–40 mg daily IV: 30 mg/kg 4–6 times/day *Children:* Not less than 0.5 mg/kg/day
prednisolone *(pred-**NISS**-oh-lohn)* (Delta-Cortef, etc.)	oral	5–60 mg daily
prednisolone acetate *(pred-**NISS**-oh-lohn **AH**-sih-tayt)*	IM	20–80 mg daily

continues

TABLE 12–3 *continued*

See **Note** at beginning of Table 12–3, page 280.

DRUG	ADMINISTRATION ROUTE	USUAL DOSE
prednisolone sodium phosphate *(pred-**NISS**-oh-lohn **SOH**-dee-um **FOS**-fayt)* (Hydeltrasol, Pediapred, etc.)	oral, IM, IV	4–60 mg daily
prednisone *(**PRED**-nih-sohn)* (Deltasone, Meticorten, Winpred, etc.)	oral	5–60 mg daily *Pediatric:* 0.1–0.15 mg/kg/day
triamcinolone *(try-am-**SIN**-oh-lohn)* (Aristocort, Kenacort, etc.)	oral	4–60 mg daily
triamcinolone acetonide *(try-am-**SIN**-oh-lohn Ah-**SET**-oh-nyde)* (Kenalog)	IM	2.5–60 mg daily
triamcinolone diacetate *(try-am-**SIN**-oh-lohn **DYE**-ah-sih-tayt)* (Aristocort Forte)	IM	40 mg/week

APPLYING THE NURSING PROCESS

Many drugs have anti-inflammatory action. Because of the variety of anti-inflammatory agents and because of the different nursing implications associated with these drugs, it is necessary to examine the major classes individually.

ASSESSMENT

A general health assessment should be done of all clients taking anti-inflammatory drugs. This includes measurement of weight and vital signs, physical assessment, and inquiry about mood and sleep patterns. The nurse must be aware of a wide range of side effects of anti-inflammatory drugs and also must observe the client for the therapeutic effectiveness of drug therapy. Clients should be asked about their ability to engage in activities of daily living (ADLs) and how this may have changed as a result of drug therapy.

NURSING DIAGNOSIS

Including but not limited to:

- Chronic pain related to inflammatory process
- Activity intolerance related to inflammatory process
- Impaired physical mobility related to connective tissue disease
- Risk for injury related to adverse effects of medications
- Deficient knowledge related to disease process and medication regimen
- Risk for noncompliance related to medication regimen of weekly IM injections.

PLANNING/GOALS

- Client will verbalize pain control on a level of 0–3/10.
- Client will demonstrate ability to maintain activities of daily living (ADLs) and other activity as desired.
- Client will not experience adverse effects of medications.
- Client will verbalize and demonstrate understanding of disease process and medication regimen.
- Client will remain compliant with medical therapies.

TABLE 12–4

Corticosteroids Administered by Local Injection

Note: Observe client for therapeutic effects.
Caution client about overuse of the affected part after drug injection.

DRUG	USUAL DOSE (highly individualized)	EXPECTED ONSET AND DURATION OF ACTION
betamethasone sodium phosphate *(**bay**-tah-**METH**-ah-sohn **SOH**-dee-um **FOS**-fayt)* (Celestone Phosphate, Betnelan ✱)	0.5–9 mg	rapid onset, short duration
dexamethasone acetate *(**dek**-sah-**METH**-ah-sohn **AH**-sih-tayt)* (Decadron-LA, Oradexon ✱, etc.)	0.8–16 mg	rapid onset, long duration
dexamethasone sodium phosphate *(**dek**-sah-**METH**-ah-sohn **SOH**-dee-um **FOS**-fayt)* (Decadron Phosphate, etc.)	0.4–6 mg	rapid onset, short duration
hydrocortisone acetate *(**hy**-droh-**KOR**-tih-sohn **AH**-sih-tayt)* (Hydrocortone Acetate, etc.)	5–50 mg	slow onset, long duration
methylprednisolone acetate *(**meth**-ill-pred-**NISS**-oh-lohn **AH**-sih-tayt)*	4–120 mg	slow onset, long duration
prednisolone acetate *(pred-**NISS**-oh-lohn **AH**-sih-tayt)*	4–100 mg	slow onset, long duration
prednisolone sodium phosphate *(pred-**NISS**-oh-lohn **SOH**-dee-um **FOS**-fayt)* (Hydeltrasol)	2–30 mg	rapid onset, short duration
prednisolone tebutate *(pred-**NISS**-oh-lohn teh-**BYOU**-tayt)* (Hydeltra-T.B.A.)	4–30 mg	slow onset, long duration
triamcinolone acetonide *(try-am-**SIN**-oh-lohn ah-**SEE**-tah-nyd)* (Kenalog, etc.)	2.5–40 mg	slow onset, long duration
triamcinolone diacetate *(try-am-**SIN**-oh-lohn die-**AH**-sih-tayt)* (Aristocort, etc.)	5–40 mg	intermediate onset and duration
triamcinolone hexacetonide *(try-am-**SIN**-oh-lohn **hek**-sah-**SEE**-toh-nyd)* (Aristospan)	2–20 mg	slow onset, long duration

CLIENTS RECEIVING NONSTEROIDAL ANTI-INFLAMMATORY AGENTS

Implementation

An important group of drugs is the nonsteroidal anti-inflammatory agents, including both aspirin and the new generation of NSAIDs diclofenac sodium/misoprostol (Arthotec), cefecoxib (Celebrex), and rofecoxib (Vioxx), which were designed for long-term use with arthritis. Aspirin is commonly administered by nurses for its analgesic, antipyretic, and anti-inflammatory effects. When aspirin is used as an anti-inflammatory agent, it must be taken in large doses for a long time. Such therapy may result in the development of side effects and client noncooperation. Whenever such a regimen is undertaken,

TABLE 12–5

Corticosteroids for Topical Use

Note: Observe client for therapeutic effectiveness.
Provide detailed instructions regarding appropriate use.
Caution client about accidental application to the eyes from the hands.

DRUG	AVAILABLE DOSAGE FORMS	USUAL STRENGTH
alclometasone dipropionate *(al-kloh-**MET**-ah-sohn die-**PROH**-pee-on-ayt)* (Aclovate)	cream, ointment	0.05%
amcinonide *(am-**SIN**-oh-nyd)* (Cyclocort)	cream, ointment, lotion	0.1%
augmented betamethasone dipropionate *(awg-**MEN**-ted **bay**-tah-**METH**-ah-sohn die-**PROH**-pee-on-ayt)* (Diprolene)	ointment, cream, gel, lotion	0.05%
betamethasone benzoate *(**bay**-tah-**METH**-ah-sohn **BEN**-zoh-ayt)* (Uticort)	cream, gel, lotion	0.025%
betamethasone dipropionate *(**bay**-tah-**METH**-ah-sohn die-**PROH**-pee-on-ayt)* (Diprosone)	aerosol, cream, lotion, ointment	0.05–0.1%
betamethasone valerate *(**bay**-tah-**METH**-ah-sohn **VAL**-er-ayt)* (Valisone, etc.)	cream, lotion, ointment	0.1%
clobetasol propionate *(kloh-**BAY**-tah-sohl **PROH**-pee-on-ayt)* (Temovate, Dermovate ✱)	cream, ointment, lotion	0.05%
clocortolone pivalate *(kloh-**KOR**-toh-lohn **PIV**-ah-layt)* (Cloderm)	cream	0.1%
desonide *(**DES**-oh-nyd)* (Tridesilon, DesOwen)	cream, ointment, lotion	0.05%
desoximetasone *(des-**ock**-see-**MET**-ah-sohn)* (Topicort)	cream, ointment, gel	0.05–0.25%
dexamethasone *(**dek**-sah-**METH**-ah-sohn)* (Decaspray, Aeroseb-Dex, etc.)	aerosol, cream	0.01–0.04% 1%
dexamethasone sodium phosphate *(**dek**-sah-**METH**-ah-sohn **SOH**-dee-um **FOS**-fayt)* (Decadron Phosphate)	cream	0.1%
diflorasone diacetate *(die-**FLOR**-ah-sohn die-**AH**-sih-tayt)* (Florone, Maxiflor, Psorcon)	cream, ointment	0.05%

continues

TABLE 12–5 *continued*

See **Note** at beginning of Table 12–5, page 283.

DRUG	AVAILABLE DOSAGE FORMS	USUAL STRENGTH
fluocinolone acetonide *(**floo**-oh-**SIN**-oh-lohn ah-**SEE**-tah-nyd)* (Fluonid, Synalar, Fluoderm, Synamel)	cream, ointment, solution, shampoo, oil	0.01–0.2%
fluocinonide *(**floo**-oh-**SIN**-oh-nyd)* (Fluonex, Lidex, Lidemol)	cream, gel, ointment, solution	0.05%
flurandrenolide *(**flur**-an-**DREN**-oh-lyd)* (Cordan, Drenison)	cream, lotion, ointment, tape	0.025–0.05%
fluticasone propionate *(floo-**TICK**-ah-sohn **PROH**-pee-on-ayt)* (Cutivate)	cream, ointment	0.005%–0.05%
halcinonide *(hal-**SIN**-oh-nyd)* (Halog)	cream, ointment, solution	0.025–0.1%
halobetasol propionate *(**hay**-loh-**BAY**-tah-sohl **PROH**-pee-on-ayt)* (Ultravate)	cream, ointment	0.05%
hydrocortisone *(**hy**-droh-**KOR**-tih-sohn)* (Cort-Dome, Hytone, Dermolate, Cortate)	aerosol, cream, gel, lotion, ointment	0.25–2.5%
hydrocortisone acetate *(**hy**-droh-**KOR**-tih-sohn **AH**-sih-tayt)* (Cortaid, CaldeCort, Cortacet)	cream, ointment	0.5–1.0%
hydrocortisone butyrate *(**hy**-droh-**KOR**-tih-sohn **BYOU**-tih-rayt)* (Locoid)	solution	0.1%
hydrocortisone valerate *(**hy**-droh-**KOR**-tih-sohn **VAL**-er-ayt)* (Westcort)	cream, ointment	0.2%
methylprednisolone acetate *(**meth**-ill-pred-**NISS**-oh-lohn **AH**-sih-tayt)* (Medrol Acetate)	ointment	0.25–1%
mometasone furoate *(moh-**MET**-ah-sohn fyou-**ROH**-ayt)* (Elocon)	cream, ointment, lotion	0.1%
prednicarbate *(pred-nih-**KAR**-bayt)* (Dermatop)	cream	0.1%
triamcinolone acetonide *(try-am-**SIN**-oh-lohn ah-**SEE**-toh-nyd)* (Aristocort, Kenalog, Triaderm, etc.)	aerosol, cream, lotion, ointment	0.025–0.5%

KEY NURSING IMPLICATIONS 12–1

Clients Receiving Nonsteroidal Anti-Inflammatory Agents

1. Acetaminophen cannot be substituted for aspirin in clients taking aspirin for its anti-inflammatory effects.
2. Ibuprofen, fenoprofen, calcium, and naproxen are not recommended for clients allergic to aspirin, those with hemophilia, or those taking anticoagulants.
3. Observe clients taking aspirin for allergic reactions, edema, excessive weight gain, constipation, gastrointestinal upset, tinnitus, and bleeding.
4. Indomethacin is ulcerogenic and can aggravate epilepsy and psychiatric disturbances. Clients allergic to aspirin should not take indomethacin.
5. Use of phenylbutazone may be associated with serious blood abnormalities. Report all evidence of sore throat, bleeding, mouth ulcers, or tarry stools immediately.

it is well to explain the reason for this therapy, its expected outcome, the possible side effects, and the expected length of treatment. Clients tend to view aspirin as a home remedy, without much therapeutic value or serious side effects. If they view treatment in this way, they may fail to take the drug as prescribed, and they may not recognize adverse side effects as being related to drug therapy. Clients need to be made aware of the possibility of tinnitus (ringing in the ears) and gastrointestinal bleeding as evidenced by pain and blood in the stool (tarry stools). It is important for the nurse to inquire about allergy to aspirin or previous history of gastric ulcers before administering the first dose. Observations for tinnitus, gastrointestinal upset, and/or bleeding need to be made throughout therapy. Gastrointestinal upset can be minimized by giving aspirin with food or milk. If plain aspirin is not tolerated, buffered aspirin or enteric-coated aspirin may be tried. The buffered preparations frequently lack sufficient amounts of buffering ingredients to be effective, and the enteric-coated preparations may result in a delayed therapeutic effect—they may also be poorly absorbed. In some cases, absorption is so poor that the drug passes through the gastrointestinal tract in virtually the same form as was administered.

Because aspirin inhibits prostaglandins, it may influence the client's elimination of sodium and water. The nurse monitors the client for the development of edema and excessive weight gain. Sodium intake may be restricted in some clients. Aspirin's ability to inhibit prostaglandins may also result in constipation, and regular use of stool softeners is recommended for clients who experience this side effect.

When clients are taking aspirin for its anti-inflammatory effect, it is well to stress to them that they cannot substitute drugs, such as acetaminophen (e.g., Tylenol and **Datril**), in place of the aspirin. Although acetaminophen may provide some pain relief, it is not effective as an anti-inflammatory agent.

All clients taking aspirin should be observed for allergic reactions. Such reactions may appear as urticaria (hives), an asthmatic response or as anaphylaxis. When such reactions appear, the aspirin must be stopped immediately and the physician must be notified. Emergency measures may be required, if the reaction is sufficiently severe. The client's care and medication records must be marked conspicuously to indicate aspirin allergy. In addition, the client must be instructed to avoid all forms of aspirin in the future. Avoidance of aspirin requires that the client be instructed to read the labels of over-the-counter (OTC) preparations, particularly pain remedies and cold preparations, as many of these products contain aspirin.

Aspirin is usually administered in divided daily doses. Those taken during the day seem best tolerated when given at mealtimes. Clients taking large doses of aspirin are advised to take a preparation that dissolves rapidly. This can be tested by dropping a tablet into a glass of room temperature water and checking to see how long it takes for the tablet to dissolve. Tablets that dissolve within 1 minute are recommended for clients taking aspirin regularly. The bedtime dose is better tolerated when given with a snack. It has been suggested that administering the largest dose of aspirin at bedtime may be helpful in decreasing the morning stiffness frequently experienced by clients with arthritis. Administering the day's first dose of aspirin 1 hour before rising may also help to decrease morning stiffness.

The nurse should be actively involved in encouraging a client to faithfully take the prescribed dose of aspirin. Often clients do not understand the importance of not missing doses. It is possible that, even though several doses are missed, the client might not experience an increase in pain. Missed doses, however, can make a difference in the progression of the disease because of the effect of aspirin on inflammation and, ultimately, on mobility. It has been suggested that periodic blood tests for salicylate levels should be done to determine if a client has been taking and absorbing the drug. It may be useful to have the results sent to the client to reinforce the relationship between taking the drug and blood level. Nurses can be actively involved in encouraging compliance and in helping clients to establish ways to remember their daily doses.

Whenever possible, the number of drug administration times should be decreased by scheduling several drugs to be given at the same time. This, of course, can only be done when significant drug interactions are not likely to occur. Also, clients require both written and oral directions for drug use and may benefit from a drug calendar with daily doses of each medication noted.

Other nonsteroidal, anti-inflammatory agents may be used as alternatives to aspirin. Some may be a little better tolerated by the gastrointestinal tract than aspirin. **Note:** None of these agents are recommended for administration to clients who are allergic to aspirin. In addition, they should not be given to clients with *hemophilia* or those taking anticoagulants, as they prolong bleeding time.

Diclofenac sodium/misoprostol (Athrotec), celecoxib (Celebrex), and rofecoxib (Vioxx) were developed to address the gastrointestinal adverse effects associated with aspirin and are becoming more commonly used. As was mentioned earlier in this chapter, these NSAIDs involve more client-friendly dosing—either once or twice a day. In addition, they have been shown to be more effective in providing pain relief than the traditional NSAIDs, such as the salicylates and the ibuprofens. The expense of the newer products may limit some use of these drugs; however, most are covered by conventional insurance policies.

Use of agents such as indomethacin (**Indocin**), **sulindac** (**Clinoril**), or **tolmetin** (**Tolectin**) is associated with a wide range of adverse effects; the most common involves the gastrointestinal tract and the central nervous system (CNS). Gastrointestinal adverse effects, such as GI pain, nausea, and vomiting, may be minimized by administering oral doses of these drugs on a full stomach, preferably after meals and with milk at bedtime (antacids are preferred with tolmetin, as food may decrease tolmetin absorption from the gastrointestinal tract). CNS adverse effects, such as headache and dizziness, have been associated with the use of indomethacin and sulindac. None of these agents should be administered to clients known to be hypersensitive to aspirin or other nonsteroidal, anti-inflammatory agents.

Phenylbutazone (**Butazolidin**) is a drug seldom used for long-term therapy because of its adverse side effects. The nurse should observe clients receiving this drug for signs and symptoms indicative of gastric ulcers and/or fluid retention. It is recommended that phenylbutazone be taken on a full stomach. In addition, this drug may produce aplastic anemia and other blood abnormalities. All clients receiving this drug for more than a week should have frequent, preferably weekly, blood counts. Any sudden fever, mouth ulcers, sore throat, evidence of tarry stools, bleeding, or easy bruising should be reported immediately to the physician. Outpatients should be cautioned about participating in activities requiring alertness, such as driving, as this drug may impair their performance.

CLIENTS RECEIVING SLOW-ACTING ANTIRHEUMATIC DRUGS

Implementation

Another type of drug therapy, chrysotherapy, or the administration of gold salts, may be useful in treating clients with rheumatoid arthritis. The nurse may be responsible for administration of gold sodium thiomalate (Myochrysine) or aurothioglucose (Solganal), as both are given by intramuscular injection. The nurse should take this opportunity to assess the therapeutic and side effects the client may be experiencing.

KEY NURSING IMPLICATIONS 12–2

Clients Receiving Slow-acting Antirheumatic Drugs

1. Assess the client receiving gold therapy for dermatitis and stomatitis. Assess symptomatic improvement in joint pain and motion.
2. Have clients receiving parenteral gold therapy wait for ½ hour before discharge from the clinic or office and monitor for the development of a vasomotor response or allergic reaction.
3. Monitor the client taking hydroxychloroquine for visual loss, often first indicated by a change in peripheral vision.
4. Penicillamine must be taken on an empty stomach.

Therapeutic effects are determined by decreased size of the affected joint(s), decreased number of affected joints, increased strength of grip, decreased need for analgesics, and improvement in the client's functional abilities, such as dressing and other self-care activities.

A number of adverse side effects are associated with gold therapy, although many are of little consequence. Dermatitis and *stomatitis* are the most common reactions. The nurse should inspect the client's oral cavity and inquire about oral discomfort. Rectal and vaginal ulceration also may occur. Skin should be examined and the client asked about itching. A metallic taste in the mouth may precede development of the rash or stomatitis. If skin and/or mucous membrane side effects become severe, gold therapy may be discontinued or gold therapy with auranofin (Ridaura) may be considered. Cessation of the gold therapy will reverse these effects.

Various blood abnormalities may occur with chrysotherapy. Periodic blood studies are ordered to evaluate the effects of gold on blood and blood-forming organs. The final side effect of some consequence is a vasomotor response to Myochrysine. This reaction, which usually occurs within 10 minutes of injection, is similar to the physiological response to nitrates. The client may experience fainting, dizziness, flushing, and perspiration. Less frequent effects are nausea, vomiting, and malaise. Most responses are mild and are more frightening than harmful. Careful observation and reassurance are indicated. Occasionally anaphylactic shock or similar serious side effects may develop. For this reason, it is well to have outclients remain in the office or clinic setting for ½ hour after parenteral administration of the drug.

Clients taking hydroxychloroquine are routinely monitored for retinal damage with loss of vision. The nurse may first become aware of visual loss by noting a change in the client's peripheral vision. Clients allergic to penicillin may take penicillamine, but must be monitored carefully. In addition to routine monitoring, the nurse should be aware that use of penicillamine affects the absorption of **pyridoxine** (vitamin B_6). Pyridoxine may be taken daily. Its daily use may alleviate the bad taste in the mouth, rash, and neuropathy. Penicillamine must be taken on an empty stomach, at least 2 hours after meals or the use of **iron** preparations.

CLIENTS RECEIVING CORTICOSTEROIDS

Implementation

The corticosteroid drugs are used for their anti-inflammatory effect in many different conditions. Local methods of administration, such as application to skin or mucous membranes and injection into joints, are sometimes used in an attempt to prevent systemic absorption. This may minimize complications while enhancing local effectiveness. Local applications of corticosteroids may, however, cause suppression of the *hypothalamic-pituitary-adrenal system* if used over long periods of time in sufficiently large amounts. Such adrenal gland atrophy may result in adrenal insufficiency if the use of corticosteroids is abruptly discontinued. Systemic administration, e.g., oral, sublingual, and intravenous, is also associated with side effects such as gastric ulceration, hypothalamic-pituitary-adrenal suppression, and fluid retention. These may be particularly evident with use of **cortisol**, cortisone, prednisone, and prednisolone. Intermittent therapy—for example, every other day—has

been used, resulting in an apparent decrease in adverse side effects and adrenal suppression without significant decrease in therapeutic effectiveness. Clients frequently want to know why, if the drug is so effective, they cannot take it every day. The nurse can be helpful by reinforcing the physician's explanation for this intermittent schedule.

The response to corticosteroids is often dramatic. Clients who receive intra-articular injections often feel so much better that they may engage in activities that are too strenuous. They must be informed that corticosteroids are effective anti-inflammatory agents, but are not curative. One must be careful, therefore, not to place too much physical stress on the affected joint to avoid further damage to the tissues.

To address their deficient knowledge, clients on long-term steroid therapy require information about the possible adverse side effects of their medication. They should have a sound understanding of their health problem and its treatment. They should know the major side effects of their drugs and what actions to take should these occur. Clients should be instructed to carry some means of identification with the name and address of their physician and the type of therapy they are receiving. They should also be cautioned not to share their medication, with anyone else, not to skip or suddenly stop their medication, and to contact their physician if they are under unusual psychological or physical stress. **Note:** All health care providers should be made aware of the long-term therapy a client has been receiving. This is important as supplemental corticosteroids may be necessary before surgery or other stressful experiences to avoid life-threatening adrenal crisis. Nurses caring for clients on long-term therapy are alert for indications of impending adrenal crisis such as hypotension, restlessness, weakness, lethargy, headache, dehydration, nausea, vomiting, and/or diarrhea. The physician must be notified immediately. Postoperative clients who have been receiving long-term therapy should be observed carefully and should have their blood pressure checked frequently. The physician will probably order additional corticosteroids for clients who show signs of impending adrenal crisis.

KEY NURSING IMPLICATIONS 12–3

Clients Receiving Corticosteroids

1. Systemic administration is associated with a broad range of side effects, including gastric ulceration, suppression of the hypothalamic-pituitary-adrenal system, hypertension, and changes in location of body fat deposits.
2. Clients receiving corticosteroids should be monitored for gastrointestinal bleeding and weight gain.
3. Both diabetics and nondiabetics should be monitored for blood glucose elevations while using corticosteroids.
4. Clients receiving intra-articular injections of these drugs must be cautioned not to overly stress the joint(s).
5. Teach clients on long-term therapy to carry identification and information about their treatment, to continue treatment, not to share medication, and to contact the physician whenever they are under unusual stress.
6. Impending adrenal crisis is indicated by hypotension, restlessness, weakness, lethargy, headache, dehydration, nausea, vomiting, and/or diarrhea.
7. Dietary modifications are specified, including sodium restriction and encouraging intake of calcium, because of a high risk for osteoporosis. Potassium supplementation may be indicated for clients taking corticosteroids.
8. Protect the client from infection and trauma and teach them measures to decrease risk.
9. Administer corticosteroids early in the day to avoid insomnia.
10. Provide instruction and support for the client being withdrawn from corticosteroids.

Recently, high-dose intravenous corticosteroids (pulse therapy) have been used in some clients with rheumatoid arthritis who are experiencing relapses. Improvement may occur after 24–48 hours, but the nurse must carefully

monitor the infusion and the client's condition. The drug is administered slowly over 1–2 hours to avoid fluid shifts, cardiac arrhythmias, blood pressure changes, peripheral edema, and congestive heart failure.

Less dramatic side effects do occur with the systemic administration of corticosteroids. Those drugs with significant mineralocorticoid activity may bring about weight gain, edema, hypertension, weakness, fatigue, and alkalosis resulting from potassium depletion. It is especially important to observe these side effects in the elderly and in clients with heart disease, as significant fluid retention may overburden their circulatory systems. Routine blood pressure measurement is indicated for all clients receiving long-term steroid therapy.

Because of the ability of corticosteroids to increase the amount of glucose in the body through *gluconeogenesis* and insulin antagonism, the nurse is alert for signs and symptoms of diabetes mellitus or worsening of existing diabetes. Such indications of diabetes should be brought to the physician's attention for further diagnostic workup and possible treatment.

Nurses should be aware that clients on long-term corticosteroid therapy may experience some changes in the distribution of body fat. Frequently fat is deposited in the face, producing a full, or moon, face or across the upper back, resulting in the so-called buffalo hump, and elsewhere in the trunk. In such clients, the extremities may tend to appear thin and frail. The nurse provides emotional support for clients who are concerned about these changes. The nurse may also be able to suggest alterations in clothing styles to minimize the impact of these body changes.

Some clients receiving long-term therapy with corticosteroids require special diets. Because of the sodium and water retention associated with some of these drugs, a sodium-restricted diet may be indicated. Clients are generally encouraged to eat foods high in potassium, such as fresh fruits and vegetables, as these are often low in sodium and also replace the body's potassium, which can be depleted through long-term steroid therapy. Increasing dietary potassium can help to prevent the weakness and lethargy sometimes reported by clients taking steroids. Also, corticosteroids can produce *negative nitrogen balance*, which can be prevented and/or treated with a high-protein, high-carbohydrate diet. When such diets are indicated, the nurse plays an important role in dietary instruction, reinforcing the instructions of others and encouraging the client to adhere to the diet. The nurse can be particularly useful in helping the client and family adapt the diet to the food habits and schedule of the client.

Another implication for dietary modification results from increased excretion of calcium and phosphorus that often accompanies steroid therapy. This may produce or aggravate already existing *osteoporosis*, particularly in postmenopausal women. Osteoporosis is a reduction in the quantity of bone, leaving the bone porous and at high risk for fracture. Such fractures are sometimes referred to as pathological fractures. A diet high in calcium and protein may help to prevent or alleviate osteoporosis. In addition, the nurse should encourage clients to engage in moderate exercise, such as walking, because calcium more readily leaves the bones of inactive individuals. Range-of-motion exercises are carried out in clients on bedrest. Also, because of the possibility of pathological fractures, the nurse discusses safety measures in the hospital and at home that are useful in preventing accidents. Supplemental **vitamin D** and **calcium** may be ordered to decrease the unwanted effects of steroids on the skeletal system.

A final dietary implication of steroid therapy is that corticosteroids may produce or aggravate an existing peptic ulcer. Such ulcers are slow to heal because of the anti-inflammatory and *catabolic* effects of steroids. Corticosteroids can cause an increase in hydrochloric acid production and inhibit the secretion of protective mucus. Whenever possible, clients should be encouraged to take their medication with food or milk. The physician may recommend taking the drug with an antacid. The nurse observes the client for gastric pain and signs of blood in the feces or emesis. Such signs should be reported immediately.

Another side effect of corticosteroid therapy the nurse must bear in mind is an altered response to healing with long-term therapy. This results in delayed wound healing, which is of

particular importance in clients with traumatic injuries and in those with surgical incisions. Appropriate support must be provided for the affected area, and the wound must be checked frequently for signs of healing.

Clients taking corticosteroids often bruise easily, as these drugs may increase the fragility of capillaries. For this reason, clients should be cautioned to avoid trauma whenever possible. An increase in **vitamin C** intake may help to reduce the amount of bruising.

Because of the metabolic effects of steroids, they may hamper growth and development in children. The use of alternate-day therapy seems to decrease this adverse effect. It is important for the nurse to be aware of the effects of corticosteroids on the CNS. These drugs can increase the excitability of the nervous system and can produce convulsive seizures, especially in children. Because of their potential for causing insomnia, steroids should be administered early in the day. Labile emotions, which may be manifested as euphoria and/or depression, can result from drug therapy. The nurse should be alert for nightmares and withdrawal from social contact, as these may indicate depression and possible suicidal behavior by the client. Such behaviors should be reported to the client's physician.

As a result of drug therapy with steroids, alterations occur in the blood. *Eosinophils*, lymphocytes, and immature red blood cells called *reticulocytes* are decreased. The production of red blood cells is increased. Nursing measures should be taken to avoid vascular stasis. Such measures include proper positioning and frequent position changes, which also decrease the likelihood of *decubitus* formation. Exercises may also be useful in improving circulation in nonambulatory clients. Clients on bedrest should be observed carefully for swelling and pain in the lower extremities, as these might indicate phlebitis. Also, because of the decrease in lymphocytes, the client is more susceptible to infection. In addition, the signs and symptoms of infection, such as fever, heat, redness, pain, and swelling may be masked by steroids. The nurse limits the hospitalized client's contact with infectious agents by screening visitors, handwashing between clients, and by the use of meticulous aseptic technique when performing procedures. Nonhospitalized clients should be instructed to avoid crowds, particularly during seasons and weather when upper respiratory infections are likely to develop.

The final nursing measures to be discussed concern supportive therapy for clients who are being withdrawn from steroids. When long-term steroid therapy is to be discontinued, it is done gradually over time; smaller doses are gradually administered to give the hypothalamic-pituitary-adrenal mechanisms a chance to resume hormone production. During this time, the nurse observes the client for flare-ups of the condition for which drug therapy was originally begun. In addition, the nurse watches for signs and symptoms of adrenal insufficiency, such as hypotension and lethargy, which indicate that additional medication might be needed. Clients are instructed to continue carrying or wearing some form of identification indicating that they require corticosteroids when under stress. It may take up to 2 years for the client's body to be able to secrete the necessary amounts of hormones under stress, and careful medical follow-up must be encouraged during this time.

A final word about caring for clients receiving steroid therapy: The importance of family and client education must be stressed. Appropriate instruction not only improves the therapeutic outcome, but may also be lifesaving. Many educational materials are available and the nurse should keep current regarding these. In addition to materials available locally, nurses can assist clients in learning about their therapy by referring them to a national association, such as the Arthritis Foundation.

EVALUATION

- Client verbalizes pain control at a level of 0–3 on a 10-point scale.
- Client demonstrates ability to maintain ADLs and other activity as desired.
- Client does not experience adverse effects of anti-inflammatory therapy.
- Client verbalizes and demonstrates understanding of disease process and medication regimen.
- Client demonstrates compliance with drug therapy.

NURSING CARE PLAN

A Client with Arthritis Taking Aspirin and Prednisone

Bernard Marshall, age 60, saw his physician in the office after experiencing severe pains in his right hand. He had recently been having trouble turning the doorknob on the front door. He has a history of rheumatoid arthritis for many years and has been taking 3–9 aspirin tablets daily for pain relief. On this visit the physician decided to prescribe prednisone 10 mg OD for 2 weeks before his next scheduled office visit.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Pain in both hands.	Chronic pain related to inflammatory joint process secondary to rheumatoid arthritis.	On a scale of 0 to 10 client will express a decrease in pain following initiation of comfort measures and new medication regimen.	Use grip test to check pain. Ask client for location and severity of pain (scale 0 to 10). Assess for factors that aggravate or alleviate pain. Physical therapy consult.	Client demonstrates relief of pain and increased tolerance for activity.
Alteration in function of fingers.	Risk for impaired physical mobility related to pain and inflammation.	Client will demonstrate no evidence of muscle deterioration. Client will maintain or improve in hand function during hospitalization.	Implement measures to improve and/or maintain mobility. Encourage client to cooperate with physical therapy program.	Client demonstrates measures to maintain or increase mobility.
Vital signs. Pain on movement.	Activity intolerance related to fatigue and pain.	Blood pressure, pulse, and respirations within normal limits during periods of activity within 1 week of beginning prednisone.	Monitor vital signs. Encourage periods of rest. Space out activities.	Client demonstrates normal blood pressure, pulse, and respirations and tolerates increasing levels of activity without fatigue.
Taking aspirin for pain.	Risk for injury related to aspirin and cortisone synergistic action.	Client verbalizes understanding of cause and management of GI bleeding/upset prior to leaving physician's office.	Teach client to monitor for symptoms of gastrointestinal hemorrhage (tarry stool, rapid pulse rate). Suggest client take largest dose of aspirin with a snack at night.	Client demonstrates no bleeding or GI upset. Client verbalizes symptoms of GI hemorrhage.
Vital signs. Edema. Salt and fluid intake.	Risk for excess fluid volume related to cortisone therapy.	The client will verbalize the need to have electrolytes measured at regular intervals and signs and symptoms of excess fluid volume prior to leaving physician's office.	Monitor blood pressure for elevation. Check client for edema. Explain to client that he may need to restrict sodium to prevent fluid overload. Encourage client to weigh himself weekly at the same time and to bring the record to his next office visit.	Client follows dietary modifications. Client does not develop problems related to excess fluid volume.

continues

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Prednisone ordered as new prescription.	Deficient knowledge related to medication therapy.	The client will verbalize understanding of how to take medication appropriately and the underlying rationale for use of prednisone prior to leaving physician's office.	Teach client to carry identification that he is taking prednisone and a list of current drugs being taken with dosage. Teach him to protect self from infection and trauma. Teach to observe for symptoms of gastric ulcers, high blood pressure, and fluid retention. Instruct client to inform all involved health care professionals that he is taking corticosteroids. Encourage client to take medication early in the day to prevent insomnia. Teach client to observe and report effectiveness of new medication regimen. Teach client side effects of prednisone therapy. Stress the importance of maintaining dosage as physician orders. Drug needs to be tapered to discontinue.	Client is cooperative with medication regimen. Client knows to report any signs of complications immediately. Client verbalizes side effects, including facial changes, hirsutism, mood swings, and increased appetite that could result from treatment with prednisone.
Knowledge of prednisone.	Risk for injury related to effects of medication on gastric mucosa.	Before leaving physician's office, client verbalizes understanding of taking medication with food.	Instruct client that prednisone should be taken with meals or an antacid.	Client demonstrates correct medication administration. Client does not experience gastric upset/GI bleeding.

HOME CARE / CLIENT TEACHING

1. Aspirin, like all medications, must be kept out of the reach of young children.
2. Clients who have difficulty opening containers of medications should ask the pharmacist for packages that are easier to open, for example, those that are not child-resistant.
3. When in the client's home, take the opportunity to ensure the safe storage of aspirin and other medications. Reinforce the use of acetominophen rather than aspirin for the treatment of febrile illnesses in children.
4. Clients on long-term therapy with corticosteroids need to be instructed about periodic assessment of their blood glucose.
5. Clients on corticosteroid therapy need instruction concerning dietary adjustments, including sodium restrictions and increased potassium intake, added protein and carbohydrates (if in negative nitrogen balance), increased calcium to help prevent osteoporosis, and increased vitamin C to help reduce the amount of bruising due to increased capillary fragility.
6. Clients on long-term therapy with corticosteroids need to be monitored for infection and instructed to wash their hands regularly and to avoid persons with infections. They also need to be told about the slowing of wound healing in the presence of corticosteroids.
7. Steroids can negatively influence growth and development in children.
8. Steroids should be administered early in the day to help prevent insomnia that can accompany steroid therapy.
9. Clients need to be instructed not to discontinue corticosteroids abruptly.
10. Clients on steroid therapy should be instructed to wear a MediAlert identification.

CASE STUDY

Hannah Rogers is a 48-year-old woman who has been suffering increasingly from morning stiffness as well as generalized joint pain. Her symptoms have intensified during the last several weeks. Both of her hands are swollen and she is no longer able to wear her wedding ring. Her joint pain has forced her to quit her job as a cashier and she now rarely ventures from her home. A thorough physical and laboratory examination results in the diagnosis of rheumatoid arthritis.

The physician instructs Mrs. Rogers to begin taking aspirin tablets at a dosage of three 325 mg (5-gr) tablets 4 times a day (3.9 g daily). After several days of therapy the client experiences moderate epigastric pain, as well as nausea. She decides to use acetaminophen (Tylenol) in place of the aspirin and experiences relief of her epigastric pain and nausea, but no improvement of her joint pain and stiffness.

At her next visit to the physician she is told to begin using ibuprofen (Motrin) at a dose of 400 mg 4 times daily. After 30 days of therapy her symptoms have improved although some nausea is occasionally evident.

Questions for Discussion

1. What measures could have been employed to improve the client's tolerance of aspirin?
2. Is acetaminophen (Tylenol) an acceptable substitute for aspirin? Explain.
3. What nursing actions would be appropriate in optimizing the long-term drug therapy of this client?
4. Would the use of systemic corticosteroids be advisable in this client? Explain.

CRITICAL THINKING EXERCISES

1. Request materials for client and family education from your local chapter of the Arthritis Foundation. Read the literature to reinforce your understanding of your role in client education.
2. Compare the therapeutic program of two clients—one receiving treatment for rheumatoid arthritis and the other being treated for osteoarthritis.
3. Plan a client education program for a child who is starting long-term treatment with corticosteroids.
4. List the major body systems and indicate the possible effects of long-term steroid treatment on each of them.
5. List the types of injury which may elicit an inflammatory response.
6. Prepare an audio-visual aid on the two phases of the inflammatory response.
7. A client taking NSAIDs is given misoprostol. Discuss why.
8. Discuss the signs and symptoms of salicylate toxicity.
9. Discuss the NSAIDs in terms of the differences in the actions they exert on the body.
10. What are the contraindications for the use of NSAIDs?
11. Create a chart that compares a salicylate and an NSAID.
12. Discuss the adverse effects of steroid therapy.

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Agents Used to Treat Hyperuricemia and Gout

13

OBJECTIVES

After studying this chapter, the student will be able to:

- Explain the difference between primary gout and secondary gout
- Describe the use of colchicine in the treatment of an acute attack of gout
- Contrast the mechanism(s) by which probenecid (Benemid), sulfinpyrazone (Anturane), and allopurinol (Zyloprim) reduce serum uric acid levels
- List three drugs whose action may be interfered with by probenecid (Benemid)
- List three drugs whose action may be interfered with by allopurinol (Zyloprim)
- List appropriate nursing measures which would be used in the administration of allopurinol (Zyloprim), probenecid (Benemid), or sulfinpyrazone (Anturane)
- Apply the nursing process in the care of a client with gout

Gout is a chronic metabolic disease associated with the development of hyperuricemia, the presence of abnormally elevated amounts of uric acid in the blood. Hyperuricemia may arise because of a reduction in the renal elimination of uric acid, an increase in uric acid production, or a combination of these two factors. Such alterations in the body's ability to control uric acid levels may be the result of a genetically transmitted metabolic defect, obesity, excessive alcohol consumption, and/or therapy with certain diuretic drugs.

In ancient times gout was recognized as a disease and was subject to many myths regarding its cause and treatment. Records indicate that Hippocrates believed gout was caused by excessive amounts of phlegm that settled in the joints. Others have thought and still do believe that gout is caused by excessive indulgence in wine, food, and/or sex. It was not until the nineteenth century that gout was recognized as a disease caused by a metabolic defect and associated with elevations of uric acid (urate) levels in the blood.

Gout affects about 3.5% of the population in the United States. It is four times more prevalent in men than in women and usually first appears during middle age. With 90% of primary gout found in men more than 30 years old, incidence peaks between the ages of 40 and 60 in men. In women, its onset generally begins after menopause. About 25% of all close relatives of clients with gout will exhibit hyperuricemia.

Uric acid is an agent formed in the body by protein breakdown (Figure 13–1). It can, therefore, either be derived from dietary protein sources or from the breakdown of body tissues. Uric acid is not metabolized by the human body. It is generally excreted unchanged in the urine or eliminated by the gastrointestinal tract. Because of its poor water solubility, the excretion of uric acid is very sensitive to changes in urine pH or renal function.

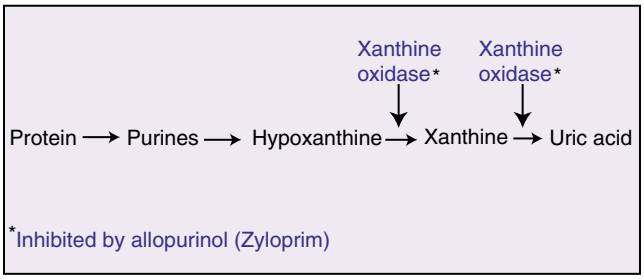

Figure 13–1 Pathway for uric acid formation in the body.

In gout, uric acid precipitates from saturated body fluids as crystals (tophi) which deposit in tissues and joints. This may cause gouty arthritis, a condition characterized by inflammation at the site of crystal deposition and acute joint pain. Although the *metatarsophalangeal* joint of the great toe is most susceptible to gout symptoms, the joints of the feet, ankles, and knees are also commonly affected (Figure 13–2). Most gout attacks appear suddenly, often at night. Pain tends to become worse as the attack progresses and fever may occur. If left untreated, gout may progress to deforming arthritis associated with destruction of affected joints and the bone surrounding them.

In addition to causing gouty arthritis, hyperuricemia may also result in the deposition of tophi in subcutaneous tissue and/or in the kidney. Although the tophi deposits in subcutaneous tissue are usually painless, they may damage underlying tendons and cause ulceration. Tophi deposited in the kidney may lead to chronic and progressive renal dysfunction and, in some cases, renal failure.

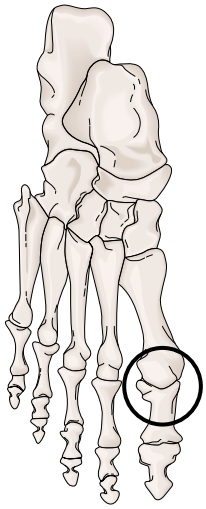

Figure 13–2 The circled area of the foot is a likely site for urate crystal deposition.

MANAGEMENT OF ACUTE GOUTY ARTHRITIS

Acute gouty attacks are extremely painful and may persist for several days to several weeks. For this reason, such attacks should be treated as soon as possible, preferably within the first few hours of onset of pain. An effective drug for the treatment of acute gout is **colchicine**, a drug which has been used for gout treatment for more than one thousand years. It is particularly beneficial in clients who are hypersensitive to aspirin and nonsteroidal anti-inflammatory agents. In treating acute gout, colchicine may be administered either orally or intravenously. A client who knows what dose is required to alleviate an attack may take one-half that dose at once and the remainder at 1-hour intervals. When administered in this fashion, joint pain and swelling generally subside within 12 hours and are usually gone in 24 to 48 hours.

Although the intravenous administration of colchicine is less likely to result in GI upset than if it were given orally, it can cause severe irritation, pain, and phlebitis at the injection site. It may also cause *leukopenia*, particularly in clients with impaired renal or hepatic function.

Although colchicine has been used for many years, its mechanism of action is still not precisely understood. There is some evidence that part of its action in gout may be due to the drug's interference with the migration of granulocytes to the inflamed area. This reduces the release of the lactic acid and enzymes that lead to a localized inflammatory response. Colchicine is successful in relieving acute gouty attacks in about 90% of all clients. The major adverse effects associated with colchicine therapy are nausea, vomiting, and diarrhea. GI bleeding, neuritis, *myopathy*, *alopecia*, and bone marrow depression have also been reported.

Many of the nonsteroidal anti-inflammatory agents (see Chapter 12) have been shown to be effective in treating acute gouty arthritis attacks. These agents may be more acceptable to clients because they are less likely to produce adverse effects. Nonsteroidal anti-inflammatory drugs are often preferred in the treatment of gout because of their anti-inflammatory action and their analgesic and antipyretic effects. See Table 13–1.

TABLE 13–1

Drugs Used to Treat Gout

Note: Monitor for effectiveness including monitoring uric acid level.
Monitor for adverse effects, including toxicity in some antigout drugs.

DRUG	ROUTE(S)	USUAL DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
allopurinol *(al-oh-**PYOUR**-in-nahl)* (Zyloprim)	oral, IV	Oral: 200–800 mg/day IV: 200-400 mg/m^2/day	Pruritic, maculopapular rash, fever, malaise	Keep urine slightly alkaline to prevent urine acid stones from forming. IV dose should be given as a single infusion.
colchicine *(**KOHL**-chih-seen)*	oral, IV	Oral: 4–8.0 mg for acute attack; 0.5–0.65 mg for prophylaxis IV: 2 mg initially followed by 0.5 mg every 6 hours until pain is controlled	Nausea, vomiting, aplastic anemia, agranulocytosis, diarrhea	Monitor effectiveness of therapy, both as to pain control as well as monitoring uric acid levels. Monitor for toxicity. IV administration can cause phlebitis. Should be taken at the first sign of gout attack.
probenicid *(proh-**BEN**-in-sid)* (Benemid, Benuryl)	oral	250 mg twice daily for 1 week, then 500 mg twice a day as maintenance dose—increasing it, if needed, to 2 g a day	Headaches, dizziness	Should be used with caution in clients with history of allergy to sulfa. Do not start this therapy until acute attack subsudes. Monitor CBC, uric acid, liver, and renal function.
sulfinpyrazone *(sul-fin-**PEER**-ah-zohn)* (Anturane)	oral	200–400 mg/day in two divided doses	Nausea, vomiting, diarrhea	Administer with meals. Monitor CBC, as well as uric acid levels. Multiple drug interactions. Consume 3–4 quarts of fluid per day.
Non-Steroidal Anti-inflammatory Agents Used to Treat Acute Gouty Arthritis				
Indomethacin *(in-doh-**METH**-ah-sin)* (Indocin)	oral	50 mg up to 4 times a day.	CNS symptoms in elderly clients and those with pre-existing CNS disorders. Nausea, vomiting, abdominal pain	Monitor for GI irritation. Do not crush the sustained-release form. Use smallest effective dose.
naproxen *(nah-**PROX**-en)* (Anaprox, Aleve)	oral	750 mg initially, then 250 mg every 8 hours	GI distress	Should be administered in the morning and in the evening. Delayed-release form not used for initial treatment of pain. Note aspirin or NSAID allergy.
sulindac *(sul-**IN**-dack)* (Clinoril)	oral	200 mg twice a day for 7–14 days	GI pain	Note aspirin or NSAID allergy. Monitor CBC, renal, and liver function.

CONTROL OF HYPERURICEMIA

Once an attack of acute gouty arthritis has subsided and the client's symptoms have completely resolved, therapy to control hyperuricemia can be started. Treatment of hyperuricemia is generally aimed at reducing serum urate levels to below 6 mg/dL. At this level, tophi do not form within the joints and tissues of the body. Two types of drug therapy may be employed to reduce serum urate levels. *Uricosuric* agents, such as **probenecid** (**Benemid**) and **sulfinpyrazone** (**Anturane**), increase the urinary excretion of uric acid, with **allopurinol** (**Zyloprim**) therapy preventing the formation of uric acid in the body (Figure 13–1 and Table 13–1).

Two agents are commonly employed as uricosuric agents in the United States: probenecid (Benemid) and sulfinpyrazone (Anturane). These agents increase uric acid excretion by preventing the reabsorption of uric acid in the renal tubules. As this may initially increase uric acid concentration in the urine quite drastically, urate stones are likely to form in the kidney. To avoid this problem, the client is encouraged to drink large volumes of water (10 to 12 8-ounce glasses daily) to ensure a urine output of more than 1 liter per day.

Probenecid is generally used orally and is usually well tolerated, but it may drastically increase the blood levels of certain drugs, including antibiotics such as the penicillins and cephalosporins, by interfering with their normal excretion. This may be useful in promoting the maintenance of higher and more sustained levels of antibiotic in the blood than could be achieved without the use of probenecid, but could also be harmful if proper adjustment of antibiotic dosage is not made. Probenecid's uricosuric activity may be reduced or abolished if doses of salicylate (e.g., aspirin) are administered at the same time. If a mild analgesic is required by a client on probenecid, therefore, acetaminophen would be a logical choice.

Although sulfinpyrazone (Anturane) is similar to probenecid in its uricosuric effects, it is also capable of affecting platelet function. This property may eventually prove to be a useful one in reducing the risk of sudden death in clients who have recently had a myocardial infarction. The use of sulfinpyrazone has been associated with the development of GI disturbances, skin rash, and blood dyscrasias in some clients.

Allopurinol (Zyloprim) has rapidly become the most commonly used drug in the control of hyperuricemia. Unlike the uricosuric agents, allopurinol interferes with the conversion of purines to uric acid by inhibiting the enzyme xanthine oxidase (Figure 13–1). As inhibition of this enzyme interferes with production of uric acid, clients on allopurinol are not as subject to renal toxicity as they would be if using uricosuric agents.

Allopurinol therapy is usually initiated with a dose of 300 mg administered as a single daily dose. Initially it may be administered with colchicine or a nonsteroidal anti-inflammatory agent (Table 13–1) to prevent an acute gouty attack during the early stages of therapy. Although allopurinol therapy is generally well tolerated, it has been reported to cause skin rashes and/or hepatotoxicity in some clients. As the action of the enzyme xanthine oxidase is inhibited by allopurinol, the action of two drugs normally metabolized by this enzyme may be prolonged. The use of allopurinol with the agents **6-mercaptopurine** (**Purinethol**) or **azathioprine** (**Imuran**) must be avoided or some dosage reduction of these agents must be made if they are to be used with allopurinol. Refer to Table 13–1.

APPLYING THE NURSING PROCESS

ASSESSMENT

Some of the drugs used in the treatment of gout are also used to treat other types of joint diseases. Chapter 12 should be reviewed for a more complete discussion of the nursing care related to some of the drugs discussed in this chapter. There are, however, certain drugs specifically used to treat gout. Nursing care related to this therapy is discussed by first examining drugs used during an acute attack, followed by drugs used for prevention and long-term therapy. Assessment focuses on examination of the painful area and measurement of pain.

Colchicine is commonly used during an acute attack, particularly the first one, because it relieves pain and confirms the diagnosis of gout. This drug will usually be ordered to be given orally every 1–2 hours. This is continued until

the client develops nausea or loose stools. The nurse assesses the client for the development of these two indicators, as therapy is terminated as soon as they occur to avoid development of overwhelming gastroenteritis and/or diarrhea. Such gastrointestinal problems not only require treatment, but may also make the client hesitant to take colchicine the next time it is needed. Colchicine can also be administered intravenously, apparently with fewer gastrointestinal side effects. **Note:** Severe local tissue reactions, however, can occur with intravenous use; infiltration into the tissues must be avoided. Use of a large vein is suggested, as extravasation from small venous sites may lead to pain and tissue necrosis.

Other drugs that may be used during the acute attack include **phenylbutazone**, naproxen, **indomethacin**, and **sulindac**. Increasingly, the nonsteroidal anti-inflammatory drugs are being used as drugs of choice during an acute attack. Chapter 12 should be reviewed for nursing care associated with these drugs. In addition, analgesic drugs are sometimes administered. The nurse should be aware that meperidine (Demerol) and other narcotics may mask the gastrointestinal symptoms of colchicine and are usually avoided during colchicine therapy.

NURSING DIAGNOSES

Including but not limited to:

- Acute pain related to deposition of urate crystals in body tissues
- Activity intolerance related to pain of gout
- Risk for injury related to adverse effects of medication
- Deficient knowledge related to disease process and medication regimen

PLANNING/GOALS

- Client will verbalize and demonstrate a pain control level of 0–3/10.
- Client will demonstrate increasing ability to perform ADLs and activities of choice.
- Client will not sustain any injuries resulting from antigout or NSAID therapy.
- Client will verbalize understanding of disease process, need to drink 3–4 quarts of fluids per day, and medication regimen.

IMPLEMENTATION

It is generally true that the earlier treatment begins, the easier it is to abort an acute gouty attack. For this reason, clients are usually given a supply of medication to keep at home. Many of these clients are diagnosed as having deficient knowledge about the cause of gout and its appropriate treatment. Nurses should reinforce the physician's instructions to begin taking these drugs at the first sign of an attack and to tell the physician that treatment has been started.

During an acute attack, it is well to advise the client to temporarily avoid red meats, fish, fowl, alcohol, and a large proportion of dietary fats. These foods may aggravate the condition. The client should be encouraged to increase fluid intake, unless there are reasons such as renal or cardiac disease which would call for restricting or careful monitoring of the fluid intake. To increase the client's comfort during an acute attack, the nurse can use a bed cradle to keep bed linens off the tender, affected area.

In order to prevent future attacks some physicians may advise clients to avoid substances known to bring on attacks. These include dietary factors: a high-fat diet, purine-rich foods such as organ meats, and alcohol, particularly beer and wine. See Box 13–1 for a listing of some foods high in purines, which should be avoided in clients with gout. Drugs that may provoke attacks are liver extracts, **nicotinic acid**, penicillin, thiazide diuretics (see Chapter 31), chemotherapeutic drugs used in cancer treatment, **levodopa**, **ethambutol**, and **ergotamine** (**Cafergot**, **Ergostat**).

BOX 13–1
Some Foods High in Purines

anchovies
bacon
beer
codfish
goose
haddock
herring
mackerel
mussels
organ meats
(e.g., liver, kidneys)
salmon
sardines
scallops
smelts
trout
turkey
veal
venison

NURSING CARE PLAN

A Client with Hyperuricemia and Gout Taking Probenecid and Colchicine

Ahmed Kohler was a postal worker who came to the doctor's office complaining of pain in his feet. The pain was more pronounced in his right heel after standing all day at work. Laboratory tests indicated a high level of uric acid. He was placed on a low purine diet and probenecid (Benemid) 0.25 g pc, BID, and colchicine 0.5 mg q6h was ordered for 3 days, then 0.5 mg BID, then 0.5 mg daily. He was also instructed not to take aspirin because it prevents the excretion of uric acid.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Pain on standing.	Acute pain: related to pain from deposition of urate crystals in body tissues.	Client will verbalize relief of pain within 1 week of starting colchicine.	Teach client to take colchicine at the first twinge of pain. Observe for nausea, vomiting, diarrhea, or abdominal pain. Teach client to report GI problems.	Client verbalizes relief of pain.
Increased uric acid level.	Risk for impaired physical mobility related to pain secondary to increased serum levels of uric acid.	Client will have reduction of uric acid levels within 10 days of taking probenecid.	Give probenecid as ordered to increase urinary excretion of uric acid. Do not take aspirin, as it interferes with excretion of uric acid. Observe for rash, headache, and gastrointestinal disturbances.	Laboratory tests show normal uric acid levels.
Pain in right heel. Elevation of limbs prn.	Activity intolerance related to pain secondary to urate crystals.	Client verbalizes treatment plan during acute attacks prior to discharge.	Elevate affected joints and immobilize during acute attack. Ice can be used to relieve swelling in affected joint. Teach importance of maintaining joint function after acute attack subsides.	Client demonstrates mobility in all joints without pain following acute attack.
Knowledge of gout and its treatment.	Deficient knowledge related to lack of exposure to gout.	Prior to discharge, client verbalizes understanding of disease process and treatment regimen. Client develops a plan for self-care, including lifestyle modifications necessary to prevent acute attacks.	Teach client that gout is caused by uric acid crystals deposited in joints. Teach client to avoid alcohol, self-prescribed drugs, trauma, and certain foods. Teach client to use acetaminophen instead of aspirin to prevent inhibition of uricosuric effects of probenecid.	Client follows treatment plan and demonstrates a decrease in the occurrence of acute attacks.
Intake of foods high in uric acid content.	Deficient knowledge related to lack of exposure to purine diet information.	Client will be able to verbalize dietary modifications to control uric acid levels prior to discharge.	Teach client to avoid foods high in purines, such as sardines, organ meats, and gravies. Maintain an alkaline ash diet by increasing foods, such as milk and fruits.	Client avoids foods high in purines and avoids alcohol. Client follows an alkaline ash diet.
Intake and output. Check for presence of renal calculi (hematuria, pain).	Risk for impaired urinary elimination related to renal calculi.	Client will maintain adequate fluid intake by drinking 10–12 glasses of fluid daily by discharge.	Teach client to drink 8 oz. of fluid 10–12 times a day to produce less concentrated urine and minimize the amount of urate in urine.	Client demonstrates urinary output of 2,000–3,000 mL/day and a specific gravity below 1.030.
Check skin and joints for presence of tophi caused by uric acid crystals.	Risk for impaired skin integrity related to urate crystals in body tissues.	Prior to discharge client verbalizes a plan for skin care and signs and symptoms to report to a health care professional.	Teach good skin care to prevent infection. Teach client to observe for signs and symptoms of joint inflammation and to report these to physician.	Client has good hygiene practices and maintains skin integrity. Client reports signs and symptoms of tophi to a health care professional.

In addition to suggesting avoidance of those substances, some physicians will order continuous treatment with drugs to attempt to prevent the recurrence of attacks, particularly in clients who seem especially recurrence-prone. Colchicine can be used daily or several times a week, and the uricosuric agents probenecid (Benemid) or sulfinpyrazone (Anturane) may also be used. When either of these drugs is used, the client should avoid aspirin and other salicylates, which could antagonize their uricosuric effects. The nurse may suggest the use of acetaminophen (Tylenol, Datril, etc.) for headaches and minor pain. The uricosuric drugs are also known to interact with other drugs, including hypoglycemic agents. Diabetic clients taking sulfonylurea hypoglycemics or insulin should be closely observed for hypoglycemia.

Clients taking uricosuric drugs must maintain a high fluid intake to prevent deposition of uric acid crystals in the kidneys. Alkalinization of the urine is also sometimes instituted in an attempt to prevent formation of uric acid crystal deposits. When administering uricosuric agents, the nurse should be aware that they may irritate the gastrointestinal tract. For this reason, they are often given at mealtimes or with milk. Clients with a history of peptic ulceration should be carefully observed for indications of gastrointestinal bleeding.

Another drug used for long-term therapy is allopurinol (Zyloprim), which blocks the formation of uric acid. Adequate fluid intake and alkalinization of the urine are useful in maximizing the benefits of allopurinol use. The nurse observes the client for skin rashes, which should be reported immediately, as they may be followed by more severe hypersensitivity reactions and gastrointestinal discomfort. Clients receiving oral anticoagulants should be carefully observed, as the the anticoagulant dose may require adjustment.

KEY NURSING IMPLICATIONS 13–1

Nursing Clients Receiving Drugs for Hyperuricemia

1. Assess the client taking colchicine for nausea or loose stools.
2. Local tissue reactions can occur with infiltration of colchicine.
3. Treatment should be initiated at the first sign of an attack of gout.
4. Factors that may provoke attacks include a high-fat diet, purine-rich foods, thiazide diuretics, liver extracts, nicotinic acid, penicillin, cancer chemotherapeutic agents, levodopa, ethambutol, and ergotamine.
5. Aspirin is avoided when probenecid or sulfinpyrazone is used.
6. Fluid intake is encouraged during probenecid, sulfinpyrazone, and allopurinol therapy.
7. Notify the prescriber promptly if skin rash occurs during allopurinol therapy.

EVALUATION

- Client verbalizes a pain control level sustained at 0–3/10.
- Client demonstrates increasing ability to perform self-care and increases activities as desired.
- Client does not experience any injuries resulting from the adverse effects of the antigout drugs
- Client verbalizes understanding of the disease process, the need for compliance with therapy, the importance of drinking 3–4 quarts of fluid/day, and medication management.

HOME CARE/CLIENT TEACHING

1. Provide clients on low purine diets with a list of foods high in purine content. Review the role of purines in precipitating attacks of gout. A list of foods high in purine content is found in Box 13–1.
2. During the initial gout attack clients should avoid red meats, fish, fowl, alcohol, and large amounts of dietary fats.
3. Clients receiving antigout drugs should be instructed to drink 3–4 quarts of fluid/day.

continues

HOME CARE / CLIENT TEACHING *continued*

4. Clients should avoid use of alcohol when taking antigout medications.
5. Clients should take colchicine after meals or with milk to minimize GI irritation.
6. Clients taking probenecid should be instructed not to take aspirin or products containing aspirin while on probenecid therapy.
7. Clients receiving sulfinpyrazone should take their medication with meals or antacid to minimize gastric irritation.
8. Clients taking sulfinpyrazone need to promptly report epigastric pain, nausea, or tarry stools to the physician.
9. Clients receiving allopurinol should immediately discontinue the drug and report any skin rash, dysuria, blood in the urine, or swelling around the lips and eyes.

CASE STUDY

Carl Simonson, a 49-year-old male construction worker, was admitted to the emergency room with severe pain in the large toe of his right foot. The toe had been sore the evening before, but this was attributed by the client to a minor accident at work. The ER physician ordered an X ray of the foot, as well as a routine laboratory evaluation (SMA-12). The X ray did not reveal a cause for the pain. All laboratory determinations were within normal limits, except for a blood uric acid value of 12 mg/dL (normal range is 3–7 mg/dL). The diagnosis of acute gout was made by the physician and the following was prescribed:

- Colchicine 0.5 mg tablets, 1 each hour until pain subsides
- Aspirin 325 mg (5 gr) tablets 2 prn

After using 5 doses of colchicine, the client experiences relief, but also develops severe diarrhea and nausea.

Questions for Discussion

1. Could the client's minor accident have contributed to the precipitation of an acute gout attack?
2. What may be the reason these symptoms have occurred and what alterations could be made to control them?
3. What nursing measures could help relieve the client's toe pain?
4. Would the use of probenecid (Benemid) with colchicine be logical therapy to control this client's pain? Explain.
5. What effect would the client's use of aspirin have on the effectiveness of probenecid?

CRITICAL THINKING EXERCISES

1. Prepare a visual aid showing the different ways in which allopurinol (Zyloprim) and the uricosuric agents (Benemid and Anturane) lower the uric acid in the body.
2. Prepare an instructional program for a client who has just experienced a first attack of gout.
3. Obtain the clinical record of an individual hospitalized for an attack of gout. Review the drug therapy used for this client and discuss the reasons each was used. Suggest what nursing care measures should be associated with the use of each of these drugs.
4. Discuss the problem of obtaining cooperation with the treatment program from an asymptomatic client with a history of gout. How can cooperation be improved?
5. Using the table of foods that are high in purine content, discuss with a client why these foods should be avoided by persons with hyperuricemia or gout. Avoid using medical terms that clients may not understand.

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SECTION 4

Agents Used to Treat Gastrointestinal Disorders

MAJOR NURSING DIAGNOSES

- Constipation
- Diarrhea
- Imbalanced Nutrition: Less than Body Requirements
- Deficient knowledge (Illness and Its Treatment)
- Deficient Fluid Volume Related to Nausea, Vomiting, or Diarrhea
- Acute Pain Related to Peptic Ulcer Disease
- Risk for Aspiration Secondary to Vomiting

14 Antacids

OBJECTIVES

After studying this chapter, the student will be able to:

- Explain why some antacids cause constipation, while others cause diarrhea
- Explain the difference between systemic and nonsystemic antacids and give an example of each
- Describe the optimal method of administration for liquid and chewable tablet antacid formulations
- Describe three ways that antacids may interact with other drugs
- List three prescription drugs that should not be administered with an antacid
- Explain why milk and other dairy foods in the diet may aggravate an ulcer condition
- Apply the nursing process related to caring for clients receiving antacid therapy

Hydrochloric acid is constantly secreted by the *parietal cells* in the lining of the stomach. The rate of acid secretion in the stomach may vary widely throughout the day, but is generally at its highest level just before or during the ingestion of a meal. The steady release of hydrochloric acid results in the creation of a corrosive gastric environment having a pH ranging from 1 to 4. In addition, gastric juice also contains the *proteolytic* enzyme pepsin, an agent that exerts its maximal protein-digesting activity at a pH below 4.

Why such a corrosive environment does not normally erode the stomach lining appears to be the result of a delicate balance that, when disturbed, results in the development of *hyperchlorhydria*.

Almost everyone occasionally suffers from hyperchlorhydria. Our society has labeled this condition with terms such as indigestion, sour stomach, heartburn, and acid stomach; all are associated with an excess of hydrochloric acid. This condition may occur after the ingestion of a large meal, particularly a fatty one; consumption of excessive amounts of alcohol, which may chemically irritate the stomach lining and increase the secretion of acid; or emotional turmoil, which may result in nervous stimulation of parietal cell activity.

Peptic ulcer is a local lesion of the gastrointestinal lining, usually in the duodenum (duodenal ulcer) or in the stomach (gastric ulcer). Although recent studies indicate that the cause of peptic ulcer disease (PUD) is related to the invasion of the GI lining by a bacterium known as *H. pylori*, there is little doubt that the constant bathing of the ulcerated area with gastric juices will potentially encourage further erosion and inhibit the healing process.

ANTACIDS

Antacids are alkaline chemical agents used for relief of symptoms associated with hyperacidity and peptic ulcer disease (PUD). There is considerable controversy as to the function of antacids in treating these common gastrointestinal disorders. Although it has long been established that antacids reduce the corrosiveness of gastric acid and decrease pepsin activity, there is little conclusive evidence to support the contention that antacids enhance the healing, decrease the frequency, or prevent the recurrence of peptic ulcers.

The primary goal of antacid therapy is the relief of pain. The pain-reducing effect of antacids is believed to be due to their:

- acid neutralizing capacity
- inhibition of the protein-digesting ability of pepsin
- action to increase the resistance of the stomach lining to irritation
- ability to increase the tone of the lower esophageal sphincter

This latter action is believed to explain why antacids are effective in reducing pain associated with gastroesophageal reflux (GER).

Selection of the proper antacid is important because most clients on antacid therapy will be using large doses for a prolonged time. An ideal antacid product:

- effectively neutralizes large volumes of acid with a reasonably small dose.
- avoids causing "acid rebound." This is a phenomenon characterized by the production of greater than normal volumes of acid by the stomach when the pH of its contents is raised above the desirable 4–5 range. Above this level, the stomach responds to alkalinization by secreting more acid, thereby returning the client to a state of hyperchlorhydria.
- has a prolonged action. It should provide prompt relief and then continue to provide relief for several hours. This is an important feature, as the client may not take the medication as directed if the antacid must be administered too frequently. In other words, client cooperation is more likely if relief continues for some time after the antacid is taken.
- does not interfere with the digestion or absorption of nutrients or drugs. Many antacids form chemical complexes with drugs such as the tetracycline antibiotics. When these drugs form complexes, the tetracycline is not absorbed well from the gastrointestinal tract and is not as effective. Antacids should, therefore, not be administered within 2 hours of an oral dose of a tetracycline. Antacids have also been found to adsorb certain drugs onto their surface—that is, the drug sticks to the surface of the antacid particles. Some antacids may slow or impair the absorption of digoxin. In situations in which antacids and digoxin are to be administered to the same client, wide dosage separation is, therefore, advisable.
- does not cause constipation or diarrhea. Most antacids, when used alone, will cause either constipation or diarrhea. Magnesium antacids such as magnesium hydroxide tend to cause diarrhea because of the ability of magnesium to draw and bind water in the gastrointestinal tract. Aluminum antacids, such as **aluminum hydroxide** and calcium antacids, such as **calcium carbonate** tend to cause constipation by exerting an astringent effect on the GI tract.
- does not release carbon dioxide gas in the stomach. Some antacids (sodium bicarbonate, calcium carbonate, etc.) release carbon dioxide gas as they neutralize stomach acid. This may bloat the client as well as cause the release of even more hydrochloric acid.
- does not interfere with electrolyte and acid-base balance at usual therapeutic doses. Some antacid products contain high concentrations of sodium, which could be hazardous to a client with hypertension or heart disease. Other antacids readily enter the systemic circulation and alkalinize the blood, thereby subjecting the client to systemic alkalosis, a state in which the acid-base balance is upset because of the abnormally high levels of alkali (base) in the body.
- is palatable. Most clients using antacids must take frequent, large doses for long periods of time. If an antacid product is not palatable, the client will be more likely to be uncooperative with the regimen.
- is inexpensive. Because of the long duration of antacid therapy in many clients, cost becomes an important factor in the selection of an antacid.

Although no antacid satisfies all of the preceding ideal criteria, one can approach the objective of safe and effective therapy by selecting the proper combination of antacids.

An important consideration when selecting an antacid product is its acid-neutralizing capacity (ANC). This measures the quantity of hydrochloric acid an antacid product can neutralize. Antacids with a high ANC are more effective than those with a low ANC.

Antacids are generally classified on the basis of whether they are systemically absorbed or they remain primarily in the gastrointestinal tract. Systemic antacids are highly soluble in gastric fluids; once dissolved, they are absorbed readily. Agents in this category (e.g., sodium bicarbonate) have a rapid onset and a short duration of action. Clients using soluble or systemic antacids for a chronic condition must take many doses at frequent intervals to compensate for this short duration of action. Systemic antacids are also the most likely to cause acid-base and electrolyte disturbances. They may also cause rebound hyperacidity. Their prolonged use often places an unusually high burden on the kidney because of the work required to excrete this high concentration of absorbed electrolyte.

The nonsystemic antacids are the most useful agents for long-term therapy. Although a small proportion of the antacid may be absorbed, most of the dose remains in the GI tract and will not alter systemic acid-base balance or electrolyte levels. Caution must be used in administering magnesium-containing antacids to clients with impaired renal function, as magnesium may accumulate and cause toxicity in such clients. In addition, prolonged use of antacids containing aluminum hydroxide has been associated with phosphate depletion. Most nonsystemic antacids will cause either constipation or diarrhea, but by combining agents with opposing actions (e.g., aluminum hydroxide and magnesium hydroxide) it is unlikely that either of these effects will be pronounced.

Antacids are capable of interacting with many other drugs. Such interactions may be caused by:

- adsorption, or binding, of other drugs on the surface of antacid particles. This reduces the oral absorption of the bound drug and may, therefore, diminish its action. Examples of drugs that may be bound by antacids include tetracyclines and **sucralfate**.
- the increase of gastric pH by antacids. Such an increase in alkalinity may decrease the absorption of certain drugs (e.g., digoxin, **chlorpromazine**, isoniazid, and phenytoin) and may increase the absorption of others (e.g., salicylates and **levodopa**).
- an increase in urinary pH. Elevation of urinary pH by antacids may inhibit the elimination of drugs that are weak bases, such as **quinidine** and amphetamines and may promote the excretion of drugs that are weak acids, such as salicylates and the barbiturates.

To minimize the likelihood of interactions between antacids and other drugs, clients should be advised not to take other oral medications within 1 to 2 hours from the time they are taking antacids.

A number of antacid products contain nonantacid ingredients meant either to improve the therapeutic response to the product or to relieve the gaseous distention commonly found in clients with hyperacidity. The most popular of these ingredients is **simethicone**, an agent that has no antacid properties, but acts to eliminate gas bubbles, thereby reducing frothing of the stomach contents. Table 14–1 lists the active antacid ingredients found in many antacid products.

Selection of the proper dosage form of antacid is often as important as selection of the proper antacid. Antacids are available in a wide range of dosage forms, including solutions, suspensions, and chewable tablets. Although liquid antacid therapy is generally better because of the finely divided and uniform nature of these products, solid dosage forms such as chewable tablets offer the advantage of convenience, an important consideration in maintaining client cooperation.

The client using chewable tablets should be advised that the tablet must be chewed completely before it is swallowed, and that drinking a glass of water after chewing the tablet will hasten and improve the antacid action. Some are also available in "quick-dissolving" tablets that require no chewing and are much more palatable than many of the chewable tablets.

Several antacids are available in the form of *effervescent* solutions or as tablets or granules that are an effervescent solution when combined with water. These antacid products are virtually all of the systemic type and should only be used, if at all, for short-term treatment. To further complicate therapy, some effervescent products contain analgesics such as aspirin. The use of such products in the treatment of chronic hyperacidity or peptic ulcer disease is not only irrational but may be dangerous, as aspirin can precipitate or worsen GI bleeding.

TABLE 14–1

Active Ingredients in Antacid Products

Note: Administration with other drugs or food may reduce the absorption of these agents.
Do not take other oral drugs within 1–2 hours of antacid administration.
Monitor quality and consistency of stool during antacid therapy.
Shake liquid antacid products well prior to use.
Follow administration of antacid with a small amount of water or milk to facilitate passage into stomach.
Do not administer within 1–2 hours of any enteric-coated drug product.
Assess the client's response to antacid use.

ANTACID	TYPE	ADVERSE EFFECTS	USUAL ANTACID DOSE	NURSING IMPLICATIONS
aluminum carbonate gel, basic *(ah-**LOO**-mih-num **KAR**-bon-ayt jel, **BAY**-sik)* (Basaljel)	nonsystemic	constipation	10 mL of regular suspension or 2 capsules or tablets up to 12 times daily	More effective phosphate depleter than aluminum hydroxide. See aluminum hydroxide gel.
aluminum hydroxide gel *(ah-**LOO**-mih-num hy-**DROX**-eyed jel)* (Amphogel, Alternagel, etc.)	nonsystemic	constipation	500–1,500 mg, 3–6 times daily between meals and at bedtime	Interferes with phosphate absorption. Prolonged use may interfere with serum phosphate levels. Monitor client for symptoms of hypophosphatemia (muscle weakness, anorexia, malaise, etc.). Constipation may be managed by administration of laxatives or stool softeners.
aluminum phosphate gel *(ah-**LOO**-mih-num **FOS**-fayt jel)* (Phosphaljel)	nonsystemic	constipation	15–30 mL every 2 hours. Do not dilute.	Does not interfere with phosphate absorption. No longer used as an antacid. Used to reduce fecal elimination of phosphates. Constipation may be managed by giving laxatives or stool softeners.
calcium carbonate, precipitated chalk *(**KAL**-see-um **KAR**-bon-ayt)* (Tums, Chooz, etc.)	nonsystemic	constipation, bloating, hypercalcemia	0.5–1.5 g as needed	Releases carbon dioxide in the stomach. May increase acid secretion in stomach. Observe client for signs of hypercalcemia (e.g., depression, bradycardia, etc.). Contraindicated in severe renal disease. Constipation may be managed by giving laxatives or stool softeners. Commonly used as a dietary calcium supplement.
dihydroxy-aluminum sodium carbonate *(**die**-hy-**DROX**-ee-ah-**LOO**-mih-num **SOH**-dee-um **KAR**-bon-ayt)* (Rolaids Antacid)	nonsystemic	constipation	334–668 mg as required	See aluminum hydroxide gel.

continues

TABLE 14–1 *continued*

See **Note** at beginning of Table 14–1, page 309.

ANTACID	TYPE	ADVERSE EFFECTS	USUAL ANTACID DOSE	NURSING IMPLICATIONS
magaldrate *(**MAG**-al-drayt)* (Riopan)	nonsystemic	diarrhea or constipation	540 mg/5 mL 5–30 mL after meals and at bedtime	Chemical combination of aluminum and magnesium hydroxides.
magnesium hydroxide *(mag-**NEE**-see-um hy-**DROX**-eyed)* (milk of magnesia, MOM)	nonsystemic	diarrhea	5–15 mL or 650 mg–1.3 g 4 times a day	Laxative in doses above 15 mL. May cause hypermagnesemia in clients with impaired renal function. Contraindicated in severe renal disease. Monitor client for development of symptoms of hypermagnesemia (nausea, vomiting, hypotension, neurological disturbances, etc.).
magnesium oxide *(mag-**NEE**-see-um **OX**-eyed)*	nonsystemic	diarrhea	400–840 mg 4 times daily with water or milk	May cause hypermagnesemia in clients with impaired renal function. Contraindicated in severe renal disease. Monitor client for development of symptoms of hypermagnesemia (nausea, vomiting, hypertension, neurological disturbances, etc.).
sodium bicarbonate *(**SOH**-dee-um by-**KAR**-bon-ayt)* (baking soda, Soda Mint)	systemic	systemic alkalosis, acid rebound, bloating	3.9–10 g in a glass of cold water after meals	Releases carbon dioxide gas in the stomach. Contraindicated in clients with congestive heart failure, hypertension, or on salt restriction. Each gram contains 274 mg (11.9 mEq) of sodium. Monitor client for development of systemic alkalosis, GI distension, or edema.

APPLYING THE NURSING PROCESS

At one time, diet was the major treatment for peptic ulcer disease. Nurses spent much of their time securing milk, cream, and bland foods. The client was encouraged to ingest these and the client and family were advised about dietary "do's and don'ts." Currently, drug therapy has become the mainstay of treatment and nurses spend more of their time administering medications and instructing the client about proper medication use.

ASSESSMENT

Nursing assessment for clients with peptic ulcer disease is focused on determining the nature, location, and duration of pain as well as observing the therapeutic response to the use of antacids and other medications used in treatment. Additionally, the nurse should determine the client's response to various foods and beverages.

NURSING DIAGNOSES

Including but not limited to:

- Acute pain related to increased stomach acid action on the sensitive mucosal lining of the stomach, presence of peptic ulcer disease (PUD)
- Risk for diarrhea related to use of magnesium antacids
- Risk for constipation related to use of aluminum antacids
- Risk for injury related to adverse effects of medication
- Deficient knowledge related to disease process and medication regimen

PLANNING/GOALS

- Client will verbalize and demonstrate a pain control level of 0–3/10.
- Client will not experience diarrhea or constipation as a result of antacid therapy.
- Client will not sustain any injuries resulting from antacid therapy.
- Client will verbalize understanding of disease process and medication use.

IMPLEMENTATION

In caring for clients during the acute phase of illness, nurses are actively involved in administration of antacids and other drugs. Antacids are generally taken about 1 hour after eating, and their neutralizing action lasts for about 3–4 hours. When taken on an empty stomach, for example, at bedtime or first thing in the morning, the neutralizing action lasts only about 30 minutes because there is nothing in the stomach to retard its emptying. For this reason, it is important to follow a schedule in administering antacids and to administer them following meals.

Several other factors about administration should be noted. Nurses should carefully follow instructions on the bottles of liquid antacids about shaking the bottle to evenly distribute the contents. Tablets are a less desirable form of administration, but one insisted on by some clients. When these are used, remember to instruct the client to chew the tablets well, unless they are using "quick-dissolving" tablets. Offer the client water to drink following this. Some clients may be persuaded to use liquid preparations instead of tablets if they are offered mouth care following administration of the liquid or if they are instructed to rinse the mouth after each dose. Finally, if an effervescent solution is being used, be certain that fizzing has stopped before the client ingests the liquid, as the additional gas can cause gastric distention leading to discomfort and encourage additional secretion of hydrochloric acid.

Other nursing measures indicated during the acute phase of peptic ulcer disease involve providing a restful environment and observing the client for signs and symptoms of complications related to the condition. These include hemorrhage, obstruction, and perforation.

KEY NURSING IMPLICATIONS 14–1

Antacids

1. Maintain a schedule for antacid administration. Antacids should be administered following meals or a snack.
2. Shake all liquid preparations thoroughly and instruct clients to chew tablets well and to follow the tablets with water.
3. Avoid the use of aspirin, ibuprofen and naproxen in clients with peptic ulcer disease.
4. Discuss the development of diarrhea or constipation with the prescriber.
5. Avoid simultaneous administration of antacids and antibiotics.

As the client progresses toward self-care, the nurse begins to offer instructions for management of the peptic ulcer disease at home. Clients and family members should be given information about ulcers. They should be told the factors that aggravate ulcers, such as stress, smoking, alcohol, coffee—both with caffeine and decaffeinated—and cola beverages. They should know that some drugs, particularly salicylates and **indomethacin** (**Indocin**), are ulcerogenic and must be avoided. Foods that may cause pain and gastric upset should be identified and suggestions given concerning their use. Fruit juices, for example, should be limited in amount and not taken on an empty stomach. For headache, the client may take acetaminophen (Tylenol, Panadol, etc.) rather than aspirin, ibuprofen, or naproxen.

A prominent note should be placed on the client's health record indicating that aspirin, ibuprofen, and naproxen are contraindicated. In addition, clients should be instructed that any time care becomes necessary from health care providers who are not familiar with their health history, the client should inform them of the ulcer. A caution should also be given to the client to carefully read the labels of over-the-counter (OTC) drugs, especially analgesics and cold remedies, as some of them contain aspirin and should be avoided.

Many clients believe that they should drink a lot of milk to soothe the ulcer. At one time, milk was important in the treatment of ulcers.

Recent research has shown, however, that both the protein and the calcium in milk are stimulators of hydrochloric acid secretion. For this reason, the amount of milk in the diet should be limited to meeting basic nutritional needs.

Clients who are away from home much of the time may find it more convenient to carry tablets than liquid antacids. This should be discussed with the physician before the client switches dosage forms. Clients should understand that not all antacids are equal in their neutralizing effects. Some readily available antacids, often in tablet form, contain calcium, which, as previously mentioned, may increase the secretion of gastric acid. In addition, some antacids have relatively high sodium content, which is contraindicated in clients with hypertension, heart disease, or kidney disease. The pharmacist is a good source of information about the sodium content of various antacids. The nurse should encourage a sodium-restricted client to consult with the pharmacist or with the physician about a suitable antacid. Such clients should carefully avoid the use of sodium bicarbonate as an antacid.

There are two other factors related to antacid therapy of which clients should be aware. The first is that some antacids containing magnesium may cause diarrhea, with those containing aluminum possibly causing constipation. If diarrhea or constipation becomes a problem, the client should contact the physician. To correct these problems, the client should be instructed to alternate magnesium- and aluminum-containing antacids, or to use an antacid containing both of these substances.

The second factor clients should be aware of is that the absorption of some antibiotics, including penicillin and most tetracyclines, is decreased when antacids are taken with those medications. When both antacids and antibiotics are prescribed, they should generally not be taken simultaneously or closely together.

Because of the availability of a wide selection of OTC antacids, many people tend to think of them as agents with minimal therapeutic potential and with few or no adverse side effects. To enhance the effectiveness of therapy, the nurse should be actively involved in client education and provide support over the course of therapy. Some clients, for example, will stop taking antacids once the pain associated with the ulcer decreases. Such clients need to be encouraged to continue the prescribed treatment for as long as recommended by the physician. These individuals should be helped to understand that the pain will often subside before the ulcer heals. Sustained acid neutralization may be essential for the ulcer to heal completely. In addition, the client should be encouraged to eat regular meals, and to identify and attempt to minimize the effects of various stressors in the environment whenever possible. These factors may be helpful in preventing the recurrence of ulcer disease.

Some clients without peptic ulcer disease may be instructed by their physician to take antacids daily, for example, persons with kidney disease. Clients with damaged kidneys may have increased serum phosphate levels as a result of decreased phosphorus excretion. High levels of serum phosphate may be corrected through use of aluminum hydroxide-containing antacids. These antacids bind phosphorus, forming an insoluble complex that is excreted in the stool. Liquid preparations are preferred to tablets, and the client is instructed to take the recommended dose 3 to 5 times daily with food. It is important for the nurse to stress that the client not substitute antacid products, as these products vary in their aluminum hydroxide content. Also, antacids containing magnesium should not be used, as clients with damaged kidneys have difficulty excreting magnesium.

Calcium-containing antacids are being recommended by some physicians for the prevention of osteoporosis in postmenopausal women. It is important to instruct the client that antacids contain varying ingredients, and that only those specifically recommended by the pharmacist or physician as good sources of calcium should be used.

EVALUATION

- Client verbalizes and demonstrates a pain control level of 0–3/10.
- Client does not experience diarrhea or constipation from taking antacids containing magnesium and aluminum.
- Client does not sustain any injury resulting from the adverse effects of antacid therapy.
- Client verbalizes understanding of disease process, medication use, and importance of compliance with medication regimen.

NURSING CARE PLAN

A Client with Peptic Ulcer Disease Taking Antacids

Susan Neuman, age 54, was admitted to the hospital with abdominal pain, nausea, and vomiting. Shortly after admission, she had an episode of vomiting with 100 mL of coffee grounds emesis. She had an endoscopy that identified a pyloric ulcer in the greater curvature of the stomach. The ulcer was cauterized and lavaged. She was medicated with meperidine (Demerol) 75 mg during the procedure, which she tolerated well. There was no further bleeding and she was discharged from the hospital on a bland diet and aluminum hydroxide (Amphogel) 30 mL QID and prn. She was instructed to take the Amphogel 30 minutes after meals and at bedtime. She has a follow-up appointment in 1 month.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Abdominal pain, burning, restlessness, diaphoresis.	Acute pain related to lesions secondary to increased gastric secretions.	Client will express feelings of comfort within 30 minutes of comfort measures.	Instruct client on use of antacids to neutralize stomach acid. Identify factors that aggravate pain and avoid. Teach client to take acetaminophen (Tylenol) instead of aspirin and to read labels of nonprescription medications to avoid aspirin-containing products.	Client verbalizes comfort after antacid and/or acetaminophen use.
Nausea and vomiting, bitter taste.	Risk for deficient fluid volume related to nausea and vomiting.	Client will maintain normal fluid and electrolyte balance during hospitalization.	Improve oral intake by providing oral care as needed. Monitor laboratory studies of electrolytes. Promote fluid intake.	Client maintains normal skin turgor, urine specific gravity, vital signs, and serum electrolytes.
Knowledge regarding endoscopy.	Fear related to bleeding, pain, and unfamiliar procedure.	Client will verbalize decreased feelings of fearfulness following description of procedure.	Explain procedure to client. Encourage client to talk about her fears. Administer meperidine as ordered.	Client verbalizes reduced feelings of fear and stress.
Eating habits.	Risk for imbalanced nutrition: less than body requirements related to lack of information regarding bland diet.	Prior to discharge, client develops a nutritionally sound meal plan following the principles of a bland diet.	Instruct client in bland diet. Avoid food and fluids containing caffeine, spices, stimulants, or alcohol. Encourage frequent small meals, 4–5 daily.	Client follows prescribed dietary modifications.
Medication routine.	Deficient knowledge regarding new medication.	Prior to discharge, client will demonstrate understanding of appropriate medication routine.	Aluminum hydroxide works in 30 minutes if taken on an empty stomach. Teach client to observe stools for consistency, color, and frequency, as this medication may cause constipation. Teach measures to avoid constipation, e.g., adequate fluid intake, exercise.	Client follows prescribed medication routine.
Level of stress, methods of coping with stress.	Risk for ineffective health maintenance related to stress.	Prior to discharge, client describes methods of coping with stress.	Teach client that stress stimulates hydrochloric acid production. Encourage client to verbalize areas of stress in her life and explore possible remedies. Encourage client to take classes in stress management and avoid stressful situations whenever possible.	Client is able to demonstrate appropriate methods of stress management.

HOME CARE / CLIENT TEACHING

1. It is important for the nurse or pharmacist to provide instruction about the use of antacids. In particular, persons taking them for treatment of disorders other than peptic ulcer disease must understand that specific types of antacids may be required. For example, women taking antacids for prevention of osteoporosis require preparations high in calcium, and persons with damaged kidneys may be wrongly using antacids containing aluminum hydroxide. Not all antacids are formulated the same; thus they may not be interchangeable.
2. Clients with diarrhea or constipation associated with the use of magnesium- or aluminum-based antacids should be instructed either to alternate these antacids or to discuss with their doctor about changing to an antacid that contains both bases.
3. Antacids should be administered after meals.
4. Clients should be reminded about factors that aggravate an ulcer condition and that need to be avoided, including smoking, stress, caffeine, and alcohol.
5. Clients should limit their ingestion of fruit juices, especially citrus.
6. Clients should be instructed to always read the labels on over-the-counter drugs.
7. Clients using chewable antacid tablets should be reminded to chew the tablets completely and to follow the tablet with 8 ounces of water.
8. Clients need to be instructed that the absorption of some antibiotics and other medications is diminished when antacids are taken simultaneously with those medications.
9. Clients should be instructed not to take other oral drugs or any enteric drug product within 1–2 hours of taking an antacid.
10. Clients should be reinforced in continuing the prescribed treatment as long as recommended by the physician.

CASE STUDY

Harry Schwartz, a tense 32-year-old junior executive for a large corporation, has had recurrent episodes of abdominal pain, anorexia, and vomiting for the last 2 years. He describes the pain as a burning sensation. It is usually most severe just prior to meals and subsides upon ingestion of a meal. Mr. Schwartz smokes two packs of cigarettes and drinks about eight cups of coffee each day.

The physician orders an upper GI series, which reveals a duodenal ulcer. The physician prescribes:

- diazepam (Valium) 5 mg, 1 TID
- Mylanta II Liquid, 30 mL hourly

Two days later the client reports some pain relief but also complains of severe diarrhea.

Questions for Discussion

1. Why is the client's pain most severe just prior to meals?
2. What is the role of cigarette smoking and coffee ingestion in the development of this client's disease?
3. Could the client's diarrhea be caused by his drug therapy? Explain.

CRITICAL THINKING EXERCISES

1. Visit a local pharmacy and record the types of antacids available without a prescription. Note the ingredients and information given for each product.
2. Prepare a client instruction outline concerned with the therapy for peptic ulcer disease.
3. List three possible causes of hyperchlorhydria.
4. List and discuss nine characteristics of an ideal antacid.
5. Discuss the role of simethicone in antacid products.
6. Write a brief report describing the use of antacids in minimizing osteoporosis in postmenopausal women.

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15 The Autonomic Nervous System and Antispasmodic Drug Action

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify the major functions of the sympathetic and parasympathetic branches of the autonomic nervous system (ANS)
- Identify the location and function of the alpha and beta adrenergic receptors
- Identify and compare the actions of four categories of drugs that affect the ANS
- State the mechanism of action of anticholinergic and direct-acting antispasmodic agents
- Identify the conditions in which the use of antispasmodic agents would be indicated or contraindicated
- Identify antispasmodic drugs that are belladonna derivatives
- Describe the proper method of administration of orally administered antispasmodic agents
- State five adverse effects of antispasmodic agents
- Apply the nursing process relative to caring for patients receiving antispasmodic drugs

A fundamental understanding of the way many classes of drugs exert their action is not possible without an awareness of the autonomic nervous system (ANS). This discussion reviews its basic anatomy and physiology, as well as describes the general ways in which antispasmodic and other drugs can affect this system.

The ANS is an involuntary system composed of two distinct branches, the *sympathetic*, or *adrenergic*, *nervous system* and the *parasympathetic*, or *cholinergic*, *nervous system* (Figure 15–1). Each of these major subdivisions of the ANS is a two-neuron system. The first, or preganglionic neuron, originates within the central nervous system (CNS) and ends in a cluster of nerve cell bodies known as the *ganglion*, which lies outside of the CNS. The second, or postganglionic, neuron begins at the ganglion and ends at the tissue upon which it acts. This two-neuron system differs from that involving the motor, or somatic, nervous system, as in the motor nervous system a single motor neuron connects the spinal cord and specific striated muscle tissues.

For an impulse to pass from one neuron to another (interneuronal transmission) or from a neuron to a tissue receptor, a chemical substance is required to carry the

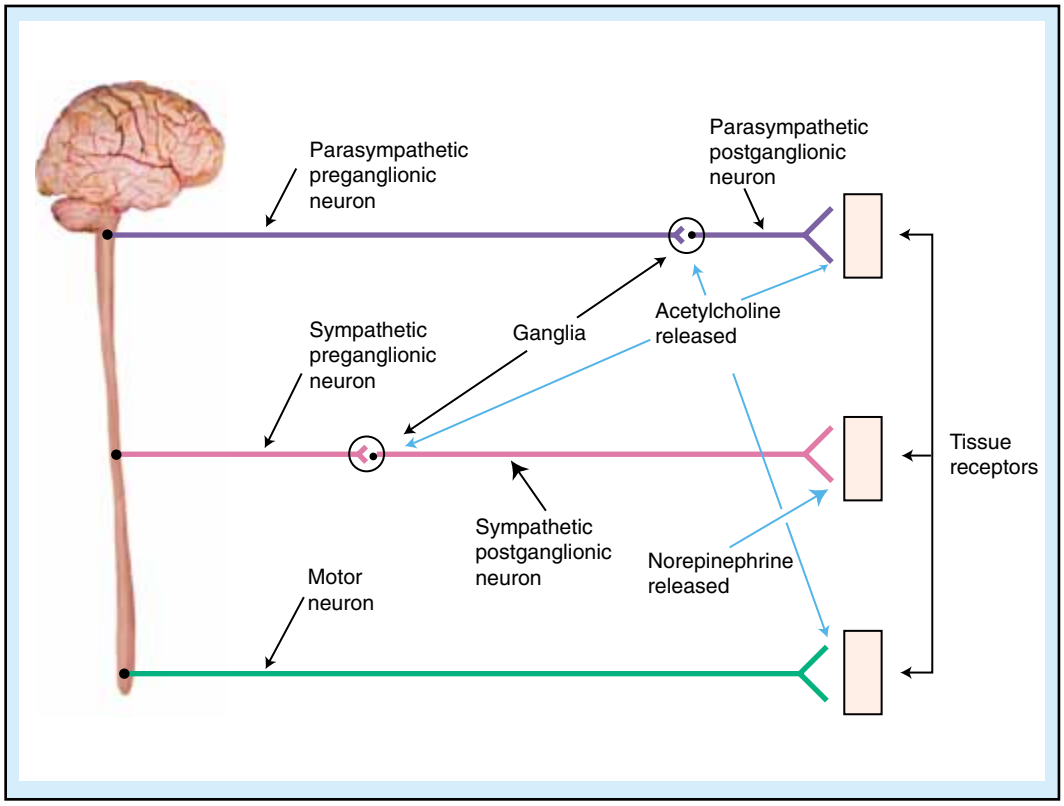
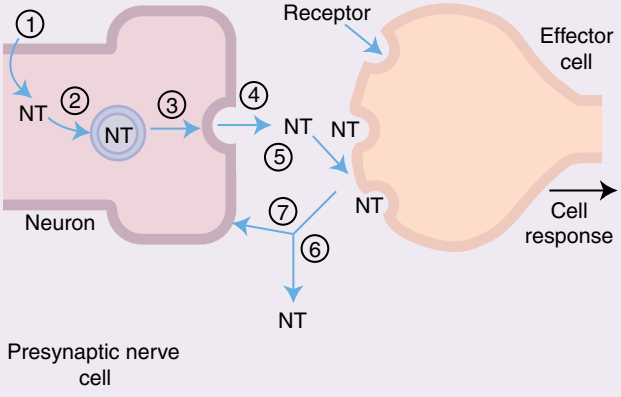


Figure 15–1 Sites of release for the neurotransmitters of the autonomic nervous system.

impulse across the gap, or *synapse*, to the next neuron or receptor (Figure 15–2). Such chemicals are known as *neurotransmitters*. They are synthesized within the neuron and stored in microscopic vesicles, or capsules. When the neuron is stimulated, small quantities of the neurotransmitter are released into the synaptic space, or cleft, and react with the next neuron or tissue receptor. Once the message has been transmitted, the neurotransmitter may diffuse away from the site, be reabsorbed by the storage vesicles, or be destroyed by various enzymes in the body, e.g., monoamine oxidase. The two neurotransmitters employed by the autonomic nervous system are **norepinephrine** and **acetylcholine**.



1. Neurotransmitter (NT) is synthesized from substances that enter or may enter neuron in intact form.
2. Neurotransmitter is stored in storage vesicles.
3. When neuron is stimulated, some storage vesicles fuse with neuron cell membranes and
4. discharge neurotransmitter into the synaptic space.
5. Some neurotransmitter diffuses to the receptor in the effector cell and produces a cell response.
6. Neurotransmitter remaining in the synaptic space is either degraded by enzymes (e.g., monoamine oxidase) or
7. it reenters the neuron and is again stored by storage vesicles.

Figure 15–2 Nerve Impulse Transmission

THE SYMPATHETIC NERVOUS SYSTEM

The sympathetic (adrenergic) branch of the ANS is sometimes known as the "fight or flight" system, because its action predominates when the body is confronted with physical or emotional stress. It also acts to suppress bodily functions that are not vital during the stressful period.

The sympathetic system stimulates body processes that promote self-preservation. Such responses to sympathetic stimulation include:

- dilation of the pupil of the eye to permit more light to enter and to improve vision in dim light conditions
- dilation of the bronchioles to permit more efficient respiration
- an increase in the rate and force of contraction of the heart to increase blood flow to the muscles of the body
- dilation of blood vessels in muscle tissue to increase the flow of blood, oxygen, and nutrients to these areas. At the same time, visceral blood vessels (e.g., those carrying blood to the GI tract) constricts. This vasoconstriction reduces the flow of blood to areas of the body not directly involved with immediate self-preservation.
- stimulation of the breakdown of glycogen (glycogenolysis) to glucose to provide fuel for tissues subject to exertion. Glycogen is a stored form of carbohydrate in the liver.

Both acetylcholine and norepinephrine are employed as neurotransmitters in the sympathetic nervous system. Acetylcholine transmits impulses between preganglionic and postganglionic neurons of the system. Norepinephrine transmits impulses between the postganglionic neuron and the tissue receptor.

Alpha and Beta Receptors

Receptors in the sympathetic nervous system are classified as being alpha (α) or beta (β) receptors. During the last decade, more specific classification of these receptors as alpha$_1$ (α_1), alpha$_2$ (α_2), beta$_1$ (β_1) and beta$_2$ (b_2) has become popular.

Alpha$_1$ (α_1) receptors are found primarily in the smooth muscle tissue of peripheral blood vessels and in the sphincters of the gastrointestinal and genitourinary tracts. When alpha$_1$ (α_1) receptors are stimulated, either by a neurotransmitter or a drug, the smooth muscle associated with them contracts. This contraction may result in an increase in blood pressure due to constriction of peripheral blood vessels. Such an action may be useful in the treatment of clients with severe hypotension. Stimulation of alpha$_1$ (α_1) receptors in the nose causes constriction of nasal blood vessels. This is useful in relieving nasal congestion and is the mechanism by which many nasal decongestants act (see Chapter 3). Sometimes a stimulant of alpha$_1$ (α_1) adrenergic receptors, such as epinephrine (**Adrenalin**) may be injected into a parenteral injection site with another drug (e.g., a local anesthetic) to constrict blood vessels within the area and prevent rapid diffusion of the drug away from the injection site.

Alpha$_2$ (α_2) receptors are believed to be located on the presynaptic neuron. These receptors seem to function as "controllers" of neurotransmitter release by the presynaptic neuron. They appear to sense the concentration of neurotransmitter in the synaptic space. When the concentration of neurotransmitter in the synapse reaches a specific level, stimulation of the alpha$_2$ (α_2) receptors takes place. This stimulation results in decreased neurotransmitter release from the presynaptic neuron. Some drugs stimulate alpha$_2$ (α_2) receptors directly, thereby reducing the release of neurotransmitters by the presynaptic neuron. Such drugs are frequently employed in reducing blood pressure (see Chapter 31).

KEY NURSING IMPLICATIONS 15–1

Alpha and Beta Adrenergic Receptors

1. Alpha$_1$ (α_1) adrenergic receptors are located in smooth muscle tissue of peripheral blood vessels, in the trigone and sphincter of the urinary bladder, in male sex organs, and in many other tissues. Their stimulation results in constriction of peripheral blood vessels, constriction of the sphincter of the urinary bladder, and maintenance of normal ejaculatory function in males, as well as many other physiological actions.
2. Alpha$_2$ (α_2) adrenergic receptors are believed to be located on the presynaptic neuron and to act as "controllers" of neurotransmitter release. Their stimulation reduces the release of neurotransmitter.
3. Beta$_1$ (β_1) adrenergic receptors are located primarily in the muscles of the heart and in fatty tissue. Their stimulation increases heart rate and force of contraction.
4. Beta$_2$ (β_2) adrenergic receptors are located primarily in bronchial smooth muscle. Their stimulation results in bronchodilation.

Beta-adrenergic receptors, depending on their location in the body, may be called $beta_1$ or $beta_2$ adrenergic receptors. $Beta_1$ receptors are located primarily in the muscles of the heart and in fatty tissue. Stimulation of these receptors in the heart produces a more rapid heart rate as well as more forceful heart muscle contractions. Drugs that stimulate $beta_1$ receptors may, therefore, be useful in the treatment of clients with depressed cardiac function. Stimulation of $beta_1$ receptors in fatty tissue promotes the breakdown of stored fat to fatty acids, which can be better utilized by the body as energy sources.

$Beta_2$ adrenergic receptors are located primarily in bronchial smooth muscle and in the walls of blood vessels located in skeletal muscle, the brain, and the heart. Stimulation of the $beta_2$ receptors in bronchial muscle results in muscle relaxation, thereby increasing the diameter of the air channels and promoting improved gas exchange. $Beta_2$ stimulants (agonists) are sometimes used, therefore, to treat bronchial asthma or other conditions marked by breathing difficulty.

It can again be seen, therefore, that adrenergic stimulation provides the body with the ability to effectively deal with a "fight or flight" situation by: (1) increasing the rate and force of contraction of the heart, (2) increasing the ability of the respiratory tract to function, (3) shunting blood to the major organs of the body, and (4) increasing the formation of energy sources within the body.

THE PARASYMPATHETIC (CHOLINERGIC) NERVOUS SYSTEM

The parasympathetic nervous system is sometimes referred to as the cholinergic nervous system because acetylcholine is the neurotransmitter involved in the transmission of impulses within the system. In many cases, its actions are opposite to those of the sympathetic nervous system. Unlike the "fight or flight" nature of sympathetic action (which utilizes energy), parasympathetic action is generally directed at conserving energy. For example, the parasympathetic nervous system promotes nutrient utilization by increasing gastric motility and acid secretion, increasing salivation, and promoting the release of digestive fluids from the gallbladder. In addition, elimination of body waste is enhanced by the increased muscle tone of the intestines and urinary bladder, relaxation of the sphincter muscles of the anus and urethra, and by the promotion of sweating.

While promoting nutrient utilization, the system also promotes energy conservation by causing a decrease in heart rate and blood pressure. In addition, the pupils of the eye constrict, thereby reducing the amount of light that enters.

Acetylcholine is not only the neurotransmitter of the parasympathetic nervous system but it is also involved in the transmission of impulses in the ganglia of the sympathetic nervous system and at the neuromuscular junction of motor neurons. In an attempt to classify the actions of acetylcholine, two different types of acetylcholine receptors have been identified. Those that lie in the postganglionic portion of the parasympathetic nervous system are known as *muscarinic* receptors. (The name originates from the observation that muscarine is a chemical agent that mimics the action of acetylcholine, but only at postganglionic receptor sites.) Those receptors located at the ganglia of the sympathetic and parasympathetic systems, as well as at the neuromuscular junction, of motor neurons are known as *nicotinic* receptors, as they respond to nicotine, a chemical found in tobacco that mimics the action of acetylcholine at these specific receptor sites. Table 15–1 compares the actions of the components of the ANS.

AGENTS THAT AFFECT THE AUTONOMIC NERVOUS SYSTEM

Drugs that affect the ANS may be classified into one of four categories:

- Sympathomimetic, or adrenergic, drugs produce actions that stimulate or mimic the actions of the sympathetic nervous system. These may be further classified as "direct-acting" or "indirect-acting." They act directly on the receptor to produce a response or they do not act on the receptor, but stimulate the sympathetic, postganglionic neurons to release norepinephrine.
- Sympatholytic, or adrenergic blocking drugs interfere with the action of the sympathetic nervous system. They may act by blocking alpha- or beta-adrenergic receptors, by depleting the stores of norepinephrine in the neuronal vesicles, or by inhibiting sympathetic activity by a direct action on the CNS.

TABLE 15–1

Some Organ Responses to Autonomic Nerve Impulses

ORGAN	SYMPATHETIC (ADRENERGIC) RESPONSE	PARASYMPATHETIC (CHOLINERGIC) RESPONSE
eye	dilation of pupil (mydriasis)	contraction of pupil (miosis) diminished accommodation (ability to focus on near objects)
heart	increased heart rate increased force of contraction increased electrical conduction velocity through the AV node	decreased heart rate decreased force of contraction decreased electrical conduction velocity through the AV node
lung	dilated bronchioles (opened airway)	contracted bronchioles (narrowed airway)
GI tract	decreased motility and tone	increased motility and tone
uterus	contraction	varies with stage of menstrual cycle and other factors
liver	increased glycogenolysis	increased glycogen synthesis
urinary bladder	relaxation of detrusor and contraction of trigone and sphincter	contraction of detrusor and relaxation of trigone and sphincter

- Parasympathomimetic, or cholinergic, drugs produce actions which stimulate or mimic the actions of the parasympathetic nervous system. These agents may be further classified as being "direct-acting" (they mimic the actions of acetylcholine) or "indirect-acting" (they inhibit the action of the enzyme **acetylcholinesterase**). As this enzyme acts in the body to destroy acetylcholine, inhibition of its action would sustain the action of acetylcholine released by the neuron.
- Parasympatholytic, or anticholinergic, drugs interfere with the action of the parasympathetic nervous system. Some of these may act by blocking acetylcholine receptors at the neuromuscular junction and/or in the ganglia. These may be specific for muscarinic or nicotinic receptors or they may be nonspecific in their action. Other parasympatholytic drugs act by inhibiting the breakdown of the enzyme acetylcholinesterase, thereby promoting the degradation of acetylcholine released by the neuron.

Because many drugs in varied pharmacological categories are capable of affecting the ANS, their specific actions are discussed in this chapter and, where appropriate, throughout this text.

Increased smooth muscle tone, or spasticity, is responsible for producing pain and discomfort in a wide variety of diseases. For example, increased spasticity of the gastrointestinal tract may be evident in some clients with peptic ulcer disease as well as in conditions noted by irritation of the lower colon, as in irritable bowel syndrome, *diverticulitis*, and mild *dysentery* infections.

Increased smooth muscle tone in the biliary tract may cause spastic disorders such as *biliary colic* while such action in the genitourinary tract may result in conditions ranging from urinary frequency and renal colic to dysmenorrhea.

SYMPATHOMIMETICS (ADRENERGICS)

Adrenergic, or sympathomimetic, drugs mimic the action of the sympathetic nervous system neurotransmitters norepinephrine, epinephrine, and dopamine. These neurotransmitters are called *catacholamines*. Catacholamine receptor sites where adrenergic drugs bind and produce their sympathomimetic response are located throughout the body.

There are two types of *adrenergic receptors*, alpha-adrenergic and beta-adrenergic receptors,

and are designated by whether they respond to norepinephrine or epinephrine respectively. The alpha-adrenergic receptor sites are located in the smooth muscle of blood vessels, gastrointestinal tract, and genitourinary tract and produce vasoconstriction when stimulated by adrenergic drugs. The $beta_1$-adrenergic receptors are located in the heart muscle and when stimulated by adrenergic drugs produce increased contractility (*positive inotropic effect*), increased heart rate (*positive chronotropic effect*), and atrioventricular and sinoatrial node conduction (*positive dromotropic effect*). Some of the most frequently used vasoactive adrenergics are **dobutamine** (**Dobutrex**), **dopamine** (**Intropin**), epinephrine (Adrenalin), **isoproterenol** (**Isuprel**), **midodrien** (**ProAmatine**), norepinephrine (**Levophed**), and **phenylephrine** (**Neosynephrine**), which are discussed in more detail in Chapter 28.

$Beta_2$-adrenergic receptors in the respiratory system, located in the bronchial muscle, produce bronchodilation when stimulated by adrenergic agents. These adrenergic agents are classified as *bronchodilators* and are useful in the treatment of asthma and bronchitis. Among the beta-adrenergic agents most frequently used are **albuterol** (**Proventil**), epinephrine (**Primatene**), isoproterenol (**Medihaler-Iso**), **metaproterenol** (**Alupent, Metaprel**), and **terbutaline** (**Brethine**), which are discussed in Chapter 25.

The muscles in the gastrointestinal tract contain both $alpha_1$ and $beta_2$ receptor sites that respond by increasing gastric motility. The sphincters have $alpha_1$ receptors, which react by causing constriction of the sphincters. Adrenergic agents used to stimulate a response in these receptor sites are used primarily as anorexiants, and, although there is much controversy surrounding the use of these agents as adjuncts to diet therapy for weight loss, some are still in use. Those include **dextroamphetamine** (**Dexadrine**) and **methamphetamine** (**Desoxyn**).

The urinary bladder sphincter has $alpha_1$ receptors that respond by constriction of the sphincter. The penis also has $alpha_1$ receptors, which respond by stimulating ejaculation. The uterus, however, has both $alpha_1$ and $beta_2$ cells, which are responsible for contracting and relaxing the uterine muscle, respectively.

Adrenergics are also useful in reducing intraocular pressure and dilating the pupils, properties helpful in treating wide-angle glaucoma. They stimulate both alpha- and $beta_2$-receptor sites, producing decreased eye congestion. The most commonly used of these agents is **tetrahydrozoline** (**Murine**, **Visine**).

Geriatric Considerations

Older clients are more sensitive to the effects of adrenergic drugs. Consequently, they need to be closely monitored for excessive cardiac and CNS stimulation. Symptoms such as chest pain, palpitations, blurred vision, headache, seizures, or hallucinations should be immediately reported to the physician. In addition, elderly clients should be monitored before, during, and after use of these agents, as clients frequently have other medical conditions, such as hypertension, peripheral vascular disease, and cardiovascular disease, which could cause adverse responses to adrenergics. These clients should have their vital signs, especially blood pressure and pulse, monitored closely during adrenergic therapy because of the effects of these agents on the cardiovascular system.

SYMPATHOLYTICS (ADRENERGIC BLOCKERS)

Sympatholytics block or inhibit the responses of adrenergic neurotransmitters at the alpha- and beta-adrenergic receptor sites and are referred to as *adrenergic blocking agents*, or blockers. Alpha-adrenergic blockers (alpha blockers) inhibit the response at the alpha receptors, and beta-adrenergic blockers (beta blockers) compete with norepinephrine at the available beta-receptor sites. The alpha blockers cause vasodilation, which decreases blood pressure, and are used to treat migraine headaches, hypertension, and peripheral vascular diseases, such as, *Raynaud's disease*, resulting in increased blood flow to the extremities. These agents are also helpful in preventing sloughing and skin necrosis associated with extravasation of vasopressors, such as epinephrine and norepinephrine. In addition, they can be used to promote blood flow to vasoconstricted areas. Hypotension and resulting dizziness are symptoms of adverse effects of alpha blockers. They also suppress ejaculation in the genitourinary system. Commonly used alpha blockers include ergotamine tartrate (**Ergostat**), used to treat migraine headaches (Chapter 10); **phenotolamine** (**Regitine**) and **prazosin** (**Minipress**), used to treat hypertension (Chapter 29); and **tolazoline** (**Priscoline**), the

most common agent used to treat neonatal pulmonary hypertension.

Beta-adrenergic blocking drugs were first introduced in the 1960s, and until 1978 only one beta blocker was approved by the Food and Drug Administration (FDA). The first of these agents was **propranolol** (**Inderal**) but since 1978, many others have been added to the list of approved beta blockers, including **metoprolol** (**Lopressor**), **nadolol** (**Corgard**), **atenolol** (**Tenormin**), **propranolol long-acting** (**Inderal LA**), and **metoprolol long-acting** (**Lopressor SR, Toprol XL**). By blocking the beta-receptor sites in the heart, beta blockers decrease pulse rate during both rest and exercise, thereby usually controlling angina. By decreasing firing rate in the sinoatrial node and conduction velocity in the atrioventricular node, beta blockers are very useful in treating various cardiac *dysrhythmias*. The decrease in myocardial muscle contractility also leads to decreased cardiac output. Beta blockers also lower blood pressure and cause bronchoconstriction. They are used to treat hypertension, as well as cardiac dysrhythmias and angina, and as a prophylactic in the prevention of myocardial infarctions (MI) in clients with a history of MI. These agents should be used with extreme caution in clients with asthma. Among the most frequently prescribed beta blockers is atenolol (Tenormin), used to treat hypertension and to prevent future MIs in clients who have experienced an MI. Propranolol (Inderal) is the prototype $beta_1$ and $beta_2$ blocker and has a long history of use in treating hypertension and ventricular and supraventricular dysrhythmias, as well as with clients during the immediate period following an MI. Metoprolol (Lopressor) has been successfully used to increase survival in clients given the drug after experiencing an MI. These agents are discussed in more detail in Chapter 31.

Geriatric Considerations

Although older adults frequently have conditions requiring the use of sympatholytic drugs, they are more sensitive to the actions of these agents. Consequently, they need to have their vital signs, especially pulse rate and blood pressure, monitored closely. If they are being treated for hypertension, they are at risk for falling, until their bodies adjust to therapeutic lowering of their blood pressure. They may also be at risk for falls as a result of the effects of decreased cardiac output on the CNS. Symptoms, such as dizziness, blurred vision, changes in mental status, and weakness, should be immediately reported to the physician. Falling is a significant concern with clients beyond 60 years old because of reduction in their bone density, which makes them subject to fractures if they fall. In addition, if they fall, these clients are at risk for bleeding head injuries, because of the increased fragility of blood vessel walls in the elderly.

Older clients taking adrenergic blocking agents should be cautioned to change positions slowly, especially when changing from a lying to sitting or sitting to standing position. The older client and his/her significant others need to be taught how to monitor the client's blood pressure and pulse. If this is not possible, the need for a social service referral should be discussed with the physician so it can generated to provide for home nursing visits for such monitoring.

PARASYMPATHOMIMETICS (CHOLINERGICS)

Cholinergics are drugs that stimulate the parasympathetic nervous system, which works with the sympathetic nervous system to promote homeostasis. Cholinergic agents mimic the action of acetylcholine, the neurotransmitter responsible for transmitting nerve impules to the receptor sites in the parasympathetic nervous system. The two categories of cholinergic receptors are nicotinic and muscarinic.

The nicotinic neuromuscular receptors are located in the ganglia of both the sympathetic and parasympathetic nervous systems. The term nicotinic is used because these receptors can be stimulated by the alkaloid nicotine. Activation of the nicotinic receptors results in depolarization of the nerve cell, causing structural changes that allow potassium and sodium ions to alter their concentrations. This stimulates skeletal muscle contraction and is useful in treating clients with *myasthenia gravis*. The most commonly used of these agents for myasthenia gravis are **pyridostigmine** (**Mestinon**), **edrophonium** (**Tensilon**), and neostigmine (**Prostigmin**), discussed in more detail in Chapter 20.

The muscarinic receptors are located in the postsynaptic junctions in the smooth muscle, cardiac muscle, and glands. The major uses of muscarinic cholinergics are for diseases of the eye and gastrointestinal and urinary systems. These agents cause contraction of the iris and ciliary muscle, as well as *lacrimation*, miosis, blurred vision, and

"accommodation spasms." Cholinergic agents, such as **pilocarpine** (**Ocuset**) and **physostigmine** (**Eserine**), are effective in treating *glaucoma* (Chapter 26). By increasing gastric, pancreatic, and intestinal motility, as well as stimulating secretions and increasing urinary frequency, these drugs are useful in treating postoperative intestinal *atony* and neurogenic bladder. These agents include **carbechol** and **bethanechol** (**Urecholine**), which are discussed in Chapters 10 and 20, respectively.

Muscarinic agonists are also used in the treatment of cardiac (atrial) dysrhythmias by decreasing the heart rate (negative chronotropic action), decreasing atrial contraction strength (negative inotropic activity), and decreasing conduction velocity (negative dromotropic). Although frequently these actions are actually adverse effects associated with the muscarinic agents' use in the treatment of myasthenia gravis, neurogenic bladder, and glaucoma, drugs in this classification are used primarily as antidotes for adverse effects associated with anticholinergic agents, such as **atropine sulfate** (Table 15–2).

Tacrine (**Cognex**) is an indirect-acting cholinergic agent that acts by blocking the degradation of acetylcholine, thus increasing the acetylcholine levels. In 1993, the FDA approved tacrine for use in mild-to-moderate cases of Alzheimer's disease, and it became the prototype for future drug development in the war against this mentally disabling disease.

Geriatric Considerations

As with most other pharmacotherapeutic agents, geriatric clients are especially sensitive to both the positive effects and adverse effects of cholinergic drugs. Older adults are the population experiencing Alzheimer's disease and glaucoma, as well as myasthenia gravis. Consequently, they make up a large proportion of clients receiving cholinergic agents. One of the adverse effects associated with cholinergics is diarrhea, which can lead to dehydration, which as with pediatric clients, can lead to serious, even life-threatening problems. Cholinergics also increase bronchial secretions and bronchoconstriction, which can aggravate conditions in the elderly with respiratory compromise, either from medical conditions or the aging process.

These clients need to receive cardiac, pulmonary, and fluid monitoring to ensure early detection of adverse effects so they can be effectively treated before problems become severe. Because clients with glaucoma and myasthenia gravis are usually treated as outpatients and self-medicate, they need to understand the adverse effects associated with cholinergic agents so they can report these immediately to the physician.

PARASYMPATHOLYTICS (ANTICHOLINERGICS)

Drugs like atropine sulfate, **scopolamine** (Hyoscine, TransdermScop), **glycopyrrolate** (Robinol), and **propantheline bromide** (Pro-Banthine) are some of the most common anticholinergic agents in use today. Because they act by blocking acetylcholine receptors, they exert the opposite effects (therapeutic and adverse) of cholinergics. By decreasing gastrointestinal and respiratory secretions, atropine sulfate and glycopyrrolate are frequently used preoperatively to decrease the risk of emesis and *aspiration* during induction and maintenance of general anesthesia. These agents are presented in more detail in Table 15–2.

One of the most critical of the adverse effects of anticholinergic agents is tachycardia associated with larger doses. As a result, these drugs are not used preoperatively with clients undergoing open heart surgery. Before repairing a structural cardiac problem, the client is placed on a cardiopulmonary-bypass device and the heart is stopped, consequently the tachycardia associated with using parasympatholytics is contraindicated.

Anticholinergic drugs can be used locally by inserting drops in the eyes for eye exams and preoperatively for eye surgery; however, they can also aggravate glaucoma through its *mydriasis* (pupillary dilation), cycloplegia (paralysis of ciliary muscles), and increased intraocular pressure.

Anticholinergics cause relaxation of the smooth muscle in the bronchi, resulting in decreased bronchial resistance and bronchodilation, as well as decreased bronchial secretions. Because of these actions, anticholinergics have been proven effective in the treatment of exercise-induced bronchospasms, asthma, chronic bronchitis, and chronic obstructive pulmonary disease.

These agents have therapeutic effects in the treatment of Parkinson's disease through their actions in the CNS of decreasing muscle rigidity and tremors. In addition, because of their action of relaxing detrusor muscles of the bladder and increased constriction of the urinary sphincter, anticholinergics have been successfully used in the treatment of incontinence and reflex neurogenic bladder.

TABLE 15–2

Antispasmodics that Are Belladonna Derivatives

Note: Administration is contraindicated in clients with narrow-angle glaucoma, renal disease, prostatic hypertrophy, obstructive disease of the GI tract, or preoperatively for open heart surgery.

May reduce tolerance to high environmental temperature.

Administer 30–60 minutes before meals and at bedtime.

Gum, hard candy, or ice chips may be provided to relieve dry mouth.

Monitor client for development of constipation, reduced urinary output, skin rash, flushing, or eye pain.

Elderly clients may develop excitement, confusion, agitation, or drowsiness.

Diminished doses should be used in the elderly.

Neostigmine methylsulfate (0.5–2 mg) may be given intravenously to treat overdose. Physostigmine (1–4 mg) administered by slow IV injection also has been successfully used to reverse anticholinergic effects.

Assess client for therapeutic effectiveness.

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
atropine sulfate *(**AT**-roh-peen **SUL**-fayt)*	oral, SC, IM, IV	*Adults:* 0.4–0.6 mg *Children:* 0.1 mg/kg	dry mouth, loss of taste, constipation, urinary retention, blurred vision, photophobia, bradycardia or tachycardia, headache, dizziness, fever	See note above. Monitor client's heart rate.
belladonna *(**bell**-ah-**DON**-ah)*	oral	*Adults:* 180–300 mcg 3–4 times a day *Children:* 9 mcg/kg 3–4 times a day	See atropine sulfate	See note above.
hyoscyamine sulfate *(**hy**-oh-**SIGH**-ah-meen **SUL**-fayt)* (Anaspaz, Levsin, etc.)	oral, SC, IM, IV	*Adults:* 0.125–0.25 mg 3–4 times daily Injectable 250–500 mcg 4–6 times a day *Children:* Individualize dosage according to weight 12.5–187 mcg 6 times a day	See atropine sulfate	See note above.
scopolamine HBr *(skoh-**POL**-ah-meen **hy**-droh-**BROH**-myd)*	oral, transdermal, SC, IM, IV, ophthalmic	*Adults:* Oral: 10–20 mg Parenteral: 10–20 mg	See atropine sulfate	See note above. Oral and transdermal forms are employed primarily for the prevention of nausea and vomiting associated with motion sickness in adults.

One of the major cautions when using anticholinergic drugs is that they have a *narrow therapeutic* index. This means that the difference between therapeutic and toxic doses is very small or narrow. Because of this, clients who experience toxic effects of these agents should be monitored continuously, including with cardiac telemetry as well as fluid volume.

Geriatric Considerations

Elderly clients are more susceptible to the effects of anticholinergic drugs and, thus, are more at risk of developing toxic effects because of the narrow therapeutic index. As with the other drugs affecting the autonomic system, anticholinergic agents are frequently indicated for health alterations affecting our older population—Parkinson's disease, bowel and bladder incontinence, chronic respiratory disorders, and atrial dysrythmias. The adverse effects to the CNS include CNS excitation, restlessness, irritability, hallucinations, and delirium. These are more likely to occur in older clients because of their reduced liver and renal function as well as CNS decline in the aging population.

Because the thermal regulatory system in older adults declines, hyperthermia is possible with anticholinergics. This happens because these agents decrease sweating, which is our natural method of cooling the body temperature during extreme rise in temperature.

Urinary retention is another adverse effect associated with anticholinergic drugs. This happens as a result of the direct action on the urinary sphincters. This problem is compounded by the decrease in secretions of the gastrointestinal tract, resulting in decreased appetite—a major source of fluid intake. This, in turn, results in a higher incidence of dehydration, which occurs as the renal tubules attempt to absorb the available fluids to maintain vascular volume. Without sufficient fluids, the urinary bladder doesn't fill enough to provide the urge to void. In addition, the concentration of solutes is high, making the urine an excellent media for bacterial growth.

These clients require instruction about the potential for adverse effects of anticholinergics so the elderly can recognize the symptoms they should report to their physicians. Clients should be cautioned that they are at a particular risk for experiencing heat stroke. The need for adequate fluid and sodium intake should be stressed especially in this population.

ANTISPASMODICS

Most drugs with antispasmodic activity act by antagonizing the action of acetylcholine at the postganglionic receptors in the parasympathetic nervous system. These are usually referred to as anticholinergic, or atropine-like, drugs, as their action tends to be pharmacologically equivalent to the most widely known member of the group, atropine.

In addition to reducing smooth muscle tone, therapeutic doses of anticholinergic drugs also affect many other organ systems. For example, a dose of atropine that reduces the motility of the gastrointestinal tract can also be expected to reduce the secretion of saliva, sweat, and bronchial secretions. This makes the use of the drug popular preoperatively to reduce oral secretions and prevent laryngospasm during intubation. Atropine may also dilate the pupils and interfere with the ability of the eye to properly focus an image as well as promote the retention of urine by the bladder.

The use of normal antispasmodic doses of anticholinergic drugs is contraindicated in clients with narrow-angle glaucoma, as dilation of the pupil may increase the pressure within the eye of such clients. Anticholinergic drugs may also cause difficulty in clients with bronchial asthma, women who are pregnant, men with *prostatic hypertrophy*, and persons with advanced hepatic or renal diseases. Because of the ability of these drugs to impair sweating, their use in the presence of high environmental temperature may result in heat prostration. High anticholinergic drug doses may produce delirium, rapid heart rate, urinary retention, psychotic effects, and coma.

Many antispasmodic drugs are naturally derived from the *Atropa Belladonna* plant and are collectively referred to as **belladonna alkaloids**. The name "Belladonna" is derived from an Italian expression meaning "beautiful woman," a term that originated from a historical period when women applied extracts of the Belladonna plant to their eyes to dilate the pupils in the belief it would make them more beautiful. The belladonna alkaloids all exert an anticholinergic action; they share the property of being rapidly absorbed from the gastrointestinal tract and being able to cross the

TABLE 15–3

Synthetic Anticholinergics Used as Antispasmodics

Note: Administration is contraindicated in clients with narrow-angle glaucoma, renal disease, prostatic hypertrophy, obstructive disease of the GI tract, or preoperatively for open-heart surgery.
May reduce tolerance to high environmental temperature (impairs ability to perspire).
Administer 30–60 minutes before meals and at bedtime.
Gum, hard candy, or ice chips may be provided to relieve dry mouth.
Monitor client for development of constipation, reduced urinary output, skin rash, flushing, or eye pain.
Elderly clients may develop excitement, confusion, agitation, or drowsiness.
Diminished doses should be used in the elderly.
Assess client for therapeutic effectiveness.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
anisotropine methylbromide *(an-**is**-oh-**TROH**-peen **meth**-ill-**BROH**-myd)* (Valpin 50)	oral	*Adults:* 50 mg 3 times daily	See note above.
clidinium bromide *(klih-**DIN**-ee-um **BROH**-myd)* (Quarzan)	oral	*Adults:* 2.5–5 mg 3–4 times daily before meals and at bedtime *Geriatric or debilitated patients:* 2.5 mg 3 times daily before meals	See note above.
dicyclomine HCl *(dye-**SIGH**-kloh-meen **hy**-droh-**KLOR**-eyed)* (Bentyl, Formulex ✱)	oral, IM	*Adults:* Parenteral: 20 mg every 6 hours Oral: 20–40 mg 4 times daily	See note above. Not for IV use.
flavoxate *(flay-**VOX**-ayt)* (Urispas)	oral	*Adults:* 100–200 mg 3–4 times daily	See note above. Used only as a urinary antispasmodic.
glycopyrrolate *(**gly**-koh-**PIR**-roh-layt)* (Robinul)	oral, IM, IV	*Adults:* Oral: 1–2 mg 3 times daily Parenteral: 0.1–0.2 mg IM or IV every 4 hours 3–4 times daily	See note above. May be used as preoperative medication as a secretory inhibitor. May cause pain at the injection site.
methantheline bromide *(meh-**THAN**-theh-leen **BROH**-myd)* (Banthine)	oral	*Adults:* 50–100 mg every 6 hours *Children:* 12.5–50 mg 2–4 times daily	See note above.
methscopolamine bromide *(**meth**-skoh-**POL**-ah-meen **BROH**-myd)* (Pamine)	oral	*Adults:* 2.5–5 mg 4 times daily Children: 200 mcg/kg/dose	See note above.

continues

TABLE 15–3 *continued*

See **Note** at beginning of Table 15–3, page 326.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
oxybutynin chloride *(**ock**-see-**BYOU**-tih-nin **KLOR**-eyed)* (Ditropan)	oral	*Adults:* 5 mg 2–3 times daily *Children over 5:* 5 mg 2 times daily	See note above. Used only as a urinary antispasmodic.
propantheline bromide *(proh-**PAN**-theh-leen **BROH**-myd)* (Pro-Banthine, Propanthel 🍁)	oral	*Adults:* Oral—7.5–15 mg ½ hour before meals and 30 mg at bedtime *Children:* 375 mcg/kg 4 times a day	See note above. May cause drowsiness. Caution patient about driving.

blood-brain barrier. This permits them to produce CNS stimulation. Table 15–2 (page 324) lists the antispasmodic agents that are belladonna derivatives.

The synthetic antispasmodic agents have a chemical structure that slows their absorption from the gastrointestinal tract, reduces their ability to stimulate the CNS, and prolongs their action in the body. The synthetic anticholinergic drugs also are less likely to affect the pupil of the eye than belladonna alkaloids. The drugs also exert their antispasmodic action by producing an anticholinergic effect. Table 15–3 lists the synthetic antispasmodic agents. Nursing implications are provided as guidelines for client care.

Considerable controversy still surrounds the use of antispasmodic agents for conditions in which they have been traditionally used. For example, little evidence can be shown to support the effectiveness of the anticholinergic agents in the treatment of gastrointestinal or renal disorders. Doubt regarding their efficacy, combined with the probability of adverse effects frequently seen in the use of these agents, has resulted in a decline in their popularity during the last decade.

APPLYING THE NURSING PROCESS

Many clients receiving antispasmodics have peptic ulcers. The student is referred to Chapter 14 for a more thorough discussion of the nursing care and drug regimens of clients on ulcer therapy. There are, however, several aspects of nursing assessment and intervention associated with the use of antispasmodics discussed here.

ASSESSMENT

When a client is taking antispasmodics, particularly those with anticholinergic activity, the nurse must watch carefully for adverse side effects. Nonhospitalized clients should be instructed to watch for the development of dryness of the mouth and flushed skin. These effects occur in most clients taking anticholinergics, but are not usually serious. Clients can be instructed to chew gum or suck hard candy to relieve the discomfort of a dry mouth. Clients noting blurred vision, headache, palpitations of the heart, difficult urination, constipation, and signs of glaucoma should be instructed to call their physician. The physician may alter the dose, stop the drug, or switch to a different preparation with

less anticholinergic activity. Hospitalized clients, particularly those not permitted fluids by mouth, should receive mouth care regularly to decrease discomfort from dry mucous membranes. The student is referred to Chapter 11 for a discussion of the use of anticholinergic drugs before surgery.

Finally, some of the available antispasmodic preparations contain sedatives, such as phenobarbital. These sedatives when used in combination with anticholinergic drugs, may produce drowsiness. Outpatients should be cautioned against driving or operating other machinery if they note any drowsiness or blurred vision.

NURSING DIAGNOSES

Including but not limited to:

- Risk for injury related to excessive CNS stimulation
- Risk for ineffective tissue perfusion related to tachycardia
- Risk for impaired gas exchange related to thickened respiratory secretions
- Risk for impaired urinary elimination related to urinary retention
- Deficient knowledge related to disease process and medical regimen

PLANNING/GOALS

- Client will not experience excessive CNS stimulation.
- Client will not experience altered tissue perfusion.
- Client will not experience altered gas exchange.
- Client will not experience negative side effects from medications including urinary retention.
- Client will verbalize understanding of disease process and medication regimen.

IMPLEMENTATION

Extreme caution must be used in administering antispasmodics, particularly those with anticholinergic activity, to older clients. The elderly seem to be more sensitive to the development of CNS disturbances (e.g., confusion) and are more likely to have glaucoma and/or prostatic hypertrophy than younger persons. Administration of anticholinergic antispasmodics to individuals with these health problems is contraindicated because they may increase intraocular pressure and promote urinary retention. The nurse should be familiar with the client's history and physical examination findings to avoid the administration of antispasmodics to these clients. If such agents are administered and urinary retention or indications of acute glaucoma occur, the physician must be contacted at once.

Generally, antispasmodics, particularly those used to treat gastrointestinal ulceration, are administered about ½ hour before meals and at bedtime. With the development of newer agents, drugs like **tincture of belladonna** are less frequently used. If the nurse has occasion, however, to administer this drug, there are several nursing actions that can facilitate treatment. The tincture, which is ordered by number of drops, may be mixed in a small amount of applesauce or juice so that the client receives the entire dosage. Drinking this juice mixture through a straw may decrease the unpleasant taste. If the client chooses to take the tincture without disguising its bitter taste, offer mouthwash or a bland food like crackers after administration of the drug.

EVALUATION

- Client does not experience signs or symptoms of CNS stimulation requiring treatment.
- Client does not experience altered tissue experience from tachycardia.
- Client does not exhibit signs or symptoms of altered gas exchange.
- Client does not experience urinary retention.
- Client verbalizes understanding of disease process, medical regimen, adverse effects of anticholinergics, and need to be compliant with therapy.

NURSING CARE PLAN

A Client with a Peptic Ulcer Taking Isopropamide Iodide (Darbid) and an Antacid

Ronald Hagen is a 32-year-old man recently diagnosed as having a peptic ulcer. His physician prescribes a regimen of isopropamide iodide (Darbid) 5 mg BID and aluminum carbonate gel, basic (Basaljel) 10 mL in water QID between meals and at bedtime. Mr. Hagen is a heavy smoker who drinks alcohol daily and who has experienced low-grade epigastric pain for years.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Epigastric pain.	Acute pain related to tissue trauma secondary to increased hydrochloric acid.	Client verbalizes decreased pain 2 days after initiation of therapy.	Discuss purpose of medications and medication schedule. Help client adapt medication administration times to his daily schedule, emphasizing that aluminum carbonate gel is used between meals because of its acid-neutralizing ability.	Client states pain is less intense and less frequent.
Recurrence of pain. Use of tobacco and alcohol.	Deficient knowledge (conditions that aggravate peptic ulcer disease).	Prior to discharge, client will verbalize factors that aggravate the illness and will describe a plan to reduce these factors. Client verbalizes the importance of taking medication as ordered.	Explain how medications work. Discuss administration schedule and importance of shaking antacid bottle before use. Teach client about role of stress, alcohol, and tobacco in aggravating peptic ulcer disease. Discuss stress management.	Client uses measures other than tobacco and alcohol to decrease stress levels. Client complies with treatment regimen.
History of allergy, skin rash.	Risk for injury related to hypersensitivity to iodine.	Client will not experience injury related to iodine hypersensitivity during hospitalization.	Take medication history and history of allergy, particularly to iodine and shellfish. Instruct client to report evidence of skin rash and any indications of drug intolerance.	Client does not experience iodine hypersensitivity.
Frequency and nature of stool.	Risk constipation related to side effects of medications.	Client describes interventions to prevent constipation and when to notify a health care professional.	Inform client that both aluminum carbonate gel and isopropamide iodide can cause constipation. Suggest an increase in fluid intake and fiber. Instruct client to report constipation to physician as a nonconstipating antacid could be substituted for current antacid.	Client reports constipation to physician and is switched to a magnesium-based antacid (see Table 14–1). Client maintains normal elimination pattern.

KEY NURSING IMPLICATIONS 15–2

Antispasmodics

1. Clients noting blurred vision, headache, urinary retention, palpitations, and indications of glaucoma are referred to the physician.
2. Antispasmodics should not be administered to clients with acute, narrow-angle glaucoma.
3. Carefully monitor elderly clients receiving antispasmodics and notify the physician if urinary retention or indications of acute glaucoma occur.
4. Tincture of belladonna may be mixed in a small amount of applesauce or juice to mask its unpleasant taste.
5. Mouth care and sucking on hard candy may help to relieve dry mouth.

HOME CARE / CLIENT TEACHING

1. Client should be informed that mouth care and sucking of hard candy may help relieve dry mouth.
2. Client should be instructed to avoid high environmental temperature because of drug's effect on diminishing ability to perspire.
3. Clients should be instructed to take anticholinergics 30–60 minutes before meals and at bedtime.
4. Clients should be informed about potential for constipation and urinary retention associated with anticholinergics.
5. Family of elderly client taking anticholinergics should be instructed to monitor elderly for excessive CNS stimulation.
6. Clients should be informed that they should use caution when driving or handling heavy equipment because of the risk of blurred vision common in clients taking anticholinergics.

CASE STUDY

Laura Mathers is a 74-year-old widow who has had rheumatoid arthritis for several years and regularly takes about ten 325 mg aspirin tablets daily. One night Mrs. Mathers awakens with sharp pain in her abdomen that subsides when she takes a dose of a nonprescription antacid product. Upon examination by her physician, it is determined that she has a small duodenal ulcer. The physician prescribes:

Maalox Liquid 30 mL, 1 hour and 3 hours p.c. and h.s.
Probanthine 15 mg, 1 tablet, qid, a.c. and h.s.

After 1 week of therapy the client calls her physician and complains of blurred vision and eye pain.

Questions for Discussion

1. What is a probable cause of the client's ocular complaint and how can it be resolved?
2. What nursing actions would be appropriate in the care of this client?

CRITICAL THINKING EXERCISES

1. Identify the specific neurotransmitters of the ANS and describe how they function.
2. Describe how you would expect the autonomic nervous system to respond during:
   - sleep
   - a fearful event
   - sexual arousal
3. Examine the medical record of a client with a duodenal or gastric ulcer. List each drug the client is receiving and the purpose for which each is being taken.
4. Prepare a teaching tool to be used in the instruction of a client who will be discharged with orders to take an antispasmodic drug.
5. Discuss the special concerns about elderly clients receiving antispasmodics.

6. What signs and symptoms would alert the nurse that a client is experiencing increased CNS stimulation?
7. Discuss the "fight or flight" mechanism in the autonomic nervous system and why it is important to the body.

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16 Other Agents Affecting Gastrointestinal Function

OBJECTIVES

After studying this chapter, the student will be able to:

- List five characteristics of an "ideal" laxative agent
- Identify the mechanism of action, common adverse effects, and appropriate nursing measures related to the use of the major laxative, antidiarrheal, emetic, and antiemetic drugs
- State the difference(s) among the major categories of laxative agents
- List five possible causes of diarrhea and suggest therapeutic management of each
- Describe how and when ipecac syrup is used in the emergency treatment of poisoning
- Contrast the actions of histamine H_2 antagonists omeprazole (Prilosec) and sucralfate (Carafate) with antacids and anticholinergic agents in the treatment of peptic ulcer disease
- Apply the nursing process for clients receiving histamine H_2 antagonists, omeprazole (Prilosec), sucralfate (Carafate), metoclopramide (Reglan), misoprostol (Cytotec), and gastrointestinal enzymes

LAXATIVES

Constipation is a condition in which passage of feces through the lower GI tract is slow or nonexistent. This results in a reduction in the frequency and an increase in difficulty of fecal evacuation.

Constipation may be caused by one or more factors including:

- ignoring the defecation urge
- environmental changes
- ingestion of a low-residue diet
- decreased physical activity (e.g., bedrest)
- emotional stress
- ingestion of constipating foods (e.g., dairy products)
- use of constipating drugs (e.g., calcium- and/or aluminum-containing antacids, anticholinergics, opiates, etc.)
- chronic misuse or overuse of stimulant laxatives
- decreased fluid intake

Laxatives are drugs intended to facilitate the passage and elimination of feces from the colon and rectum. (Figure 16–1 is an illustration of the digestive system.) They are used to:

- prepare clients for a lower GI X-ray series or surgery
- reduce the strain of defecation in clients with cardiovascular disease or in postoperative clients

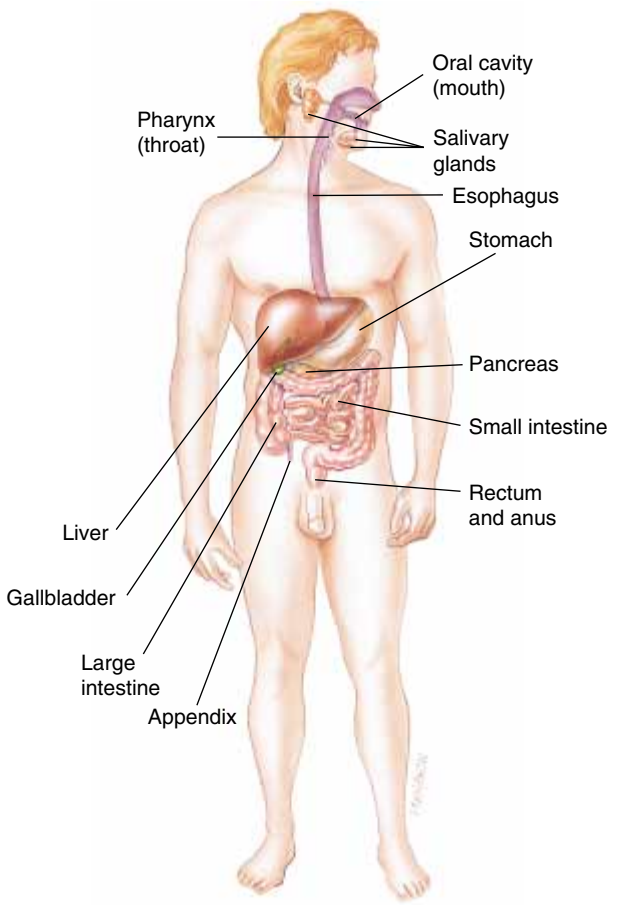

Figure 16–1 Diagram of the digestive system. Refer to the diagram to identify the site of action of the drugs discussed.

- diagnose and treat parasitic infestations of the GI tract
- help remove unabsorbed poisons from the GI tract when oral poisonous substances have been consumed
- prevent or treat constipation

Laxative use by the general public is widespread but controversial because of the lack of objective data to justify their routine use. Most laxatives are used to either prevent or treat constipation. Although occasional constipation is normal, many persons tend to overreact and use a multitude of drugs to treat their "condition." This may result in laxative dependence, in which the client will require larger and larger doses for appropriate defecation. Prolonged laxative use may also cause extensive fluid and electrolyte loss, malnutrition, and liver disease.

Because of the dangers of unrestrained laxative use it is important to understand how laxatives work and how they are properly used. The ideal laxative should:

- not irritate the GI tract
- not produce toxic systemic effects
- act rapidly, with the production of a normally formed stool
- not have a residual effect beyond the production of one bowel movement
- only act in the lower GI tract (i.e., the descending colon and sigmoid colon)
- not interfere with drug or nutrient absorption

None of the agents currently used in clinical practice satisfies all of these ideal criteria.

Stimulant Laxatives

The stimulant laxatives increase the motility of the GI tract by chemical irritation of the intestinal mucosa or by a more selective action on specific nerves in the intestinal wall. They also may act by increasing the secretion of water into both the small and large intestines. Their site of action may vary from only the large or small intestine to the entire GI tract. In general, the action of stimulant laxatives is directly proportional to the dosage administered. They tend to produce a watery, often diarrheal, stool.

Although most stimulant laxatives are derived from natural sources, two agents, **phenolphthalein** and **bisacodyl** are synthetics. Many of these agents are absorbed into the systemic circulation and are capable of causing a variety of adverse effects, ranging from skin rash to discoloration of the urine. In 1997, the Food and Drug Administration requested that companies using phenolphthalein in their laxative preparations remove them from the market. Although many of the brand name products are still being retailed, they have been reformulated. An example of this is Ex-Lax,™ which now contains senna extract instead of phenolphthalein. Of all laxative classes, the stimulants are the most likely to cause laxative dependence. Table 16–1 compares the properties of some stimulant laxatives.

Saline Laxatives

Saline laxatives draw water through the intestinal wall by osmotic action and thereby increase the fluidity of the stool and stimulate greater intestinal motility. Virtually all of the agents in this category are salts which may have an unpleasant taste and may be readily absorbed into the systemic circulation. This may result in poor client compliance and the possible development of toxicity, particularly in clients with impaired renal function and/or cardiovascular disease. Prolonged use of saline laxatives may also cause dehydration. Saline

TABLE 16–1

Stimulant Laxatives

Note: Contraindicated for use in clients with abdominal pain, nausea, vomiting, or rectal fissures.
Should only be used for short-term treatment.
Evaluate effectiveness of laxative.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	NURSING IMPLICATIONS
bisacodyl *(bis-**ACK**-oh-dill)* (Dulcolax, Bisacolax, Apo-bisacodyl)	oral, rectal	*Adults:* Oral: 10–30 mg Rectal: 10 mg *Children over 6:* Oral: 5–10 mg Rectal: 10 mg *Children under 2:* Rectal: 5 mg	Oral: 6–8 hours Rectal: 15 min–1 hour	Tablets are enteric-coated and should be taken whole should not be taken with antacids. Tablets should not be taken within 1 hour of milk ingestion.
cascara sagrada *(kas-**KAIR**-ah sah-**GRAH**-dah)*	oral	*Adults:* Liquid: 5mL Tablet: 325 mg at bedtime	6–10 hours	May discolor urine and stool. Breast-fed infants of nursing mothers may experience diarrhea. Liquid product contains about 18% alcohol. Drink 6–8 glasses of water/day.
castor oil *(**KAS**-tor oil)* (Neoloid)	oral	*Adults:* 15–60 mL *Children 6–12 yrs:* ½ adult dose *Children under 2 yrs:* ¼ adult dose	2–6 hours	Higher doses required with emulsion dosage forms. Give with juice or carbonated beverage to mask unpleasant taste. Emulsion products should be well shaken before use. Generally produces evacuation within 3 hours. Do not administer within 2 hours of any other oral drug.
phenolphthalein *(**fee**-nohl-**THAY**-leen)* (Ex-Lax, Alophen, etc.)	oral	*Adults:* 60–200 mg	6–10 hours	May cause reddish discoloration of urine and/or feces. May cause rash. If rash occurs, discontinue use. Laxative effect may last for 3–4 days.
senna *(**SEN**-ah)* (Gentlax, Mucinum, Senokot)	oral, rectal	*Adults:* Solid—0.5–2.0 g Syrup—10–15mL *Children 6–12 yrs:* ½ adult dose *Children 1–5 yrs:* ¼ adult dose	6–10 hours	May discolor urine.

laxatives are only employed in the rapid evacuation of the bowel (in preparing a client for endoscopic examination) and when unabsorbed poisons are to be removed from the GI tract. Table 16–2 compares the saline laxative agents in clinical use.

Bulk-Forming Laxatives

These are among the safest laxatives available. They are natural or semisynthetic compounds that absorb fluid and swell in the intestine, thereby stimulating peristaltic action. Their effect is generally slow and may require from 12–72 hours to produce a clinical response. Unlike the stimulant laxatives, the bulk-forming agents tend to produce normally formed stools. They also have minimal effect on nutrient absorption and are not systemically absorbed. Bulk-forming laxatives are particularly useful in clients who require prolonged

TABLE 16–2

Saline Laxatives

Note: Should only be used for short-term treatment.
Contraindicated for use in clients with abdominal pain, nausea, vomiting, or other symptoms of appendicitis.
Evaluate the effectiveness of laxative.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	NURSING IMPLICATIONS
magnesium citrate *(mag-**NEE**-see-um **SIH**-trayt)* , citrate of magnesia	oral	*Adults:* 240 mL *Children:* ¼ the adult dose	½–3 hours	Available in liquid effervescent form. Use with extreme caution in clients with renal insufficiency.
magnesium hydroxide *(mag-**NEE**-see-um hy-**DROX**-eyed)*, milk of magnesia, MOM	oral	*Adults:* 30–60 mL daily *Children over 2:* 5–30 mL	½–3 hours	Shake well before using. Used as an antacid in lower doses. Use with extreme caution in clients with renal insufficiency.
magnesium sulfate, epsom salts *(mag-**NEE**-see-um **SUL**-fayt, **EP**-sum salts)*	oral	*Adults:* 10–15 g *Children 6 and over:* 5–10 g	½–3 hours	Should be dissolved in water before administering. Use with extreme caution in clients with renal insufficiency.
sodium phosphate, sodium biphosphate, disodium phosphate *(**SOH**-dee-um **FOS**-fayt, **SOH**-dee-um **BY**-fos-fayt, dye-**SOH**-dee-um **FOS**-fayt)* (Fleet Phospho-Soda, Fleet Enema, etc.)	oral, rectal	Various	Oral: ½–3 hours Rectal: 2–15 min	May be dangerous to use in clients subject to a sodium-restricted diet. Use with extreme caution in clients with renal insufficiency.

therapy or those in whom more potent agents are to be avoided (e.g., pregnant women).

Because of their strong affinity for fluids, the bulk-forming laxatives should *always* be taken with a large volume of fluid. If chewed or taken in dry powder form, these agents can cause esophageal obstruction and/or fecal impaction. Table 16–3 compares the bulk-forming laxatives currently in use.

Lubricant Laxatives

These are oils that act as lubricants to facilitate the passage of the fecal mass through the intestine. There is some evidence that the oils may also form a barrier to reduce absorption of water through the wall of the colon and thereby maintain adequate hydration of the fecal mass. The most popular intestinal lubricant is **liquid petrolatum** (mineral oil). It has an advantage over other oils (e.g., vegetable oils) of not being digestible or absorbable. The client using liquid petrolatum is, therefore, not subject to systemic effects or an increased caloric load. Its major drawback is its ability to impair the absorption of fat-soluble drugs and nutrients. This can be avoided by administering liquid petrolatum on an empty stomach.

Liquid petrolatum can be administered in its pure form by either the oral or rectal (e.g., Fleet Oil Retention Enema) route. It is also available in an

TABLE 16–3

Bulk-forming Laxatives

Note: Laxative effect may not be evident for up to 3 days.
Contraindicated for use in clients with abdominal pain, nausea, vomiting or other symptoms of appendicitis.
Should be mixed with cold liquid and drunk immediately. Follow with another glass of liquid.
Evaluate effectiveness of laxative.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	NURSING IMPLICATIONS
barley malt extract *(**BAR**-lee malt **ECKS**-tract)* (Maltsupex)	oral	*Adults:* 3 g or equivalent 2–4 times daily	12–72 hours	—
methylcellulose *(**meth**-ill-**SELL**-you-lohs)* (Citrucel)	oral	*Adults:* 15 ml (2 g) in 8 oz cold water 1–3 times daily *Children over 6 yrs:* 2 g in 4 oz cold water 1–3 times daily	12–72 hours	Follow each dose with a full glass of water to prevent fecal impaction.
polycarbophil *(**pol**-ee-**KAR**-boh-fill)* (Fibercon, Mitrolan, etc.)	oral	*Adults:* 1 g 4 times daily *Children 6–12 yrs:* 0.5 g 3 times daily *Children 2–6 yrs:* 500 mg 2 times daily	12–72 hours	Also indicated for the treatment of diarrhea.
psyllium *(**SILL**-ee-um)* (Metamucil, Novo-Mucilax, Perdiem, etc.)	oral	3.5 g 1–3 times daily	12–72 hours	Some products, particularly effervescent ones, contain a high sodium content. Many psyllium products are composed of 50% dextrose. These should be avoided in diabetic clients. Mix powder and liquid just before use to prevent mixture from becoming thick and difficult to drink.

emulsified form which is more palatable than the pure form and which is believed by some to have greater efficacy as a laxative agent. Several products combine liquid petrolatum with more potent laxatives such as magnesium hydroxide (**Haley's M-O**) or phenolphthalein (**Agoral**).

Stool Softeners

These are detergent-like drugs that permit easier penetration and mixing of fats and fluids with the fecal mass. This results in a softer, more easily passed stool. Unlike most of the agents previously discussed, wetting agents do not irritate the intestine or stimulate peristaltic action. Although they do provide a prophylactic action to maintain the stool in a soft state, this action is often not evident until several days after initiating therapy. Because they are not systemically absorbed, wetting agents do not cause dependence or toxicity. They are available in several easily administered dosage forms. The wetting agents are particularly useful in infants and children, as well as in elderly, bedridden clients. Table 16–4 compares the fecal wetting agents in current use.

Suppositories

Several laxative suppositories containing stimulant drugs are available. **Glycerin** suppositories are

TABLE 16–4

Stool Softeners

Note: Liquid dosage form may be given in milk, fruit juice, or formula to mask taste.
Action may not be evident for up to 3 days.
Prevents development of constipation. However, it is not used to treat existing constipation.
Avoid use for longer than 1 week.
Evaluate client for the effectiveness of these agents.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	NURSING IMPLICATIONS
docusate calcium, dioctyl calcium sulfosuccinate *(**DOCK**-kyou-sayt **KAL**-see-um, die-**OCK**-till **KAL**-see-um **sul**-foh-**SUCK**-sih-nayt)* (Calax ✱, Surfak)	oral	*Adults:* 240 mg daily *Children 6 yrs and over:* 50–150 mg/day	12–72 hours or longer	A full glass of fluid should be taken with each dose.
docusate potassium, dioctyl potassium sulfosuccinate *(**DOCK**-kyou-sayt poh-**TASS**-ee-um, die-**OCK**-till poh-**TASS**-ee-um **sul**-foh-**SUCK**-sih-nayt)* (Dialose, Kasof)	oral	*Adults:* 100–300 mg/day *Children 6 yrs and over:* 100 mg at bedtime	12–72 hours or longer	Contraindicated for use in clients with renal dysfunction. A full glass of fluid should be taken with each dose.
docusate sodium, dioctyl sodium sulfosuccinate (DSS) *(**DOCK**-kyou-sayt **SOH**-dee-um, die-**OCK**-till **SOH**-dee-um **sul**-foh-**SUCK**-sih-nayt)* (Colace, Selax ✱, etc.)	oral	*Adults:* 50–500 mg/day *Children 6 yrs and over:* 40–120 mg/day *Children 3 to 6 years:* 20–60 mg daily *Children under 3 yrs:* 10–40 mg/day	12–72 hours or longer	Use with caution in clients on sodium-restricted diet. A full glass of fluid should be taken with each dose.

the most popular of these, but newer products have utilized the stimulant effect of bisacodyl, **senna**, and other agents in their formulations. One of the most novel types of laxative suppository is that which releases carbon dioxide gas when inserted rectally (**Ceo-Two**). The gas distends the wall of the lower colon and stimulates the defecation reflex.

Although many laxative products are available and their use may be justified in some situations, their overuse is rampant. Clients who medicate themselves with laxatives should be cautioned not to use them longer than 1 week. Their use should be entirely avoided in infants and debilitated clients unless prescribed by a physician.

Lactulose (Acilac ✱, Cephulac, Chronulac, Duphalac)

Lactulose is a synthetic disaccharide containing the monosaccharides galactose and fructose. When administered orally, this sugar is not digested or absorbed in the stomach or small intestine and passes to the colon unchanged. In

the colon, lactulose is digested by colon bacteria to form acidic substances, such as lactic acid, formic acid, and acetic acid. These acidic compounds cause water to be drawn and retained by the colon, thereby increasing stool water content and producing a laxative effect. The formation of these acids in the colon also causes ammonia from the blood to pass into the colon. The laxative action produced by lactulose also acts, therefore, to expel ammonia from the body. This may be useful in treating clients with portal-systemic encephalopathy, often characterized by the accumulation of toxic levels of ammonia in the body.

For the treatment of constipation, 10 to 20 g of lactulose (15–30 mL of lactulose syrup) is administered daily. For the prevention and treatment of portal-systemic encephalopathy, 20 to 30 g (30 to 45 mL of lactulose syrup) is administered to adults 3 or 4 times daily. Initially, such doses may be required each hour. Clients receiving lactulose may mix it with fruit juice, water, or milk to improve taste.

Polyethylene Glycol-Electrolyte Solution (CoLyte, GoLYTELY, OCL, Colovage)

When administered orally, this product, which contains the water-soluble polymer polyethylene glycol and a salt mixture, rapidly causes a large volume of water to be retained in the colon. This results in the induction of a diarrheal state within 30 to 60 minutes after starting therapy. When administration is continued over 3 hours, complete evacuation and cleansing of the bowel is accomplished within about 4 hours from the beginning of therapy.

Polyethylene glycol-electrolyte solution is indicated for bowel cleansing prior to GI examination and is administered to clients who have fasted for 3 to 4 hours. Adult clients are generally asked to consume 4 liters of this solution within 3 hours at a rate of 240 mL every 10 minutes. The first bowel movement will generally occur within 1 hour. As a mixture of salts is a component of this product, the client experiences little change in water or electrolyte balance as a result of therapy.

Enemas

The administration of liquids directly into the lower colon by the use of an enema is often useful in eliciting a laxative response, as well as in cleansing the bowel prior to a surgical, diagnostic or obstetrical procedures. Solutions containing salts (e.g., **Fleet Enema**) are most commonly employed as ingredients in laxative enemas and act by osmotically drawing fluid into the colon to initiate the defecation reflex. Other agents such as soap, glycerin, and mineral oil have also been used in enemas to relieve constipation or to cleanse the bowel.

ANTIDIARRHEAL AGENTS

Diarrhea is defined as the abnormally frequent passage of watery stools. It is generally caused by the failure of the small and large colon to adequately absorb fluid from the intestinal contents. Diarrhea is not a disease, but a symptom of an underlying disorder. As no fewer than fifty different medical conditions have been named as causing diarrhea, it is important that clients with chronic diarrhea or severe forms of acute diarrhea be properly diagnosed before symptomatic antidiarrheal treatment is begun. Box 16–1 lists some of the possible causes of diarrhea. Note that many of the causes of this condition are serious and potentially life-threatening diseases that must be directly treated. If left untreated, diarrhea may result in malnutrition, fluid and electrolyte loss, and exhaustion.

Drug therapy of diarrhea is generally aimed at reducing the motility of the GI tract, thereby permitting normal dehydration of the intestinal contents to take place. Some agents act to remove irritants from the GI tract, with others designed to replace microorganisms that normally inhabit the intestine, but may have been destroyed by antibiotic therapy.

BOX 16–1
Some Causes of Diarrhea

allergy	lactose intolerance
amebic dysentery	medication
antibiotics	radiation
cancer of the GI tract	regional enteritis
food poisoning	ulcerative colitis

Drugs That Reduce GI Motility

Two classes of drugs may be used to treat diarrhea by reducing GI motility. The opium derivatives, or opiates, that contain morphine, reduce the propulsive movement of the small intestine and colon and thereby permit dehydration of intestinal contents to take place. Such agents, which include **opium powder**, tincture of opium, and camphorated opium tincture (paregoric), may lead to dependence with prolonged use and depression of the central nervous system (CNS) with even occasional use. Clients using these products must, therefore, be closely monitored and cautioned to avoid other CNS depressants (e.g., tranquilizers, alcohol, etc.).

Difenoxin HCl (**Motofen**), **diphenoxylate HCl** (**Lomotil**), and **loperamide HCl** (**Imodium**), although not opium derivatives, are chemically related to meperidine, another narcotic. They are also used as antidiarrheal agents and require the same caution as the opiate compounds.

Anticholinergic drugs, described in Chapter 15, are also used to treat diarrhea. When administered in adequate doses (equivalent to 0.6–1 mg of **atropine sulfate**), these agents reduce intestinal motility and reverse the diarrheal condition. When used at this dosage level, however, the anticholinergics often cause unpleasant and potentially dangerous side effects which limit their usefulness. Table 16–5 compares antidiarrheal agents that reduce GI motility.

Adsorbents

Adsorbents such as **kaolin**, **bismuth salts**, **attapulgite**, and aluminum hydroxide are the most commonly used antidiarrheal agents. They can bind drugs, digestive enzymes, toxins, bacteria and other noxious substances that may be the cause of the diarrheal condition. Because of their lack of specificity, the adsorbents may prevent the *absorption* of other drugs the client has taken. They should not, therefore, be used within several hours of other oral drug administrations.

Adsorbents are usually clay-like materials administered in a tablet or liquid suspension form after each loose bowel movement. This is continued until the condition has been controlled. Although these agents are safe to use and are contained in a wide variety of commercial antidiarrheal products, there is little scientific evidence to support their effectiveness.

Polycarbophil (**Mitrolan**, **Equalactin**, etc.) is an effective antidiarrheal that acts to absorb free fecal water and, thereby, produces formed stools. In the treatment of both diarrhea and constipation, polycarbophil restores a more normal moisture level to the colon. The usual dose as an antidiarrheal is 1g four times a day as needed for adults. For children, the usual dose is 500 mg one to three times a day, not to exceed 1.5 g in a 24-hour period.

Lactobacillus Products

A novel approach in the treatment of diarrhea is the seeding of the bowel with lactobacillus organisms such as *Lactobacillus acidophilus*, which are a portion of the normal bacterial population of the GI tract. This therapy has been advocated for the treatment of diarrhea associated with antibiotic therapy. It is based on the presumption that such diarrhea is caused by disruption of the normal bacterial composition of the GI tract by broad-spectrum antibiotics. Lactobacillus products must usually be kept refrigerated during storage to maintain the viability of the bacterial culture. The FDA panel studying antidiarrheal products has suggested that a comparable therapeutic effect can be attained in such clients by the administration of milk or yogurt containing live lactobacillus cultures.

EMETICS AND ANTIEMETICS

Emetics

Emetics are agents that cause vomiting. They are used exclusively in the treatment of oral drug overdose and other kinds of poisoning. They are not used in all cases of poisoning, and they are never given to clients who are unconscious.

Ipecac syrup, the most commonly used emetic in the United States, is administered orally in a dose of 5–10 mL for children less than 1 year of age. It is followed with 1/2–1 glass of water. In older children, 15 mL of ipecac syrup is administered and followed with 1–2 glasses of water; in adults, 15–30 mL is given, followed with 3–4 glasses of water. In any case, the dosage may be repeated once if vomiting does not occur within 20 minutes. Ipecac syrup should never be given with activated charcoal, as the charcoal may absorb the emetic component of the ipecac.

The misuse of ipecac syrup has increased greatly over the last decade. Persons with eating disorders, such as *bulimia*, may use ipecac as part of the binge–purge cycle often seen in this disorder.

TABLE 16–5

Antidiarrheal Drugs That Reduce GI Motility

Note: Monitor client for development of CNS depression, especially when used with alcohol or other CNS depressants. Evaluate the effectiveness of treatment by noting the consistency of the stool and frequency of evacuation.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
difenoxin HCl *(**dye**-fen-**OX**-en **hy**-droh-**KLOR**-eyed)* (Motofen)	oral	*Adults:* 1–2 mg every 3 to 4 hours as needed	Product contains low dose of atropine sulfate to discourage deliberate overdosage. Daily dosage should not exceed 8 mg. Not to be used in children under 2 years of age.
atropine sulfate and diphenoxylate HCl *(**dye**-fen-**OX**-ih-layt **hy**-droh-**KLOR**-eyed)* (Lomotil, etc.)	oral	*Adults:* 2.5–5 mg 3–4 times/day as needed *Children 2–12 yrs:* 0.3–0.4 mg/kg/day in divided doses	Products contain low dose of atropine sulfate to discourage deliberate overdosage. Children 2–12 years old should only receive liquid form. Not to be used in children under 2 years of age.
loperamide HCl *(loh-**PER**-ah-myd **hy**-droh-**KLOR**-eyed)* (Imodium, Imodium A-D, etc.)	oral	*Adults:* 4 mg initially followed by 2 mg after each unformed stool; not to exceed 16 mg/day *Children 2–12:* 1–2 mg 2–3 times daily	Not to be used in children under 2 years of age. Only liquid form is recommended for pediatric clients.
paregoric, camphorated opium tincture *(**par**-eh-**GOR**-ick **KAM**-for-ay-ted **OH**-pee-um **TINK**-shur)*	oral	5–10 mL after each loose bowel movement	May cause physical dependence when used for prolonged periods.

Misuse may result in ipecac toxicity, which may include muscle weakness and cardiotoxic effects.

Antiemetics

Antiemetics are given to prevent and treat nausea and vomiting. They are used in the prophylaxis and treatment of nausea associated with motion sickness, CNS disorders, administration of certain drugs (e.g., antineoplastic agents), and radiation therapy.

There are numerous drugs with antiemetic action that differ only in their mechanism of action. Anticholinergics, such as scopolamine, act by binding to and blocking acetylcholine receptors, thus preventing the nauseous stimuli from being transmitted. Antihistamines, such as promethazine (**Phenergan**), **meclizine** (**Antivert**, Dramamine), and diphenhydramine (Benadryl), act by blocking H_2 receptors preventing cholinergic stimulation. Neuroleptic agents, such as chlorpromazine (**Thorazine**), **perphenazine** (**Trilafon**), and **prochlorperazine** (**Compazine**) act by binding with dopamine receptors. Prokinetic agents, such as **metaclopramide** (**Reglan**), block dopamine and stimulate acetylcholine to increase gastric emptying.

Among the newest of the antiemetics are the serotonin blockers. These include **granisetron** (**Kytril**), **ondansetron** (**Zofran**), and **dolasetron mesylate** (**Anzemet**). As they block serotonin receptors in the GI tract and the CNS where the emetic center is located, they selectively antagonize 5-hydroxytrytamne3 receptors thus preventing nausea and vomiting. The serotonin blockers are the most used antiemetics to prevent nausea and vomiting in clients receiving antineoplastic agents (Chapter 39) to treat cancer. Refer to Table 16–6 for more information about antiemetics.

TABLE 16–6

Antiemetics

Note: Evaluate client of relief of nausea and/or vomiting.

DRUG	ROUTE(S)	USUAL DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
Anticholinergic				
scopolamine HCl *(scoh-**POLL**-ah-meen)* (Transderm-Scop)	IM, IV, SC, topical	*Adults:* 0.3–0.6 mg as a single dose *Children:* 0.0006 mg/kg as a single dose	increased heart rate, disorientation, decreased respiratory rate	Monitor vital signs at least every 4 hours. Protect solution from light. Assess for relief of nausea/vomiting.
Antihistamines				
diphenhydramine *(dye-fen-**HY**-drah-meen)* (Benadryl)	oral	*Adults:* 25–50 mg 3 or 4 times a day *Children:* 5 mg/kg/day	drowsiness	If to prevent nausea, administer 30 minutes prior to exposure to noxious stimuli. Monitor for effectiveness.
meclizine *(**MEK**-lih-zeen)* (Antivert)	oral	25–50 mg	drowsiness, excitation, nervousness	Monitor for side effects. Monitor client for therapeutic response.
promethazine HCl *(proh-**METH**-ah-zeen)* (Phenergan)	oral, IM, IV, rectal	12.5–25 mg	drowsiness	Not compatible with Lactated Ringer's IV solution. Monitor for effectiveness.
Neuroleptic agents:				
chlorpromazine HCl *(klor-**PROH**-mah-zeen)* (Thorazine)	oral, IM, IV	*Adults:* Oral: 10–25 mg six times a day IM: 12.5 mg IV: 2 mg/fractional injection at 2 min. intervals *Children:* Oral: 0.55 mg/kg IM: 0.5 mg/kg IV: 1 mg/fractional injection at 2 min. intervals	drowsiness, blurred vision, hypotension	If administering IM use large muscle. Monitor for adverse effects. Monitor for effectiveness.
perphenazine *(per-**FEN**-ah-zeen)* (Trilafon)	oral, IM, IV	Oral: 8–16 mg/day IM: 5 mg IV: up to 5 mg	hypotension, dizziness, fainting	Assess for dehydration. Monitor BP. Monitor WBC and differential count for blood dyscrasias.

continues

TABLE 16–6 *continued*

See **Note** at beginning of Table 16–6, page 341.

DRUG	ROUTE(S)	USUAL DOSE	SIDE EFFECTS	NURSING IMPLICATIONS
prochlorperazine *(proh-klor-**PAIR**-ah-zeen)* (Compazine)	oral, IM, rectal	*Adults:* Oral: 5–10 mg 3–4 times/day IM: 5–10 mg repeat every 3–4 hours as needed. *Children:* Oral: 2.5 mg 1–2 times/day IM: 0.132 mg/kg	hypotension, dizziness, fainting, drowsiness	Do not give SC. Do not dilute with any material containing the preservative parabens. Monitor for effectiveness.
Prokinetic:				
metaclopramide *(meh-tah-**KLO**-prah-myd)* (Reglan)	oral, IV	Oral: 1–2 mg/kg given 30 min. before chemotherapy.	extrapyramidal reactions occurring most frequently with children and young adults anxiety, restlessness	Monitor for dehydration. Monitor bowel function for drug-induced constipation. Monitor for effectiveness.
Serotonin Blockers:				
dolasetron mesylate *(dohl-**AH**-she-tron)* (Anzemet)	oral, IV	*Adults:* Oral: 100 mg IV: 1.8 mg/kg *Children:* Oral: 1.8 mg/kg IV: 1.8 mg/kg	headache, dizziness, hypotension	Not for children less than 2 years old. Monitor BP. Monitor for effectiveness.
granisetron HCl *(gran-**ISS**-eh-tron)* (Kytril)	oral, IV	*Adults/children over 2 years-old:* Oral: 1–2 mg twice daily IV: 10 mg/kg	headache, somnolence, agitation, anxiety	Infuse IV dose over 5 minutes. Administer 30 minutes before starting chemotherapy.
Ondansetron HCl *(on-**DAN**-sih-tron)* (Zofran)	oral, IV, IM	Oral: 8 mg IV: .15 mg/kg/dose	diarrhea, constipation	Given primarily for chemotherapy-induced nausea vomiting. Monitor for effectiveness. Administer 30 minutes prior to the administration of chemotherapy. Administer every 4 hours for 24 after initial dose as premed for chemotherapy.

HISTAMINE H_2 RECEPTOR ANTAGONISTS

Cimetidine (**Tagamet**), **ranitidine** (**Zantac**), **famotidine** (**Pepcid**), and **nizatidine** (**Axid**) are classified as histamine H_2 receptor antagonists. They are used to treat duodenal ulcers, gastric ulcers, and certain disorders characterized by the secretion of excessive acid within the stomach. These agents inhibit the action of histamine at the histamine-sensitive H_2 receptor sites of the parietal cells in the stomach. This results in a drastic reduction in acid secretion within the stomach and promotes healing of the acid-sensitive ulcer. Unlike the anticholinergic agents described in Chapter 15, the histamine H_2 receptor antagonists do not cause atropine-like side effects. However, they occasionally cause diarrhea, muscle pain, rash, sleepiness, dizziness, and/or confusion in some clients. They are not recommended for nursing mothers or children under 16 years of age.

TABLE 16–7

Histamine H_2 Receptor Antagonists

Note: These drugs are not recommended for use in nursing mothers or children under 16 years of age. Evaluate client for relief of gastric pain and discomfort.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
cimetidine *(sigh-**MET**-ih-deen)* (Tagamet, Peptol ✱)	oral, IM, IV	Oral: 300 mg 4 times daily or 400 mg 2 times daily or 400–800 mg at bedtime depending on the nature and severity of disorder IM or IV: 300 mg every 6 hours	Cigarette smoking may diminish the effectiveness of cimetidine. The use of cimetidine may increase the pharmacological effects of many drugs (see Box 16–2). Dosage adjustment may be required. The use of antacids may reduce the absorption of cimetidine. Do not administer antacids within 1–2 hours of taking cimetidine. Oral cimetidine doses should be administered with or immediately following a meal. May cause confusion in elderly persons or those with kidney or liver disease.
famotidine *(fah-**MOH**-tih-deen)* (Pepcid)	oral, IV	Oral: 20–40 mg once daily at bedtime or 20 mg every 6 hours IV: 20 mg every 12 hours	May be administered with antacid dose.
nizatidine *(nye-**ZAY**-tih-deen)* (Axid)	oral	300 mg once daily at bedtime or 150 mg 2 times daily	The use of nizatidine in a dose of 150 mg twice daily has been reported to raise serum salicylate levels in patients receiving high (3900 mg/day) aspirin doses.
ranitidine *(rah-**NIH**-tih-deen)* (Zantac, Nu-Ranit ✱)	oral, IM, IV	Oral: 150 mg 2 times daily or 300 mg once daily at bedtime IM or IV: 50 mg every 6 to 8 hours	Avoid the administration of antacids at the same time as ranitidine. Hemodialysis may reduce ranitidine blood levels.

While each of the drugs in this class may produce similar adverse effects, cimetidine is the only one shown to produce antiandrogenic effects (e.g., impotence and *gynecomastia*) and CNS effects (e.g., mental confusion). Of particular clinical significance is the finding that cimetidine is the only member of this drug class that may significantly impair the metabolism of other drugs in the liver. The use of cimetidine has been reported to increase the pharmacological effects and toxicity of many drugs. Box 16–2 lists drugs whose action may be enhanced by the use of cimetidine. Cigarette smoking has also been shown to reverse the effects of cimetidine in reducing nocturnal acid secretion. Table 16–7 lists the histamine H_2 receptor antagonists currently available in the United States.

BOX 16–2
Drugs Reported to Exhibit Increased Pharmacological Effects When Administered with Cimetidine

alprazolam
caffeine
calcium channel blockers
carbamazepine
chlordiazepoxide
chloroquine
diazepam
ethanol
flurazepam
labetalol
lidocaine
lorazepam
metoprolol
metronidazole
pentoxiphylline
phenytoin
propranolol
quinidine
quinine
sulfonylureas
theophylline
triazolam
tricyclic antidepressants
warfarin

OMEPRAZOLE (PRILOSEC)

Omeprazole (**Prilosec**) is a drug that does not have anticholinergic or H_2 histamine antagonist action. It does appear to suppress gastric acid secretion by inhibiting the gastric acid pump in the parietal cells of the stomach. This is accomplished by blocking the final step of acid production. Single or divided daily doses of omeprazole suppress acid secretion for up to 72 hours. Currently, the drug is indicated for the treatment of gastroesophageal reflux disease (GERD) and in clients with gastric hypersecretory conditions. Clients using omeprazole in combination with diazepam, phenytoin, or warfarin may experience increased blood levels of these agents because of omeprazole's inhibition of the metabolism of these drugs.

LANSOPRAZOLE (PREVACID)

Lansoprazole (**Prevacid**) is one of the newest proton-pump inhibitors used to treat GERD and to help heal gastric and duodenal ulcers. It acts as an antisecretory compound by suppressing gastric acid secretion. It does not exert anticholinergic and H_2-receptor antagonist properties, but rather inhibits an enzyme system at the secretory surface of the gastric parietal cell that blocks the last step of gastric acid production. The daily dosage is 15–30 mg and the term of treatment ranges from 4 to 8 weeks. For short-term treatment of duodenal ulcers, the regimen is 15 mg daily for 4 weeks; for gastric ulcers, the regimen is 30 mg daily for up to 8 weeks. For maintenance of healed duodenal ulcers, the treatment is 15 mg daily. Lansoprazole comes in oral form only and has not been approved for use in children under 18 years of age.

METRONIDAZOLE (FLAGYL)

Metronidazole (**Flagyl**), an antimicrobial/antiprotozoal agent (see Chapter 7) has been used successfully in combination with **bismuth subsalicylate** (**Pepto-Bismol**) and tetracycline for a period of 4 weeks to eradicate Helicobacter pylori, an organism associated with the development of peptic ulcer disease.

SUCRALFATE (CARAFATE)

Sucralfate (**Carafate**) is a chemical derivative of sucrose that acts unlike all other currently available drugs used to treat duodenal ulcers. Sucralfate's primary action is a local one at the ulcer site. It appears to combine with protein at the affected site to form an adherent complex that covers the ulcer and protects it from further attack by acid, pepsin, and bile salts. It does little to neutralize gastric acid.

Sucralfate is approved for short-term duodenal ulcer treatment (up to 8 weeks). Also, it is employed at a reduced dosage for maintenance therapy of duodenal ulcers after healing of acute ulcers. In treating active duodenal ulcers, it is recommended that 1 g be administered orally 4 times daily on an empty stomach: 1 hour before each meal and at bedtime. Although antacids may be used in conjunction with sucralfate, they should not be given within 30 minutes before or after sucralfate is administered. Administration of sucralfate with tetracycline, phenytoin or cimetidine may interfere with the absorption of these drugs. It is suggested that such drugs be administered at least 1 hour before or after sucralfate. Therefore, avoid antacids containing aluminum.

To date, only minor adverse effects have been associated with the use of sucralfate. Most of these have involved the GI tract (e.g., nausea, constipation, diarrhea), but none requires discontinuation of the drug's use.

MISOPROSTOL (CYTOTEC)

Misoprostol (**Cytotec**) is a synthetic prostaglandin compound reported to decrease gastric acid secretion and possibly exert a protective effect on the mucosal surface of the stomach. It is specifically indicated for the prevention of gastric ulcers produced by the use of nonsteroidal anti-inflammatory drugs (NSAID) such as aspirin, **indomethacin** and others that inhibit prostaglandin synthesis (see Chapter 12).

Although a substantial proportion of clients using this drug are reported to experience diarrhea, abdominal pain, and other adverse GI effects, of particular concern is its ability to produce uterine contractions and cause miscarriage. The drug is, therefore, contraindicated for use by pregnant women.

The usual dose of misoprostol is 200 mcg 4 times daily with food. The last dose of the day should be taken at bedtime. If the 200 mcg dose cannot be tolerated, 100 mcg doses may be used. Misoprostol should be administered for the duration of NSAID therapy.

METOCLOPRAMIDE (REGLAN, EMEX)

Metoclopramide is a drug that stimulates the motility of the upper gastrointestinal tract without stimulating the production of gastric, biliary, or pancreatic secretions. When administered orally, intramuscularly, or intravenously, metoclopramide increases the force of gastric contractions, relaxes the pyloric sphincter, and increases peristalsis in the duodenum and jejunum without affecting the motility of the large intestine. It also increases lower esophageal sphincter pressure, thereby decreasing the likelihood of gastroesophageal reflux (GER). The ultimate effect of administering metoclopramide is, therefore, to accelerate gastric emptying and passage of gastrointestinal contents through the small intestine.

The action of metoclopramide is attributed to its apparent ability to sensitize tissues to the action of the neurotransmitter acetylcholine (Chapter 15). Agents that interfere with acetylcholine activity, e.g., anticholinergic drugs, have been shown to abolish the action of metoclopramide.

Metoclopramide is employed clinically in the treatment of diabetic *gastroparesis*, a condition manifested by delayed gastric emptying, nausea, vomiting, and anorexia. It is also used in treating clients with symptomatic gastric reflux who have not responded to other forms of therapy and in preventing nausea and vomiting in clients receiving *emetogenic* cancer chemotherapy.

The use of metoclopramide is contraindicated in situations where stimulation of gastrointestinal motility may be harmful (e.g., gastrointestinal perforation, obstruction, or hemorrhage). It should also be avoided in clients who are known to be sensitive to metoclopramide; in epileptic clients, who may more readily experience seizures while using this drug, and in clients using drugs that produce *extrapyramidal* reactions (e.g., phenothiazine antipsychotic agents), as metoclopramide may increase the likelihood of such reactions.

Adverse effects associated with metoclopramide therapy include CNS depression, gastrointestinal upset and the development of parkinsonism-like reactions. The usual adult dose for metoclopramide used orally or parenterally is 10 mg. Oral doses are generally given 4 times daily, 30 minutes before each meal and at bedtime. Therapy for longer than 12 weeks is not recommended.

Cisapride (**Propulsid**) was an agent used like metoclopramide, however, because of severe adverse effects, cisapride lost its FDA approval in 2000.

GASTROINTESTINAL ENZYMES

Congenital abnormality, disease, advancing age, or surgery may cause a deficiency in the gastrointestinal enzymes that normally assist in food digestion. Such deficiencies may manifest themselves as occasional gastrointestinal discomfort or may have serious nutritional implications over the life of a person. Many of these deficient enzymes may be provided orally using commercially available products. These include pancreatic enzymes such as pancrelipase and pancreatin, as well as enzymes that help digest lactose (e.g., lactase).

Pancreatic Enzymes

Pancreatic enzymes such as pancrelipase and pancreatin are required for the proper digestion of fats, proteins, and complex carbohydrates. They may be deficient in clients with pancreatic disease (pancreatitis, pancreatic cancer, etc.), cystic fibrosis (90% of pancreatic enzymes are used in cystic fibrosis clients), or after some types of gastrointestinal surgery. A number of pancrelipase (**Pancrease**, **Zymase**, etc.) and pancreatin (**Entozyme**, **Viokase**, **Donnazyme**) products are available commercially. Most contain enyzmes derived from animals such as pigs or cows. Because these enzymes are rapidly destroyed in acid environments, the products generally are enteric-coated tablets or capsules containing enteric-coated enzyme beads. It is important to monitor clients beginning to use these products and to recognize the possibility of hypersensitivity reactions that some people have when exposed to animal derivatives.

Lactase Enzyme (LactAid, Lactrase, Dairy Ease)

With advancing age, a significant proportion of the population develops lactose intolerance. In adults, such intolerance is generally due to inadequate production of lactase enzyme, an enzyme that breaks down lactose into absorbable monosaccharides, such as glucose. With lactase deficiency, clients often exhibit symptoms of intolerance, which may include diarrhea, flatulence, and bloating. These usually develop shortly after consuming milk or other lactose-containing dairy products. The use of commercial lactase enzyme products, either with the consumption of lactose-containing foods or actually mixed with them will often permit better tolerance of such food products.

APPLYING THE NURSING PROCESS

CLIENTS RECEIVING LAXATIVES

Assessment

Nurses are frequently approached by both hospitalized and nonhospitalized individuals for advice about laxatives. Nurses also help to prepare people for diagnostic tests and surgical, gynecological, and obstetrical procedures that may require the prior use of laxatives and/or enemas to produce a lower gastrointestinal tract free from gas and feces. Nursing actions in such cases are based on knowledge about the client and the agents available, as well as on the physician's order. In many cases, the physician will write an order for laxative of choice PRN. The nurse selects or assists the client in selecting the appropriate laxative for use. To facilitate selection of an appropriate drug, the nurse should consider:

- age and general physical condition of the person
- special restrictions or limitations due to illness or the treatment program (such as sodium-restricted diet or the presence of fluid or electrolyte imbalance)
- past experiences with laxatives
- daily schedule and time at which bowel evacuation is desired

There are guidelines the nurse can use in selecting and/or administering laxatives. Stimulant laxatives are generally avoided in elderly, acutely ill, and debilitated clients. They act fairly rapidly and are, therefore, frequently used to prepare a client for a diagnostic or surgical procedure. To avoid interrupting the client's sleep, the nurse should know the agent's onset of action, see Table 16–1.

In general, the nurse should stress the importance of bowel regularity over frequency, indicating that there is no "normal" pattern for everyone. A daily bowel evacuation is not a necessary prerequisite for optimal health. The public should also be made aware of the dangers of laxative dependence and the factors that can decrease need for laxative use. Such factors include a diet with roughage and fruit juices, adequate daily fluid intake, exercise, and attention to time and relaxation necessary for proper bowel functioning. The nurse is also aware of the necessity of avoiding laxatives when the client is experiencing abdominal pain, nausea, or vomiting. Special care must also be used in taking laxatives during pregnancy.

Nursing Diagnoses

Including but not limited to:

- Constipation related to disease process
- Risk for diarrhea related to administration of laxatives
- Risk for deficient fluid volume related to administration of laxatives
- Deficient knowledge related to constipation and use of laxatives

Planning/Goals

- Client will experience a return of his/her normal bowel habits.
- Client will not experience diarrhea secondary to laxative use.
- Client will experience fluid balance.
- Client will verbalize understanding of causes of constipation and judicious use of laxatives.

Implementation

Many hospitalized clients, particularly confined to bedrest, will require special nursing attention to avoid constipation. The nurse provides supportive measures, such as hydration, exercise, and privacy, which may encourage defecation without the use of drugs. Nurses keep a daily record of the bowel movements of all hospitalized clients. If the client goes several days without a movement, the nurse discusses this with the physician.

General guidelines for nursing interventions for clients taking the various types of laxatives follow. If **castor oil** is ordered, it should be disguised to make its use acceptable to the client. If not contraindicated by the client's condition or treatment program, a special mixture of juice, sodium bicarbonate and castor oil can be prepared to decrease the unpleasant taste of the laxative. When using this mixture, prepare the ingredients (the amount of castor oil ordered, about a quarter teaspoon of sodium bicarbonate,

and a glass containing 6–8 fluid ounces of fruit juice—orange or whatever flavor the client likes). Place about 3–4 fluid ounces of juice in a second glass. Approach the client, explain the nature of the medication and the reason why it has been ordered. Secure the client's cooperation, then mix the castor oil and sodium bicarbonate in the larger amount of juice. When it begins to fizz, give it to the client to drink. Following this, offer the smaller amount of juice or mouthwash to clear the taste of the oil from the mouth.

Clients taking stimulant laxatives should be made aware that some laxatives (e.g., phenolphthalein) discolor the urine and/or feces. Clients not aware of this effect may become concerned and think they are bleeding or have injured themselves in some way.

Saline laxatives must be used carefully by the frail elderly, infants, and clients with cardiac and renal diseases subject to fluid and electrolyte imbalances. The noninstitutionalized elderly are frequent users of this group of drugs. The nurse must be certain that the use of saline laxatives does not interfere with the treatment of health problems, such as cardiac conditions, in which sodium salts may be restricted. Some of the laxatives in this group are fast-acting and best administered well in advance of bedtime.

The bulk-forming laxatives are generally mild and are frequently used in pregnant and postpartum women. They are also used in the care of postsurgical clients, as well as the institutionalized elderly. Bulk-forming laxatives may take 12 or more hours to act and generally do not cause fluid and electrolyte imbalances. It is important for the nurse to remember that bulk-forming laxatives should be mixed with food or fluid, preferably the latter, before administration. In addition, sufficient fluid (at least 1 glass) must follow administration to prevent gastrointestinal obstruction. Before administering these agents, the nurse should read the label, because some bulk-forming laxatives may have high dextrose or sodium contents (e.g., effervescent products), making them unsuitable for diabetic or cardiac clients.

Lubricant laxatives, such as mineral oil, are generally unpleasant to take. The client's cooperation can be gained by refrigerating the oil and by mixing it in fruit juice. The use of ice chips before and after administration or the use of mouthwash following administration helps to decrease the unpleasant taste. Special care must be taken whenever any oil is administered to avoid aspiration of the oil; this could result in aspiration pneumonia. The nurse should not rush or distract the client, particularly elderly clients, during administration, as this could increase the chances of aspiration. As previously noted, it is important to administer liquid petrolatum (mineral oil) on an empty stomach and/or discourage frequent use, as it may decrease the absorption of fat-soluble drugs and nutrients.

KEY NURSING IMPLICATIONS 16–1

Laxatives

1. In selecting a laxative, consider the age and general condition of the client, special restrictions due to illness, the client's past experience with laxatives, and the time at which evacuation is desired.
2. In general, avoid the use of stimulant laxatives in the elderly.
3. Nondrug measures, such as dietary modification, fluid intake, and exercise, should be encouraged to promote regularity.
4. Disguise the taste of castor oil.
5. Inform clients using laxatives, such as phenolphthalein and senna, that they discolor urine or feces.
6. Follow bulk-forming laxatives with at least 1 glass of fluid to prevent gastrointestinal obstruction.
7. Avoid rushing or distracting clients taking lubricant laxatives in order to prevent aspiration.
8. Support is necessary for clients taking fecal wetting agents, because they are slow in producing effects.
9. Instruct clients using suppositories at home about proper storage and administration.
10. Always assess the effectiveness of laxatives.
11. Never administer laxatives to clients experiencing abdominal pain, nausea or vomiting until you have consulted their physician.
12. Inform clients taking laxatives that they must drink 6–8 glasses of water to avoid dehydration.

Heavy, rather than light, mineral oil is the preferred form, as it is less likely to result in anal leakage.

Fecal wetting agents are useful in cases where many other laxatives would be contraindicated—for example, in cardiac and debilitated clients. Clients should be advised that these agents are slow-acting, and that their effects may not be noticed for several days. Nursing support is often necessary during this time to prevent the client from demanding or consuming other laxative drugs.

Some clients, because of preference or medical condition prohibiting oral administration of laxatives, will be receiving rectal suppositories. Special nursing measures are necessary for optimal effectiveness. The procedure should first be explained to the client. The client is asked to lie on one side and, whenever possible, bend the leg at the knee (Figure 16–2). The nurse puts on a disposable glove or a finger cot on the index finger used for administration. The nurse then prepares the suppository by lubricating the tip with a water-soluble lubricant. Carbon dioxide-producing suppositories, however, should only be lubricated with water. Spreading the buttocks, the nurse gently inserts the suppository, tapered end first, as far as the index finger will reach into the rectum (usually about 3 inches or 7.5 cm). The little finger may be used in administering suppositories to infants or young children. Then the finger is withdrawn and the buttocks held together for several seconds to prevent expulsion of the suppository. The anal area should always be checked for cleanliness and dryness and the lubricant removed before considering the procedure completed. Record the procedure and the client's response to it.

If the client will be using suppositories at home, the client and family members should be instructed in the use and proper storage of suppositories (many must be stored in the refrigerator). Although it may sound unnecessary to the knowledgeable nurse, clients must be instructed that these suppositories are for rectal use only and must have their protective coverings removed before using. In addition, as with other drugs, it is well to stress keeping these medications out of the reach of children. All laxatives, particularly those that are chocolate- or mint-flavored and contain phenolphthalein, must be kept away from children to avoid serious poisoning.

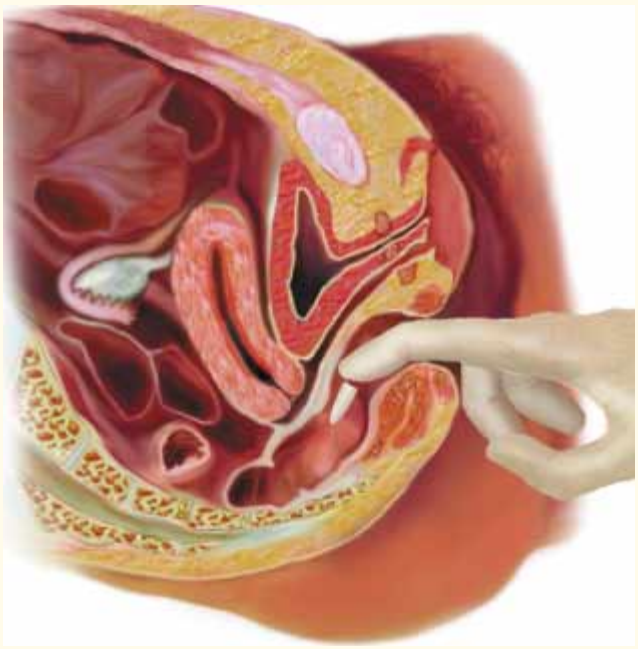

Figure 16–2 A rectal suppository is inserted about 3 inches (7.5 cm) in adults so it will be placed above the internal sphincter.

Nurses in many settings administer retention and nonretention enemas to clients. The nurse must be aware of the general principles of administration and the adaptation required because of the client's age and/or physical condition. Many enemas come prepackaged with instructions for their use. These instructions should be read carefully, as they contain important information designed to ensure client comfort and safety and maximal effectiveness of the enema. The general procedures for administering a nonretention enema are described in Figure 16–3.

Evaluation

Regardless of the type of laxative used, nurses caring for institutionalized clients must make careful notations about administration and outcome of laxative use. Clients should be instructed to inform the nurse about the effectiveness of the laxative, preferably by calling the nurse to inspect the results. This is particularly indicated where chronic constipation has been a problem. Inspection allows the nurse to record both the nature and amount of the evacuation.

1. Introduce yourself and explain procedure.
2. Prepare the solution, assure temperature within range of 99° to 102°F by using a thermometer or placing a few drops on your wrist.
3. Wash hands and don gloves. The following equipment is needed: Enema bag (disposable comes with rectal tip catheter; reusable may need to have rectal tip catheter checked for damage and rectal tip may need to be replaced), towel and washcloth, solution per physician's order, water-soluble lubricant, clean gloves, bedpan, commode, or toilet.
4. Assist patient to left side-lying position, with right knee bent.
5. Hang bag of enema solution 12 to 18 inches above anus.
6. Lubricate 4 to 5 inches of catheter tip.
7. Place bedpan, commode, robe and slippers within easy reach.
8. Separate buttocks, insert catheter tip into anal opening, slowly advance catheter approximately 4 inches.
9. Slowly infuse solution via gravity flow; bag height may be increased but not to exceed 18 inches above anal opening.

Figure 16–3 Administering a non-retention enema.

- Client returns to his/her normal bowel pattern.
- Client does not experience diarrhea while taking laxatives.
- Client does not experience dehydration or electrolyte imbalance.
- Client verbalizes understanding of causes of constipation and the judicious use of laxatives.
- Client demonstrates compliance with medication regimen and does not overuse laxatives.

CLIENTS RECEIVING ANTIDIARRHEAL AGENTS

Assessment

Clients should have their fluid intake and output monitored, and daily weights are suggested for individuals at special risk, particularly infants and young children.

Clients receiving drugs that reduce gastrointestinal motility, such as paregoric, diphenoxylate HCl (Lomotil), difenoxin HCl (Motofen), and loperamide (Imodium) must be observed carefully for CNS depression. This is particularly true if they are taking other CNS depressants.

Nursing Diagnoses

Including but not limited to:

- Diarrhea related to disease process
- Risk for constipation related to administration of antidiarrheals.
- Risk for deficient fluid volume related to diarrhea.
- Deficient knowledge related to diarrhea and use of antidiarrheals.

Planning/Goals

- Client will experience a return of his/her normal bowel habits.
- Client will not experience constipation secondary to laxative use.
- Client will experience fluid balance.
- Client will verbalize understanding of causes of diarrhea and medical treatment.

Implementation

General nursing actions related to caring for clients with diarrhea include:

- describing the frequency and nature of the stools
- recording the number of stools and when they are produced
- providing skin care
- collecting specimens for diagnostic tests
- observing for fluid and electrolyte imbalances
- providing supportive care
- administering antidiarrheal drugs and observing their effects

Outpatients should be cautioned about the use of drugs such as paregoric, diphenoxylate HCl

NURSING CARE PLAN

A Client with Hiatal Hernia Taking Metoclopramide (Reglan) and Nizatidine (Axid)

Shirley Rockinstein is a 32-year-old woman who had been diagnosed as having an ulcer. She has been on a bland diet and antacids. She is currently in the physician's office because she has had severe heartburn particularly at night, which has created problems with sleeping. She smokes a pack of cigarettes a day and frequently attends parties where she drinks alcoholic beverages. The physician decided to admit Shirley to the hospital for diagnostic tests, which verified a peptic ulcer, in addition to a hiatal hernia. Her discharge instructions include dietary management, metoclopramide (Reglan) 10 mg QID, ac and hs and nizatidine 150 mg BID.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Heartburn. Sour tasting regurgitation. Gastric reflux.	Chronic pain related to tissue trauma secondary to reflux of gastric contents into esophagus.	Client will verbalize decreased epigastric pain within 24 hours after admission.	Teach client to prevent gastric reflux by avoiding twisting at waist, bending, lifting, coughing, vomiting, or straining at stool as well as wearing tight clothes. Avoid gum, hard candy, or smoking, which promotes increased air swallowing. Drink water after reflux to cleanse esophagus.	Client demonstrates understanding of lifestyle modifications. Client has relief from bloating and reflux.
Dietary intake of caffeine, alcohol, or spices. Bloating after meals.	Deficient knowledge (dietary practices that aggravate gastric reflux).	Prior to discharge, client will develop a meal plan adhering to dietary modifications necessary to decrease gastric reflux.	Teach client to eat small, frequent bland meals. Avoid citrus juices, alcoholic beverages, highly seasoned foods, and gas-producing foods. Eat fibrous foods and drink fluids to prevent straining at stool. Eat in sitting position and avoid reclining after eating. Do not eat before bedtime.	Client adheres to dietary modifications. Client verbalizes relief from bloating and reflux.
Pain occurring at night. Difficulty sleeping.	Disturbed sleep pattern related to discomfort secondary to gastric reflux.	Client will demonstrate ability to sleep through night 48 hours after admission.	Keep head of bed elevated at least 6 inches. Use extra pillows at home. Assume semi-Fowler's position if pain occurs. Sleep on right side.	Client demonstrates understanding of sleep aids and verbalizes adequate rest and sleep.
Medication history.	Deficient knowledge (new drugs metoclopramide and cimetidine).	Client verbalizes understanding of drug regimen prior to discharge.	Teach client that metoclopramide will increase gastric and bowel emptying and prevent reflux. Take metoclopramide 30 minutes before meals and at bedtime. Teach client to stop medication and notify physician if GI bleeding or congestive heart failure develops. Teach client that cimetidine may cause diarrhea, dizziness, hallucinations, rash, or confusion.	Client adheres to medication regimen. Client recognizes and reports complications of medications.
Smoking history.	Deficient knowledge (effect of smoking on disease condition).	Client will verbalize knowledge of smoking's effect on condition and a plan to decrease or stop smoking.	Teach client that smoking stimulates gastric acid production and prevents ulcer healing. Support client in her efforts to decrease or eliminate smoking.	Client identifies the way cigarettes affect her health. The client decreases or stops smoking.

(Lomotil), difenoxin HCl (Motofen), and loperamide (Imodium) when operating automobiles and machinery. Clients are instructed to avoid alcohol and other CNS depressants while they are taking antidiarrheal agents. Use of anticholinergic preparations should be avoided in clients with glaucoma or an enlarged prostate gland.

Adsorbents, such as kaolin and attapulgite, are commonly used, as they can be purchased without a prescription. Clients should be instructed to avoid taking an adsorbent within several hours of taking other oral drugs, as this may prevent the desired absorption of the other drugs. Also, clients should be instructed to see their physician: (1) if they develop a fever, (2) if the diarrhea persists for several days, or (3) if any indications of fluid imbalance appear, such as dry mucous membranes and skin or poor skin turgor.

The use of lactobacillus products to treat diarrhea, particularly that resulting from an imbalance in normal intestinal flora, has been gaining in popularity. Whether used at home or in the hospital, these ingredients must be refrigerated. The granules and contents of capsules may be stirred into milk or yogurt for administration. These agents may be purchased without prescription. Clients should be instructed to see a physician if fever or fluid imbalance appears, or if diarrhea persists.

In addition to the use of these antidiarrheal drugs, some dietary modifications may be necessary. It is suggested that very hot or cold liquids be avoided as they may stimulate peristalsis, thus aggravating the problem.

Evaluation

- Client returns to his/her normal bowel pattern.
- Client does not experience constipation while taking antidiarrheals.
- Client does not experience fluid or electrolyte imbalance.
- Client verbalizes understanding of causes of diarrhea and the judicious use of antidiarrheals.

It is important to evaluate the effectiveness of antidiarrheal therapy. Clients are instructed to inform the nurse about the frequency of stools and their nature. When possible, the nurse should observe the nature of the stool to accurately record the effectiveness of treatment. Also record observations relating to the amount of abdominal cramping reported by the client and the client's skin turgor and lubrication of mucous membranes.

Infants and young children may quickly become dehydrated and lose electrolytes. Fluid and electrolytes can be replaced through the use of oral rehydration solutions. The nurse instructs the parents to monitor the child's weight and skin turgor to assess the adequacy of rehydration.

KEY NURSING IMPLICATIONS 16–2

Antidiarrheal Agents

1. Monitor fluid intake and output and record information about the frequency and nature of stools. Monitor body weight in infants.
2. Observe clients receiving paregoric, diphenoxylate HCl (Lomotil), difenoxin (Motofen), or loperamide (Imodium) for CNS depression.
3. Adsorbents should not be taken within several hours of taking other oral medications.
4. Lactobacillus products must be refrigerated.
5. Refer adult clients with fever, dehydration, or diarrhea persisting for several days to a physician.
6. Infants and young children must be referred sooner.

CLIENTS RECEIVING EMETICS AND ANTIEMETICS

Assessment

Emetics are substances that induce vomiting. The most important nursing measures associated with the use of emetics concern finding out what toxic substance has been ingested, and contacting a poison control center for more specific information. (See Chapter 5 for further discussion of poisoning.)

Nursing Diagnoses

Including but not limited to:

- Risk of aspiration related to inducement of vomiting.

KEY NURSING IMPLICATIONS 16–3

Emetics and Antiemetics

1. Identify the toxic substance ingested and call a poison control center for information.
2. Emetics are not administered to persons who have swallowed corrosive substances or oils or to those who are unconscious.
3. Antiemetics are used carefully in clients taking other drugs with a CNS depressant effect and are best avoided in pregnant women.

- Risk for deficient fluid volume related to vomiting.
- Risk for injury related to adverse effects related to use of emetics/antiemetics.
- Deficient knowledge related to use of emetics/antiemetics.

Planning/Goals

- Client will not experience aspiration if taking emetics.
- Client will maintain fluid balance.
- Client will not experience adverse effects when using emetics/antiemetics.
- Client will verbalize and demonstrate an accurate understanding of use of emetics/antiemetics.

Implementation

When toxic substances have been ingested, an emetic, such as ipecac syrup, followed by water may be given, unless the substance ingested contains oil (petroleum products, furniture polish, etc.) or is a corrosive substance, such as lye. Vomiting of oil could result in aspiration of the oily substance into the lungs. If a corrosive substance were taken, vomiting would rapidly lead to destruction of even more tissue, with the substance coming into contact with the stomach, esophagus, throat, mouth, and lips.

Bouncing a child up and down, along with fluid administration, may hasten the emetic action of ipecac. Additional considerations in using ipecac include restricting its use to the hour immediately following ingestion and avoiding the simultaneous use of activated charcoal. The charcoal would inactivate the emetic action of ipecac. Nurses working with parents of young children may suggest obtaining a bottle of ipecac syrup to be stored in the home for possible emergency use.

The nurse should remember that antiemetics must be used very carefully in women of childbearing age, as they may be associated with fetal abnormalities if ingested during pregnancy. If the client is severely nauseated or vomiting, the antiemetic may be given intravenously or in the suppository form. Supportive measures include the use of tea, ginger ale, or straight cola syrup over cracked ice. Because many antiemetics produce CNS depression, they must be used with extreme care in clients taking other CNS depressants, particularly infants and the elderly.

Evaluation

- Client does not experience aspiration while taking emetics.
- Client does not experience fluid or electrolyte imbalance.
- Client remains free of adverse effects of medication regimen.
- Client verbalizes and demonstrates understanding of use of emetics/antiemetics.

The nurse observes the effectiveness of the antiemetic and records observations about the frequency and nature of the emesis and the situations and times at which vomiting occurs.

CLIENTS RECEIVING HISTAMINE H_2 RECEPTOR ANTAGONISTS AND SUCRALFATE (CARAFATE)

Assessment

Clients taking cimetidine are monitored for the development of diarrhea, dizziness, drowsiness, and rash. Elderly clients, in particular, are assessed for the development of confusion when used over a prolonged period. Some males taking cimetidine have developed gynecomastia, or impotence. Significant drug interactions have been reported with cimetidine and benzodiazepines, beta-blocking agents, lidocaine, phenytoin, theophylline, and warfarin. Drug interactions are less likely to occur in clients using ranitidine, famotidine, or nizatidine. The most common problem developed by clients

KEY NURSING IMPLICATIONS 16–4

Drugs Used to Treat Peptic Ulcer Disease

1. Monitor clients taking cimetidine for diarrhea, dizziness, rash, and confusion.
2. Clients taking ranitidine may develop headache, while those taking sucralfate commonly develop constipation.
3. Do not administer sucralfate simultaneously with antacids, cimetidine, digoxin, phenytoin, tetracycline or warfarin.
4. Always secure the client's cooperation in complying with an extended treatment program.

taking ranitidine is headache, with constipation occurring most often in clients using sucralfate.

Nursing Diagnoses

Including but not limited to:

- Risk for injury related to development of peptic ulcers.
- Risk for injury related to adverse effects when using histamine H_2 blockers.
- Deficient knowledge related to disease process and use of histamine H_2 blockers.

Planning/Goals

- Client will not develop peptic ulcer disease or, if PUD already exists, client will experience relief of symptoms.
- Client will not experience adverse effects when using histamine H_2 blockers.
- Client will verbalize and demonstrate an understanding of disease process and use of histamine H_2 blockers.

Implementation

Because of drug interactions, sucralfate should not be administered simultaneously with antacids, cimetidine, digoxin, phenytoin, tetracycline, or warfarin.

These drugs may be administered in a treatment program with other drugs, for example antacids, over a period of weeks. It is very important to gain the client's cooperation in continuing this treatment over an extended period. For additional comments concerning supportive nursing care for clients with peptic ulcers, see Chapter 14.

Evaluation

- Client does not experience peptic ulcer development.
- Client with PUD experiences relief of symptoms.
- Client remains free of adverse effects of medication regimen.
- Client verbalizes and demonstrates understanding of use of histamine H_2 blockers.

NURSING CLIENTS TAKING METOCLOPRAMIDE

Assessment

Nursing assessment of a client receiving metoclopramide (Reglan) is important. Some clients may develop extrapyramidal reactions. Clients receiving antipsychotic and antidepressant drugs known to cause neurological problems are monitored especially carefully. Persons who are seizure-prone are also monitored carefully, as some have developed an increase in the severity of their seizures while taking metoclopramide.

Acute dystonic reactions such as facial grimacing, *torticollis*, and *oculogyric* crisis have occurred in young children and adolescents who have been given this drug for its antiemetic properties. The dystonic reaction can be reversed by the use of a parenteral dose of diphenhydramine (Benadryl).

Nursing Diagnoses

Including but not limited to:

- Risk for injury related to adverse effects when using metoclopramide.
- Deficient knowledge related to use of metoclopramide.

Planning/Goals

- Client will not experience adverse effects when using metoclopramide.
- Client will verbalize and demonstrate an understanding of use of metoclopramide.

Implementation

Clients receiving metoclopramide may experience drowsiness and fatigue. The nurse must provide for the client's safety by the use of siderails and caution the client to avoid activities which require alertness.

When given as a bolus intravenously, metoclopramide is injected slowly over 1–2 minutes. This helps to decrease the feelings of anxiety and restlessness that may otherwise occur.

Evaluation

- Client remains free of adverse effects of medication regimen.
- Client verbalizes and demonstrates understanding of use of metoclopramide.

NURSING CLIENTS TAKING MISOPROSTOL

Assessment

Because misoprostol (**Cytotec**) is used to prevent the development of peptic ulcers in persons taking nonsteroidal anti-inflammatory drugs (NSAIDs), the nurse must continually assess the client for the development of epigastric pain or other indicators of ulceration. Also, before therapy is initiated, it is important to determine that female clients are not pregnant.

Nursing Diagnoses

Including but not limited to:

- Risk for injury, development of peptic ulcers related to NSAID use.
- Deficient knowledge related to use of metoclopramide.

Planning/Goals

- Client will not experience development of peptic ulcers while using NSAID therapy.
- Client will verbalize and demonstrate an understanding of use of misoprostol.

Implementation

Clients are instructed to take this drug after meals and at bedtime for maximal absorption and effectiveness. Administration at these times also may decrease abdominal discomfort and diarrhea sometimes associated with treatment. It is important for the client to understand how this drug works and why it is being used. Clients are instructed to take the medication exactly as ordered for as long as they are using the NSAID.

Evaluation

- Client remains free of development of peptic ulcers.
- Client verbalizes and demonstrates understanding of use of misoprostol.

CASE STUDY

Timothy Sweet is a partially disabled 69-year-old widower whose wife died about 2 years previously. He lives alone and relies on a small pension for subsistence. Most of Mr. Sweet's meals require little or no effort in preparation and often consist of hot tea or canned soups. Recently he has begun to complain of constipation and tells the visiting nurse that he regularly uses senna extract (**Ex-Lax**) tablets to treat his condition. The client also reports some minor rectal bleeding, which began about two days after starting to use Ex-Lax.

Questions for Discussion

1. Which factors might be responsible for the development of the client's constipation?
2. How could the client's report of "rectal bleeding" be explained?
3. What disadvantages are there in the prolonged use of Ex-Lax by this client?
4. What recommendations might the nurse make to the client to relieve his constipated condition?

HOME CARE/CLIENT TEACHING

1. Client taking laxatives should be instructed to drink at least 6–8 glasses of water to avoid dehydration.
2. Elderly clients, infants, and clients with fragile fluid and electrolyte balances should be discouraged from using saline laxative.
3. Clients should be informed that it may take up to 3 days for bulk-forming laxatives to work.
4. Clients should be informed that laxatives may be habit-forming and avoid overuse.
5. Client self-administering suppositories and/or enemas should be instructed about proper techniques for administration.
6. Clients should be informed that they should use caution when driving or handling heavy equipment because of the risk of blurred vision common in clients taking atropine sulfate and diphenoxylate HCL (Lomotil).
7. Clients with glaucoma or enlarged prostate should avoid anticholinergic antidiarrheals.
8. Clients should be instructed to avoid taking an adsorbent within several hours of taking other oral drugs, because it may alter the absorption of the other drugs.
9. Clients receiving histamine H_2 antagonists, metoclopramide, and misoprostol should be instructed about drug interactions when using these agents.
10. Laxatives and enemas should not be used for the treatment of acute abdominal pain. Clients are advised to check with a health care professional before initiating self-treatment under this circumstance.
11. Ensure that suppositories are stored under proper conditions.
12. Advise mothers or caregivers that infants and young children can easily become dehydrated as a result of vomiting and/or diarrhea. Suggest monitoring of body weight and skin turgor, as well as maintaining continued contact with health care professionals.

CRITICAL THINKING EXERCISES

1. Visit a local pharmacy and note the drugs available for the treatment of constipation and diarrhea. Select five of these preparations, note their ingredients, and list the types of clients who should avoid their use.
2. Prepare a visual to use in instructing clients and families about the administration of rectal suppositories.
3. Read about the preparation of the client for a barium enema, as required in your clinical area and explain.
4. Prepare a week's menu that could be used for elderly clients to facilitate regularity and decrease their dependence on laxatives.
5. Discuss the nursing measures that can be used to protect the skin of clients with diarrhea.
6. Describe five causes of constipation.
7. Describe the procedure for the administration of a nonretention enema, including the modifications necessary because of the client's age.
8. Visit a local pharmacy and note the types of products available to aid digestion. Review the labels of three of these products noting their contents, instructions for use, and contraindications.

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SECTION 5

Agents Affecting the Central Nervous System

MAJOR NURSING DIAGNOSES

- Disturbed Sleep Pattern
- Disturbed Thought Processes
- Anxiety
- Disturbed Body Image
- Imbalanced Nutrition: More Than Body Requirements; Less than Body Requirements
- Deficient Knowledge (Illness and Its Treatment)
- Impaired Physical Mobility
- Risk for Activity Intolerance
- Disturbed Sensory Perception
- Risk for Injury
- Deficient Self-Care Related to Weakness and Fatigue
- Impaired Social Interaction
- Ineffective Individual Coping

17 Sedatives and Hypnotics

OBJECTIVES

After studying this chapter, the student will be able to:

- State the difference between a drug used as a sedative and one used as a hypnotic
- List four classes of drugs that may interact with barbiturate sedative-hypnotics
- Identify the therapeutic effects and side effects of the major barbiturate and nonbarbiturate sedative-hypnotics
- Identify general supportive nursing interventions used in the treatment of sleep pattern disturbances
- Apply the nursing process related to the administration of each of the barbiturate and nonbarbiturate sedative-hypnotic agents

Sedatives and hypnotics are drugs which depress the central nervous system (CNS) by inhibiting transmission of nerve impulses. In doing so, these agents depress the action of many physiological systems and are capable, therefore, of causing a wide range of desirable and undesirable effects.

Drugs are classified as sedatives or hypnotics based on the degree of CNS depression they produce. *Sedatives* are agents that produce a diminished responsiveness to stimuli without producing sleep. Therefore, they reduce anxiety and nervousness, excitability and irritability. They are frequently referred to as antianxiety agents, or *anxiolytics*. *Hypnotics* tend to have a more intense depressant effect on the CNS and usually produce sleep. Many drugs can act as either sedatives or hypnotics, depending on the dose administered and are, therefore, sometimes referred to as sedative-hypnotics.

BARBITURATES

Barbiturates are chemical derivatives of barbituric acid, a compound first synthesized nearly a century ago. Although more than 2,500 barbiturates have been synthesized, only about 50 have been approved for clinical use in the United States and fewer than a dozen are commonly employed.

All barbiturates exert a depressant effect on the CNS. The extent of their action may range from mild sedation to deep anesthesia (see Chapter 11). They are believed to act primarily by interfering with the chemical transmission of impulses across synaptic junctions within the ascending reticular formation of the brainstem. This action has been attributed, in part, to the ability of the barbiturates to potentiate the inhibitory effects on nerve impulse transmission of a substance known as gamma-aminobutyric acid (GABA), an amino acid found in high concentrations in the CNS. It has been shown to mediate many inhibitory actions on nerve impulse transmission throughout the CNS. Some barbiturates, namely phenobarbital,

mephobarbital and metharbital, also exert a fairly selective action on the motor cortex and produce an anticonvulsant action as well.

The barbiturates tend to dramatically reduce rapid-eye movement (REM) sleep during the first few days of hypnotic therapy. This type of sleep, often also referred to as dream sleep, is believed to be necessary in proper amounts for deriving adequate rest from the sleep process. Considerable evidence accumulated in sleep research studies indicates that clients regularly deprived of REM sleep tend to become agitated more easily, have a diminished capability in dealing with normal levels of stress and have a decreased metabolic rate. This may explain why clients using barbiturates often do not feel as fully rested as those who sleep normally. Upon withdrawal of a drug that reduces REM sleep, a rebound period may occur during which the proportion of REM sleep is increased, the client dreams much more than normally, and nightmares are possible.

Although most clients using barbiturates tolerate them quite well, the following are the most common adverse effects associated with their use:

- *excessive central nervous system depression*—Barbiturates may cause drowsiness, listlessness, and a "hangover" effect (i.e., vertigo, dizziness, nausea and vomiting, diarrhea, and emotional disturbances). These effects are usually magnified if the client is using any other CNS depressants such as alcohol, narcotic analgesics or antihistamines.
- *hypersensitivity reactions*—These may be manifest as skin rashes and swelling of the eyelids, lips, and cheeks, as well as severe *exfoliative dermatitis*. Such reactions are more likely to occur in clients with asthma and/or a history of sensitivity to other agents.
- *excitement*—Such a response may be characterized by restlessness, confusion, disorientation, nightmares, and delirium. This paradoxical reaction (opposite to expected reaction) is particularly likely in elderly and/or debilitated clients. Such clients may experience excitement instead of the expected sedation.

High barbiturate doses tend to depress the respiratory and vasomotor centers of the *medulla*, thereby causing respiratory depression and hypotension. In acute drug intoxication, death may result. Barbiturates also tend to exert a variety of effects on the liver. The most important of these is an increase in the production of hepatic microsomal enzymes, agents responsible for the metabolism of warfarin, theophylline, phenytoin, steroids, and many other drugs including the barbiturates, themselves. The use of barbiturates can, therefore, increase the metabolism of such drugs and diminish their effectiveness. As barbiturates can stimulate their own metabolism, their use for even short periods of time (several days) can result in the development of tolerance, i.e., higher and higher doses of the drug are required to produce a given pharmacological effect. Tolerance to barbiturates may also be due to the adaptation of nervous tissue to the presence of the drug. Experimental evidence has revealed that some of the barbiturate hypnotic agents lose their effectiveness after 2 weeks of continuous use.

The prolonged use of barbiturates and most other sedative-hypnotic agents can produce psychological and physical dependence. In addition, withdrawal symptoms appear upon discontinuation of drug administration. The severity of withdrawal symptoms is generally dependent on the dosage and duration of administration prior to withdrawal, as well as how abruptly the drug is discontinued. Rapid withdrawal of the drug from a client who has used high and frequent doses for extended periods of time may produce severe convulsions and death.

Selection of the proper barbiturates for a particular therapeutic application often depends on the duration of action required. The barbiturates have enjoyed wide popularity because of their versatility in providing actions which range in duration from several seconds to as long as 24 to 36 hours. Ultra short-acting barbiturates (e.g., **thiopental**) are used primarily as intravenous anesthetics, usually in combination with an inhalational agent. Their duration of action may be as brief as several seconds, thereby permitting close control of a client during surgery. Short- and intermediate-acting barbiturates are primarily used in treating insomnia, as they have a rapid onset of action (10 to 15 minutes) and a short duration of action (1 to 6 hours). Because of their relatively brief action, the client is usually not subjected to any significant "hangover" effect, as may be the case with longer acting agents. Long-acting barbiturates (e.g., phenobarbital) are primarily used in the treatment of convulsive disorders. They may also be used as sedatives. Their prolonged action reduces the necessity of administering frequent daily doses and maintains a fairly constant blood level throughout the day. Table 17–1 compares the properties of some of the more popular barbiturates in current use.

TABLE 17–1

Barbiturates Used as Sedatives and Hypnotics

Note: For all clients receiving barbiturates:

Avoid the use of other central nervous system depressants.

Provide for the client's safety through the use of siderails, assistance with ambulation, and instruction to avoid activities requiring mental alertness.

Monitor drug use very carefully in depressed, suicidal, or confused clients and in known drug abusers.

Doses of oral anticoagulants and phenytoin (anticonvulsant) may need to be adjusted.

Prolonged use of barbiturates may increase vitamin D requirements.

Watch for toxicity, including confusion, excitement, deep sleep, coma, pupil constriction, cyanosis, clammy skin, and hypotension.

Drug dosages should be tapered off gradually. Abrupt withdrawal can lead to seizures and death.

Elderly and debilitated clients may be more sensitive to barbiturates. Dosage reduction may be required.

Record observations about the effectiveness of these agents.

DRUG	ROUTE(S)	USUAL SEDATIVE DOSE	USUAL HYPNOTIC DOSE	DURATION OF ACTION	NURSING IMPLICATIONS
amobarbital, amobarbital sodium *(**am**-oh-**BAR**-bih-tal, **am**-oh-**BAR**-bih-tal **SOH**-dee-um)* (Amytal, Novamobarb ✱)	IM, IV oral	Oral/ Parenteral: for preanesthetic sedation, 200 mg 1–2 hours before surgery *Children:* 2–6 mg/kg/ day	Parenteral: 65–200 mg Oral: 65–200 mg	intermediate	Has anticonvulsant activity. IM injections should be made into large muscle. Use parenteral solutions within 30 minutes after preparation. Do not use cloudy or precipitated solution. See note above.
butabarbital sodium *(**byou**-tah-**BAR**-bih-tal **SOH**-dee-um)* (Butisol)	oral	15–30 mg 3–4 times daily	50–100 mg preoperative or at bedtime *Children:* 2–6 mg/kg	intermediate	See note above.
mephobarbital *(**mef**-oh-**BAR**-bih-tal)* (Mebaral)	oral	10–60 mg 3–4 times daily	*Adults:* 32–100 mg 3–4 times/day Children: 16–32 mg 3–4 times/day	long	Has anticonvulsant activity. See note above.
pentobarbital, pentobarbital sodium *(**pen**-toh-**BAR**-bih-tal, **pen**-toh-**BAR**-bih-tal **SOH**-dee-um)* (Nembutal)	oral, rectal, IM, IV	*Adults:* 20 mg 3–4 times daily *Children:* 2–6 mg/kg/ day	100 mg Parenteral: 150–200 mg Rectal: 120–200 mg	short	Do not use parenteral solutions if precipitate is present. Use parenteral solution within 30 minutes after preparation. When using IV, avoid infiltration into tissues as necrosis may occur. IM injections should be given deeply into a large muscle mass to prevent pain and abscess formation. Do not mix in same syringe with meperidine HCl. See note above.

continues

TABLE 17–1 *continued*

See **Note** at beginning of Table 17–1, page 360.

DRUG	ROUTE(S)	USUAL SEDATIVE DOSE	USUAL HYPNOTIC DOSE	DURATION OF ACTION	NURSING IMPLICATIONS
phenobarbital, phenobarbital sodium *(**fee**-noh-**BAR**-bih-tal, **fee**-noh-**BAR**-bih-tal **SOH**-dee-um)* (Luminal)	oral, IM, IV	10–30 mg 2–4 times daily *Children:* 2 mg/kg 3 times/day	100–320 mg Parenteral: 100–325 mg	long	Has anticonvulsant activity. Use injection solution within 30 minutes of preparation. Do not use cloudy or precipitated solution. Do not mix in same syringe with meperidine HCl. IM injections must be given deeply into muscle to avoid pain and abscess formation. See note above.
secobarbital, secobarbital sodium *(**see**-koh-**BAR**-bih-tal, **see**-koh-**BAR**-bih-tal **SOH**-dee-um)* (Seconal)	oral, IM, IV	30–100 mg	200–300 mg *Children:* 2–6 mg/kg	short	Has anticonvulsant activity. Do not use parenteral solution if discolored or if precipitate is present. Parenteral solutions must be kept in the refrigerator. IM injections must be given deeply into muscle to avoid pain and abscess formation. Parenteral dose for preop sedation should be administered 1–2 hours prior to surgery. See note above.

BENZODIAZEPINES

The benzodiazepines are a widely used chemical class of drugs employed primarily in the treatment of anxiety. Their depressant action on the CNS appears to be closely related to their ability to potentiate gamma-aminobutyric acid (GABA)-mediated neural inhibition. Recent research has identified specific binding sites for benzodiazepines in the CNS and has established the close relationship between the sites of action of the benzodiazepines and GABA.

Some members of this group including **flurazepam HCl** (Dalmane), **temazepam** (Restoril), **triazolam** (Halcion), **estazolam** (ProSom), and **quazepam** (Doral), have emerged as useful hypnotic agents. Unlike the barbiturates, these drugs do not appear to significantly suppress REM sleep, their withdrawal does not result in rebound REM sleep development, and their use does not appear to cause the development of tolerance. This makes them useful hypnotic agents for clients who need prolonged therapy (longer than 1 to 2 weeks). Benzodiazepines do not stimulate the production of microsomal enzymes in the liver (see Chapter 1). This factor permits them to be used safely by clients who are taking drugs metabolized by microsomal enzymes (e.g., warfarin).

Many adverse effects of these agents are quite similar to those of the barbiturates, such as vertigo, dizziness, and oversedation. They may also cause excitement, particularly in elderly clients. Psychological and/or physical dependence may occur when these drugs are used improperly. Overdosage may result in CNS and respiratory depression, as well as hypotension and coma.

The use of triazolam (Halcion) has been reported to produce *anterograde* amnesia and/or paradoxical psychiatric reactions in some clients. This and the reports of other adverse reactions associated with the use of this drug have resulted in its removal from the market in Great Britain and several other countries. Discontinuation of the drug's use is advised when and if such problems develop. Abrupt discontinuation of triazolam may lead to rebound sleep disorder, a condition in which insomnia recurs to levels worse than before

TABLE 17–2

Benzodiazepines Used as Hypnotic Agents

Note: Monitor clients for vertigo, dizziness, and oversedation.
Monitor for effectiveness.
Monitor children and the elderly closely, as adverse side effects are most likely to occur in these clients.
Provide for client safety by use of siderails, assistance with ambulation, and instruction to avoid activities requiring mental alertness.
Monitor carefully in clients who are suicidal, depressed, or known drug abusers.

DRUG	ROUTE(S)	USUAL DOSE	MAJOR ADVERSE EFFECTS	NURSING IMPLICATIONS
diazepam *(die-**AS**-I-pam)* (Valium)	IV, IM	*Adults:* 5–20mg *Older adults:* 2-5 mg	vertigo, dizziness, oversedation, ataxia	For children dose must be determined by physician and used with caution. Has amnesic effect when used IM or IV.
estazolam *(es-**TAYZ**-oh-lam)* (ProSom)	oral	*Adults:* 1 mg at bedtime	See diazapam	See diazepam.
flurazepam HCl *(flur-**AYZ**-eh-pam)* (Dalmane)	oral	*Adults:* 15–30 mg at bedtime *Older Adults:* 15 mg at bedtime	See diazepam	See diazepam
lorazepam *(lor-**AYZ**-eh-pam)* (Ativan)	oral, IM, IV, subligual	*Adults:* oral: 2–4 mg sublingual, IM,IV: based on body weight, but not more than 4 mg	See diazapam	Administer at bedtime for sleep. Used for sedation before surgery.
midazolam *(my-**DAYZ**-oh-lam)* (Versed)	IM, IV	IM: 5 mg IV: 1–2.5 mg *Children:* 0.1-0.15 mg/kg up to 0.5 mg/kg	Bronchospasms after IV injection, respiratory depression	Requires close respiratory monitoring if given IV. Side effects most common when drug used for conscious sedation.
quazepam *(**QUAS**-eh-pam)* (Doral)	oral	*Adults:* 7.5–15 mg	See diazapam	See diazapam.
temazepam *(the-**MAZ**-eh-pam)* (Restoril)	oral	*Adults:* 15 mg at bedtime *Older Adults:* 7.5 mg at bedtime	See diazepam	See diazapam.
triazolam *(try-**AYZ**-oh-lam)* (Halcion)	oral	*Adults:* 0.125–0.25 mg at bedtime *Older Adults:* At first, 0.125 mg at bedtime	See diazapam	See diazepam.

therapy began. Gradual withdrawal of the drug is recommended. Although the use of any of the benzodiazepines during pregnancy is likely to cause fetal abnormalities, flurazepam (Dalmane) is entirely contraindicated for use during pregnancy. Table 17–2 compares some of the benzodiazepines most commonly used for sedation or as hypnotics.

ALCOHOL (ETHANOL)

Although often viewed as a stimulant by society, alcohol is actually a fairly potent CNS depressant. Depending on the amount consumed and the rate it is ingested, alcohol may produce sedation, sleep, and/or general anesthesia by a direct action on the CNS. Alcohol also depresses CNS control mechanisms that inhibit certain brain functions. This may disrupt normal thought processes (i.e., memory, concentration, etc.), as well as motor coordination and produce a feeling of detachment and euphoria.

Alcohol is sometimes useful in moderate amounts as a sedative, particularly in elderly clients; its actions are relatively transient and usually pleasant. For some clients, alcohol may be used as a social facilitator to encourage better interaction. It should be noted, however, that it is a CNS depressant and should be avoided by clients receiving other CNS depressant drugs, those with a history of alcohol abuse, and clients who have recently experienced head trauma.

The pharmacological properties of alcohol are reviewed in Chapter 41.

OTHER SEDATIVE-HYPNOTICS

Chloral Hydrate (Noctec). This agent is among the oldest nonbarbiturate sedative-hypnotic agents, having first been synthesized in the mid-nineteenth century. Unlike the barbiturates, **chloral hydrate** does not appear to suppress REM sleep at usual therapeutic doses and, because of its relatively short duration of action, only rarely produces a "hangover" effect. However, tolerance to the hypnotic action of chloral hydrate develops rapidly, thereby making it useful only for short-term therapy (less than 10 days). When high doses are administered, GI irritation and dependence may develop. Combinations of chloral hydrate and alcohol (Mickey Finn, knockout drops) cause rapid loss of consciousness.

Glutethimide (Doriden). Glutethimide produces CNS depression similar to the barbiturates and is indicated for the oral treatment of insomnia. Its major differences from the barbiturates include its:

- *anticholinergic action*—This property requires that extreme caution be used when this agent is employed in clients with conditions that can be intensified by anticholinergic activity (e.g., narrow-angle glaucoma, prostatic hypertrophy, cardiac *arrhythmias*).
- *lack of respiratory depressant action*—This permits the drug to be safely used preoperatively and during the first stages of labor.

As with the barbiturates and chloral hydrate, clients who take glutethimide develop drug tolerance rapidly, thereby limiting its use to several days.

Ethchlorvynol (Placidyl). **Ethchlorvynol** is similar in action to the barbiturates, but is not chemically related to them or to any of the agents previously discussed. It is useful in the short-term treatment of insomnia, particularly in clients who do not tolerate other hypnotic agents.

Paraldehyde. This is a liquid sedative and hypnotic used primarily in institutionalized clients. It is rapidly absorbed from the GI tract and generally produces sleep within 10–15 minutes after administration. Its oral use has diminished in popularity, because it can irritate mucous membranes and has an unpleasant odor and taste. When exposed to air and certain plastics, paraldehyde decomposes; this further limits its usefulness.

Propiomazine HCl (Largon). This is a short-acting sedative and antiemetic agent generally administered IM or IV to reduce apprehension preoperatively, during surgery, or during labor.

Zolpidem Tartrate (Ambien). This drug is a nonbarbiturate, nonbenzodiazepine hypnotic agent that appears to exert an effect similar to the benzodiazepines, but without producing muscle relaxation or anticonvulsant effects. It is generally used in the short-term (7–10 days) treatment of insomnia. Clients using **zolpidem** should avoid alcohol and other CNS depressants when using this drug.

Table 17–3 compares the nonbarbiturate sedative-hypnotics in current use.

Nonprescription Sleep Aids

A number of nonprescription products (e.g., **Compoz**, **Sominex**, and **Sleep-eze**) are promoted for the treatment of insomnia. Virtually all of these products contain an antihistamine (e.g.,

TABLE 17–3

Nonbarbiturates/Sedatives-Hypnotic Agents

Note: Avoid using with other central nervous system depressants.

Provide for client safety by use of siderails, assistance with ambulation, and instruction to avoid activities requiring mental alertness.

Monitor carefully in clients who are suicidal, depressed, or known drug abusers.

Record observations about the effectiveness of these agents.

DRUG	ROUTE(S)	USUAL SEDATIVE DOSE	USUAL HYPNOTIC DOSE	NURSING IMPLICATIONS
chloral hydrate *(**KLOR**-al **HY**-drayt)* (Noctec, etc.)	oral, rectal	250 mg 3 times daily *Children:* 25–50 mg/kg	500–1,000 mg	Take oral doses with full glass of liquid after meals to minimize GI upset. May interfere with copper reduction glucose test (e.g., Clinitest). Use glucose oxidase test instead (e.g., TesTape). Store suppositories in refrigerator. Store oral dosage forms in a dark container. Dosage of oral anticoagulants may need to be adjusted. See note above.
ethchlorvynol *(eth-**KLOR**-veh-nohl)* (Placidyl)	oral	—	500–1,000 mg	Elderly and/or debilitated clients should receive lowest effective dose possible. Withdraw gradually; may cause dependence and withdrawal symptoms. Store in dark container to avoid deterioration. Dosage of oral anticoagulants may need to be adjusted. See note above.
glutethimide *(gloo-**TETH**-ih-myd)* (Doriden)	oral	—	500 mg at bedtime	If skin rash appears, discontinue medication. Gradually withdraw drug to avoid nervousness, tremors, insomnia, tachycardia and convulsions. Dosage of oral anticoagulant may need adjustment.
midazolam HCl *(my-**DAYZ**-oh-lam)* (Versed)	IM, IV	IM: 5 mg IV: 0.1–0.35 mg/kg depending on use	—	Monitor client for the development of respiratory depression and/or hypotension. May be used in the induction of anesthesia. IV doses should be reduced by 25–30% in elderly and debilitated clients.

continues

TABLE 17–3 *continued*

See **Note** at beginning of Table 17–3, page 364.

DRUG	ROUTE(S)	USUAL SEDATIVE DOSE	USUAL HYPNOTIC DOSE	NURSING IMPLICATIONS
paraldehyde *(par-**AL**-deh-hyd)* (Paral)	oral, rectal	Must be determined by physician	—	Administer oral doses with milk or fruit juice to mask odor and taste. For rectal use, drug may be dissolved in oil and administered as a retention enema. Do not use solution that is discolored or has a pungent acetic acid (vinegar) smell. Do not use solution from container that has been open longer than 24 hours. With repeated doses, watch for respiratory depression. See note above. Use only in psychiatric facilities.
trazodone *(**TRAZ**-oh-dohn)* (Desyrel)	oral	*Adults:* 50–100 mg at bedtime *Older Adults:* 25 mg at bedtime	—	Non–habit-forming. As tolerance occurs dosage may need to be increased in 25 mg increments.
zaleplon *(za-**LEP**-lon)* (Sonata)	oral	*Adults:* 10 mg at bedtime *Older adults:* 5 mg at bedtime	—	Assess mental status. Assess potential for abuse. For clients over 65 years old and for those clients weighing less than 50 kg., dosage should not exceed 10 mg. Assess for pain and medicate as needed; pain decreases sedative effects. Caution client to avoid use of alcohol or other CNS depressants.
zolpidem tartrate *(**ZOHL**-pih-dem **TAHR**-trayt)* (Ambien)	oral	—	10 mg *Older adults:* 5 mg	Initial dose of 5 mg should be used in elderly clients. Food delays the hypnotic action of the drug.

doxylamine or **diphenhydramine**) that exerts a depressant effect on the CNS to produce sedation. Thus, the side effect of the antihistamine is the desired effect in these sleep aids. Some products also may contain an analgesic, such as aspirin or acetaminophen, to reduce minor pain that might prevent or disrupt sleep.

Clients using nonprescription sleep aids should be advised to use caution in engaging in hazardous tasks while using these medications. They also should be advised to seek medical assistance if insomnia persists for more than 2 weeks. Nonprescription sleep aids should not be used without a physician's advice by clients with asthma or glaucoma. Clients using these drugs should be cautioned to avoid the use of alcohol or other CNS-depressant drugs, as these may interact with the nonprescription sleep aids.

APPLYING THE NURSING PROCESS

ASSESSMENT

The nurse has contact with clients with sleep pattern disturbances and taking sedatives and hypnotics in a variety of settings. If a client is hospitalized, the nurse must obtain orders for a sedative or hypnotic and/or make decisions about the administration of PRN orders for these drugs. When the client is receiving sedatives or hypnotics primarily for the relief of anxiety or the promotion of sleep, supportive nursing measures are also required. The administration of medication does not relieve the nurse of responsibility to help the client obtain mental tranquility or restful sleep. More specifically, an effort should be made to identify the causes of any mental or physical discomfort and to formulate a nursing plan to relieve these problems. This effort on the part of the nursing staff, much like that involved with relief of pain, must be an around-the-clock effort.

If the client is having difficulty sleeping, the nurse should attempt to determine the cause and nature of the sleep pattern disturbance (e.g., whether it occurs in falling asleep or in waking early). Possible causes include anxiety, hunger, pain, environmental distractions, discomfort caused by unfamiliar surroundings, and the effects of other drugs the client is receiving. Anti-Parkinson drugs, beta-blocking agents, and nonprescription drugs containing caffeine are examples of drugs that may produce sleeplessness. In critically ill infants, agitation and sleep pattern disturbances may be related to respiratory insufficiency, pain or such environmental factors as lights and machinery. Many children, whether at home or in the hospital, experience sleep pattern disturbances. Parents can be advised to keep a diary to document sleep patterns. This information then is used in planning interventions.

When the factors associated with disturbed sleep patterns are known, specific nursing interventions can then be directed toward the factors contributing to the sleep disturbance. Whenever possible, bedtime routines should be as close as possible to those used at home. Also, the nurse should avoid waking a client who has finally fallen asleep unless it is absolutely necessary. Planning care with this in mind helps promote rest and recovery.

Care should be taken in the use of PRN orders for sedatives and hypnotics. In some cases, dependency and withdrawal symptoms may be experienced. In other cases, particularly with the use of hypnotics, an insufficient amount of REM sleep may occur. As a result, the client may experience symptoms such as irritability, tenseness, and confusion. In addition, it may take several weeks following the discontinuance of sleeping medications for a predrug sleep pattern to be re-established.

NURSING DIAGNOSES

Including but not limited to:

- Disturbed sleep pattern related to known or unknown cause
- Risk for injury related to adverse effects of sedatives/hypnotics
- Deficient knowledge related to disease process and medical regimen

PLANNING/GOALS

- Client will experience relaxed undisturbed sleep as evidence by verbalizations of client.
- Client will not experience injury from falls or other adverse effects from medication regimen.
- Client will verbalize understanding of sleep process and medication regimen.

IMPLEMENTATION

Special care must be taken in the administration of sedatives and hypnotics to children and the elderly. Their activities, especially *ambulation*, must be carefully monitored, as these two particular groups may become confused or unsteady in their gait. When hypnotics are used, it is recommended that siderails be raised, that call bells be placed close at hand, and that clients be instructed to call for the nurse before attempting to get out of bed. Outpatients should be cautioned against driving a car or operating dangerous machinery while under the influence of these

drugs. In addition, the nurse may suggest that outpatients keep their medication somewhere other than on or in the nightstand. Accidental overdose can occur if a client takes additional doses in the middle of the night without being aware of the number of doses previously taken. Additionally, a nightstand or table is not a safe place to keep medications if there are children in the home. For their own safety, clients should be instructed to avoid the use of other drugs that could enhance the CNS depressant effect of the sedative or hypnotic.

A number of nursing interventions can be used to promote rest and sleep. These include relief of pain, anxiety and hunger; encouraging consistent times for retiring and rising; encouraging exercise during the day; avoiding CNS stimulants (e.g., caffeine); and providing information about sleep and the conditions that impair restful sleep. Children especially benefit from having a regular schedule for sleep and a routine to prepare them for sleep.

KEY NURSING IMPLICATIONS 17–1

Rest and Sleep

1. Supportive nursing care is always required when sedatives and hypnotics are used.
2. Whenever the client has difficulty sleeping, attempt to determine the nature of the difficulty and its cause.
3. Provide for the safety of clients using sedatives and hypnotics through the use of bedrails, cautions about ambulating without assistance and avoiding operation of hazardous equipment.
4. Nursing interventions to relieve sleep pattern disturbances include relief of pain, anxiety, and hunger, and promotion of schedule consistency.
5. CNS stimulants should be avoided and clients should be given information regarding sleep and conditions that interfere with restful sleep.

EVALUATION

- Client has undisturbed, restful sleep for 8 hours.
- Client does not experience falls or other adverse effects of sedative/hypnotic medications.
- Client verbalizes understanding of sleep process, medical regimen, adverse effects of sedatives/hypnotics, and need to be compliant with therapy.

CLIENTS RECEIVING BARBITURATES

Assessment

The nurse should be aware of the side effects of barbiturates: excessive CNS depression, hypersensitivity reactions, and excitement. Clients should be counseled to avoid operating machinery or automobiles with sedation. Also, they should avoid simultaneous use of other CNS depressants. It is particularly important that clients, especially those who are elderly, be observed for the *paradoxical* excitement that sometimes occurs with barbiturate use. The nurse also should be aware that this excitement may be a side effect of therapy and that a higher dosage will not produce sedation. The development of excitement should be reported to the prescriber, who may order a nonbarbiturate sedative or hypnotic in place of the barbiturate.

Nursing Diagnoses

Including but not limited to:

- Disturbed sleep pattern related to known or unknown cause
- Risk for injury related to drug interactions when using barbiturates
- Risk for injury related to barbiturate use in clients with depression, suicidal, or drug dependency
- Deficient knowledge related to medications

Planning/Goals

- Client will experience relaxed undisturbed sleep as reported by client.
- Client will not experience injury when taking barbiturates.
- Client will verbalize understanding of sleep process and medication regimen.

Implementation

Nurses should be aware that barbiturates interact with many other drugs. Clients taking barbiturates must be observed carefully when

other drugs are given. One of the interactions to be aware of is the enhancement of sedation when alcohol, antihistamines, hypnotics, narcotic analgesics, or psychotherapeutic drugs are also used. As a result of this type of interactive effect, barbiturates are often used with other drugs in suicide attempts. In addition to enhancement of sedation, the use of barbiturates may impair the actions of some drugs. This is particularly true of those metabolized by the liver, for example warfarin (**Coumadin**) and the anticonvulsant phenytoin (**Dilantin**). An adjustment in the dosage of these drugs may be required when barbiturates are added to or deleted from the client's treatment program.

Purposeful or accidental overdose of barbiturates can occur, resulting in toxicity and possibly death. It is particularly dangerous to take barbiturates with other CNS depressants. Persons attempting suicide often achieve their goal if they consume both barbiturates and alcohol. The nurse is especially careful to monitor barbiturate therapy in depressed clients, persons who are potentially suicidal, and those who are drug-dependent or who have a history of drug abuse.

Signs of barbiturate toxicity include confusion and excitement followed by heavy sleep and coma, pupillary constriction (which ends in pupillary dilation in the terminal stage), *cyanosis*, clammy skin, and hypotension. If ingestion has occurred within 4 hours of making the diagnosis, gastric lavage is used. Following this period, dialysis may be used.

Supportive care is essential in all cases. Such care may include maintenance of a patent airway through use of an endotracheal tube if necessary, the use of vasopressors to raise the blood pressure, and administration of adequate fluids. Intravenous administration of fluids is often necessary. Nursing actions include frequently changing the position of clients with decreased awareness to prevent pneumonia, monitoring urinary output and reporting low output (30 mL or less per hour), checking vital signs and level of awareness, administering fluids, and providing for client safety and comfort, including warmth.

When sodium salts of barbiturate drugs are given by injection, they must not be mixed in the same syringe with meperidine HCl (Demerol). These two drugs are not chemically compatible. To be effective, they must be administered in separate syringes.

KEY NURSING IMPLICATIONS 17–2

Clients Receiving Barbiturates

1. Watch for excessive CNS depression, hypersensitivity reactions, and paradoxical excitement.
2. Do not mix sodium salts of barbiturates in the same syringe with meperidine HCl.
3. Avoid using CNS depressants, such as alcohol or antihistamines in clients taking barbiturates, and be aware of other possible drug interactions, e.g., warfarin and anticonvulsants, especially phenytoin.
4. Barbiturates may be used in suicide attempts. The nurse protects the potentially suicidal client and intervenes promptly whenever barbiturate toxicity is noted.
5. Barbiturates should be discontinued gradually if they have been used for a prolonged period of time. Abrupt withdrawal may result in convulsions.

Evaluation

Because of the potential for tolerance and dependency, nurses should carefully observe clients who take these drugs over a period of time. Notations should be made about their therapeutic effectiveness (i.e., relief of anxiety, production of sedation). When clients are being withdrawn from barbiturates, generally the dosage of the drug is gradually reduced over a period of time to prevent withdrawal symptoms. Rapid withdrawal may produce convulsions.

- Client verbalizes restful sleep for 8 undisturbed hours.
- Client does not experience injury while taking barbiturates.
- Client verbalizes understanding of sleep process, medical regimen, and adverse effects of barbiturates and need to be compliant with therapy.

CLIENTS RECEIVING NONBARBITURATES

Assessment

The nursing care of clients taking nonbarbiturate sedatives and hypnotics is similar to that given to clients taking barbiturates. Observations

are made of drug effectiveness and the development of side effects.

Refer to "Nursing Diagnoses" and "Planning/Goals" for clients receiving sedatives/hypnotics.

Implementation

Nursing interventions related to all persons taking nonbarbiturate drugs include ensuring client safety through the use of siderails and supervision. Outpatients should be advised to avoid driving and operating machinery. Other drugs that enhance CNS depression must be avoided or used only under careful supervision.

There are several specific measures related to administration of this group of drugs. As previously noted, paraldehyde is no longer frequently used. However, the nurse may be asked to administer this drug in certain settings, for example, a nursing home or long-term psychiatric setting. If given orally, its disagreeable taste and odor may be disguised by keeping the drug cold and administering it in cold fruit juice or milk. The drug should be given immediately after measurement of the dose because paraldehyde will decompose into acetic acid if it is permitted to stand. Paraldehyde is excreted through the lungs, resulting in a characteristic odor that pervades the client's environment.

Chloral hydrate (**Noctec**) also has an unpleasant taste. If the liquid preparation of this drug is used, it should be disguised in fruit juice or milk. In most instances, if the client is able to swallow capsules, this is the preferred form. When any drug is disguised in juice or milk, the nurse should be certain that the liquid is not contraindicated by the client's health condition, treatment program, or chemical incompatibility. Also, the client should find the mixture palatable. Finally, because many of the clients to whom liquid medications are given are children or elderly, the nurse should avoid using too large an amount of the disguising agent for the individual to drink all of it.

Chloral hydrate is only useful for short-term therapy. After a period of about 10 days, its use should be reviewed by the prescriber.

The general nursing care for clients receiving triazolam (Halcion), flurazepam (Dalmane), temazepam (Restoril), estazolam (ProSom), and quazepam (Doral) is the same as for clients taking other benzodiazepines (see Chapter 18 for a complete discussion). It is important to remember that these drugs are contraindicated in pregnancy, since they may result in fetal damage when used during the first trimester and in fetal CNS depression when used late in pregnancy. Benzodiazepines are excreted in milk and are not recommended for nursing mothers. Whenever these drugs are to be discontinued after a prolonged period of use, the dose is tapered off to avoid withdrawal symptoms.

KEY NURSING IMPLICATIONS 17–3

Clients Receiving Nonbarbiturates

1. Client safety must be assured.
2. Orally administered paraldehyde is less disagreeable if chilled and administered in juice or milk.
3. Inject parenteral paraldehyde into a large muscle mass, preferably using the Z-track method.
4. The liquid preparation of chloral hydrate should be disguised in juice or milk.
5. Benzodiazepine hypnotics are contraindicated in pregnancy and should always be slowly withdrawn after prolonged use.
6. The use of all sedative and hypnotic drugs should be subject to periodic review.
7. Evaluate client's objective and subjective responses to use of these drugs and to their withdrawal.

Evaluation

The use of all sedative and hypnotic drugs should be subject to routine periodic review. This review should consider: (1) the client's condition, (2) the necessity or advisability of continuing the drug, (3) the development of dependency and (4) the effectiveness of the drug at that point in time. Most sedative and hypnotic agents are designated as controlled substances in the United States.

When possible, direct observation should be made of the client's sleep pattern. Clients should also be questioned about their subjective response to the medication, for example, their level of anxiety and feelings of being rested or refreshed following sleep. Objective behavioral and subjective responses to withdrawal of these medications are obtained, recorded, and discussed with the prescriber.

NURSING CARE PLAN

A Client with Anxiety Taking Diazepam (Valium)

Bituf Chow, age 32, was admitted to the hospital to rule out myocardial infarction. He had suffered chest pain at the stadium during an exciting Cleveland Browns-Pittsburgh Steelers football game. His pain was gone by the time he was admitted to a monitored unit for observation. Initial laboratory work was negative for enzyme elevation, but his EKG showed inverted T waves, his potassium level was low at 3.0, and his blood alcohol level was high. He admitted smoking 2 packs of cigarettes a day and had attended a "tailgate party" before the game started. He appeared restless and was placed on diazepam 5 mg q4h po. He was kept on a cardiac monitor with q6h blood work during the next 24-hour period. When no chest pain recurred and laboratory work was found to be normal, he was discharged with prescriptions for sublingual nitroglycerin and diazepam and instructions to report for a stress test in 1 week.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Chest pain.	Risk for acute pain: related to cardiac ischemia.	Client will have relief of chest pain within 10 minutes of initiation of treatment, as evidenced by observation and verbal statements.	Provide sublingual nitroglycerin for emergency use and teach client how and when to use it. Maintain calm atmosphere; i.e., soft music, diminished lights. Approach client calmly. Provide reassurance.	Client verbalizes pain relief 15 minutes after using nitroglycerin. Demonstrates understanding of how nitroglycerin works and when to use it.
EKG changes. Laboratory work.	Risk for decreased cardiac output related to myocardial ischemia.	Client will maintain normal cardiac output as evidenced by normal vital signs, EKG, and mentation. Cardiac enzymes will remain within normal limits, as will heart rate and rhythm.	Monitor for EKG changes and treat as necessary. Monitor laboratory work. Monitor vital signs every hour for first 24 hours then every 4 hours.	Client's EKG, vital signs, electrolytes, and enzymes are within normal limits prior to discharge.
Smokes 2 packs cigarettes daily. Drinks alcohol.	Risk for ineffective health maintenance related to insufficient knowledge of effects of smoking, alcohol, and stress.	Prior to discharge, client will identify relationship of smoking, alcohol, and stress to cardiac disease.	Explain to client that smoking narrows blood vessels and alcohol increases fluid volume, which may lead to high blood pressure and cause heart attack or stroke. Discuss stress management.	Client decreases or eliminates smoking and alcohol consumption and makes lifestyle changes to reduce stress.
Restless, anxious.	Anxiety related to present admission and unknown etiology for chest pain.	Client will verbalize feelings of decreased anxiety and exhibit less restlessness 24 hours after admission.	Explain therapy and procedures to client. Encourage client to describe fears. Teach relaxation techniques. Provide conditions conducive to restful sleep including a backrub HS and limiting interruptions during periods of sleep.	Client does not show overt signs of anxiety. Reports and discusses anxiety.

Familiarity with diazepam and over-the-counter agents that can interact with it.	Deficient knowledge (diazepam, side effects, and potentiation with other agents).	Client verbalizes proper use of diazepam, potential side effects, and interactions prior to discharge.	Maintain dosage, as stopping long-term use may cause withdrawal symptoms. Teach client to report drowsiness, fatigue, and dizziness. Caution client about using machinery, as diazepam reduces alertness. Schedule monthly blood work for white blood count, bilirubin. Assess extent of alcohol use, as it potentiates diazepam's sedation.	Client describes proper use of diazepam, importance of drug compliance, side effects, and that diazepam should not be used with antihistamines, alcohol, sleeping pills, or other central nervous system depressant drugs.
Oxygen needs.	Risk for impaired gas exchange related to alteration in cardiac function and smoking.	Client will have normal respiratory rate and rhythm during hospitalization.	Maintain oxygen as needed. Monitor client for changes in respiratory status. Restrict smoking as mutually agreed upon with client.	Client does not show oxygen deprivation.
Asking questions.	Fear related to perceived role changes.	Client will verbalize positive feelings about ability to adapt lifestyle to prescribed regimen prior to discharge.	Assist client in personal planning for maintenance of healthy lifestyle. Identify smoking cessation groups and counseling.	Client identifies plan for health maintenance prior to discharge.
Cardiac risk factors.	Deficient knowledge (cardiac risk factors of diet, smoking, and activity.)	Client will identify own risk factors and methods of management prior to discharge. Client verbalizes importance of follow-up stress test.	Teach client general principles about low-fat, low-cholesterol diet and its importance. Encourage client to stop smoking.	Client makes lifestyle modifications to reduce risk factors. Client returns for follow-up stress test.
Knowledge about stress test.	Deficient knowledge (procedures to diagnose cardiac problem).	Client will verbalize the stress test procedure.	Explain need for stress testing and procedure for test.	Client keeps appointment for stress test.

HOME CARE / CLIENT TEACHING

1. It is important in all contacts with persons taking sedatives and hypnotics to stress the safe storage and administration of these drugs and to caution them about engaging in hazardous activities while using these drugs.
2. Home visits provide an opportunity for the nurse to directly assess the client's environment and to make suggestions about environmental modifications and/or behavioral modifications that might alter sleep pattern disturbances.
3. Clients need to be instructed not to take sedatives/hypnotics, unless their schedule allows for a full night's sleep.
4. Clients should be informed to notify physician if sleep pattern has not improved.
5. Because dosing is specific for each client, client needs to be instructed not to change dosage without the direction of the physician.
6. Elderly clients and children need to be closely monitored when taking sedatives/hypnotics.
7. Clients need to informed concerning drug interactions associated with use of barbiturates.
8. Clients need to be instructed on the potential of drugs for being habit-forming.
9. Clients should avoid use of alcoholic beverages.

CASE STUDY

Mrs. Pala is a 75-year-old woman admitted to the hospital following a fall on the ice. The X-ray reveals a fractured hip and the client is placed on bedrest in traction. On the night of her admission, she has difficulty sleeping. The resident physician writes an order for chloral hydrate (Noctec) 250 mg, p.o. PRN for sleep. The nurse administers this medication at midnight. At 2 AM, the night nurse notices that Mrs. Pala is still awake. A check of the client's medication orders shows the following:

- Multivitamin q.d.
- Digoxin (cardiotonic) 0.25 mg p.o. q.d.
- Morphine Sulfate 1–2 mg IV q1–2h PRN for pain
- Chloral hydrate (Noctec) 250 mg. p.o. H.S. PRN, may repeat x 1 PRN

Questions for Discussion

1. How does chloral hydrate compare with barbiturates in terms of effectiveness, duration of action, and side effects?
2. Can chloral hydrate be used effectively for this client if she is hospitalized for 6 weeks?
3. As the night nurse, what would you do about Mrs. Pala's inability to sleep at 2 AM?
4. What safety measures should be instituted for any hospitalized client taking a hypnotic drug?

CRITICAL THINKING EXERCISES

1. Visit a local pharmacy and examine the available over-the-counter sleep aids. What is the major ingredient in each of these preparations?
2. Examine the medication record of a client taking a barbiturate drug. What possible drug interactions could occur? What is the nature of these interactions (enhancement, antagonism, etc.)?
3. Request assignment to a client with a sleep disturbance. Do an appropriate nursing assessment and develop a plan of care to relieve this problem.
4. Examine the PRN orders for sedatives and hypnotics in the clinical setting where you are assigned. Classify these drugs as barbiturates or nonbarbiturates. Which drugs are being used most frequently?
5. Discuss the drug interactions associated with use of barbiturates.
6. Describe the sleep process.
7. A client is brought to the emergency department of the hospital with a suspected barbiturate overdose. What symptoms would you expect to see and why to they occur?
8. You are working in a doctor's office and a client taking benzodiazepines for insomnia asks for a 3-month supply of her medication, because she is going on an "around-the-world" cruise and wants enough to last her the entire time she is on the cruise. The doctor refuses. You explain to the client why the doctor refuses. What do you tell her?

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18 Agents Used to Treat Psychiatric Disorders

OBJECTIVES

After studying this chapter, the student will be able to:

- List the major classes of psychotropic agents and give an example of an agent in each class
- Identify the mechanism of action of the major classes of psychotropic agents
- List the major therapeutic and side effects associated with the use of each class of psychotropic agents
- State the behavioral observations the nurse should make when a client is receiving a psychotropic agent
- Identify the antipsychotic agents that may be administered on a once-daily schedule and discuss the advantage of this regimen
- Apply the nursing process related to providing care for clients receiving each of the classes of agents used in the treatment of psychiatric disorders

Most people experience anxiety, depression, and/or grief during their lifetime. Such feelings usually do not disrupt the functioning severely enough to require treatment. However, when such symptoms become severe and/or prolonged or if they interfere with work or relationships with friends and relatives, therapy may be required.

Psychotropic agents are drugs used to treat emotional and mental disorders. They are among the most frequently prescribed medications in the United States. They are often referred to as tranquilizers by the lay public and by health professionals. Although the use of such drugs is widespread, evaluating their effectiveness in a given client may be difficult, and a wide array of adverse effects may accompany their use. Careful diagnosis and treatment by the physician as well as careful observation of the progress of the client being treated for an emotional disorder are required to maintain optimal client care.

This chapter looks at the drugs used in the treatment of *anxiety*, *psychoses*, and *affective disorders*.

ANTIANXIETY AGENTS (ANXIOLYTICS)

Anxiety is a universal emotion of humans. At moderate levels, anxiety tends to improve performance and may actually be desirable (Figure 18–1). At higher levels, anxiety may not be beneficial but detrimental.

When anxiety becomes severe and interferes with a person's normal functioning, therapy may be required. Situational anxiety is when a stressful or threatening occurrence provokes an anxious response. Such anxiety is generally of short duration

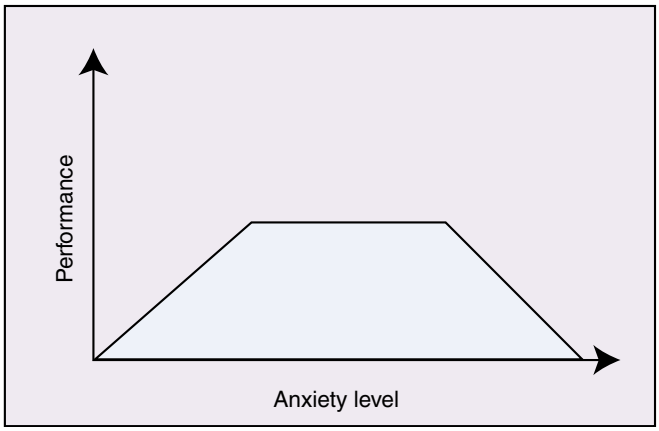

Figure 18–1 With increasing levels of anxiety there is first an increase in performance, then a plateau, and, eventually, a reduction in performance.

and therapy is not usually required. Pathologic anxiety cannot generally be related to any specific outward cause. It is usually a severe form of anxiety frequently accompanied by insomnia, headache, diarrhea, tremors, apprehension, and/or many other symptoms. Such anxiety is generally treated successfully by the use of antianxiety agents (anxiolytics). It is estimated that about 15% of the adult population of the United States has used an anxiolytic agent during the last several years. Such drugs have been referred to as "minor tranquilizers" by some, but this term is misleading, as it mistakenly implies a low level of potency.

Four groups of anxiolytics are currently employed in the United States. These are the barbiturates, the antihistamines, the carbamates, and the benzodiazepines. Each of the agents in these groups is capable of producing some degree of depression of the central nervous system (CNS), which may, at least in part, account for its anxiolytic, or anxiety-reducing effect.

Barbiturates

The barbiturates have long been used for the treatment of insomnia (see Chapter 17) and anxiety. Their action is attributed to the ability to depress the CNS and thereby produce a sedative effect. Studies that have attempted to evaluate the anxiolytic effects of these drugs have revealed that they have little, if any, effect on anxiety. Furthermore, their use has been associated with the development of daytime drowsiness that may interfere with a client's ability to engage in normal activities. These drugs may also cause fatigue and the development of a "hangover" feeling because of their ability to suppress rapid-eye-movement (REM) sleep. In addition, the barbiturates are potent inducers of hepatic microsomal enzyme production. This may interfere with the action of other drugs in the body that are metabolized by these enzymes. Lastly, the barbiturates are generally more toxic than other anxiolytic agents and may, therefore, be more likely to result in death with overdose.

The many problems associated with barbiturate use, coupled with the lack of evidence of their effectiveness in anxiety treatment, have led to a decline in the use of these agents for antianxiety therapy.

Carbamates

These chemically related drugs were the first nonbarbiturate drugs to be used in the treatment of anxiety. The most popular member of this group, **meprobamate**, was initially thought to be superior to the barbiturates. After more than two decades of clinical experience with this drug, there is little evidence to prove that it is any more effective than the barbiturates.

Many of the problems associated with barbiturate use are also evident in the use of the carbamates. They cause considerable daytime sedation, suppress REM sleep, and may interfere with motor coordination. As with barbiturates, the use of carbamates also results in the rapid development of tolerance, as well as the likelihood of dependence with prolonged use. Severe withdrawal reactions have also been reported in clients who have received carbamates. The use of carbamates in the elderly has been associated with the development of hypotension, particularly during the initial stage of therapy.

Antihistamines

Most antihistaminic drugs produce some degree of sedation because of their ability to depress the CNS. Two members of this group, **hydroxyzine hydrochloride** (**Atarax**) and **hydroxyzine pamoate** (**Vistaril**), have been used in the treatment of anxiety. These agents produce greater sedative effects than most other antihistamines, but do not exert the potent anticholinergic effects that are seen with the use of other antihistamines.

The anxiolytic action of the antihistamines is attributed primarily to their sedative effects, as no

other anxiolytic action has been identified in their use. The rationale for prescribing them for the treatment of anxiety is questionable. They have been employed, however, with some success in reducing anxiety associated with *pruritic dermatoses* (skin disorders with excessive itching). In such disorders, the action of the antihistamines appears to be related to their antipruritic activity rather than to any central anxiolytic action.

Benzodiazepines

The benzodiazepines are chemically related compounds that have emerged as the most widely prescribed drugs for the treatment of anxiety. Two members of this group, diazepam (Valium) and **chlordiazepoxide** (Librium), were at one time the two most widely prescribed drugs in the United States. Benzodiazepines are popularly used as anxiolytics because they:

- cause relatively little drowsiness at normal therapeutic doses
- are relatively safe to use at normal therapeutic dosage levels
- do not suppress REM sleep
- do not readily cause the development of tolerance
- do not interfere with the metabolism of other drugs

Although the precise mechanism of action of the benzodiazepines is not completely understood, it appears that they exert their primary action on the *limbic system* of the brain. The benzodiazepines appear to act, at least in part, by potentiating the inhibitory action of gamma-aminobutyric acid (GABA), an amino acid that appears to mediate nerve impulse transmission in the CNS. Specific benzodiazepine-binding sites have also been identified in various parts of the brain. Binding of the benzodiazepines to these sites appears to produce sedation and an anxiolytic effect. Unlike most other anxiolytic agents, the action of the benzodiazepines is not completely dependent on their ability to cause sedation. In fact, long after the sedative effects of these agents wear off, their anxiolytic action continues. As the agents in this chemical group do not appreciably suppress REM sleep, they are somewhat superior to other anxiolytic drugs as hypnotic agents (see Chapter 17).

After administration, most of the benzodiazepines are metabolized extensively, primarily by microsomal enzymes in the liver.

Coadministration of certain drugs (e.g., cimetidine and propranolol), which are metabolized by the same liver enzymes as benzodiazepines, can lead to a longer duration of activity of the benzodiazepine. A client should be watched for signs of excess sedation. In the process of being metabolized, active metabolites are often generated with a much longer duration of action than the parent compound. This is evidenced by the poor correlation between the expected duration of action of the benzodiazepine drug administered and the duration of action observed. **Oxazepam** (**Serax**) and **lorazepam** (**Ativan**) are metabolized to inactive compounds and, therefore, have short half-lives and brief duration of activity. For this reason, the use of these agents may be preferred in clients with liver disease or in the elderly.

The major disadvantages of the benzodiazepine group of drugs are their potential for accumulation in the body and the ability to elicit serious withdrawal symptoms when use is discontinued. With the exception of triazolam (Halcion), most of the benzodiazepines have a relatively long half-life in the body. If this is not considered in the clinical use of these agents, accumulation and toxicity may occur. This effect is of particular concern when treating the elderly, as even relatively low doses may produce considerable sedation, confusion, or even paradoxical excitement.

When used over long periods of time, tolerance often develops to the sedative and euphoric actions of these agents—but not to their anxiolytic action. Physical dependence does occur, but may not appear for as long as a week after therapy has been discontinued because of the long half-life of many of the drugs and their active metabolites in the body. Ironically, such withdrawal symptoms may take the form of nervousness and severe anxiety. Some clients who have been maintained on high benzodiazepine doses for long periods may experience seizures upon abrupt withdrawal of the drug. To minimize the likelihood of withdrawal symptoms in clients who have used benzodiazepines for prolonged periods, the drug should be gradually discontinued over a 4- to 8-week period.

In using benzodiazepines for the treatment of anxiety the dosage should be adjusted to obtain relief with a minimal degree of sedation. Because of the long half-life of some of these drugs in the body, some clients may require only one or two doses each day. Such doses are often best administered at bedtime to take advantage of the sedative and hypnotic action of the agent.

Flumazenil (**Mazicon**) is a benzodiazepine receptor antagonist used to reverse the CNS-depressant effects caused by therapeutic or toxic doses of the benzodiazepines. Within minutes after administering an IV dose of flumazenil, a reversal of sedation occurs and the client regains alertness. Over time, some benzodiazepine effects may recur. Therefore, clients should avoid engaging in potentially hazardous activities or consuming alcohol or nonprescription drugs for 18 to 24 hours after flumazenil has been administered.

Buspirone (**BuSpar**) is a relatively new anxiolytic drug that is chemically different from other anxiolytic drugs. Unlike most of these other agents, buspirone does not cause sedation or functional impairment and has little potential for abuse. However, buspirone requires 1 to 2 weeks of regular therapy to produce a clinical response and 3 to 4 weeks of therapy for optimum results to be seen. It may be useful, therefore, for clients who require extended treatment of anxiety.

Table 18–1 compares the properties of the anxiolytic agents in current use.

ANTIPSYCHOTIC AGENTS

Antipsychotic drugs are primarily employed in the treatment of *schizophrenia*, *organic psychoses*, and the *manic* phase of *bipolar affective disorders*, i.e., disorders involving mood changes with both a manic and a depressive component. Since the introduction of these drugs in the early 1950s, several hundred million people have been treated with them. Their use has revolutionized the treatment of persons with mental illness and resulted in a drastic reduction in the number of clients who require institutionalization. Yet, considerable misunderstanding continues among the lay public and some health professionals about the action of these drugs. It should be carefully noted that the antipsychotic agents do not cure mental illness, but only alleviate some of its symptoms.

Because the antipsychotic agents are used in the treatment of serious mental illness, they are often referred to as "major tranquilizers." Others have introduced the term *neuroleptic*, because these agents may suppress spontaneous movements and complex behavior, but do not alter spinal reflexes as do some of the general anesthetics, sedatives, and hypnotics.

During the past several years, several hypotheses have evolved to explain how and why psychotic behavior occurs. One hypothesis relates psychotic behavior to a state of overactivity of the neurotransmitter dopamine in the limbic system, cortex, and other parts of the brain. Although this hypothesis may not explain all aspects of psychotic behavior, it does help explain how antipsychotic drugs work. These drugs appear to act by reducing excessive dopamine activity, by blocking postsynaptic dopamine receptors in the cerebral cortex, basal ganglia, hypothalamus, limbic system, brainstem, and medulla (Figure 18–2). In so doing they appear to inhibit or alter the dopamine-mediated response in the brain. Such action correlates well with symptomatic improvement of clients with psychotic disorders.

Several different chemical classes of antipsychotic drugs have emerged. Although quite different in chemical structure, all of these compounds tend to exert similar pharmacological and clinical effects.

The first antipsychotic agent to be introduced was **chlorpromazine** (**Thorazine**). This drug is part of the chemical group known as the phenothiazines. In the thirty years following its introduction, dozens of other phenothiazine derivatives were marketed. Although these compounds share a similar chemical structure, they have individual properties that make them unique.

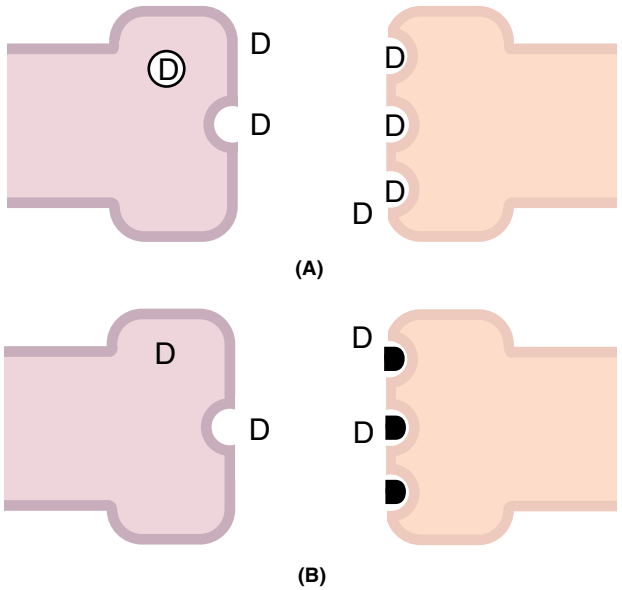

Figure 18-2 (**A**) Dopamine Ⓓ normally combines with postsynaptic dopamine receptors in the central nervous system. (**B**) Antipsychotic drugs ◗ appear to act by blocking postsynaptic dopamine receptors.

TABLE 18–1

Oral Anxiolytic Agents

Note: Barbituates may impair mental and physical abilities.
Instruct client to avoid activities requiring mental alertness.
Clients should avoid alcohol and other CNS depressants (e.g., antihistamines, opioids, other psychotropic drugs) while using barbiturates.
Monitor drug use very carefully in depressed, suicidal or confused clients and in known drug abusers.
Doses of oral anticoagulants and phenytoin (anticonvulsant) may need to be adjusted in persons using barbiturates.
Drug doses should be tapered off gradually.
Observe for respiratory depression because this may be the first sign of overdose.

DRUG	USUAL ANXIOLYTIC DOSE (ORAL)	NURSING IMPLICATIONS
Barbiturates		
amobarbital, amobarbital sodium *(**am**-oh-**BAR**-bih-tal, **am**-oh-**BAR**-bih-tal **SOH**-dee-um)* (Amytal, Amytal Sodium, etc.)	*Adults:* 30–50 mg 2–3 times daily	Has anticonvulsant activity. See note above.
aprobarbital *(**ap**-roh-**BAR**-bih-tal)* (Alurate)	*Adults:* 40 mg 3 times daily	See note above. Reduced dosages may be necessary in older adults.
butabarbital sodium *(**byou**-tah-**BAR**-bih-tal **SOH**-dee-um)* (Butisol Sodium)	*Adults:* 15–30 mg 3–4 times daily *Children:* 2 mg/kg	See note above. Older persons may manifest confusion, excitement, or mental depression.
mephobarbital *(**mef**-oh-**BAR**-bih-tal)* (Mebaral, etc.)	*Adults:* 32–100 mg 3–4 times daily *Children under 5:* 16–32 mg 3–4 times daily	Has anticonvulsant activity. See note above.
pentobarbital, pentobarbital sodium *(**pen**-toh-**BAR**-bih-tal, **pen**-toh-**BAR**-bih-tal **SOH**-dee-um)* (Nembutal, Novo-Pentobarb ✤)	*Adults:* 20 mg 3–4 times daily *Children:* 2–6 mg/kg/day	See note above.
phenobarbital *(**fee**-noh-**BAR**-bih-tal)* (Luminal, etc.)	*Adults:* 10–40 mg 2–3 times daily *Children:* 2 mg/kg	Has anticonvulsant activity. See note above.
secobarbital, secobarbital sodium *(**see**-koh-**BAR**-bih-tal, **see**-koh-**BAR**-bih-tal **SOH**-dee-um)* (Seconal, Seconal Sodium, etc.)	Not indicated for oral treatment of anxiety.	See note above.
Antihistamines		
hydroxyzine HCl, hydroxyzine pamoate *(hy-**DROX**-ih-zeen **hy**-droh-**KLOR**-eyed, hy-**DROX**-ih-zeen **PAM**-oh-ayt)* (Apo-Hydroxyzine ✤, Atarax, Multipax ✤, Vistaril, etc.)	*Adults:* 25–100 mg 4 times daily *Children:* 0.5 mg/kg	Hydroxyzine HCl may be administered IM in acute cases. Has antiemetic effect. May be used with other pre- and post-operative medications. Caution patient to avoid activities that require mental alertness. Drowsiness usually decreases as therapy continues.

continues

TABLE 18–1 *continued*

Note: Benzodiazepines may impair mental and physical abilities.
Client should avoid activities requiring mental alertness.
Client should avoid the use of alcohol and other CNS depressants.
Monitor drug use very carefully in depressed, suicidal, or confused clients and in known drug abusers.
Doses should be tapered off gradually.
Benzodiazepine overdose may be treated with flumazenil given intravenously.

DRUG	USUAL ANXIOLYTIC DOSE (ORAL)	NURSING IMPLICATIONS
Benzodiazepines		
alprazolam *(al-**PRAY**-zoh-lam)* (Xanax)	*Adults:* 0.25–0.5 mg 3 times daily	Lower doses should be employed in elderly and debilitated patients.
chlordiazepoxide *(**klor**-dye-**ayz**-eh-**POX**-eyed)* (Librium, Medilium, Novopoxide)	*Adults:* 5–25 mg 3–4 times daily *Children (6–12):* 5–10 mg 2–3 times daily	Available for IM or IV use in the treatment of acute anxiety or withdrawal symptoms of acute alcoholism. Special diluent must be used for IM injections.
clorazepate dipotassium *(klor-**AY**-zeh-payt dye-poh-**TASS**-ee-um)* (Novoclopate, Tranxene)	*Adults:* 15–60 mg daily in single or divided doses Extended release: 3.75–7.5 mg 3 times daily	Daily dose should not exceed 90 mg.
diazepam *(dye-**AZ**-eh-pam)* (E-Pam, Meval, Valium, Valrelease)	*Adults:* 2–10 mg 2–4 times daily *Children:* 1–2.5 mg 3–4 times daily *Older adults:* 2–2.5 mg 1–2 times daily	Available for IV use. If administered IV, drug solution should be injected by direct IV route. Dilution in IV fluids prior to administration is not advisable, because of the possibility of precipitation of the drug.
halazepam *(hal-**AZ**-eh-pam)* (Paxipam)	*Adults:* 20–40 mg 3–4 times daily *Older adults:* 20 mg 1–2 times daily	Lower doses should be employed in elderly and debilitated patients.
lorazepam *(lor-**AZ**-eh-pam)* (Ativan, Novolorazem)	*Adults:* 2–6 mg daily in 2–3 divided doses *Older adults:* 0.5–2 mg/day	May also be administered by IM or IV route. Lower doses should be employed in elderly or debilitated patients.
oxazepam *(ox-**AZ**-eh-pam)* (Ox-Pam, Serax, Zapex)	*Adults:* 10–30 mg 3–4 times daily	Useful in older patients.
Miscellaneous Anxiolytic Agents		
buspirone *(byou-**SPY**-rohn)* (BuSpar)	*Adults:* 5–10 mg 2–3 times daily Usually does not exceed 60 mg/day	Buspirone exerts less sedating action than most other anxiolytic agents. Should not be used in combination with MAO inhibitor. Do not administer more than 60 mg/day. Should be given at regular intervals; PRN dosing is not effective.

continues

TABLE 18–1 *continued*

Note: Physical and psychological dependence may occur with the use of carbamates.
Avoid using in the first trimester of pregnancy.
Avoid use of central nervous system depressants, including alcohol.

DRUG	USUAL ANXIOLYTIC DOSE (ORAL)	NURSING IMPLICATIONS
doxepin HCl *(**DOX**-eh-pin **hy**-dro-**KLOR**-eyed)* (Adapin, Sinequan, Triadapin ✱)	*Adults:* 75–150 mg daily in 3 divided doses	Not recommended for children under 12. Although compound has antidepressant action, its precise anxiolytic action is unknown. MAO inhibitors should be discontinued at least 2 weeks before initiating doxepin therapy. Caution client to avoid tasks requiring mental alertness.
Carbamates		
meprobamate *(meh-**PROH**-bah-mayt)* (Equanil, Miltown, Novo-Mepro, etc.)	*Adults:* 1,200 mg/day in 3–4 divided doses *Children (6–12):* 100–200 mg 2–3 times daily	Observe client for evidence of allergic manifestations (dermatoses, bronchospasm, etc.) and/ or hematological changes which may be manifested as fever, sore throat, etc. Do not exceed 2,400 mg daily. Tablets and sustained-release capsules should not be crushed or chewed.

In addition to the dopamine antagonism all antipsychotic agents appear to produce, the phenothiazines have also been shown to depress various components of the reticular activating system (RAS). This system helps to control body metabolism and temperature, wakefulness, vasomotor tone, emesis, and hormonal balance. In addition, these compounds also exert peripheral effects on the autonomic nervous system (ANS).

The use of any of the currently available antipsychotic agents may result in a wide array of adverse effects. These most commonly affect the CNS, ANS, and/or the cardiovascular system. By far the most common CNS effect of these agents is sedation. This may be undesirable in a client in whom sedation can interfere with a normal lifestyle. It may, however, be useful in an agitated, psychotic client with insomnia. The ability of various antipsychotic agents to cause sedation varies considerably and tolerance to the sedative effect may develop after several weeks of use.

Another CNS effect often seen in the use of antipsychotic drugs, particularly with some of the phenothiazines, is an increased likelihood of seizure development. This is believed to result from the action of these agents to lower the seizure threshold of the CNS. Clients taking such drugs who have a history of seizure disorders must, therefore, be monitored closely and may require treatment with anticonvulsant drugs or an alteration in existing anticonvulsant therapy.

Autonomic effects of the antipsychotic agents are often anticholinergic or atropine-like in nature. They include dry mouth, constipation, urinary retention, and blurred vision as well as interference with ejaculation in male clients. Many of these effects can be anticipated and prevented by the use of appropriate measures (e.g., initiation of therapy with laxatives and/or stool softeners to prevent constipation, regular mouth care, and/or providing hard candy to relieve dryness of the mouth). Many of the autonomic adverse effects caused by these agents may lessen or disappear with continued therapy and almost always disappear upon discontinuation of antipsychotic drug therapy.

Adverse cardiovascular effects caused by the antipsychotic agents may be serious and even life-threatening, particularly in elderly clients and/or those with preexisting cardiovascular problems. One of the most serious of these effects is orthostatic hypotension, considered to be a reflex mechanism associated with the hypotensive action of these drugs. In addition, the anticholinergic

effects of these drugs may result in the development of tachycardia and other rhythm changes of the heart. For this reason, a baseline electrocardiogram is often performed prior to initiating therapy in order to readily detect the cardiac alterations produced by these drugs.

Perhaps the most dramatic of all of the actions of the antipsychotic drugs are the neurological effects which they may produce in some clients. Of these, the extrapyramidal symptoms (EPS) are the most alarming to the client. Such symptoms often include uncontrollable, involuntary, Parkinsonian-like tremors and movements. They are believed to result from the disruption of the normal balance of the neurotransmitters acetylcholine and dopamine within the basal ganglia. This may cause a relative increase in cholinergic activity to occur. Other clients may develop *akathisia*, a subjective feeling of restlessness resulting in an inability to sit still. Akathisia often is confused with anxiety, as the client may develop insomnia and a compulsion to pace the floor. Careful assessment is required to differentiate akathisia from increased agitation related to the person's illness. This assessment is necessary, however, to prevent prescribers from inappropriately increasing the dose of the antipsychotic when the akathisia should be treated instead. Low doses of propranolol or lorazepam or reduction in the dosage of the antipsychotic agent are useful in treating akathisia. Such EPS may also include *dystonias* or prolonged *tonic* contractions of various muscle groups, as well as *dyskinesias*, which are manifest as rhythmic *clonic* contractions of various muscles. Such dyskinesias may be manifested as an assortment of spasms, *tics*, and other involuntary muscle movements. The use of anticholinergic drugs in clients experiencing EPS will often reverse some of these undesirable effects.

Tardive dyskinesia is an extrapyramidal symptom that does not usually appear until the client has been on 2 or more years of antipsychotic drug therapy. It appears to be the result of dopamine receptor hypersensitivity, which may develop with prolonged blockage of these receptors by antipsychotic drug use. Such effects usually do not appear until antipsychotic drug doses are lowered or use of these drugs is discontinued. The dyskinesias seen are probably the result of exaggerated dopaminergic activity in the brain. Mild tardive dyskinesia is usually seen as rhythmic involuntary movement of facial muscles—often appearing as flycatching movements of the tongue, lip smacking, and chewing movements. More severe tardive dyskinesia may result in dyskinetic movements of the extremities, which may appear as jerking movements of the limbs, fingers, and toes. When tardive dyskinesia appears within 2 years of initiating psychotropic drug therapy, it may be reversible on discontinuation of the drug. When psychotropic drug therapy is continued for many years, tardive dyskinesia that develops is more likely to be irreversible.

Other adverse effects associated with antipsychotic drug use include impaired temperature regulation, lowering of the convulsive threshold, endocrine effects, dermatological reactions, photosensitivity, and pigmentary changes in the eye. Impaired temperature regulation caused by these drugs appears to be caused by their action on the hypothalamus and/or pituitary. Hypothermia has been reported to occur in some clients receiving phenothiazines, and chlorpromazine (Thorazine) has been used specifically as an adjunct in inducing hypothermia. Dopamine receptor blockade produced by these drugs in the hypothalamus appears to increase the rate of prolactin secretion and tends to reduce the urinary concentration of gonadotropins, estrogens, and progestins.

Some clients taking antipsychotic agents have been reported to experience a neuroleptic malignant syndrome (NMS), similar to malignant hyperthermia during anesthesia (see Chapter 11). These clients may develop fever, muscle rigidity, altered consciousness, and alterations in vital signs. It occurs most commonly within 2 weeks of starting or increasing the dosage of an antipsychotic drug. This condition requires prompt treatment, which may include anticholinergic agents, dopamine antagonists, and skeletal muscle relaxants.

One of the newest antipsychotic drugs is **clozapine** (**Clozaril**). It appears to be effective in treating some persons with major mental illness who have not responded to other antipsychotic drugs. Although it lacks many of the adverse effects seen in the use of other antipsychotic agents, its use has been associated with the development of *agranulocytosis*, a blood disorder fatal in about 2% of cases. Weekly blood tests are required to monitor for the development of agranulocytosis.

Table 18–2 summarizes the properties of the antipsychotic agents in current use. Note that chlorpromazine and prochlorperazine are available in long-acting oral forms, and **haloperidol** is available as a long-acting injection. Many antipsychotics are available in liquid oral dosage forms. The nurse may want to investigate these alternative dosage forms.

TABLE 18–2

Antipsychotic Drugs

Note: These drugs may impair mental or physical abilities.
Client should avoid activities requiring alertness.
Client should avoid the use of alcohol or other CNS depressants.
Monitor client for signs of extrapyramidal symptoms (EPS), anticholinergic effects, and orthostatic hypotension.
Monitor client for the occurrence of tardive dyskinesia.

DRUG	USUAL ROUTE	USUAL DAILY DOSAGE RANGE	SEDATIVE EFFECT	EXTRA-PYRAMIDAL SYMPTOMS	ANTI-CHOLINER-GIC EFFECTS	ORTHOSTATIC HYPOTENSION
Phenothiazines						
chlorpromazine *(klor-**PROH**-mah-zeen)* (Largactil, Thorazine, etc.)	oral, rectal, IM, IV	30–900 mg *Children over 6 mo:* 0.55 mg/kg	+ + +	+ +	+ +	+ + +
fluphenazine *(flew-**FEN**-ah-zeen)* (Modecate, Moditen, Permitil, Prolixin)	oral, IM	2.5–20 mg/day	+	+ + +	+	+
mesoridazine *(mes-oh-**RID**-ah-zeen)* (Serentil)	oral, IM	30–150 mg	+ + +	+	+ + +	+ +
perphenazine *(per-**FEN**-ah-zeen)* (Apo-Perphenazine, Trilafon)	oral, IM	16–64 mg/day	+	+ + +	+	+
prochlorperazine *(**proh**-klor-**PER**-ah-zeen)* (Compazine, Prorazin, Stemetil)	oral, rectal, IM	15–150 mg	+ +	+ + +	+	+
promazine *(**PROH**-mah-zeen)* (Sparine, etc.)	oral, IM, IV	40–1200 mg	+ +	+ +	+ + +	+ +
thioridazine *(**thigh**-oh-**RID**-ah-zeen)* (Mellaril, Novo-Ridazine)	oral	150–800 mg	+ + +	+	+ + +	+ + +
trifluoperazine (***try**-floo-oh-**PAIR**-ah-zeen)* (Solazine, Stelazine)	oral, IM	2–40 mg	+	+ + +	+	+
trifluprom azine *(**try**-floo-**PROH**-mah-zeen)* (Vesprin)	IM	60–150 mg	+ + +	+ +	+ + +	+ +

continues

TABLE 18–2 *continued*

See **Note** at beginning of Table 18–2, page 382.

DRUG	USUAL ROUTE	USUAL DAILY DOSAGE RANGE	SEDATIVE EFFECT	EXTRA-PYRAMIDAL SYMPTOMS	ANTI-CHOLINER-GIC EFFECTS	ORTHOSTATIC HYPOTENSION
Nonphenothiazines						
chlorprothixine *(klor-proh-**THICKS**-een)* (Taractan)	oral, IM	75–200 mg	+ + +	+ +	+ +	+ +
clozapine *(**KLOH**-zah-peen)* (Clozaril)	oral	25–900 mg	+ + +	+	+ + +	+ + +
haloperidol *(**hah**-loh-**PER**-ih-dohl)* (Haldol, Peridol ✱)	oral, IM	0.5–100 mg	+	+ + +	+	+
loxapine *(**LOX**-ah-peen)* (Loxapac ✱, Loxitane)	oral, IM	20–300 mg	+ +	+ + +	+	+ +
molindone *(moh-**LIN**-dohn)* (Moban)	oral	50–225 mg	+	+ + +	+	+
pimozide *(**PIM**-oh-zyd)* (Orap)	oral	1–10 mg	+ +	+ + +	+ +	+
risperidone *(riss-**PER**-ih-dohn)* (Risperdal)	oral	2–16 mg	+	0/+	+	+
thiothixine *(**thigh**-oh-**THICKS**-een)* (Navane)	oral, IM	6–60 mg	+	+ + +	+	+

Key: + + + High + + moderate + Low

AGENTS USED TO TREAT AFFECTIVE DISORDERS

Affective disorders are those characterized by changes in mood. Such changes may range from severe depression to mania. Major or severe depression is characterized by feelings of pessimism, worry, intense sadness, loss of concentration, and slowing of mental processes. It is among the most common forms of mental illness and is frequently accompanied by physical changes such as insomnia, anorexia, decreased *libido*, and in about 15% of such clients, suicidal behavior. Mania is characterized by feelings of intense elation, insomnia, hyperactivity, and irritability. In some clients, there may be periodic mood swings between depressed and manic states. This is often called bipolar affective disorder.

Normally, nerve impulse transmission between two nerves or between a nerve and an affector tissue takes place by the release of neurotransmitters, such as norepinephrine or serotonin, from their storage sites at the nerve terminal (Figure 15–2). After the neurotransmitter has combined with its appropriate receptors, several mechanisms can reduce the concentration of neurotransmitter in the synaptic space. One involves the re-uptake of the neurotransmitter by the nerve terminal from which it was released. A second mechanism involves the destruction of the neurotransmitter by the enzyme monoamine oxidase (MAO).

A number of hypotheses have been suggested to explain the cause of affective disorders. One of the most popular is the biogenic amine hypothesis. This hypothesis relates affective disorders to a deficiency of serotonin and/or norepinephrine at the

postsynaptic adrenergic receptors in the CNS. The appearance of depression or mania, according to this hypothesis, is related to the level of norepinephrine in these sites. When norepinephrine is deficient, depression is thought to be triggered. With an excess of norepinephrine, it is posited that mania occurs.

ANTIDEPRESSANT AGENTS

Drugs employed in the treatment of depression are thought to act by one of two mechanisms, both ultimately resulting in an increase in neurotransmitter concentration in the CNS. The tricyclic antidepressants, e.g., **amitriptyline** and **imipramine** are widely employed for the treatment of depression. One tricyclic drug, **clomipramine HCl** (**Anafranil**) is currently being used to treat obsessive-compulsive disorder (OCD). They share a chemical configuration characterized by a three-ring or tricyclic structure. **Fluoxetine** (**Prozac**), **sertraline** (**Zoloft**), **bupropion** (**Wellbutrin**), **paroxetine** (**Paxil**), **venlafaxine** (**Effexor**), and **nefazodone** (**Serzone**) are relatively new antidepressants chemically unrelated to the tricyclics. All of these antidepressant drugs are believed to work in relieving depression by interfering with the reuptake of neurotransmitters by the presynaptic nerve cell and increasing their free concentration at postsynaptic adrenergic receptors in the CNS. This higher neurotransmitter concentration has been associated with relief of symptoms of depression. By inhibiting the enzyme monoamine oxidase (MAO), the so-called MAO inhibitors (e.g., **phenelzine**) reduce the destruction of neurotransmitters and also increase their free level in the CNS.

In the last decade, it has become evident that the mechanisms of action of the antidepressant drugs extend beyond those described. It is currently felt that some of these drugs may increase the sensitivity of receptors to the neurotransmitters, thereby enhancing their activity and relieving the depressed state. The *biogenic amine* hypothesis (BAH) suggests that alterations in neurotransmitters in the CNS are responsible for depression. This hypothesis states that depression is the result of deficiency of neuronal and synaptic catecholamines. Another hypothesis—the permissive hypothesis—claims that depression results from decreased levels of both serotonin and catecholamines. Both of these hypotheses state that mania results from increases in these products

When antidepressant therapy is begun, therapeutic effects may not be evident until 2–3 weeks of therapy have elapsed. The use of such drugs on a PRN basis is therefore irrational. Some of these agents have significant sedating effects, which may interfere with therapy. Yet, such an effect may be used to advantage in a client who experiences insomnia as part of the depressed state.

Antidepressants also may exert both peripheral and central anticholinergic actions. These result in the most serious adverse effects related to these agents: dry mouth, constipation, urinary retention, and worsening of narrow-angle glaucoma. Some clients may experience cardiac *palpitations*, tachycardia, and cardiac arrhythmias, which, in rare cases, may result in death. Orthostatic hypotension also may be caused by the use of some antidepressants. For this reason, antidepressants must be used with great caution in clients with preexisting cardiac disorders. In clients over the age of 40, confusion and tremor also may occur with the use of these agents.

Overdoses of antidepressant drugs are among the most serious types of poisoning currently encountered and account for 10%–20% of all drug overdose cases. This problem is compounded by the fact that depressed clients are at high risk for attempting suicide. It is important, therefore, that clients receiving antidepressant drugs not be given prescriptions containing more than about 1.25 g of total drug (e.g., 50 doses of 25 mg tablets), as ingestion of this quantity or more may be fatal. During acute depression, careful administration and control of all doses of these drugs should be maintained by the nurse or a relative of the client to avoid such tragedy, and not more than a week's supply of drug should be accessible to an acutely depressed client.

Dosing of antidepressant drugs should be done carefully. The client should be started on moderate, divided daily doses that are gradually increased until the desired dosage level is reached. This level should be maintained for about 4–6 weeks, after which the client's progress is carefully evaluated. Further dosage increases may then be made gradually, if they are required, until a maximum desirable dose is reached. Lower initial doses and more gradual adjustment of dosage are often required in elderly clients. Because virtually all of the antidepressants have a long half-life in the body, a single daily dose of the drug may be given at bedtime once the client's dosage requirements have been determined. Bedtime dosing permits the sedative side effects of these agents to be used advantageously. Table 18–3 reviews the properties of the antidepressant drugs.

TABLE 18–3

Antidepressants

Note: For all clients receiving antidepressants:

Monitor drug use very carefully and limit client access to the drug during the acute phase of illness to prevent overdosage and suicide attempts.

These drugs may cause drowsiness and impair the clients' ability to perform hazardous tasks in which alertness is required.

Provide for the clients' safety through the use of siderails and assistance with ambulation.

Monitor client for excess sedation, orthostatic hypotension, and anticholinergic effects.

Abrupt discontinuation of this medication may cause nausea, headache, and malaise.

DRUG	USUAL ROUTE	USUAL DAILY DOSAGE RANGE	ANTI-CHOLINERGIC	SEDATION	ORTHOSTATIC HYPOTENSION
amitriptyline *(**am**-ih-**TRIP**-tih-leen)* (Elavil, Endep, Levate 🍁, etc.)	oral, IM	50–150 mg *Children 6–12 yr:* 10–30 mg/day	+ + + +	+ + + +	+ +
amoxapine *(ah-**MOX**-ah-peen)* (Asendin)	oral	50–300 mg *Older adults:* 100–150 mg/day	+ + +	+ +	+
bupropion *(byou-**PROH**-pee-on)* (Wellbutrin, Zybean)	oral	150–400 mg	+ +	+ +	+
clomipramine *(kloh-**MIP**-rah-meen)* (Anafranil)	oral	25–250 mg	+ + +	+ + +	+ +
desipramine *(des-**IP**-rah-meen)* (Norpramin, Pertofrane)	oral	100–300 mg *Children 6–12 yr:* 10–30 mg	+	+	+
doxepin *(**DOX**-eh-pin)* (Adapin, Sinequan, Triadapin 🍁)	oral	75–150 mg	+ +	+ + +	+ +
fluoxetine *(floo-**OX**-eh-teen)* (Prozac)	oral	20–80 mg	+/0	+/0	+/0
imipramine *(ih-**MIP**-rah-meen)* (Impril 🍁, Tofranil, Janimine, etc.)	oral, IM	75–200 mg	+ +	+ +	+ + +
maprotiline *(mah-**PROH**-tih-leen)* (Ludiomil)	oral	25–150 mg	+ +	+ +	+

continues

TABLE 18–3 *continued*

See **Note** at beginning of Table 18–3, page 385.

DRUG	USUAL ROUTE	USUAL DAILY DOSAGE RANGE	ANTI-CHOLINERGIC	SEDATION	ORTHOSTATIC HYPOTENSION
nefazodone *(neh-**FAY**-zoh-dohn)* (Serzone)	oral	300–600 mg	0	+/–	0
nortriptyline *(nor-**TRIP**-tih-leen)* (Aventyl, Pamelor)	oral	75–150 mg	+ +	+ +	+
paroxetine *(payr-**OX**-eh-teen)* (Paxil)	oral	10–50 mg	0	+/0	0
protriptyline *(proh-**TRIP**-tih-leen)* (Triptil, Vivactil)	oral	15–60 mg	+ + +	+	+
sertraline *(**SIR**-trah-leen)* (Zoloft)	oral	50–200 mg	0	+/0	0
trazodone *(**TRAY**-zoh-dohn)* (Desyrel)	oral	150–400 mg	+	+ +	+ +
trimipramine *(try-**MIP**-rah-meen)* (Rhotrimine, Surmontil)	oral	75–200 mg	+ +	+ + +	+ +
venlafaxine *(ven-lah-**FAKS**-een)* (Effexor)	oral	75–375 mg	0	0	0

Key: + + + + Highest + + + High + + Moderate + Low 0 None
*higher doses may be employed in treating severe depression and/ or in institutionalized clients.

The monoamine oxidase (MAO) inhibitors are generally used only in those clients who cannot tolerate or who do not respond well to therapeutic doses of the previously discussed antidepressant drugs. The use of MAO inhibitors has been associated with adverse effects which may range from orthostatic hypotension to death. Of particular concern is their use in clients who consume foods rich in tyramine (Table 18–4). This substance, found in many foods particularly those containing aged protein, causes the release of certain biogenic amines in the body. When the breakdown of these substances is inhibited by MAO inhibitors, the client's blood pressure may rise rapidly to extremely high levels as these *pressor* substances accumulate in the body. Such drastic blood pressure elevation may result in intracranial bleeding and death. The use of sympathomimetic amines (see Chapter 23) with MAO inhibitors may elicit the same reaction.

Table 18–5 compares the use of the monoamine oxidase (MAO) inhibitors. All of these preparations are given orally.

Maprotiline HCl (**Ludiomil**), a tetracyclic antidepressant, is pharmacologically and therapeutically similar to the tricyclic antidepressants. In general, lower doses of maprotiline should be administered to clients over age 60. Maprotiline is not recommended for clients under 18 years of age.

The antidepressant drug, **trazodone HCl** (**Desyrel**) is neither a tricyclic compound nor a monoamine oxidase inhibitor. Although its action as an antidepressant seems to be similar to that of the tricyclics, it appears to produce fewer adverse

TABLE 18–4

Some Tyramine-Rich Foods

FOOD	TYRAMINE CONTENT
cheddar cheese	1416 mcg/g
other aged cheese	100–500 mcg/g
chicken livers	100 mcg/g
pickled herring	3000 mcg/g
chianti wine	25 mcg/mL
sour cream	NA
yogurt	NA
canned figs	NA
raisins	NA
bananas	NA
avocados	NA
soy sauce	NA
yeast extracts	NA
beer	1.8–4.4 mcg/mL

NA = Not available

anticholinergic and cardiovascular effects. This may make trazodone a useful antidepressant for elderly clients, clients with cardiovascular disease, and clients who do not tolerate the tricyclic drugs.

Fluoxetine HCl (Prozac), paroxetine (Paxil), venlafaxine (Effexor), nefazodone (Serzone), and sertraline (Zoloft), although chemically unrelated to tricyclic antidepressants, are believed to act in a similar fashion. These agents generally produce fewer sedative and anticholinergic side effects than other antidepressants. The major adverse side effects of fluoxetine include anxiety, anorexia, and nausea. Because fluoxetine can also cause insomnia, the drug should be administered at least 6 hours before bedtime. The major adverse side effects of sertraline include nausea, dry mouth, headache, and dizziness, with the use of paroxetine (Paxil), nefazodone (Serzone), or venlafaxine (Effexor) associated with side effects such as nausea, dry mouth, headache, and drowsiness.

Bupropion HCl (Wellbutrin), one of the newest antidepressants, is not related to other antidepressants, and its mechanism of action is unclear. Bupropion use has been associated with seizures and it should not be used in clients with convulsive disorders.

ANTIMANIC AGENTS

Lithium is currently the drug of choice for the treatment of manic episodes. Because its effects are often not evident until about a week of therapy has elapsed, lithium is often used initially with an antipsychotic drug such as a **phenothiazine** or haloperidol (Haldol) to control the client's symptoms.

TABLE 18–5

Monoamine Oxidase (MAO) Inhibitors

Note: For all clients receiving monoamine oxidase inhibitors:
Avoid consumption of tyramine-rich foods.
Routinely check clients' vital signs, especially blood pressure.
Provide clients with instructions about proper diet and the importance of regular follow-ups.

DRUG	USUAL ADMINISTRATION ROUTE	USUAL DOSE
isocarboxazid *(**eye**-soh-kar-**BOX**-ah-zid)* (Marplan)	oral	10–30 mg daily in single or divided doses
phenelzine sulfate *(**FEN**-el-zeen **SUL**-fayt)* (Nardil)	oral	1 mg/kg/day–90 mg daily in divided doses
tranylcypromine sulfate *(tran-ill-**SIH**-proh-meen **SUL**-fayt)* (Parnate)	oral	30–60 mg daily in 2 divided doses

Unlike the antipsychotic agents, lithium has no appreciable sedative action and its mechanism as a mood stabilizer is unknown. The drug is generally administered orally as a solid or liquid dosage form. Initially, 2–4 300 mg doses are administered at evenly spaced intervals each day. If no response is evident at the end of 10 days of therapy, gradual increases in dosage may be made to a maximum of 3600 mg daily. Dosage changes are generally made not more frequently than every 3–5 days to permit stabilization of serum levels. During this initial stage of therapy, serum tests must be performed at least weekly to ascertain lithium serum levels. Serum lithium concentrations should be measured about 12 hours after the last dose has been administered. Serum levels should optimally be maintained between 0.8 and 1.2 mEq/Liter during the initial stage of treatment. Once the client has responded to therapy, the dose of lithium may be reduced to produce a desirable maintenance lithium serum level of 0.4–1.0 mEq/Liter.

Lithium toxicity may be manifest in a number of different forms. Nausea, vomiting, diarrhea, fatigue, and/or tremors may be evident in some clients. Those receiving lithium for long periods may experience the development of *hypothyroidism* or *diabetes insipidus*. Annual thyroid and renal function testing is advisable for clients on long-term lithium therapy. Acute lithium intoxication is characterized by severe vomiting, diarrhea, *ataxia*, coma, convulsions, and death.

The use of diuretics that increase the excretion of sodium may cause lithium retention and the development of toxicity. Such an effect may also be induced if the client restricts dietary intake of sodium. Such clients may require a readjustment of their lithium dose. Lithium is available as tablets and capsules (e.g., **Eskalith**), as slow-release tablets (e.g., **Lithobid**) which permit BID dosing and as a syrup (e.g., **Cibalith-S**) containing **lithium citrate** in a dose equivalent to 300 mg of **lithium carbonate** in each 5 mL volume.

APPLYING THE NURSING PROCESS

ASSESSMENT

Clients who take any psychotropic drug require emotional support. However, physical needs must not be overlooked in the assessment process. Basic needs, such as nutrition, rest and appropriate activity, water, oxygen, temperature regulation, clothing, shelter, recreation, and sex must be considered, as well as the psychological needs.

Whenever caring for clients with mental illness receiving medication, the nurse must assess:

- the meaning of the illness and its treatment for both client and family
- the health status of the client, including vital signs; the presence of anxiety, confusion, delusions, and/or hallucinations; suicidal intentions; ability to use constructive coping mechanisms; and the client's overall health
- the ability of the client and family to form a trusting relationship with the nurse and other members of the health team
- other medications the client may be taking
- the client's knowledge about the illness and its treatment
- the client's ability and reliability in managing self-care

NURSING DIAGNOSES

Including but not limited to:

- Disturbed thought processes related to disease process
- Risk for injury related to adverse effects of psychotropic agents
- Noncompliance related to altered thought processes
- Deficient knowledge related to disease process and psychotropic therapy

PLANNING/GOALS

- Client will exhibit positive changes in thought processes as exhibited by positive coping mechanisms.
- Client will not sustain injury resulting from psychotropic therapy.
- Client will remain compliant with therapy.
- Client will verbalize understanding of medication regimen.

IMPLEMENTATION

Special attention must be given to the administration and monitoring of medication for persons with mental illness. Many clients will refuse to take their medications at some point during treatment. Careful assessment should be made of the reason(s) for refusal. Some clients are frightened or suspicious about taking medications, because of the nature of their illness. Some have experienced or are experiencing unpleasant side effects or adverse effects from taking these medications. Some of these side effects, particularly those associated with sexual functioning, such as impotence, may not be freely reported by the client. It is important for the nurse to remember that persons with mental illness, like those with any other illness, may refuse to take medications or to comply with their treatment program. Because of the questions surrounding the competence of the person to make such decisions during an acute stage of their illness or because of the possibility of harming themselves or others, policies and regulations have been developed to address refusal of treatment. These policies and regulations differ by jurisdiction and agency, and the student is referred to the policy manual of the clinical setting.

It is important for the nurse to remember that drugs used in the treatment of mental illnesses have a variety of unpleasant side effects. For that reason, to encourage the person to continue treatment, the lowest dose necessary to control the symptoms of illness should be used. Prompt identification of and early intervention for side effects and adverse effects resulting from medication use is important.

Nurses should devise interventions to address the deficient knowledge that many persons have about mental illness and its treatment. Medication groups may be used as one way of providing information. A curriculum for such groups should include a discussion of the possible causes and nature of the illnesses, the treatment of illness and what is known about the effectiveness of these treatments, and information about medications including instructions for use and the side effects and adverse effects of specific medications. Group members should also be given the phone number of someone to call if they have questions and concerns. Clients should be helped to understand that research has supported the effectiveness of antipsychotic medications in preventing relapse in the community. They also need to know that many people, perhaps most, recover from mental illness and may eventually be free of taking medications. Referral to support groups and self-help groups may be beneficial in fostering recovery.

Persons wishing to discontinue their medication should have a thorough evaluation and receive support in their decision. The prescriber can make suggestions about a tapering schedule and provide information about the half-life of the medication and the expected response to withdrawal. Their progress should be monitored carefully and supportive treatment provided, as needed. Symptoms indicating relapse or need for evaluation should be discussed with the person and someone close, such as a family member, case manager, self-help group leader, or friend. Before discontinuing the medication, it may be beneficial to work with the person to identify his or her preferences for treatment if the illness should recur.

EVALUATION

- Client exhibits increased alertness and orientation, along with coping skills.
- Client does not experience injury during psychotropic therapy.
- Client remains compliant with therapy.
- Client verbalizes understanding of medical regimen, adverse effects of psychotropics, and need to be compliant with therapy.

CLIENTS RECEIVING ANXIOLYTICS

Assessment

The nurse who cares for clients receiving anxiolytic agents assesses therapeutic and side effects of medication use. In addition, the nurse engages in client education designed to foster informed use of the medication and cooperation with the regimen. Because anxiolytic agents are used for the treatment of both physical and emotional problems, the nurse must know the purpose for which the client is receiving the medication. The assessment of therapeutic effects can then be focused on the goal to be accomplished—for example, decrease in blood pressure or frequency of seizures, decreased muscle spasms,

or decreased anxiety. In determining therapeutic effects of anxiolytic agents, it is important to have some baseline measures of predrug use, such as blood pressure, number and nature of seizures, and the nature, occurrence, and intensity of anxiety. Baseline physiological measures such as blood pressure can also help to evaluate side effects. Routine measurement of blood pressure should be done on inpatients.

Nursing Diagnoses

Including but not limited to:

- Anxiety related to disease process
- Risk for injury related to adverse effects of anxiolytic agents
- Noncompliance related to anxiety-produced altered thought processes
- Deficient knowledge related to disease process and anxiolytic therapy

Planning/Goals

- Client will experience reduced anxiety as exhibited by positive coping mechanisms.
- Client will not sustain injury resulting from anxiolytic therapy.
- Client will remain compliant with therapy.
- Client will verbalize understanding of medication regimen.

Implementation

Attention needs to be directed toward client safety, including decreasing the occurrence of orthostatic hypotension by avoiding sudden changes in position. Some clients with orthostatic hypotension are helped by putting on elastic stockings before they rise in the morning or by consuming a high-protein snack at night. Outpatients should be cautioned about possible hypotension. If mental alertness is impaired, clients should be advised to avoid situations requiring mental alertness, such as operating an automobile. Initially, some clients are given the largest dose of anxiolytics at bedtime to take advantage of sedative effects.

Client teaching is focused on several aspects of safe use. Clients should know what drug they are taking and that it can decrease mental alertness. Also, they must know that CNS depressants, such as alcohol and other tranquilizing agents, must not be used simultaneously, because they may intensify the CNS depression. Generally cimetidine (Tagamet), propranolol (Inderal) and other enzyme-inhibitor drugs are not ordered to be taken at the same time, as they may increase the blood level of some benzodiazepine anxiolytic agents and increase the chance of adverse effects.

Elderly clients, in particular, may suffer from excessive sedation. They should be helped with ambulation, as falls may occur. Some elderly clients appear to become withdrawn from group and individual activities during the course of therapy. This may be due to excessive sedation or to the development of double vision. The nurse assesses the client's ability to read and may speak to the prescriber about lowering the dose of the anxiolytic or changing to an anxiolytic with a shorter half-life.

Clients are instructed not to discontinue their medication abruptly, as this can result in withdrawal symptoms. These symptoms include insomnia, weakness, anxiety, irritability, muscle tremors, *anorexia*, nausea, vomiting, and headache. The drug should be taken as ordered and not stopped or increased in dosage without consulting the prescriber. Increasing the dosage may cause drug intoxication.

Emotional dependence on the drug can occur. Clients will need to learn skills to cope with the stresses of everyday life, rather than resorting to drug use, if they wish to avoid drug dependency. They should be instructed not to share their medication with others who may be experiencing discomfort in dealing with stress. The nurse provides supportive care and referral for individuals having difficulty in coping with stressful situations.

Much has been written in the popular press concerning the use or abuse of anxiolytics by both clients and physicians. This has made some persons hesitant to take these drugs as prescribed. These individuals should receive an explanation about why a particular drug was selected for use, what is expected to be accomplished as a result of using the drug, and how long the therapy is expected to last. The client is then encouraged to cooperate with the treatment plan.

A final word of caution about the use of anxiolytics. They must always be kept in a safe place away from children and depressed persons. Those who may be taking them for emotional problems are only given a small supply at a time

KEY NURSING IMPLICATIONS 18–1

Anxiolytic Drugs

1. Obtain baseline measures, such as blood pressure readings, and monitor vital signs throughout the course of therapy.
2. Orthostatic hypotension may be alleviated by changing position slowly, putting on elastic stockings before rising, and consuming a high-protein snack at night.
3. Observe the client for excessive sedation. Teach the client to avoid the simultaneous use of other central nervous system depressants.
4. Avoid abrupt discontinuation of these drugs.

and must be required to see a physician regularly. These drugs are sometimes used in suicide attempts. Despite their wide margin of safety, combining them with other CNS depressants, particularly alcohol, creates a potentially dangerous situation. Persons who have become increasingly withdrawn or suicidal must be referred for immediate evaluation.

Evaluation

- Client experiences reduced anxiety as evidenced by vital signs, WNL, and positive coping skills.
- Client does not experience injury from anxiolytic therapy.
- Client remains compliant with therapy.
- Client verbalizes understanding of medical regimen, adverse effects of anxiolytics, and need to be compliant with therapy.

CLIENTS RECEIVING ANTIPSYCHOTIC AGENTS

Nurses perform a variety of functions in caring for clients receiving antipsychotic agents. These include administration of medications, monitoring therapeutic and side effects, and client education.

Assessment

Routine assessment of vital signs, including temperature, pulse, blood pressure, body weight, appearance, and behavior is made before therapy is begun to have a baseline for comparison. Thereafter, periodic checks are made to determine significant changes. Behavioral observations are important in determining the effectiveness of therapy. Such observations include sleeping and eating habits, speech patterns and content, personal hygiene and appearance, interactions with others, and level and purposefulness of activity. The presence of *delusions* or *hallucinations* and any unusual behavior are noted and discussed with others responsible for developing the treatment plan.

Because of the possible development of dyskinesia in persons taking antipsychotic drugs, routine assessment of motor functioning in clients on such therapy is important. The most commonly used instrument to detect movement disorders is the Abnormal Involuntary Movement Scale (AIMS). Assessments are made in the areas of facial and oral movements, extremity movements, trunk movements, global judgments, and dental status. Assessment using this screening tool should be done before beginning treatment and twice a year thereafter.

Nursing Diagnoses

Including but not limited to:

- Disturbed thought processes related to disease process
- Disturbed sensory perception related to disease process and medication regimen
- Impaired social interaction related to disease process
- Risk for injury related to adverse effects of antipsychotic agents
- Noncompliance related to disease process and altered thought processes
- Deficient knowledge related to disease process and antipsychotic agent therapy

Planning/Goals

- Client will experience no further deterioration of thought processes.
- Client will exhibit alertness and orientation to time, place, and person.
- Client will exhibit increasing ability to interact with others in a productive way.
- Client will not sustain injury resulting from antipsychotic therapy.

- Client will remain compliant with therapy.
- Client will verbalize understanding of medication regimen.

Implementation

When a client first begins to take an antipsychotic agent he/she may be too ill to understand what the medication is and why it should be taken. The nurse must be both firm and patient in getting the person to take the medication. Care is taken to ensure that oral medication is actually swallowed. Agitated clients may be given injections, rather than oral medication. Liquid concentrates are sometimes used for clients who do not swallow tablets or capsules. The nurse must be careful when measuring and administering concentrates, as they may be very irritating to the skin and eyes. If spilled or splashed, the area should be washed immediately. When administering the concentrate to a client, it may be diluted with approximately 60 mL of fruit juice to disguise its taste. Failure to respond to treatment with concentrates may indicate that there is an incompatibility between the concentrate and the liquid vehicle. Discuss the use of the specific vehicle and/or use of a new liquid vehicle with the pharmacist.

When the client has been on medication for some time, the administration schedule is often changed from divided daily doses to a once-daily bedtime dose. This has several advantages, including ease of administration, which encourages cooperation. Also, if side effects occur, they are most likely to do so during sleep and are, therefore, less troublesome to the client. Single daily doses are also less expensive than multiple doses, and outclients do not need to carry medication with them during the day. Some clients feel less drug dependent when not required to carry daily medication. Finally, client education is easier to accomplish if all medications are taken once a day at bedtime, rather than spaced throughout the day.

Routine assessment of vital signs, including temperature, pulse, and blood pressure, as well as body weight, appearance, and behavior, is made before therapy is started to have a baseline for comparison. Thereafter periodic checks are made to determine significant changes. Behavioral observations are important in determining the effectiveness of therapy. Such observations include sleeping and eating habits, speech patterns and content, personal hygiene and appearance, interactions with others, and level and purposefulness of activity. The presence of delusions or hallucinations and any unusual behavior are noted and discussed with others responsible for developing the treatment plan.

As noted previously, there are many side effects associated with the use of antipsychotic agents. The nurse must be aware of those associated with the agent(s) the client is receiving. Many of these side effects are dose-related and dose adjustment is discussed with the physician. Early detection of side effects is important, because intervention is most effective initially, and because clients are more likely to take the medication if annoying side effects can be controlled. Nurses must be aware that antipsychotic medications may decrease the seizure threshold. Therefore, persons with epilepsy must especially be observed carefully for seizure activity. Also, most antipsychotic agents are secreted in milk and cross the placental barrier. Women in childbearing years are told this. They are advised to discuss their plans regarding children with their primary care practitioner, who is best prepared to evaluate the risks to both mother and child of continuing or discontinuing medication.

Many antipsychotic drugs are associated with annoying, but often temporary, side effects such as nasal congestion and dry mouth. Clients experiencing these are told they are temporary and are encouraged to continue the medication. Clients are advised that they may suck on sugarless hard candy. Candy containing sugar is usually avoided, because sustained use could result

KEY NURSING IMPLICATIONS 18–2

Adverse Effects Produced by Antipsychotic Agents

1. sedation
2. orthostatic hypotension
3. tachycardia
4. extrapyramidal symptoms
5. anticholinergic effects
6. impaired temperature regulation
7. lowering of the convulsive threshold
8. endocrine effects
9. dermatological reactions
10. photosensitivity reactions
11. pigmentary changes in the eye

in dental caries, intake of unnecessary calories, and/or fungal infections of the mouth.

Another problem that may be experienced by clients taking antipsychotics is photosensitivity. Clients are advised to avoid direct sunlight, to wear protective clothing, and to use sunscreen preparations on the skin and lips. Some clients will develop constipation and steps should be taken to minimize this side effect. These steps include increasing fluid intake, roughage in the diet, exercise, and the use of stool softeners, if indicated. Some clients retain fluid and many experience an increase in appetite leading to weight gain. The nurse monitors the client's weight and encourages the client to consume a low-calorie diet if a client prefers high-calorie foods. Finally, about 15% of clients have developed blurred vision while taking antipsychotic drugs. This may affect participation in social and recreational activities, and change to another drug may be indicated.

Medication should be discontinued and the physician notified if there is any sign of a paradoxical reaction. The development of a paradoxical reaction may appear as a worsening of the psychosis. Reevaluation of the client is recommended before dosage is increased.

The most serious effect associated with taking antipsychotic drugs has been sudden death. This seems to occur most frequently among healthy young clients. One of the factors contributing to sudden death may be an impairment of the gag reflex. This occurs most often in clients taking multiple drugs with strong anticholinergic effects. Other clients have experienced fatal arrhythmias or vascular collapse. Careful monitoring, particularly of persons who have been restrained or placed in seclusion, is indicated. Because clients may be at increased risk for cardiovascular effects of antipsychotic drugs with dehydration, the nurse should ensure that adequate hydration is maintained during such periods.

Clients who experience side effects that are not life-threatening are generally encouraged to continue their medication, if the prescriber believes this is the best treatment, until the maximum therapeutic effect is achieved. At that point, the dosage may be decreased or the client and prescriber may agree that the desireable effects outweigh the discomforts associated with therapy.

Some clients with mental illness or organic brain damage experience rage reactions or engage in assaultive behavior. A number of drugs have been used to control these violent episodes. Among these drugs is propranolol, a beta-adrenergic blocking agent (see Chapter 31). When a client receives this treatment, the nurse assesses the therapeutic effectiveness and observes the client for the development of bradycardia or hypotension.

Client education, conducted either individually or in a group, is important. Discontinuing antipsychotic medication may be associated with relapses. The client is given this information as well as the name, dose, and schedule of drug administration. Additional knowledge includes the major side effects associated with drug treatment and what to do if these occur. The client is supplied with the name and phone number of someone to contact if side effects or indications of a relapse are noted. Finally, instructions are given about how to deal with skipped doses. If the client skips one of several (divided) daily doses of the antipsychotic, instructions are generally given to add the skipped dose to the next daily dose. If, however, the client skips a single, once-daily dose, instructions are given to wait and take only the usual dose at the next regularly scheduled time.

Evaluation

- Client exhibits alertness and orientation to time, place, and person.
- Client exhibits productive interpersonal skills.
- Client does not experience injury resulting from antipsychotic therapy.
- Client remains compliant with antipsychotic therapy.
- Client verbalizes understanding of medical condition and medication regimen.

Some clients are discharged from an inpatient setting while still taking prescribed antipsychotic medication. They may be scheduled for follow-up in the community. Clients taking clozapine are monitored with blood studies on a regular basis (weekly) to detect the development of agranulocytosis or other blood dyscrasias. In many cases, nurses through mobile treatment teams or visiting nurse associations will be responsible for the follow-up. It is important for the nurse to assess the client for therapeutic and

NURSING CARE PLAN

A Client with Bipolar Illness Receiving Lithium Carbonate

Marta Wolenski, age 34, was diagnosed 3 months ago as having bipolar affective illness and placed on lithium carbonate, 450 mg QID. Her manic behavior has been well-controlled and she was discharged home to her husband and four children. Two weeks after discharge, she and her husband attended a Slovak wedding reception. When the music turned to polkas, Marta started dancing. At first she was laughing and appeared to be having a good time.Then it became obvious that she was flirting with many different partners. After the sixth dance she was flushed, giddy, and talking rapidly about how nice it was in Hawaii (she has never been to Hawaii). When she returned to her husband, he realized that she had been drinking between dances. He asked her how she felt. She said, "I feel fantastic, weddings are wonderful. I hope I can have a nice wedding someday." At this point he decided to take her home. She got in the car and screamed, "They are after me. I'm so afraid." Her husband drove her to the hospital, having discovered that she had been drinking on and off for 2 weeks and had been taking her medication sporadically. On arrival in the emergency room, her initial blood work indicated toxic lithium levels. She was admitted to the inpatient psychiatric unit for evaluation. While on the nursing unit, she was restless and disruptive. She paced back and forth and repeated, "Oh my God, somebody help me." One day she was found lying in bed crying, saying "I just know I'm never going to get better." She had frequent lithium levels drawn during the next 3 weeks. She became more receptive to the treatment program and participated in discharge planning.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Paranoid statements, inflated self-esteem.	Disturbed thought processes related to impaired perception of reality.	Client will be reoriented to reality and be able to maintain orientation.	Keep client aware of reality (day, date, place, person, situation) and involve in reality situations. Use honesty in a consistent approach to develop trust. Encourage husband to bring in pictures of family. Encourage client to maintain contact with family and friends.	Prior to discharge, the client is oriented to time, place, and person with no evidence of paranoid statements.
Flirting and giddiness, pressured speech, inappropriate affect.	Impaired social interaction related to disinhibition secondary to acute manic state.	Client will be able to demonstrate appropriate behavior in social situations in therapeutic environment prior to discharge.	Set consistent limits on behavior that are acceptable in the treatment unit. Focus on the client's feelings. Decrease stimulation by providing "time-outs" in client's room.	Client is able to resume appropriate participation in activities.
Pacing and restless, distractable.	Deficient diversional activity related to inability to concentrate.	Client will participate in activities on the nursing unit on a gradual basis.	Encourage activities that will permit client to move about freely while avoiding competition. Involve occupational and recreational therapists.	Client spends 1–2 hours each day in unit activities as tolerated.
Pacing and increased activity.	Disturbed sleep pattern related to hyperactivity.	Client will be able to have 8 hours of uninterrupted sleep per day.	Remove excess stimulation or noise. Assist with warm bath and administer sedatives as ordered. Tailor evening activities to preretirement activities engaged in at home.	Client states that she is able to sleep through the night and nurses confirm this.

Crying over illness, lability, rapid mood fluctuations.	Hopelessness related to potential for recurrence and long-term therapy for illness.	Client will be able to verbalize ability to manage lifestyle prior to discharge.	Encourage client to talk about decision making and identify coping mechanisms. Discuss events causing readmission. Assess need for home care visits to assist with transition to home roles. Discuss cyclical nature of illness and that many people recover from major mental illness, such as mania. Refer to self-help group.	Client is able to verbalize plans to continue medication in home setting. Client understands importance of outclient follow-up.
Nervousness and fearfulness.	Anxiety related to perceived loss of control or inappropriate behavior.	Client will express feelings of decreased anxiety by end of week 1.	Assist client to identify tensions and factors that create anxiety. Encourage appropriate coping.	Client is more relaxed in appearance and is able to verbalize methods of coping.
Lithium actions and interactions. High lithium blood levels.	Deficient knowledge (effects of medication and interactions).	Client describes actions, dosage, and major side effects of lithium and lists food and beverage interactions to avoid. Prior to discharge, client discusses why pregnancy should be avoided while she is taking lithium.	Teach client to maintain dosage, drink at least 2,000 mL water daily and have blood levels checked monthly. Observe for polydipsia and polyuria. Report persistent nausea, vomiting, diarrhea, and dizziness. Avoid alcohol, diuretics, and salt-restricted diets, because they increase the likelihood of lithium toxicity. Discuss effective birth control methods with client. Provide phone number of someone to call if she has questions about treatment or experiences adverse effects. Explain that if a dose of lithium is missed, she must not double the next dose to compensate. Explain why caffeine-containing beverages and alcohol must be limited while she is taking lithium.	Client describes actions, dosage, and side effects of lithium. Client follows drug regimen and obtains follow-up blood work. Client describes plan for preventing pregnancy.
Understanding about nature of illness.	Deficient knowledge (understanding cyclic nature of illness).	Prior to discharge, client and husband verbalize cyclic nature of illness and importance of drug therapy in preventing relapse and describe signs and symptoms indicating relapse.	Teach client about cyclic nature of this illness. Stress importance of medication in preventing relapse. Help client and husband identify signs and symptoms that illness is recurring. Provide information about whom to contact if relapse is imminent.	Client adheres to treatment regimen. Client and/or husband recognize and report signs and symptoms of an impending relapse.

KEY NURSING IMPLICATIONS 18–3

Antipsychotic Agents

1. Monitor vital signs and observe the client's behavior and response to treatment. Record observations and discuss the response to treatment with the prescriber.
2. Immediately flush with water any body tissue that has been in contact with liquid concentrate preparations of these drugs.
3. Nasal congestion and dry mouth are often temporary side effects that will improve with continued treatment and nursing measures.
4. Be aware of the possibility of impaired gag reflex, cardiac arrhythmias and vascular collapse in clients taking these drugs.
5. Protect the photosensitive client with sunscreens and cautions regarding dress and exposure to the sun.
6. Appropriate nursing intervention may be necessary in clients with constipation, weight gain and fluid retention.
7. If one of a divided daily dose of medication is skipped, the client is advised to add the skipped dose to the next daily dose. If a single daily dose is skipped, however, instructions are given to take only the next daily dose at the appropriate time.

adverse side effects related to the medication. The client is encouraged to cooperate with the treatment plan and to discuss concerns about the drug treatment with the prescriber. The nurse must be alert for indications of a relapse and make appropriate referrals for medical care, psychological care, social welfare, and/or social or community integration services.

CLIENTS RECEIVING ANTIDEPRESSANTS

Assessment

Depressed clients and those who are candidates for treatment with antidepressants should always have a thorough physical examination before drug therapy is begun. This can prove useful, as some physical illnesses, such as pernicious anemia, viral hepatitis, lymphoma, hypothyroidism, and systemic *lupus erythematosus* (SLE), are associated with depression.

Antidepressants, particularly tricyclic antidepressants, must be used carefully in clients with physical disorders, such as cardiovascular disease, prostatic hypertrophy, narrow-angle glaucoma, seizure disorders, and liver dysfunction. The nurse also assesses the client's behavior before treatment is begun and routinely thereafter to determine if the therapy is effective. Observations include appetite and eating habits, sleeping patterns, energy level and activity—including interactions with others—and the nature and content of communications. The nurse is particularly alert for comments or behavior indicating changes in self-esteem or suicidal tendencies. If the client is severely depressed (particularly with psychomotor retardation) when therapy is initiated, the danger of suicide may be increased after treatment is underway. The safety of such clients must be assured through careful observation and by decreasing environmental hazards. Clients should not be given large amounts of antidepressants when the prescription is filled, as these drugs are frequently used in successful suicide attempts. The physical parameters monitored most closely are blood pressure, pulse rate and quality, and body weight, which may change dramatically with treatment. The tricyclic antidepressants may produce tachycardia and orthostatic hypotension. Confusion, tremors, and cardiac problems, such as palpitations, tachycardia, and arrhythmias, are most common in clients over 40 years of age. MAO inhibitors may produce a hypertensive crisis when tyramine-containing foods or medications containing pressor agents are taken concurrently.

Nursing Diagnoses

Including but not limited to:

- Risk for injury or suicide related to disease process
- Impaired social interaction, related to disease process
- Risk for injury related to adverse effects of antidepressant agents
- Noncompliance related to disease process and altered thought processes
- Deficient knowledge related to disease process and antidepressant therapy

KEY NURSING IMPLICATIONS 18–4

Antidepressants

1. A complete physical examination is indicated before therapy is begun.
2. Monitor vital signs and observe the client's behavior and response to treatment. Record observations and discuss the response to treatment with the prescriber.
3. Be aware of the possibility of suicide and take measures to protect the client.
4. Teach the client taking MAO inhibitors to avoid tyramine-rich foods and medications containing pressor agents which could result in hypertensive crisis.
5. Provide support for the client and use appropriate nursing measures to decrease unpleasant side effects early in therapy when the client may be discouraged by an apparent lack of response to treatment.

Planning/Goals

- Client will experience no injury related to increased threat of suicide due to disease process.
- Client will exhibit increasing ability to interact with others in a productive way.
- Client will not sustain injury resulting from antidepressant therapy.
- Client will remain compliant with therapy.
- Client will verbalize understanding of medication regimen.

Implementation

The nurse is aware of the many side effects that can occur as a result of drug treatment for depression and should institute appropriate interventions. As with antipsychotic therapy, the appearance of side effects will influence client cooperation. For example, advising a client that drowsiness and blurred vision generally decrease as therapy is continued promotes client acceptance. Because antidepressant drugs may have a long half-life, a single dose of medication may be ordered at bedtime. This helps many clients tolerate therapy better, as maximal drowsiness caused by the drug occurs at night. Minor problems, such as dry mouth, are dealt with by using simple nursing measures, in this case offering frequent fluids, mouth care, and nonsugar-containing hard candies. One adverse side effect that may require a change in medications is sexual ejaculatory and erection disturbances which, when they occur, are often responsible for client noncompliance.

Client teaching is important for clients taking antidepressants. Many of these individuals are treated on an outpatient basis and are essentially responsible for their own daily care. It is critical that clients taking MAO inhibitors know the names of foods containing tyramine (see Table 18–4 for a listing of tyramine-rich foods), as well as drugs containing pressor agents (such as cold and hay fever remedies) and anorexiants, which may result in a hypertensive crisis. The client is instructed to call the primary health care provider immediately if headache, stiff neck, nausea, vomiting, or irregular heartbeat are noted after ingestion of food or drugs. All clients taking antidepressants and their families must be familiar with the indicators of relapse and be instructed regarding whom to call for assistance.

Evaluation

- Client does not attempt suicide and remains safe.
- Client exhibits increased ability to interact with others.
- Client does not experience injury resulting from antidepressant therapy.
- Client remains compliant with antidepressant therapy.
- Client verbalizes understanding of medical condition and medication regimen.

CLIENTS RECEIVING ANTIMANIC AGENTS

Assessment

Special care is needed for clients taking lithium. First the client must be supported during the 3 weeks or so required to see if the therapy is going to be successful. Clients are told that most side effects, such as a metallic taste, will stop after a few weeks or decrease with a lowered dose. In the meantime, it may be helpful to encourage frequent mouth care, especially before meals. If nausea occurs, the doses are given with meals. Also, it is important that periodic serum tests be done to determine serum levels and assess toxicity. In clients on maintenance doses these are done about every 3 months, early in

the morning. Nurses must be aware of the conditions that cause toxicity. These include *polyuria*, decreased sodium intake, and decreased lithium excretion as a result of kidney disease and *hemoconcentration*, such as that resulting from fever. If toxicity is suspected, the drug is withheld and the physician informed. Meanwhile, vital signs are monitored.

Nursing Diagnoses

Including but not limited to:

- Disturbed thought processes related to manic state.
- Risk for injury related to adverse effects of lithium
- Noncompliance related to disease process and altered thought processes
- Deficient knowledge related to disease process and lithium therapy

KEY NURSING IMPLICATIONS 18–5

Antimanic Drugs

1. Metallic taste in the mouth may be temporary and decrease over time or with a lower dose of lithium. Offer mouth care.
2. Factors which produce polyuria or hemoconcentration can result in lithium toxicity.
3. Clients taking lithium should not change brands or double up to compensate for a missed dose.
4. Lithium should not be taken by pregnant or nursing women.

CASE STUDY

A 20-year-old man, Lester Pliskin, was brought to an emergency department by several friends. He was very agitated and said that the CIA was trying to contact him for a special mission and he must get away to meet his contact in Paris. The examining physician admitted Lester to the psychiatric ward for observation. Psychotropic drug treatment was started with haloperidol (Haldol) 40 mg per day. After several days of therapy, no improvement was noted in the client's behavior. In fact, the client seemed to be even more agitated and had attacked a fellow client. The dosage of haloperidol was raised to 50 mg, but still no improvement was observed.

Because his continued acting-out behavior was unresponsive to haloperidol therapy, Lester's treatment was discussed at a staff conference. During the conference, one of the staff members noted that Lester had had one previous admission, when he received **trifluoperazine** (**Stelazine**). He did well enough on this medication to be discharged to a supervised community residence. A decision was made to discontinue the haloperidol and to begin trifluoperazine (Stelazine) 20 mg per day in 2 divided doses. The nursing staff noted improvement in Lester's behavior, and he was granted increasing independence, culminating in his transfer to a community residence. Lester's medication dose has been gradually decreased so that he will be continuing to take trifluoperazine 10 mg daily at bedtime while living in the community residence.

Questions for Discussion

1. When a client begins to take an antipsychotic agent like haloperidol, what observations should the nursing staff make about the client's behavior to determine the effectiveness of the medication?
2. What are the common side effects of haloperidol and trifluoperazine?
3. What are the advantages of single daily bedtime doses of medication over divided doses?
4. What should this client know about his medication before he is discharged to a community residence?

Planning/Goals

- Client will demonstrate alertness and orientation to person, place, and time.
- Client will not sustain injury resulting from lithium therapy.
- Client will remain compliant with therapy.
- Client will verbalize understanding of medication regimen.

Implementation

Clients taking lithium are advised not to double up doses if a dose is skipped. They are instructed also to limit fluids which produce polyuria and *polydipsia*; for example, caffeine- and alcohol-containing beverages. The nurse should be especially concerned about the development of toxicity in clients excreting three liters or more of urine daily.

Other advice given to clients is to continue to use the same brand of lithium. Changing brands may result in loss of control of the illness. Clients are instructed not to discontinue their medication suddenly as they may develop withdrawal symptoms. These include insomnia, weakness and anxiety. Female clients are advised to avoid pregnancy since lithium should not be used during the first trimester. Nursing is also avoided since lithium is excreted in human milk.

Evaluation

- Client demonstrates alertness and orientation to time, place, and person.
- Client does not experience injury resulting from lithium therapy.
- Client remains compliant with therapy.
- Client verbalizes understanding of medical condition and medication regimen.

HOME CARE / CLIENT TEACHING

1. Persons receiving drugs known to cause tardive dyskinesia or other extrapyramidal symptoms must be routinely monitored for the development of these conditions. The use of a standardized assessment procedure, for example, the Abnormal Involuntary Movement Scale (AIMS) is suggested. Assessments should be conducted every 6 months.
2. Periodic evaluation of all persons receiving long-term drug treatment for mental health problems is suggested. The evaluation should focus on the continued need for the medication, the appropriate dosage, and the client's general state of health and well-being, as well as deleterious side effects that may interfere with the person's functioning and quality of life.
3. Nurses and other health care professionals need to be actively involved in efforts to educate the public about mental health problems to decrease the stigma associated with these problems.
4. Clients with recurrent mental illness should be actively engaged in setting goals for themselves. Nurses working as case managers or with case managers should assist clients in meeting these goals through concrete services and sustained support.
5. Clients receiving anxiolytics should be cautioned about the potential for hypotension.
6. Clients receiving psychotropic therapy should be instructed on what drugs they are taking, the adverse effects, and under what circumstances they should notify their physician.
7. Clients should be instructed not to discontinue their medications abruptly, but should only stop medications under the advice of their physician.
8. Clients should be informed of the importance of compliance with their medication regimen.
9. Clients taking antipsychotic drugs should be advised to avoid direct sunlight, to wear protective clothing, and to use sunscreen preparations.
10. Clients taking antipsychotics may be at increased risk of cardiovascular effects if they become dehydrated, so they must maintain adequate hydration.
11. Clients taking MAO inhibitors should be instructed to avoid tyramine-rich foods and medications containing pressor agents, as this could result in hypertension.
12. Clients taking lithium should be informed of the importance of having blood work to determine lithium level and the signs and symptoms of lithium toxicity.

CRITICAL THINKING EXERCISES

1. Develop a medication education sheet for clients who are being discharged from the hospital on psychotropic medication.
2. Prepare a visual aid for instruction of clients taking anxiolytic agents.
3. Prepare a brief paper on how phenothiazine antipsychotic agents affect the central nervous system.
4. Prepare a brief presentation on theories related to the biochemical causes of schizophrenia.
5. Prepare a class presentation on suicide prevention.
6. Visit a local pharmacy and identify preparations advertised as helping persons cope with the stresses of everyday life. What ingredients do these preparations contain?
7. Prepare a handout on foods and drugs to be avoided by persons taking MAO inhibitors.
8. Prepare a class presentation on self-help groups for persons diagnosed with mental illness.
9. Obtain a copy of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.). (Washington, DC: American Psychiatric Association, 1994) and review how mental disorders are defined and diagnosed.

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Anorectic Agents and Other Central Nervous System Agents

19

OBJECTIVES

After studying this chapter, the student will be able to:

- List three indications for the use of central nervous system stimulants
- List three adverse effects associated with the use of anorectic drugs
- List three symptoms of attention-deficit hyperactivity disorder
- Identify central nervous system stimulant drugs having anorectic activity and those without anorectic activity
- State specific nursing interventions related to the administration of anorectic drugs
- Apply the nursing process related to the use of central nervous system stimulants

ANOREXIANTS

Anorexiants or anorectic agents are drugs that reduce appetite. They are used as short-term adjuncts to caloric restriction in clients who are on a weight-reducing regimen. Their use has been controversial during the last decade, because of the lack of scientific evidence to support their effectiveness in contributing to weight loss.

Virtually all anorexiants are sympathomimetic agents believed to act by suppressing appetite control centers in the brain. Tolerance has been shown to develop rapidly to the anorectic effect of these drugs, thereby requiring the use of progressively greater doses to maintain a given level of anorectic activity. Most of these agents also cause central nervous system (CNS) and cardiovascular stimulation, which may be manifest as restlessness, sleeplessness, anxiety, palpitations, rapid heartbeat (tachycardia), disturbances of cardiac rhythm (arrhythmias), and an increase in blood pressure. Some of the anorectic agents are chemically and/or pharmacologically related to the CNS stimulant **amphetamine**. Prolonged use of these may lead to psychological dependence. These factors make it necessary to use anorectic drugs for only short periods in clients who do not have a history of substance abuse or disorders that would be adversely affected by the use of such drugs (e.g., heart disease, high blood pressure, sleep disorders). In addition, clients using anorectic drugs must be monitored continuously to prevent the development of dependence or adverse effects.

The abuse of amphetamine and similar drugs as a means of overcoming fatigue and increasing energy and alertness has been widespread for many years. Because of the potential for the development of serious cardiac and psychological effects, the use of these drugs for such purposes should be discouraged.

Table 19–1 compares some anorectic agents in current use. Note that many of these drugs are available as both short-acting and sustained-action dosage forms. Short-acting products should be administered about ½ hour before each meal. Sustained-action products should be administered once daily in mid-morning.

All of the agents listed in Table 19–1 are classified as controlled substances by the federal government, as well as by many state and local governments, thereby limiting their legal use and availability.

It should be noted that some anorectic agents are also used in the treatment of *narcolepsy* and attention-deficit/hyperactivity disorder (ADHD). Narcolepsy is a condition characterized by attacks of sleep that occur often throughout the day. CNS stimulants act to reverse this tendency and allow better sleep regulation. ADHD is characterized by restlessness, distractibility, impulsive behavior, learning disorders, and several other subjective symptoms. Although it is most commonly seen in young school-age children, it is now clear that it may affect adults as well. Several approaches, including exclusion of certain foods and additives from the diet, have been proposed as possible modes of treatment for this disorder, yet the greatest degree of documented success has been seen with the use of CNS stimulants, such as amphetamines (e.g., amphetamine and methamphetamine), **methylphenidate HCl** (**Ritalin**) and **pemoline** (**Cylert**). Although seemingly paradoxical in their action, these agents tend to produce a calming effect and improve the attention span of adults and children with ADHD. Some children taking CNS stimulants for this disorder may develop GI distress, insomnia, headache, and/or depression. Prolonged use of these agents has also been associated with growth depression, but this appears to be reversible on discontinuation of therapy.

ANALEPTICS

Other CNS stimulants (analeptics) have been used clinically in the treatment of respiratory depression caused by excessive doses of a CNS depressant such as alcohol, barbiturates, narcotics, and/or general anesthetics. Analeptics have also been used for respiratory distress caused by electric shock. Their use has declined sharply during the last decade, because of the determination that mechanical assistance for depressed respiration is safer, more reliable, and more effective than drug-induced respiratory stimulation. Table 19–2 lists the properties of nonanorectic CNS stimulants available in the United States. Note that caffeine, the CNS stimulant found in many popular beverages (e.g., coffee, tea, cola, hot chocolate), is the most commonly used CNS stimulant in nonprescription products (Table 19–3).

TACRINE HCL (COGNEX)

Tacrine HCl is used in the treatment of mild to moderate dementia of the Alzheimer's type, that is, Alzheimer's disease. It acts to inhibit the action of cholinesterase, an enzyme that normally degrades the neurotransmitter acetylcholine in the brain. In doing so, tacrine HCl causes the levels of acetylcholine in the brain to increase.

Clients with Alzheimer's disease generally develop mild-to-moderate dementia in the early phases of the disease. This has been associated with a decrease in levels of acetylcholine in the brain of such clients. By elevating brain levels of acetylcholine, it is believed that tacrine HCl may delay the onset and/or reduce the severity of dementia associated with this disease.

Tacrine HCl must be used with caution in clients with preexisting hepatic dysfunction, because its use may result in a greater chance of hepatotoxicity. Because the drug also inhibits **theophylline** metabolism, clients using theophylline should be monitored carefully and the theophylline dose may need to be reduced. The use of cimetidine by clients on tacrine may result in significantly higher tacrine plasma concentrations because of the ability of cimetidine to inhibit tacrine metabolism. Administration of tacrine with meals may significantly reduce its plasma levels. The drug should, therefore, be administered between meals.

The initial dose of tacrine is 40 mg/day administered in 4 equally divided doses. This dosage is continued for a minimum of 6 weeks and the hepatic enzyme level is carefully monitored. After the initial period of therapy, the dose may be increased to 80 mg/day if the client has not experienced hepatic dysfunction. The client may be titrated onto higher doses at 6-week intervals if the lower doses are well tolerated.

ERGOLOID MESYLATES (HYDERGINE, ETC.)

Ergoloid mesylates are a group of chemical agents used to improve cognitive skills, motivation, and general mental capacity in individuals

TABLE 19–1

Anorectic Agents

Note: A weight reduction program should be instituted along with use of anorectic drugs.
May produce psychological dependence.
May mask fatigue. Ensure sufficient rest and sleep.
Do not administer late in the evening; may cause sleeplessness.
Advise client about adverse side effects including nervousness, dizziness, insomnia, tachycardia and palpitations.
Contraindicated in hyperthyroidism, hypertension, some cardiac and renal diseases and in clients with a history of substance abuse. Also contraindicated for use during or within 14 days following administration of monoamine oxidase (MAO) inhibitors.
Withdraw drug gradually.
Do not crush or chew sustained-release products.

DRUG	AVAILABLE DOSAGE FORMS	USUAL ANORECTIC DOSE	NURSING IMPLICATIONS
amphetamine complex, amphetamine sulfate, dextroamphetamine sulfate *(am-**FET**-ah-min **KOM**-plex, am-**FET**-ah-min **SUL**-fayt, **deck**-stroh-am-**FET**-ah-meen **SUL**-fayt)* (Dexedrine, etc.)	oral	5–30 mg daily in divided doses of 5–10 mg administered 30–60 minutes before meals Sustained action: 15–30 mg in the morning 5–60 mg/day for ADHD	May be used in treating narcolepsy and attention-deficit/hyperactivity disorder. Should not be used as an anorectic agent in children under 12 years of age. Clients should avoid the use of caffeine-containing beverages and medications. Carefully monitor blood glucose levels in diabetic clients. Routinely monitor vital signs.
benzphetamine HCl *(benz-**FET**-ah-meen **hy**-droh-**KLOR**-eyed)* (Didrex)	oral	25–50 mg once daily in the morning; may be increased to 25–50 mg 3 times daily, if needed	Clients should avoid use of caffeine-containing beverages and medications. Carefully monitor blood glucose levels in diabetic clients. Routinely monitor vital signs.
diethylpropion HCl *(dye-**ETH**-ill-**PROH**-pee-on **hy**-droh-**KLOR**-eyed)* (Nobesine ✱, Tenuate, Tepanil, etc.)	oral	25 mg 3 times daily 1 hour before meals, and in mid-evening to overcome night hunger, if needed Sustained action: 75 mg once daily in midmorning	May increase convulsions in some epileptic clients. Rarely causes insomnia.
mazindol *(**MAY**-zin-dohl)* (Mazanor, Sanorex)	oral	1 mg daily	Dose may be taken with meals to avoid GI distress.
methamphetamine HCl *(**meth**-am-**FET**-ah-meen **hy**-droh-**KLOR**-eyed)* (Desoxyn, etc.)	oral	5 mg 30 minutes before each meal Sustained action: 10–15 mg once daily in the morning	May be used to treat attention-deficit/hyperactivity disorder—5 mg 1 to 2 times a day.
phendimetrazine tartrate *(**fen**-dye-**MET**-trah-zeen **TAR**-trayt)* (Plegine, Prelu-2, etc.)	oral	35 mg 2–3 times daily 1 hour before meals Sustained action: 105 mg once daily in the morning after breakfast	—
phentermine HCl *(**FEN**-ter-meen **hy**-droh-**KLOR**-eyed)* (Fastin, Ionamin)	oral	Sustained action: 15–37.7 mg before breakfast or 10–14 hours before bedtime	—

TABLE 19–2

Nonanorectic Central Nervous System Stimulants

Note: Use carefully in clients with cardiac disease and/or hypertension.
Routinely monitor vital signs.
Monitor the growth of children using these products.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
caffeine, citrated caffeine *(**KAF**-feen)* (Vivarin, NoDoz)	oral, IM, IV	Oral: 100–200 mg every four hours Parenteral: 500 mg IM or IV as needed	One cup of brewed coffee contains about 170–180 mg of caffeine. May have a diuretic effect. Avoid use in clients with peptic ulcer disease. Tolerance or psychological dependence may occur. Parenteral caffeine products may contain sodium benzoate to increase the solubility of caffeine.
doxapram HCl *(**DOX**-ah-pram **hy**-droh-**KLOR**-eyed)* (Dopram)	IV	0.5–2 mg/kg not to exceed 3 g daily	Arterial blood gases must be monitored carefully prior to initiating therapy with this drug. Onset of action usually occurs within 20–40 seconds. Duration of effect may range from 5–12 minutes.
methylphenidate HCl *(**meth**-ill-**FEN**-ih-dayt **hy**-droh-**KLOR**-eyed)* (Ritalin)	oral	*Adults:* 10–60 mg daily divided into 2–3 doses *Children 6 and over:* 5–10 mg before breakfast and lunch initially; may be increased by 5–10 mg weekly to a limit of 60 mg daily if needed	Commonly used to treat attention-deficit/hyperactivity disorder. Not for use in children under 6. May cause psychological dependence. May result in serious drug interactions if used with guanethidine, anticoagulants, MAO inhibitors, and several other drugs. Periodic blood studies recommended with long-term use. May increase seizures in epileptics. May interact with anticholinergics, anticoagulants, anticonvulsants and tricyclic antidepressants.
pemoline *(**PEM**-oh-leen)* (Cylert)	oral	37.5 mg daily initially; may be increased by 18.75 mg/day at weekly intervals to a limit of 112.5 mg/day	Primarily used in treating attention-deficit/hyperactivity disorder. Hepatic function should be monitored during prolonged therapy. May cause insomnia.

NURSING CARE PLAN

A Child with Attention-Deficit/Hyperactivity Disorder Taking Methylphenidate HCl (Ritalin)

Jennifer Hagen is a 4-year-old recently enrolled in a day care center by her mother, who is recuperating from an illness. In talking with the day care teacher, the mother says she is tired all the time, but Jennifer on the other hand has volumes of energy. She is constantly moving, refuses to take naps, and is always busy investigating and searching. She will sit to watch television for only a very short time, but rapidly loses interest and begins another activity. The living room is constantly filled with toys, as she can never decide what to play with and, therefore, gets out one thing after another. When Jennifer travels in the car with her mother, she is constantly crawling about and climbing out of the car seat. The day care teacher recognizes that Jennifer is much more active than the other children and suggests to the mother that Jennifer be evaluated in the child behavior clinic. The mother takes Jennifer to the clinic and they first check for hyperthyroid disease, which is negative. Based on the diagnosis of attention-deficit/hyperactivity disorder (ADHD), Jennifer is started on methylphenidate HCl (Ritalin), along with a low-sugar, low-additive diet.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Height and weight.	Risk for imbalanced nutrition: less than body requirements related to increased metabolic needs secondary to hyperactivity.	Child eats 90% of a high-calorie, age-appropriate diet with few food additives. Child maintains current weight.	Weigh child weekly. Instruct parents on providing a high-calorie, age-appropriate diet low in food additives.	Child weighs within 10% of ideal body weight. Family identifies sources of food additives and sugar.
Number of hours of sleep. Number and length of naps.	Disturbed sleep pattern related to increased activity.	Child will sleep at least 10 hours a night and 1 hour in the afternoon.	Teach parents to maintain a regular sleeping, eating, playing schedule. Establish nightly routine (story, favorite objects, etc.). Set firm limits and follow with discipline, if needed. Discuss appropriate discipline techniques.	Child demonstrates 10 hours of uninterrupted sleep a night.
Disrupted play patterns. Short span of attention.	Impaired social interaction related to short attention span and changing activities frequently.	Child will demonstrate ability to talk and play with other children without exhibiting negative interaction behavior for 15 minutes.	Provide successful play opportunities with 1 to 2 others, gradually increasing the time. Avoid situations that cause excessive excitement or fatigue. Role model acceptable social behaviors.	Child participates in group activities with other children for increasing periods of time.
Speech patterns.	Impaired verbal communication related to rapid speech pattern and distractibility.	Child demonstrates effective use of language to communicate needs. Child demonstrates the ability to follow directions.	Instruct family in setting reasonable limits, giving directions one at a time, dividing tasks into small, manageable parts, and spending individual, relaxed time with child.	Child responds appropriately to directions. Does not demonstrate anger or confusion. Child communicates needs.
Accident history.	Risk for injury related to frequent changes in activity and increased activity.	Child will reduce number and seriousness of accidents.	Channel energy into safe, appropriate activity. Teach safety awareness.	Child does not have any severe or unusual accidents.
Need for medication.	Deficient knowledge related to the effects of medication.	Child's family will verbalize understanding of medication routine.	Teach parents to give methylphenidate HCl after breakfast and lunch to avoid reducing appetite, not after dinner, as insomnia may occur. Teach parents side effects to observe for. Check blood pressure and pulse twice weekly. Report nervousness or insomnia. Teach parents about the importance of keeping appointments for follow-up blood studies and physician visits. Teach parents not to abruptly discontinue medication.	Drug schedule is maintained by parents. Child does not experience adverse effects.

over 60 years of age who have experienced mental decline caused by an irreversible condition (e.g., Alzheimer's disease, multi-infarct dementia). These agents are believed to act by increasing cerebral blood flow and brain metabolism.

Initially, a dose of 1–2 mg three times daily is generally used. This may be administered orally as a tablet or liquid or they may be administered using a sublingual dosage form. Benefit from these agents may not be evident until 3 or 4 weeks after starting therapy. Up to 6 months of therapy may be required to determine complete client response. Doses of these agents may be increased to as much as 12 mg/day if needed.

TABLE 19–3

Caffeine Content of Common Beverages

Coffee (drip or percolation):	170–180 mg/ 5 oz
Coffee (instant):	100 mg/ 5 oz
Coffee (decaffeinated):	5 mg/ 5 oz or less
Tea (brewed):	50 mg/ 5 oz
Cola soda:	30–50 mg/ 12 oz
Chocolate milk (and chocolate desserts):	less than 10 mg/ serving

APPLYING THE NURSING PROCESS

ASSESSMENT

Obesity is an important health problem in the United States because of its association with serious and often life-threatening diseases such as diabetes mellitus and cardiovascular disorders. Many individuals find it difficult to reduce their weight. In their contacts with physicians, persons wishing to lose weight often seek medication to control their appetite and help them achieve desired weight loss.

Clients taking drugs to assist in weight loss are routinely monitored for changes in body weight and changes in vital signs. Side effects that the client should be aware of include nervousness, dizziness, insomnia, tachycardia, or rapid pulse rate and palpitations. Insomnia is generally avoidable by not administering these anorectic agents late in the day. If side effects cause discomfort, the client is instructed to notify the physician, who may make an adjustment in dose, prescribe a different drug, or suggest a change in the administration schedule.

NURSING DIAGNOSES

Including but not limited to:

- Imbalanced nutrition more than body requirements related to obesity
- Risk for injury related to excessive CNS stimulation
- Risk for ineffective tissue perfusion related to tachycardia
- Deficient knowledge related to nutrition and medical regimen

PLANNING/GOALS

- Client will lose one pound every 1 to 4 weeks until desired weight is attained.
- Client will not experience excessive CNS stimulation.
- Client will not experience adverse side effects from medications, including tachycardia.
- Client will verbalize understanding of nutrition and medication regimen.

IMPLEMENTATION

Clients who are taking medication for weight control must receive some basic nutritional instruction. It is important for them to understand the relationship between caloric intake and expenditure and the resulting change in body weight. Clients are given assistance and support in changing their eating habits and in planning a reasonable program of physical activity that is not contraindicated by their health problems.

The nurse can play an important role in teaching clients about alterations in nutrition due to food intake in excess of body requirements

KEY NURSING IMPLICATIONS 19–1

Nursing Persons Taking Anorectic Drugs for the Treatment of Obesity

1. Basic instruction in nutrition and the relationship between calorie intake and energy expenditure is necessary for clients wishing to lose weight.
2. Clients taking anorectic drugs should be advised that these drugs mask fatigue and that they are habit-forming when taken over a prolonged period.
3. Anorectic agents are generally taken 1 hour before meals. Insomnia is avoided by giving these agents early in the day.
4. Common side effects include nervousness, dizziness, insomnia, tachycardia, and palpitations.

KEY NURSING IMPLICATIONS 19–2

Nursing Persons Taking Central Nervous System Stimulants for the Treatment of Other Problems

1. Methylphenidate HCl (Ritalin) use may result in a lowering of the convulsive threshold.
2. Central nervous system irritability may be indicated by muscle twitching prior to the development of convulsive seizures.
3. Insomnia is avoided by giving these agents early in the day.

and in providing support for individuals over the time necessary to lose weight. Continued interest and support are also necessary for clients to maintain their ideal weight. Clients who are taking amphetamines or related anorectic agents must understand the purpose of these drugs. They should be told that these drugs may mask fatigue, thereby potentially resulting in exhaustion and that they are habit-forming if taken over a prolonged period. They are generally used, therefore, for short-term treatment. Clients should understand that the treatment program often includes gradual withdrawal from the medication to prevent convulsions, lethargy, and depression. This also gives clients confidence that they can maintain the weight loss without drugs. Client education includes instructions to take short-acting anorectic agents about 1 hour before meals. If long-acting agents are being used, they are taken as indicated in Table 19–1.

When working with clients who are obese or who have eating disorders, the nurse must be aware that clients who are displeased with the prescribed treatments or their progress may resort to crash diets, fad treatments, and over-the-counter medications. It is important for the nurse to establish and maintain a good relationship with the client. This provides the opportunity to discuss the consequences of various approaches to weight loss with the client. The client should understand that the use of crash programs seldom results in weight loss that is maintained over time.

As previously stated, some CNS stimulants are also used in the treatment of narcolepsy and ADHD. As part of the care given to persons with these health problems, the nurse assists in assessing the effectiveness of the treatment program. Information on narcoleptic episodes, school performance, behavior at home, and other indicators of daily functioning is shared with the physician.

Methylphenidate HCl (Ritalin) is one of the drugs most commonly used to treat ADHD. It is important for the nurse to be aware that this drug may lower the *convulsive threshold*, making some individuals (such as those with epilepsy) more prone to seizures. Most clients receiving this drug will have periodic blood studies, because blood abnormalities have occasionally been associated with its long-term use. Methylphenidate HCl use in children has also been associated with suppression of growth, particularly body weight. Finally, the use of this drug is associated with many possible drug interactions. These include interactions with anticholinergics, anticoagulants, anticonvulsants and tricyclic antidepressants (refer to Chapters 15, 30, 22, and 18 for further discussion about these classes of drugs). Clients taking drugs with known interactions may require adjustment of their treatment program or schedule of administration. Parents are instructed not to abruptly stop methylphenidate therapy. This could result in fatigue, overactivity, and mood changes.

Nurses, particularly those working in special care units, are occasionally responsible for the

administration of analeptic drugs for the treatment of respiratory depression. These drugs can cause convulsions so the nurse observes the client carefully for indications of central nervous system irritability such as muscle twitching, which may precede convulsions. Measures are taken promptly to avoid convulsions because injuries, including compression fractures of the vertebrae, may occur. In addition, occasionally laryngospasm can occur; therefore the nurse carefully observes the client for signs of respiratory distress.

EVALUATION

- Client loses 1 pound a week for first 2 months then loses 1 pound every other week.
- Client does not experience CNS stimulation or tachycardia.
- Client does not experience adverse side effects of medications.
- Client verbalizes and demonstrates understanding of nutrition, weight loss, and medication regimen.

HOME CARE/CLIENT TEACHING

1. The drug treatment of obesity is only one small part of an effective treatment strategy. Clients need to be advised about nutrition and exercise and should be supported and rewarded in their weight control efforts. On home visits, review the client's eating patterns and environment.
2. Clients taking amphetamines or related anorectic agents must be instructed about the purpose of these drugs, adverse effects, and short-term nature of use of these agents.
3. Clients taking anorectic agents should be informed that they are short-acting and should be taken 1 hour before meals.
4. Clients receiving methyphenidate HCl should have periodic blood studies done to determine if blood abnormalities have resulted from long-term therapy.
5. Clients should be instructed regarding the multiple drug interactions associated with analeptics.

CASE STUDY

Sylvia Milner is an obese 57-year-old woman (height 160 cm, weight 110 kg). Her major complaint is recurrent back and leg pain. The physician performs a comprehensive physical examination and determines that Mrs. Milner's blood pressure is slightly elevated beyond normal limits and that her pain is the result of osteoarthritis which is aggravated by the client's excessive weight. The physician prescribes the following and asks the client to return after 30 days.

- Aspirin 325 mg (5 gr) tablets, 1–2 q4h prn for pain
- Benzphetamine HCI 50 mg tablets—1 daily
- 1,000-calorie diet
- Multivitamin tablets—1 daily

After several days the client calls the physician to report the development of insomnia and severe headaches.

Questions for Discussion

1. What might be the cause of the client's insomnia and headache?
2. What other anorectic drug might be suitable for use by this client?
3. Why would it be inadvisable for the client to use the anorectic agent for longer than several weeks?
4. What recommendations might be made to the client regarding the use of the anorectic drug?

CRITICAL THINKING EXERCISES

1. Examine the emergency supplies in the clinical unit where you work. Which of the drugs are classified as analeptic drugs? In what situations would these drugs be used?
2. Obtain information about the Feingold diet used in the treatment of ADHD. Prepare a class discussion comparing a treatment program using this diet with a program based on the use of methylphenidate HCl (Ritalin).
3. Caffeine is a commonly used drug in our society. Find out how much caffeine is contained in various beverages (e.g., coffee, tea, colas, cocoa), foods (e.g., chocolate), and drug preparations (e.g., pain relievers, CNS stimulants). Keep a daily record to determine the amount of caffeine you consume in an average week.
4. Design a visual aid to be used in explaining the relationship between caloric intake, caloric expenditure, and body weight.

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20 Agents Used in Musculoskeletal Disorders

OBJECTIVES

After studying this chapter, the student will be able to:

- List three uses for neuromuscular blocking agents
- Compare the mechanism of action of competitive and depolarizing neuromuscular blocking agents
- List the names of three drugs that may intensify the action of neuromuscular blocking agents
- Identify the therapeutic effects, side effects, and routes of administration of the major neuromuscular blocking agents and centrally acting skeletal muscle relaxants
- Apply the nursing process related to administration of the major neuromuscular blocking and centrally acting skeletal muscle relaxants and stimulants

Skeletal muscles are those attached to the skeleton and generally activated by voluntary control. They function to:

- produce movement of the body
- help maintain normal body posture
- counteract opposing physical forces (e.g., as may be encountered in pulling or pushing objects)

Skeletal muscle is composed of numerous muscle fibers, or cells, each connected to a single motor nerve fiber. This motor fiber originates at the spinal cord. As each motor nerve fiber is connected to numerous muscle cells, stimulation of a single motor nerve fiber activates many muscle cells. The combination of a single motor nerve fiber and all of the muscle cells innervated by it is known collectively as a motor unit.

When a motor nerve is stimulated sufficiently, each muscle cell in its motor unit will contract or shorten. If no impulses pass through the motor nerve or the impulses are relatively weak, the muscle cells in the motor unit relax and become *flaccid*.

Transmission of an impulse from the motor nerve to each muscle cell occurs across a space known as the neuromuscular junction (Figure 20–1). (For further information, review Chapter 15.) The portion of the muscle cell in closest proximity to the nerve ending is known as the motor end plate. This area is very sensitive to chemical changes in its immediate environment. When a sufficiently strong electrical impulse from the spinal cord reaches the neuromuscular junction, the cholinergic neurotransmitter acetylcholine is released by the motor nerve ending. This agent is taken up by receptors in the motor end plate and causes the generation of an electrical charge, which is known as the end plate potential. As the electrical

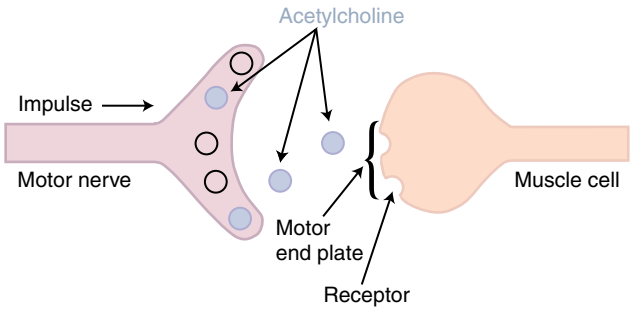

Figure 20–1 Neuromuscular junction and release of acetylcholine (a neurotransmitter) by motor nerve ending.

charge travels from the motor end plate across the entire length of the muscle fiber, depolarization of the fiber is produced, calcium is released, and the muscle contracts. The acetylcholine causing this action is rapidly destroyed by the enzyme cholinesterase, thereby readying the muscle fiber for a response to the next nerve impulse.

NEUROMUSCULAR BLOCKING AGENTS

Sometimes it is clinically desirable to relax or inactivate one or more skeletal muscles to:

- facilitate surgery by reducing muscle movement and/or to permit use of lower anesthetic doses
- facilitate electroconvulsive therapy (ECT) by reducing excessive muscular contraction
- prevent muscle spasm of the larynx (laryngospasm) in clients who require endotracheal intubation
- aid in the treatment of tetanus (a disease characterized by severe muscle spasm)

This is also termed *neuromuscular blockade* and is the intentional paralysis of a client using medications that paralyze skeletal muscle groups, but do not affect cardiac muscle. The most common reason for using these agents is to expedite intubation and to facilitate mechanical ventilation by preventing clients from "fighting the ventilator."

Some neuromuscular blocking agents facilitate muscle relaxation by occupying receptor sites on the motor end plate, thereby blocking the action of acetylcholine. Agents that act in this manner are known as competitive neuromuscular blocking agents, as they compete with acetylcholine for the same receptor sites. Although the muscle fiber does not respond to acetylcholine when these agents are used, it will still respond to electrical stimulation.

Other neuromuscular blocking agents mimic the action of acetylcholine and, thereby, cause depolarization of the muscle fiber. As such agents are not rapidly destroyed by cholinesterase, their action is much more prolonged than that of acetylcholine and the muscle fiber becomes temporarily incapable of being stimulated by another nerve impulse. Agents (e.g., **succinylcholine**) that act in this manner are known as depolarizing, or noncompetitive, neuromuscular blocking agents.

All neuromuscular blocking drugs are usually administered intravenously. Clients receiving them require extremely close monitoring, as these agents are all potentially capable of causing respiratory paralysis and/or cardiac collapse. Therefore, respiratory support and cardiovascular resuscitation equipment, as well as antidotal drugs, such as **neostigmine** or **edrophonium**, must be readily available. These antidotal agents can only reverse the actions of competitive neuromuscular blocking agents (e.g., **tubocurarine**) by inactivating the enzyme cholinesterase and preventing the breakdown of existing acetylcholine at the neuromuscular junction. As such anticholinesterase agents can produce profound cholinergic effects, such as bradycardia (slow heart rate), hypotension, and increased gastric motility, atropine or a similar anticholinergic drug is often administered with these agents.

Neuromuscular blocking agents are not useful for spasticity and rigidity of muscles caused by neurological disease or trauma. In addition, the action of neuromuscular blocking agents may be interfered with or enhanced by the action of a number of other drugs. Antibiotics such as gentamicin, neomycin, **streptomycin**, **tobramycin**, **colistin**, and polymyxin can intensify the neuromuscular blockade produced by some neuromuscular blocking agents. Such antibiotics must, therefore, be used with extreme caution in surgical or postsurgical clients who have received such blocking agents. Likewise, the use of quinidine and similar antiarrhythmic agents is to be avoided in clients who have recently received neuromuscular blocking agents since the antiarrhythmic drugs may also potentiate the action of these agents. Other agents that enhance and prolong the action of neuromuscular blocking agents include **bretylium** (**Bretylol**), calcium-channel blockers, clindamycin (**Cleocin**), corticosteroids, diazepam (Valium), and other benzodiazepams, lidocaine, **magnesium**, phenytoin (Dilantin), and propranolol (Inderal). In addition, inhalant general

anesthetic agents, such as **enflurane** (**Ethrane**) and **isoflurane** (**Fluothane**), enhance the action of the neuromuscular blockers. Potassium-wasting diuretics, such as furosemide (Lasix) enhance the action by causing a loss of potassium, which is an important neuromuscular transmitter in the body. Table 20–1 provides a comparison of the properties of some popular neuromuscular blocking agents.

CENTRALLY ACTING SKELETAL MUSCLE RELAXANTS

Agents that relax skeletal muscle by their action on the central nervous system (CNS) are employed in the treatment of acute muscle spasm associated with sprains, strains, and other acute traumatic conditions involving skeletal muscles. These agents have also been used in treating chronic disorders, such as arthritis, *spondylitis*, and diseases characterized by involuntary motor activity (such as *cerebral palsy*).

Unlike the neuromuscular blocking agents, these skeletal muscle relaxants do not act at the neuromuscular junction. They appear to reduce skeletal muscle spasm by depressing the CNS specifically in the brainstem, basal ganglia, and the *internuncial neurons* of the spinal cord. Apparently, they do not alter nerve conduction, neuromuscular transmission, or muscle excitability.

Virtually all centrally acting skeletal muscle relaxants exert some degree of sedation. This has led to some controversy as to how these agents produce their therapeutic effect and how they should be pharmacologically classified. As muscle spasm is often accompanied by anxiety, it is often difficult to establish whether the symptoms are being relieved by the muscle relaxant properties of the drug, its sedative effect, or both. Because of the sedation caused by the central-acting muscle relaxants, they must be cautiously used with other CNS depressants, such as alcohol and the narcotic analgesic agents. Ambulatory clients should be warned against engaging in activities requiring mental acuity and/or good coordination while on these medications (e.g., driving, operating dangerous machinery, climbing stairs).

Most centrally acting skeletal muscle relaxants can be administered either orally or parenterally. Parenteral administration is generally preferred, as it has been shown to be five to ten times as effective as equivalent doses administered orally. Table 20–2 compares the properties of the centrally acting skeletal muscle relaxants.

DIRECT-ACTING SKELETAL MUSCLE RELAXANTS

Dantrolene exerts a direct muscle relaxant effect on skeletal muscles. Although it does not interfere with neuromuscular transmission or the electrical excitability of muscle, it does appear to inhibit the release of calcium from the muscle. This action makes the muscle less responsive to nerve impulses.

Dantrolene is primarily used in the treatment of skeletal muscle spasm associated with multiple sclerosis, cerebral palsy, spinal cord injury, and stroke. It is also used in the management of malignant hyperthermia syndrome. Although it is often used when painful and debilitating muscle spasm is present, dantrolene may cause muscle weakness, which can interfere with functional improvement as well as the client's participation in physical therapy programs.

Other side effects associated with dantrolene therapy include diarrhea, which may be severe at times; gastrointestinal upset; photosensitivity; and neurological effects, such as changes in sensory perception, insomnia, and depression. Dantrolene is capable of causing hepatotoxicity and overt *hepatitis* in some clients, particularly in female clients, clients over 35 years of age, and those using other medication. Such adverse hepatic effects are particularly likely to occur between the third and twelfth month of dantrolene therapy. The drug should, therefore, only be used with appropriate monitoring of hepatic function and should not be administered for longer than 45 days if improvement is not evident.

Dantrolene dosage is generally individualized for each client. In adults, 25 mg is initially administered orally once daily. If necessary, this dosage may be increased by 25 mg daily at 4–7 day intervals until a maximum dose of 400 mg daily has been reached. In children, an initial dose of 0.5 mg/kg twice daily is used. This may be gradually increased, if needed, in small increments until a maximum dosage of 100 mg, given 4 times daily has been reached.

Dantrolene is also available in an intravenously administered form. This form is indicated for the management of hypermetabolism of skeletal muscle associated with malignant hyperthermia crisis (see Chapter 11). It is administered by continuous, rapid IV push beginning at a minimum dose of 1 mg/kg of body weight. Administration is continued until symptoms subside or until a maximum total dose of 10 mg/kg has been reached.

TABLE 20–1

Neuromuscular Blocking Agents (Intravenous)

Note: Low serum potassium levels antagonize the action of these drugs, with acidosis potentiating their effects.

Antidotes (for competitive blocking agents) and emergency equipment to support respiration must be available when these drugs are given.

Monitor vital signs frequently after administration.

Evaluate the therapeutic effectiveness of these agents.

DRUG	TYPE	USUAL DOSE	NURSING IMPLICATIONS
atracurium besylate *(ah-trah-**KYOU**-ree-um **BES**-ih-layt)* (Tracrium)	competitive	0.4–0.5 mg/kg initially; additional doses of 0.08–0.1 mg/kg may be administered as needed	Do not administer with alkaline solutions; drug may lose activity and precipitate. Administer as IV bolus. Do not administer intramuscularly. Safety of drug has not been established in clients under the age of 1 month. Refrigerate drug solutions.
cisatracurium *(sis-tah-**TRAY**-cue-reh-um)* (Nimbex)	competitive	0.03 mg/kg IV bolus; Continuous Infusion: 3 mcg/kg/min.	Monitor for bradycardia, hypotension, flushing, brochospasm, rash. Administer IV bolus or IV infusion. Because it isn't excreted by the kidneys, it is safe for use in renal clients.
doxacurium chloride *(**dox**-ah-**KYOU**-ree-um **KLOR**-eyed)* (Nuromax)	competitive	0.025–0.05 mg/ kg initially; for IV administration only	Discard any unused portion of diluted drug after 8 hours. Do not administer with alkaline solutions (e.g., sodium phenobarbital). Administer as IV bolus.
mivacurium chloride *(mih-vah-**KYOU**-ree-um **KLOR**-eyed)* (Mivacron)	competitive	*Adults:* 0.1–0.15 mg/kg administered intravenously over 5–15 seconds. Continuous infusion may be used to maintain neuromuscular block. *Children:* 0.2 mg/kg administered intravenously over 5–15 seconds.	Do not add any other drugs to mivacurium chloride solutions. Do not run in same line as barbiturate solutions.
pancuronium bromide *(**pan**-kyou-**ROH**-nee-um **BROH**-myd)* (Pavulon)	competitive	0.06–0.1 mg/kg initially followed by additional doses if needed; 0.1–0.2 mg/kg every 1–3 hours; administer IV only	Drug is about five times as potent as tubocurarine chloride. Do not use in clients allergic to bromides. Store in the refrigerator. Do not mix in same syringe with barbiturates. Monitor intake and output.
pipecuronium bromide *(**pih**-peh-kyou-**ROH**-nee-um **BROH**-myd)* (Arduan)	competitive	*Adults:* 0.07–0.085 mg/ kg initially *Children:* 0.04–0.057 mg/ kg; for IV administration only	Discard unused reconstituted solution after 24 hours.

continues

TABLE 20–1

See **Note** at beginning of Table 20–1, page 413.

DRUG	TYPE	USUAL DOSE	NURSING IMPLICATIONS
rapacuronium *(rap-ah-**CURE**-oh-meh-um)* (Raplon)	competitive	*Adults:* 0.5-1.5 mg/kg *Children:* 2 mg/kg	Monitor for bradycardia, hypotension, tachycardia. Administer IV bolus or IV infusion. Children's dose only used for intubation with children under halothane anesthesia. Repeat dosing in children has not been studied nor is recommended.
rocuronium bromide *(roh-kyou-**ROH**-nee-um **BROH**-myd)* (Zemuron)	competitive	0.6–1.2 mg/kg initially given intravenously.	Product should be refrigerated during storage and used within 30 days of removal from refrigeration.
succinylcholine chloride *(**suck**-sih-nill-**KOH**-leen **KLOR**-eyed)* (Anectine, Quelicin, Sucostrin)	depolarizing	*Adults:* Intravenous: up to 2.5 mg/ kg initially *Infants and children:* Intravenous: 1–2 mg/ kg initially	May be administered IM or IV. Only freshly prepared solution should be used. Although the IV route is preferred, the IM route may be employed when a suitable vein is not available. Store reconstituted solution in the refrigerator. Do not mix in same syringe with barbiturates.
tubocurarine chloride *(**too**-boh-kyou-**RAH**-rin **KLOR**-eyed)*	competitive	0.1–0.5 mg/ kg depending on use; although the IV route is preferred, it may be administered IM or IV. If administered by IV route, dose should be injected over a 1–1½-minute period	Record intake and output. Do not mix in same syringe with barbiturates. Notify physician immediately if signs of paralysis occur (e.g., inability to keep eyelids open or difficulty in swallowing or speaking).
vecuronium bromide *(veh-kyou-**ROH**-nee-um **BROH**-myd)* (Norcuron)	competitive	0.08–0.1 mg/ kg initially; additional doses of 0.01–0.015 mg/ kg may be administered as needed	Administer as IV bolus. Discard unused reconstituted solution after 24 hours.

SKELETAL-MUSCLE STIMULANTS

Drugs that stimulate skeletal muscle action are primarily used in the treatment of myasthenia gravis (MG). They are also used to reverse or antagonize the action of nondepolarizing neuromuscular blocking agents (e.g., **tubocurarine chloride**). MG is a chronic illness that affects about 1 out of every 20,000 persons. It is characterized by the development of skeletal muscle weakness that may range in severity from slight interference with normal muscular strength to widespread severe muscle weakness. As the ocular muscles and other cranial muscles are often affected in this disorder, the classic appearance of a client with myasthenia gravis frequently includes drooping eyelids, difficulty in swallowing, and inability to perform even simple tasks. Although the precise cause of MG is still in question, recent evidence seems to indicate that it results from damage to acetylcholine receptors at the neuromuscular junction caused by an *autoimmune* reaction. This damage interferes with normal nerve impulse transmission and thereby reduces muscle activity.

Therapy for MG is aimed at increasing the concentration of the neurotransmitter acetylcholine at the neuromuscular junction. This is accomplished by the administration of drugs that exert an anticholinesterase action, i.e., they inhibit the action of cholinesterase, the enzyme that destroys

TABLE 20–2

Centrally Acting Skeletal Muscle Relaxants

Note: Caution client to avoid activities that require mental alertness, especially early in therapy.
Avoid using other central nervous system depressants with these drugs.
Avoid alcoholic beverages.
Evaluate the therapeutic effects of these drugs on client's functioning.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
baclofen *(**BACK**-loh-fen)* (Alpha-Baclofen, Lioresal)	oral	Titration schedule: 5 mg tid for 3 days 10 mg tid for 3 days 15 mg tid for 3 days 20 mg tid for 3 days may be increased if needed to a maximum of 80 mg daily	Indicated primarily for treatment of spasticity caused by multiple sclerosis or spinal cord injury. Not to be used in children under 12. Abrupt drug withdrawal should be avoided.
carisoprodol *(**kar**-eye-soh-**PROH**-dohl)* (Soma)	oral	*Adults:* 350 mg 3–4 times daily *Children 5–12 years:* 6.25 mg/kg 4 times/day	Observe client for idiosyncratic reaction following first dose. Take last dose of day at bedtime.
chlorphenesin carbamate *(klor-**FEN**-eh-sin **KAR**-bah-mayt)* (Maolate)	oral	Initial—800 mg tid Maintenance—400 mg qid or less	Safe use for periods longer than 8 weeks has not been established. Liver function determination and blood count should be monitored while client is on drug.
chlorzoxazone *(klor-**ZOX**-ah-zohn)* (Paraflex, Parafon Forte DSC)	oral	*Adults:* 500 mg tid or qid as needed *Children:* 125–500 mg tid or qid	Drug may discolor urine orange or purple-red. Administer with food or water if GI upset occurs.
cyclobenzaprine HCl *(**sigh**-kloh-**BEN**-zah-preen **hy**-droh-**KLOR**-eyed)* (Flexeril)	oral	10 mg tid, not to exceed 60 mg/day	Drug exerts anticholinergic activity which may cause increase in intraocular pressure, urinary retention, dry mouth, increased heart rate, and hypertension. Not to be used longer than 2–3 weeks.
diazepam *(die-**AYZ**-eh-pam)* (E-Pam, Meval, Valium, Valrelease, etc.	oral, IM, IV	*Adults:* Oral: 2–10 mg tid or qid *Geriatric:* 2–2.5 mg 1 or 2 times daily initially, increasing as needed and tolerated Parenteral: 2–5 mg IM or IV *Children* Oral: 1–2.5 mg tid or qid Parenteral: 1–2 mg IM or IV as needed	May cause dependence. Monitor vital signs particularly for hypertension. Discontinue drug gradually to avoid insomnia, weakness, anxiety, irritability, muscle tremors, anorexia, nausea and vomiting and headache. Avoid using in depressed clients and those with a history of drug abuse. When administered intravenously, use direct rather than IV drip method to avoid precipitation of the drug. Avoid mixing diazepam in syringe with any other drug.

continues

TABLE 20–2

See **Note** at beginning of Table 20–2, page 415.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
metaxalone *(meh-**TACKS**-ah-lohn)* (Skelaxin)	oral	*Adults and Children over 12 years:* 800 mg tid or qid	May cause false positive reaction with Clinitest and similar Benedict's tests for glucose in the urine. May be administered with meals to reduce drug-induced GI upset.
methocarbamol *(**meth**-oh-**KAR**-bah-mohl)* (Robaxin, etc.)	oral, IM, IV	*Adults* Oral: 1.5 g qid initially, followed by 0.75–1.5 g tid or qid as needed Parenteral: 1 g initially, followed by additional doses if needed up to 3 g daily	Oral dose may be administered with food to minimize GI upset. Not for pediatric use as a muscle relaxant. May turn urine brown, black, or green. Do not administer subcutaneously.
orphenadrine citrate *(or-**FEN**-ah-dreen **SEYE**-trayt)* (Norflex, etc.)	oral, IM, IV	Oral: 100 mg each morning and evening Parenteral: 60 mg IM or IV; dose may be repeated every 12 hrs	Not for pediatric use. Contraindicated for use in clients with glaucoma and/ or other conditions adversely affected by anticholinergic effects. Some products are sustained-release: Do not crush or chew.

acetylcholine at the neuromuscular junction. Several anticholinesterase drugs are currently available, one of the most popular being **pyridostigmine bromide** (Mestinon). Others include neostigmine (**Prostigmin**), **ambenonium bromide** (**Mytelase**), and **edrophonium chloride** (Tensilon, **Reversol**). Pyridostigmine and ambenonium are most popularly used for oral treatment of myasthenic symptoms, because they have a relatively long duration of action and are usually better tolerated by the oral route than is neostigmine. Edrophonium (Tensilon, Reversol) is administered only parenterally and is employed primarily in the diagnosis of MG or in the emergency treatment of myasthenic crises. Its brief duration of action makes long-term therapy undesirable.

Parenteral forms of acetylcholinesterase drugs are also used in attempting to reverse or antagonize the action of nondepolarizing neuromuscular blocking agents.

A number of adverse effects may occur in clients using anticholinesterase drugs. Many of these (e.g., lacrimation, salivation, diarrhea, intestinal cramping, bradycardia, and miosis) are related to excessive cholinergic activity which may occur with the use of these agents. While these may initially be troublesome and interfere with therapy, tolerance often develops to these effects. Toxicity symptoms caused by the anticholinesterase agents may not be easily distinguishable from those resulting from a myasthenic crisis. When such symptoms appear, therefore, rapid differentiation of their cause is essential. This is often accomplished by observing the client's response to a parenteral dose of edrophonium, i.e., whether or not the client's symptoms improve or worsen. Atropine sulfate should be administered IV to reverse the toxic effects of these drugs.

Table 20–3 summarizes the properties of the anticholinesterase muscle stimulants.

TABLE 20–3

Anticholinesterase Muscle Stimulants

Note: Use cautiously with clients who have asthma or cardiac disease.
Monitor client for development of depressed respirations or respiratory arrest.
Atropine sulfate by IV should be rapidly available to reverse toxic effects of these drugs.
Routinely obtain vital signs and assess muscle strength.
Determine client's ability to swallow before drug administration.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
ambenonium chloride *(**am**-bee-**NOH**-nee-um **KLOR**-eyed)* (Mytelase Caplets)	oral	5–25 mg 3–4 times daily *Children:* 300 mcg/kg/day	Observe client for development of adverse cholinergic symptoms. Initial dosage should be low and gradually increased until the condition is controlled and/ or toxicity occurs.
edrophonium chloride *(**ed**-roh-**FOH**-nee-um **KLOR**-eyed)* (Enlon, Reversol, Tensilon)	IM, IV	*Adults:* IV: 2–10 mg IM: 10 mg *Children:* IV: 1–5 mg *Infants:* IV: 0.5 mg	When administered by IV route, only about 20% of intended dose is first injected as a test dose. If no reaction occurs after 45 seconds, the remaining portion of the dose is administered.
neostigmine bromide *(**nee**-oh-**STIG**-min **BROH**-myd)* (Prostigmin)	oral	15–150 mg daily in divided doses	Neostigmine bromide should not be used in clients with a history of bromide sensitivity.
neostigmine methylsulfate *(**nee**-oh-**STIG**-min **meth**-ill-**SUL**-fayt)* (Prostigmin Methylsulfate)	IM, IV, SC	IM, SC: 0.5 mg IV: 0.5–2 mg by slow IV injection	Drug may cause a skin rash. Observe client for development of adverse cholinergic symptoms.
pyridostigmine bromide *(**peer**-ih-doh-**STIG**-meen **BROH**-myd)* (Mestinon, Regonol)	oral, IM, IV	Oral: 600 mg daily in divided doses IM, IV: 1/30 of the oral dose administered IM or by slow IV injection	Should not be used in clients with a history of bromide sensitivity. May cause a skin rash. Observe client for development of severe cholinergic symptoms, such as muscle weakness, dyspnea, dysphagia.

APPLYING THE NURSING PROCESS

Clients with musculoskeletal disorders require nursing care supplemented by drug therapy. Drugs are used to relax or stimulate muscle action. Generally, drugs fall into three major categories: those that inhibit neuromuscular activity, those that act on the CNS; and those that reverse the action of nondepolarizing neuromuscular blocking agents.

CLIENTS TAKING NEUROMUSCULAR BLOCKING AGENTS

Assessment

The nursing care of clients receiving neuromuscular blocking agents includes taking a nursing history on admission to the hospital. It is particularly important to obtain information on past health problems, current drug therapy, drug allergies and response to past surgery or other procedures in which neuromuscular blockers were likely to have been used. This information will help the physician select an appropriate drug, as the action of neuromuscular blocking agents can be affected by prior or concomitant use with some antibiotics and quinidine. Also, **metocurine iodide** (**Metubine Iodide**) and **gallamine triethiodide** (**Flaxedil**) contain **iodine**, to which some clients may be sensitive. Past medical history and current laboratory studies should be available on the physiological status of the client. For example, low levels of serum potassium antagonize these muscle relaxants, while acidosis potentiates their effects.

Nursing Diagnoses

Including but not limited to:

- Risk for ineffective breathing pattern related to side effects of neuromuscular blocking agents
- Risk for injury related to side effects of neuromuscular blocking agents
- Impaired verbal communication related to intubation and mechanical ventilation and effects of neuromuscular blocking agents
- Fear related to inability to breath independently, mechanical ventilation, neuromuscular blocking agents and inability to communicate verbally
- Deficient knowledge related to medical regimen

Planning/Goals

- Client will maintain adequate ventilation to keep arterial blood gases within normal limits (WNL).
- Client will not experience injury related to side effects of neuromuscular blocking agents.
- Client will communicate nonverbally through eye movements and small finger movements.
- Client/family will appear less apprehensive, as explanations are provided concerning medical care and medication regimen.
- Client/family will indicate understanding of need for mechanical ventilation and use of neuromuscular blocking agents.

Implementation

Whenever neuromuscular blocking agents are used, the nurse must observe the client carefully. As most are given intravenously, there is a rapid response to the drug. Antidotes and emergency equipment to support respiration must be available for use if respiratory depression or circulatory collapse should occur. Antidotes are available only for the competitive neuromuscular blocking agents.

The nurse needs to make sure that all alarms on mechanical ventilators are set to detect any changes in ventilatory pressure. Alarms need to be answered immediately, because clients receiving neuromuscular blocking agents are unable to breath independently. Client's pulse oximetry (peripheral and external monitoring device to determine oxygen saturation in the client's capillaries, which is an excellent indicator of gas exchange in the body) should be continuously monitored. Frequent monitoring of respiratory functioning and level of paralysis should be performed. Because the client is paralyzed the nurse needs also to be sure to assess the skin for areas of breakdown and to change the client's position at least every 2 hours.

One of the most frightening experiences for the client is his/her inability to communicate

fears, anxieties, and concerns including the most looming fear of not being able to breath on his/her own and fear that the ventilator will fail. Some physicians are now using lower doses of neuromuscular blocking agents so that clients can communicate with their eyes or lift their index fingers to indicate "Yes" and "No." This provides the clients with the ability to express themselves.

All clients receiving neuromuscular blocking agents must have their vital signs monitored frequently following administration.

Evaluation

- Client does not experience side effects related to neuromuscular blocking agents.
- Client's oxygen saturation monitored by pulse oximetry is maintained at 95% to 100%.
- Client blinks eyes once for "yes" and twice for "no."
- Client eye expressions indicate decreasing fear and anxiety and family verbalizes decreased anxiety.
- Client/family indicate understanding of medical care, mechanical ventilation, and medication regimen.

CLIENTS TAKING CENTRALLY ACTING SKELETAL MUSCLE RELAXANTS

Assessment

The most important aspect of nursing care for clients receiving these skeletal muscle relaxants is the recognition that the drugs produce drowsiness and sedation. Generally these side effects decrease as the drug is used for a longer period of time. The nurse, however, must observe clients carefully when therapy is initiated. Clients should be cautioned to avoid activities requiring mental alertness, judgment, and coordination. In addition, several of these drugs may produce jaundice or exert anticholinergic activity, resulting in such problems as dry mouth and blurred vision. Drugs with anticholinergic activity should not be used in clients with narrow-angle glaucoma or those subject to lower urinary tract obstruction.

Nursing Diagnoses

Including but not limited to:

- Acute pain related to muscle spasms
- Risk for injury related to side effects of centrally acting skeletal muscle relaxants
- Deficient knowledge related to medical regimen

Planning/Goals

- Client will verbalize relief of muscle spasms and pain that accompanies them.
- Client will not experience injury related to side effects of centrally acting skeletal muscle relaxants.
- Client will demonstrate understanding of medication regimen.

Implementation

Nurses caring for clients taking these centrally acting muscle relaxants must remember to advise clients to avoid the use of other CNS depressants. Examples of drugs to be avoided include alcohol, barbiturates, and most psychotropic agents. Safety precautions are important, particularly early in therapy. Clients should be assisted with ambulation and cautioned about engaging in activities requiring mental alertness, such as driving.

Evaluation

- Client verbalizes relief from muscle spasms and accompanying pain.
- Client does not experience injury related to falls while taking centrally acting skeletal muscle relaxants.
- Client verbalizes understanding of medication regimen.

CLIENTS TAKING DIRECT-ACTIVE SKELETAL MUSCLE RELAXANTS

Assessment

In an effort to avoid the CNS depression associated with centrally acting skeletal muscle relaxants, **dantrolene sodium** (**Dantrium**) was introduced. Some CNS depression can occur with dantrolene use, but it is usually minor. Other

KEY NURSING IMPLICATIONS 20–1

Neuromuscular Blocking Agents

1. Obtain a history of current drug use and drug allergies before neuromuscular blocking agents are used.
2. Antidotes such as the anticholinesterase muscle stimulants listed in Table 20–3 and emergency equipment must always be available when these drugs are used.
3. Monitor vital signs carefully.

KEY NURSING IMPLICATIONS 20–2

Centrally Acting Skeletal Muscle Relaxants

1. These drugs may produce drowsiness and sedation. Take appropriate measures to protect the client's safety.
2. Avoid the use of other central nervous system depressants during therapy with these drugs.
3. Always report a personal or family history of malignant hyperthermia before a client is scheduled for anesthesia.

psychological symptoms, including confusion, mental depression, and insomnia, can occur, and clients should be observed for these. In addition, photosensitivity is possible.

Nursing Diagnoses

Including but not limited to:

- Acute pain related to muscle spasms
- Risk for injury related to side effects (especially photosensitivity) of dantrolene sodium
- Deficient knowledge related to medical regimen

Planning/Goals

- Client will verbalize relief of muscle spasms and pain that accompanies them.
- Client will not experience injury related to side effects of dantrolene sodium.
- Client will demonstrate understanding of medication regimen.

Implementation

Clients should be cautioned to avoid unnecessary exposure to sunlight. Sunscreens can be used to decrease the adverse effects of exposure to the sun.

A study of the effectiveness of dantrolene over a 2-year period showed that the fatigue, malaise, and weakness often experienced by clients when the drug is first administered tend to decrease as the drug is continued. Some improvement in self-care was reported by about one-third of the clients. The nurse should continue to offer supportive care and assistance with daily activities over the course of dantrolene use.

Dantrolene is also used to treat malignant hyperthermia. In an emergency, dantrolene is given intravenously. It helps to decrease hyperthermia by reversing or attenuating the effects of calcium release. Dantrolene treatment is continued for 2 to 3 days following control of the hyperthermia. Dantrolene can also be used prophylactically preoperatively to prevent the development of malignant hyperthermia in clients with a personal or family history of the condition. The dosage of dantrolene is based on body weight, and doses are administered 12 and 4 hours before surgery. Whenever the nurse obtains a family history of malignant hyperthermia, the physician must be informed immediately. See Chapter 11 for a more complete discussion of this life-threatening condition.

Evaluation

- Client verbalizes relief from muscle spasms and accompanying pain.
- Client does not experience injury related to photosensitivity.
- Client verbalizes understanding of medication regimen.

CLIENTS TAKING SKELETAL MUSCLE STIMULANTS

Assessment

Nursing assessment includes the measurement of vital capacity and evaluation of the presence and degree of *ptosis* of the eyelids and muscle strength. Such assessments are made before a dose of medication is administered, periodically following administration to deter-

mine effectiveness of therapy, and whenever the client's condition appears to be deteriorating. Blood pressure, pulse, and respirations are assessed routinely throughout the day.

Nurses must be aware that overdose with a cholinesterase inhibitor may produce a cholinergic crisis. It may be difficult to determine if the client's weakened condition is due to the disease or to its treatment. Whenever doubt exists, the physician should be contacted. In most cases, the physician will order the administration of an intravenous dose of edrophonium to determine if symptoms improve (myasthenic crisis) or worsen (cholinergic crisis) when an anticholinesterase drug is administered. If the symptoms occurred because the client was unable to swallow the medication, and if strength improves with intravenous administration of an anticholinesterase drug, the client was experiencing myasthenic crisis. On the other hand, if there is a history of increased drug intake or muscle weakness that increases within an hour of anticholinesterase ingestion, cholinergic crisis is diagnosed.

Nursing Diagnoses and Planning/Goals

Refer to Nursing Care Plan in this chapter.

Implementation

In planning care, nurses must be aware and make others aware of the need to adhere to a set schedule of drug administration. For this reason, care is taken in scheduling diagnostic and treatment procedures. Clients who have had MG for some time often learn to tailor their medication to their needs. They are on a demand schedule, rather than a fixed schedule. Such clients must always have a sufficient supply of medication available. Because clients have greater muscle strength soon after taking their medication, respiratory protective measures such as coughing, deep breathing, and sighing, plus other physical activities are planned for these times.

Clients with myasthenia gravis generally feel strongest in the morning and experience increasing fatigue and muscle weakness as the day progresses. It is important, therefore, to ensure that medication is taken early, before muscle weakness affects the client's ability to chew, swallow, and engage in self-care. Generally, a dose is taken 30–60 minutes before breakfast to ensure sufficient strength to eat. As the medication is not well tolerated when taken on an empty stomach, it may be taken with juice or milk, rather than water. Before administering a dose of anticholinesterase medication, the nurse determines the client's ability to swallow. Clients with difficulty swallowing may need to receive parenteral, rather than oral, medication.

Client and family education is an important nursing function. Clients are advised to carry an identification card or tag indicating that they have myasthenia gravis. Information must always be available about their medication schedule and dosages, along with the name and phone number of their physician. Clients and family members are instructed in the identification of signs and symptoms indicating the need for medication. Once a medication schedule is developed, the client must adhere to the schedule. Clients must understand the consequences of early or late administration or skipping a dose. Finally, clients are advised not to start taking any prescription or over-the-counter drugs without consulting their primary care provider.

Evaluation

Refer to Nursing Care Plan in this chapter.

KEY NURSING IMPLICATIONS 20–3

Skeletal Muscle Stimulants

1. Assess the client's ability to swallow, ptosis of the eyelids, and muscle strength as well as vital signs.
2. Contact the physician whenever the client develops a weakened condition that may be related to myasthenic crisis or cholinergic crisis.
3. Clients with myasthenia gravis should receive their medication early in the morning before they eat or engage in self-care activities.
4. Physical activities are planned for the time shortly after taking medication when the muscle strength is greatest.
5. Clients with myasthenia gravis are instructed to carry information about their medication and must understand the importance of complying with the medication schedule.

NURSING CARE PLAN

A Client with Myasthenia Gravis Taking Pyridostigmine Bromide (Mestinon) and Receiving Edrophonium Chloride (Tensilon, Reversol)

Natasia Johnson, age 33, is admitted to the hospital and scheduled for thymectomy. Natasia has had a diagnosis of myasthenia gravis and has been on pyridostigmine bromide (Mestinon) 100 mg q4h for the last year. In doing Natasia's preoperative teaching, it is apparent that she understands her condition well and is aware of her medication routine. When Natasia is told she will be on nothing by mouth after midnight, she was reassured that her pyridostigmine can be given by injection. Natasia knows that both cholinergic crisis and myasthenic crisis could lead to muscle weakness and respiratory depression. Postoperatively, Natasia develops respiratory failure and needs to be maintained on a ventilator. She is frightened and is reassured by the physician, who decides to test for cholinergic crisis by using edrophonium chloride (Tensilon, Reversol). A small test dose was given and muscle weakness improved. The probable reason for the respiratory failure was that Natasia received tubocurarine for muscle relaxation during surgery. She is placed on pyridostigmine bromide 100 mg q4h.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Breathing patterns.	Impaired gas exchange related to muscle weakness of chest wall.	Client will maintain adequate gas exchange. Arterial blood gases will be within normal range.	Monitor oxygenation with arterial blood gases. Suction to maintain airway. Observe ventilator for correct settings and function. Schedule breathing exercises for shortly after medication is administered.	Client has good oxygenation. Skin is warm and dry and no cyanosis is present. ABGs are within normal limits.
Activity.	Activity intolerance related to fatigue and muscle weakness.	Client will turn self in bed on day of surgery without shortness of breath or increase in heart rate.	Turn client frequently. Permit client to assist as muscle strength is available. Encourage client to remember that as medication works, strength will return.	Client maintains activity level within capabilities as evidenced by normal vital signs with activity.
Mobility.	Impaired physical mobility related to weakness of skeletal muscles.	Client sits in chair for 30 minutes with assistance on second postoperative day. Client walks to door and back with assistance on third postoperative day.	Have client sit in chair ×2 on second postoperative day. Assist as necessary. Schedule ambulation for period when muscle strength is greatest. Ambulate client with assistance ×2 on third postoperative day.	Client sat in chair for 15 minutes twice on second postoperative day. Required assistance getting in and out of chair. No shortness of breath or increase in heart rate. Client ambulated to door and back ×2 with assistance on third postoperative day. No shortness of breath, but heart rate increased 30 bpm.
Communication.	Impaired verbal communication related to muscle weakness and tracheal intubation.	Client uses alternative forms of communication while on ventilator.	Plan communication for client on ventilator. "Yes" and "No" questions are good. Read lips. Have client write, if she has adequate muscle strength.	Client communicates needs with eye movements and hand signals while on ventilator.

Injury.	Risk for injury related to muscle weakness.	Client will not experience injury during hospitalization.	Observe client closely for changes in muscle strength that might lead to falls or other types of injury. Assess client for risk of falls. Provide assistance for ambulation. Implement strategies for preventing falls.	Client has no injuries during hospitalization.
Fearfulness. Need for information.	Powerlessness related to inability to control symptoms.	After extubation, client verbalizes fears and explores ways to achieve some control over her personal situation.	Give psychological support. Reassure client that the crisis will pass. Explain all actions and procedures. Keep client informed about medication schedule. Encourage involvement in decision making.	After extubation, client verbalizes fear of never getting off machine and identifies three ways to achieve some control over the situation.
Signs of myasthenic crisis.	Risk for altered health maintenance related to not recognizing symptoms of disease.	Prior to discharge, client lists signs of myasthenic crisis to report to health care provider.	Client teaching after crisis passes should include reporting: dysphagia, dysarthria, eyelid ptosis, diplopia, tachycardia.	Prior to discharge client identifies signs of myasthenic crisis and reports them to health care provider.
Signs of cholinergic crisis.	Deficient knowledge related to unfamiliarity with drug therapy.	Client describes appropriate medication routine and symptoms of overdose prior to discharge.	Pyridostigmine bromide should be taken with food. Report rash, nausea, diarrhea, excessive salivation and sweating. Teach client to never skip a dose unless physician approves. Instruct client to carry identification and information about drug therapy with her at all times. Client is taught that atropine is used as an antidote when overdose with pyridostigmine occurs.	Client adheres to drug therapy regimen and experiences no adverse reactions or promptly reports signs and symptoms of adverse effects to health care provider.

HOME CARE / CLIENT TEACHING

1. The nurse stresses safety measures for clients taking skeletal muscle relaxants that depress the (CNS). These measures include avoiding concomitant use of other drugs that depress the CNS, including ethanol, and avoidance of hazardous tasks, such as driving.
2. Clients taking skeletal muscle stimulants to treat myasthenia gravis need to be informed concerning signs and symptoms of cholinergic crisis, so they can report these to their physician and seek immediate medical care.
3. Clients with myasthenia gravis should be instructed to wear identification indicating that they have the condition.
4. Clients with myasthenia gravis should be instructed to take their medication early in the morning before breakfast and the importance of adhering to a strict schedule of medication self-administration.
5. Clients with myasthenia gravis should be informed not to take any prescription or over-the-counter medication without consulting their physician.

CASE STUDY

Tom Wheeler is a 26-year-old construction worker who is brought to the emergency room after having fallen off a scaffolding while working on a building project. His primary complaint is of severe pain in the lower back. He has minor cuts and abrasions as well. The client's recent medical history does not reveal any previous back disorder or medication use. During the admitting interview Mr. Wheeler reveals that he consumes about one six-pack of beer each day.

X-ray studies reveal no serious injury and the client is discharged with the following medications:

- Oxycodone 5 mg tablets: 24 tablets, 1 tablet q4h prn for pain
- **Methocarbamol** (**Robaxin**) 500 mg: 80 tablets, 2 tablets QID

Several days later the client is again brought to the emergency room after having fallen from a ladder. He is admitted with a fractured shoulder and two fractured fingers.

Questions for Discussion

1. By what mechanism would the methocarbamol (Robaxin) reduce the lower back pain of the client?
2. Could the client's use of the prescribed drugs have contributed to the second accident? Explain.
3. Could the client's use of alcohol have contributed to the first and (or) the second accident? Explain.

CRITICAL THINKING EXERCISES

1. Interview a physical therapist about methods other than drug therapy used to produce muscle relaxation.
2. Identify the neuromuscular blocking agents used. What is the purpose of these medications?
3. Attend a clinic for physically handicapped children, or observe the treatment of these children in a rehabilitation setting. Identify the types of treatment the children are receiving. Prepare a discussion of the ways in which drug therapy is related to these other treatment modalities.

4. State the mechanism by which the physiological process of skeletal muscle contraction occurs.
5. Prepare a care plan for a client with myasthenia gravis or cerebral palsy.

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21 Anti-Parkinson Agents

OBJECTIVES

After studying this chapter, the student will be able to:

- State the mechanism by which levodopa acts to alleviate the symptoms of Parkinson's disease
- Identify the actions and side effects of carbidopa, amantadine (Symmetrel), selegiline (Eldepryl), pergolide mesylate (Permax), bromocriptine mesylate (Parlodel), and anticholinergic drugs when used in the treatment of Parkinson's disease
- Apply the nursing process related to the administration and use of the major anti-Parkinson agents

Parkinson's disease, or paralysis agitans, is a neurological disorder characterized by muscle tremor, rigidity, and lack of coordination. Figure 21–1 shows some characteristics of the client with Parkinson's disease. Disturbances of posture

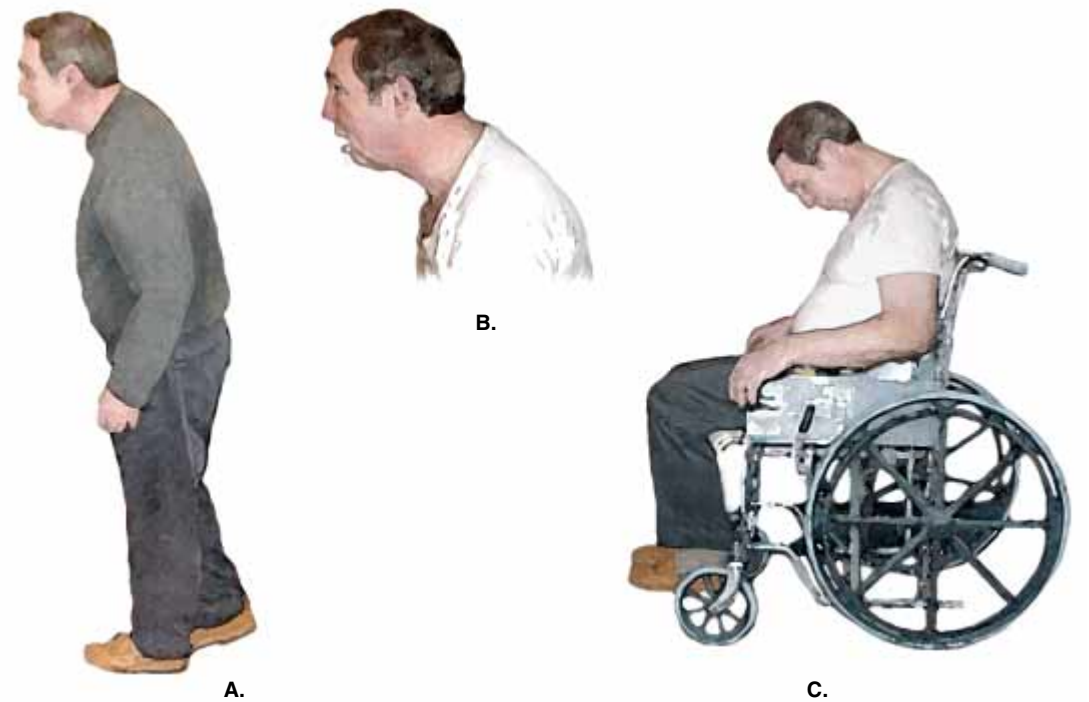

Figure 21–1 The shuffling gait and early postural change of Parkinson's disease is shown in (A), (B) and (C) show an advanced stage of the disease with drooling, head held forward, and inability to stand.

and equilibrium are often present. The onset of the disease is usually slow, with symptoms developing over several months to several years. Approximately 1 million persons in the United States have Parkinson's disease. Two-thirds of all Parkinson clients develop the disease between the ages of 45 and 69. There is about a 2% chance that a person will develop Parkinson's disease in his/her lifetime. Men and women experience equal incidence, and family history does not at present seem to be a predisposing factor. The disease is progressive, and, if left untreated, gradually contributes to the client's death.

The cause of Parkinson's disease is not completely understood, but is believed to be the result of an imbalance in the concentration of certain neurotransmitters in the brain. Experimental evidence has revealed that clients with this disease have an excessive amount of acetylcholine (the chemical neurotransmitter of the cholinergic system) and a deficiency of dopamine in the central nervous system (CNS) (Figure 21–2).

Drug therapy of Parkinson's disease is aimed at correcting this neurotransmitter imbalance by enhancing the effects of dopamine and/or inhibiting the effects of acetylcholine. Drugs employed in the treatment of Parkinson's disease may be divided into two categories: (1) those exerting dopaminergic action and (2) those exerting anticholinergic action.

It should be noted that all forms of treatment for Parkinson's disease are *palliative*, not curative. During therapy, the disease often continues to progress, necessitating periodic changes in the dosage and types of drugs used.

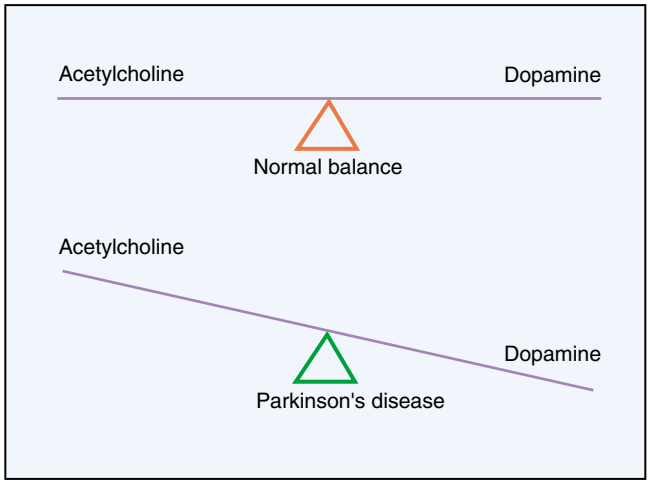

Figure 21–2 Dopamine imbalance with Parkinson's Disease.

DOPAMINERGIC AGENTS

Levodopa

Levodopa has evolved as the most effective drug in the treatment of Parkinson's disease. When levodopa enters the bloodstream, it is rapidly converted in the peripheral circulation to dopamine by the enzyme dopadecarboxylase and eventually increases the dopamine content of the brain.

$$\text{levodopa} \xrightarrow{\text{dopadecarboxylase}} \text{dopamine}$$

When appropriate doses of levodopa are administered to Parkinson clients, many of a client's symptoms subside or disappear and the client is frequently able to lead a more functional existence.

Several adverse effects are often evident in clients taking levodopa, however. Their intensity and characteristics tend to vary considerably and are almost always dosage-dependent and reversible. The most common adverse effects produced by levodopa are nausea, vomiting, and orthostatic hypotension. In some clients, particularly those with a history of cardiac disturbances, arrhythmias may occur. Other clients, on long-term levodopa therapy may experience psychiatric disturbances or intensification of existing narrow-angle glaucoma. Some clients receiving levodopa will have an irregular response to the drug. This phenomenon, sometimes referred to as the "off-on" phenomenon, often occurs in clients who have been on long-term levodopa therapy. It is generally best managed by reducing the maintenance dose of levodopa and substituting another anti-Parkinson drug.

Many of the adverse effects reported with the use of levodopa can be attributed to the high doses often employed in Parkinson treatment. Because more than 95% of the oral dose of levodopa is converted to dopamine by the enzyme dopadecarboxylase, and as dopamine cannot penetrate the blood-brain barrier, large oral doses of levodopa are required to get therapeutic amounts of intact levodopa into the brain.

Several years ago, it was noted that clients using levodopa and multivitamin products were not as responsive to levodopa therapy as those who did not use multivitamins. On investigation of this phenomenon, it was found that pyridoxine (**vitamin B_6**), a component of most multivitamin products, facilitated the breakdown of levodopa to dopamine in the peripheral circulation and, thereby, reduced the amount of levodopa that could enter the brain. Clients using levodopa should, therefore, not take multivitamin products containing pyridoxine, but may take a pyridoxine-free product, such as **Larobec**.

Carbidopa-Levodopa (Sinemet)

Carbidopa is an inhibitor of the dopadecarboxylase enzyme. Carbidopa used in combination with levodopa reduces the required levodopa dose to one-fourth of what it would be without carbidopa. By preventing levodopa breakdown in the peripheral circulation, more levodopa is available for entry into the brain and less dopamine is present in the peripheral circulation, thereby substantially reducing the incidence and severity of drug-related adverse effects.

The use of carbidopa-levodopa combinations (e.g., **Sinemet-10/100**) has evolved as one of the most effective forms of therapy for Parkinson's disease. Because the conversion of levodopa to dopamine is inhibited when the levodopa-carbidopa combinations are used, pyridoxine-containing vitamin products can be safely used without concern about reducing levodopa activity.

Carbidopa (**Lodosyn**) is available without levodopa for use in clients who require precise adjustment of their carbidopa and levodopa dosage.

Amantadine (Symmetrel)

This drug was originally developed and used for the prophylaxis and treatment of viral disorders. On observing that Parkinson clients improved after receiving antiviral doses of amantadine, it was determined that the drug is also an effective anti-Parkinson agent. Although not as effective as levodopa, amantadine has proven to be a valuable adjunct to levodopa therapy, as it appears to exert an additive effect, particularly in clients who cannot tolerate high levodopa doses.

Amantadine is believed to act by releasing dopamine from central neurons, thereby increasing dopamine concentration in the CNS. Although it causes relatively few serious adverse effects, amantadine has been associated with gastrointestinal distress and psychiatric disorders.

Bromocriptine Mesylate (Parlodel), Pergolide Mesylate (Permax) and Selegiline HCl (Eldepryl)

These agents also appear to be useful dopaminergic agents in the treatment of Parkinson's disease. They may be used as adjuncts to levodopa therapy or in place of it in situations where clients have developed tolerance to levodopa. Unlike levodopa and amantadine, both of which appear to increase central dopamine levels, **bromocriptine mesylate** and **pergolide mesylate** appear to stimulate dopamine receptors in the brain directly.

Selegiline HCl inhibits monoamine oxidase (MAO) and may also act by unclear mechanisms to increase the activity of dopamine. When used in combination with levodopa, selegiline HCl allows less levodopa to be used to achieve effects similar to larger doses of levodopa.

ANTICHOLINERGIC AGENTS

Drugs that exert a central anticholinergic action have long been used to treat Parkinson's disease. These agents appear to act by reducing excessive cholinergic activity in the brain. Belladonna derivatives (e.g., atropine, scopolamine) were the first used in such treatment. However, their extensive adverse effects (e.g., dry mouth, urinary retention, blurred vision) led to the development and use of a variety of synthetic anticholinergic agents and antihistamines with anticholinergic activity.

Popular examples of these agents include **trihexyphenidyl** (**Artane**), **benztropine mesylate** (**Cogentin**), **biperiden** (**Akineton**), **ethopropazine** (**Parsidol**), and diphenhydramine (Benadryl). Although not as effective as other anti-Parkinson drugs that have been discussed, anticholinergic agents are still used: (1) for clients with only minimal symptoms, or (2) in combination with other anti-Parkinson drugs as adjuncts to therapy. Most of the anticholinergics should be used with caution in clients with narrow-angle glaucoma and other disorders that are adversely affected by anticholinergic drugs. Table 21–1 lists the properties of drugs used to treat Parkinson's disease.

TABLE 21–1

Drugs Used to Treat Parkinson's Disease

Note: Clients with epilepsy should be monitored carefully for increased seizure activity while taking medications to treat Parkinson's disease.

Monitor for development of psychological changes, such as depression, nervousness, psychotic behavior, and confusion.

Evaluate the client's response to medication, including improved mobility, decreased tremor, and improved daily functioning.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
A. Dopaminergic Drugs			
amantadine HCl *(ah-**MAN**-tah-deen **hy**-droh-**KLOR**-eyed)* (Symmetrel)	oral	100 mg 2 times daily	Monitor for side effects, including psychological changes and purple mottling. Orthostatic hypotension may sometimes occur when clients use this drug.
bromocriptine mesylate *(broh-moh-**KRIP**-teen **MES**-ih-layt)* (Parlodel)	oral	Initially 1.25 mg 2 times daily; dosage may be increased by 2.5 mg daily every 2–4 weeks, if needed	If bromocriptine dosage must be reduced to counteract adverse effects, dosage should be reduced gradually in 2.5 mg increments.
carbidopa *(kar-bih-**DOH**-pah)* (Lodosyn)	oral	Used to supplement carbidopa dosage in combination carbidopa-levodopa products	Carbidopa is used with carbidopa-levodopa combinations in clients who experience nausea and vomiting and are receiving less than 70 mg of carbidopa daily in the combination product.
carbidopa-levodopa *(**kar**-bih-**DOH**-pah **lee**-voh-**DOH**-pah)* (Sinemet-10/100, Sinemet-25/100, Sinemet-25/250, Sinemet CR)	oral	300–800 mg levodopa and 75–200 mg carbidopa daily in divided doses	Available in a sustained-action dosage form for administration 2 or 3 times daily. Pyridoxine (vitamin B_6) does not interfere with the action of carbidopa-levodopa combinations. Levodopa administration should be discontinued at least 8 hours before carbidopa-levodopa therapy is begun. Sinemet CR may be administered as whole or half tablets that should not be crushed or chewed.
entacapone *(en-**TAK**-a-pone)* (Comtan)	oral	200 mg with each dose of levadopa/carbidopa up to 8 times daily	Contraindicated in clients taking MAO-1 inhibitors. Clients need to have liver function tests monitored every 2 weeks for the first year of therapy then every 4 weeks for the next 6 months. Acts as an adjunct to levodopa/carbidopa to treat clients with the signs and symptoms of end-of-dose "wearing off," sometimes called "fluctuating" clients. Monitor parkinsonian and extrapyramidal symptoms, including restlessness or desire to keep moving, rigidity, tremors, difficulty speaking or swallowing, loss of balance control.

continues

TABLE 21–1 *continued*

See **Note** at beginning of Table 21–1, page 429.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
levodopa *(**lee**-voh-**DOH**-pah)* (Dopar, Larodopa, etc.)	oral	0.25–8 g daily divided into 2 or more doses	Should be administered with non-protein food to reduce GI upset. Doses of more than 10 mg of pyridoxine (vitamin B_6) will reverse the effect of levodopa. May darken client's urine. Monitor client for disturbances in thought processes or behavior.
pergolide mesylate *(**PER**-goh-lyd **MES**-ih-layt)* (Permax)	oral	Initially 0.05 mg daily for the first two days; dosage is then increased by 0.1 mg/day or 0.15 mg/day every third day for the next 12 days of therapy; thereafter dosage may be increased by 0.25 mg/day every third day, if required Daily dosage should be given in three divided doses	Monitor client for the development of hypotension, GI upset, CNS depression, dyskinesia, dizziness, or hallucinations.
selegiline HCl *(seh-**LEJ**-ih-leen **hy**-droh-**KLOR**-eyed)* (Eldepryl)	oral	10 mg daily (5 mg at breakfast and 5 mg at lunch)	Do not administer more than 10 mg daily. Monitor clients for development of nausea or dizziness.
tolcapone *(tol-cah-pone)* (Tasmar)	oral	100–200 mg three to four times per day	Contraindicated in clients taking MAO-1 inhibitors. Clients need to have liver function tests monitored every 2 weeks for the first year of therapy, then every 4 weeks for the next 6 months. Reductions in levodopa dosages may be required.

B. Anticholinergic Drugs

Note: Anticholinergic drugs are contraindicated in clients with narrow-angle glaucoma and prostatic hypertrophy.

Elderly clients should be monitored carefully while using these agents as they are more likely to develop adverse effects.

Fluids and mouth care should be provided frequently since these drugs may cause dry mouth.

Evaluate client's response to medication including improved mobility, decreased tremor, and improved daily functioning.

benztropine mesylate *(**BENZ**-troh-peen **MES**-ih-layt)* (Cogentin)	oral, IM, IV	0.5–4 mg daily in single or divided doses as needed Injection: 1–4 mg/day	Single daily doses are best given at bedtime. Divided doses should be given after meals.
biperiden *(by-**PER**-ih-den)* (Akineton)	oral, IM, IV	2 mg 3–4 times daily Injection: 2 mg	May be used parenterally (IM or IV) in treatment of drug-induced extrapyramidal disorders. IV injections are given slowly.

continues

TABLE 21–1 *continued*

See **Note**, page 430.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
diphenhydramine* *(**dye**-fen-**HY**-drah-meen)* (Benadryl, etc.)	oral, IM, IV	Oral: 25–50 mg 3–4 times daily Parenteral: 10–50 mg IV or deep IM	Agent has antihistaminic properties. Useful for elderly clients who cannot tolerate more potent agents. Drug may cause drowsiness.
ethopropazine HCl *(**eth**-oh-**PROH**-pah-zeen **hy**-droh-**KLOR**-eyed)* (Parsidol, Parsitan ✱)	oral	50–600 mg daily	Chemically related to phenothiazine antipsychotic agents. Monitor for development of drowsiness or confusion.
procyclidine *(proh-**SIGH**-klih-deen)* (Kemadrin, Procyclid ✱)	oral	2.5–5 mg 3 times daily as needed	Clients may become drowsy while using this drug. Administer after meals to reduce GI upset.
trihexyphenidyl HCl *(try-**heck**-see-**FEN**-ih-dill **hy**-droh-**KLOR**-eyed)* (Aparkane ✱, Artane, etc.)	oral	1–15 mg daily divided into 3–4 doses taken at mealtimes and bedtime	Available in sustained-action oral form for administration once or twice daily. Clients may become drowsy while using this drug.

*Although not truly an anticholinergic drug, diphenhydramine does produce some anticholinergic effects. It is primarily used as an antihistamine.

CATECHOL-O-METHYLTRANSFERASE INHIBITORS

Catechol-O-methyltransferase inhibitors is a new class of anti-Parkinson medications. **Tolcapone** (**Tasmar**) is the first of this class and is used only in clients with Parkinson's disease who have not responded to the more traditional dopaminergic therapy. Because of the risk of liver failure, physicians are advised to have the client sign an informed consent before taking tolcapone. Tolcapone acts by increasing the action of levodopa by decreasing its biotransformation in peripheral tissues. When administered with levadopa/carbidopa, tolcapone provides for a more sustained dopaminergic plasma level and more constant stimulation to the brain. It may also, however, increase the adverse side effects associated with levodopa, such as dyskinesia, orthostatic hypotension, dystonia, somnolence, and gastrointestinal irritation. In 4% of clients, severe diarrhea creates threats of fluid and electrolyte imbalances and skin breakdown. Clients over 75 years old may develop more hallucinations and less dystonia than in younger clients. Refer to Table 21–1 to compare tolcapone with other anti-Parkinson drugs.

APPLYING THE NURSING PROCESS

ASSESSMENT

Most clients with Parkinson's disease will be taking one or more drugs to treat this condition. If the client is taking levodopa, the nurse must carefully observe for adverse side effects. Vital signs should be routinely monitored with special attention to the rhythm of the heart and the possibility of orthostatic hypotension. Because of this latter possibility, the client should be gradually assisted into a sitting and then a standing position before ambulating. The other side effect of major concern is the appearance of psychiatric disturbances. These may include paranoia, mental depression, or confusion. Such symptoms should be reported promptly to the

physician. Finally, when therapy is first begun, the client may have gastrointestinal side effects, such as lack of appetite, nausea, and vomiting. The client should be encouraged to continue treatment, as these side effects usually diminish as therapy continues.

Most persons with Parkinson's disease develop the health problem in their later years. The age and general physical condition of the client are important factors influencing nursing care.

Some clients experience widely fluctuating plasma levels of levodopa. It has been suggested that food, particularly high-protein food, may decrease or delay absorption of this drug. The drug may be taken with a low-protein snack such as fruit or juice. High-protein meals have been associated with decreased mobility in persons with Parkinson's disease. Multivitamin preparations and fortified cereals may contain pyridoxine (vitamin B_6), which can decrease the effects of levodopa. Foods and medications high in pyridoxine are to be avoided by clients taking levodopa.

Fewer side effects are reported for carbidopa-levodopa in combination and therefore therapy is often better tolerated by the client. The nurse, however, continues to observe the client for the side effects associated with levodopa treatment. Nurses should also record observations of the client's condition, including self-care ability, ease in ambulation, changes in ability to speak and eat without difficulty and changes in the amount of rigidity and tremor. Such observations will help the physician to determine the appropriate treatment plan.

Clients taking amantadine (Symmetrel) are observed especially for psychological changes such as depression, nervousness, psychotic behavior and confusion. The physician should be notified of these promptly. Orthostatic hypotension, urinary retention and gastrointestinal symptoms may also occur.

Bromocriptine mesylate (**Parlodel**) may also cause hallucinations, psychiatric symptoms, and abnormal movements. Nursing assessment is important in detecting these changes in the client.

Several other drugs are often used in combination with the previously mentioned drugs. These may also be used as the sole treatment in mild cases of parkinsonism or in the treatment of a drug-induced parkinsonism. The phenothiazine tranquilizers (see Chapter 18) are probably the major cause of this drug-induced disease. If insomnia becomes a problem, the last dose of the day should be given several hours before bedtime.

Ethopropazine HCl (Parsidol), a drug related to the phenothiazines, is used to treat parkinsonism. It has the advantage of promoting sleep, in addition to reducing rigidity and tremor. The nurse should observe the client for indications of CNS depression, including drowsiness, inability to concentrate, and confusion.

Compounds having anticholinergic activity are also used for the treatment of Parkinson's symptoms, including those induced by drug therapy. These drugs must be used very carefully in older persons, as clients may have undiagnosed glaucoma or *prostatic hypertrophy* that could precipitate serious problems. Male clients must be observed for urinary retention. Also, because anticholinergics cause a dry mouth, mouth care and fluids should be offered frequently.

Clients taking anticholinergics may develop constipation. Sufficient fluids, fruits, and vegetables should be included in the diet to promote regular elimination.

The final group of drugs used to treat Parkinson's disease are antihistamines. These drugs are often used in elderly clients, as they are less likely to cause mental disturbance. Their sedative effect is often beneficial in counteracting the insomnia produced by other drugs used in the treatment of this disease. Chapter 23 reviews the subject of antihistamines in more detail.

NURSING DIAGNOSES

Including but not limited to:

- Impaired physical mobility related to muscle tremors and spastic movements
- Disturbed body image related to tremors and posture
- Risk of constipation related to altered muscle tone and anti-Parkinson drugs
- Risk for injury, from falls related to side effects of anti-Parkinson drugs
- Imbalanced nutrition, less than body requirements related to disease process
- Deficient knowledge related to disease process and treatment regimen

PLANNING/GOALS

- Client will verbalize and demonstrate positive effects of medication therapy, including decreasing tremors and spasms.
- Client will verbalize positive feelings about body image.
- Client will maintain regular bowel elimination pattern.
- Client will not experience injury due to falls or side effects of medication therapy.
- Client will maintain weight within normal limits, per standardized chart.
- Client will verbalize understanding of disease process and medical regimen.

IMPLEMENTATION

Regardless of the specific drug therapy prescribed, several general principles should be followed in caring for the client. One of these is not to rush the client. This is particularly true during ambulation, eating, or taking medications. Maintenance of balance is problematic for these clients and falls can occur. Swallowing and excessive salivation are often problems, and the client could aspirate the drug if rushed during administration of oral medications.

Two other general principles are important. One is to encourage the client to remain active and to continue to provide as much self-care as possible. The second principle is to continue contact with the client and provide emotional support. Because these clients often exhibit mask-like expressions characteristic of the disease, people often avoid interacting with them. It is difficult to identify mood, response or presence of pain without asking the client, as facial cues are often absent.

Persons taking **selegilene HCl** (**Eldepryl**) are advised to rise slowly from a sitting or lying position to avoid hypotension. It is important to note that tyramine dietary restrictions that apply to other monoamine oxidase inhibitors have not been necessary with therapeutic doses of this drug.

Supportive physical, occupational, and speech therapy are often used in the treatment of persons with Parkinson's disease. Newer treatments being tested currently include the use of low-protein diets and antioxidants, such as **vitamin E**. The nurse may be helpful to the client and family by providing names of organizations to contact for more information about this illness and its treatment. Such organizations are the American Parkinson's Disease Association (116 John Street, Suite 14, New York, New York 10038) and the Parkinson Foundation of Canada (Suite 232, ManuLife Center, 55 Bloor Street W., Toronto, Ontario M4W 1A6).

KEY NURSING IMPLICATIONS 21–1

Anti-Parkinson Drugs

1. Clients taking levodopa should be monitored for orthostatic hypotension and cardiac arrhythmias. Also watch for psychiatric disturbances.
2. Record the client's positive responses to treatment as well as side effects experienced.
3. Clients taking amantadine are observed for psychological changes, orthostatic hypotension, urinary retention, and gastrointestinal symptoms.
4. Anticholinergics may produce dry mouth, urinary retention, and constipation and may precipitate an acute attack of glaucoma. Monitor clients carefully.
5. Do not rush the client during administration of oral medications.
6. Clients taking levodopa should avoid foods and medications containing substantial amounts of pyridoxine (vitamin B_6).

EVALUATION

- Client verbalizes and demonstrates positive effects of medication therapy, including decreasing tremors and spasms
- Client demonstrates ability to provide basic self-care with limited assistance.
- Client experiences one bowel movement per day without difficulty.
- Client does not experience injury due to falls related to side effects of medication therapy.
- Client maintains weight within normal limits per standardized chart.
- Client verbalizes understanding of disease process and medical regimen.

NURSING CARE PLAN

A Client with Parkinson's Disease Taking Levodopa (Larodopa) and Amantadine (Symmetrel)

Clarence McKee, age 68, lives alone after his wife had a stroke and was placed in a nursing home. He has three children who are all married and live out of state. He has had problems with tremors at rest for quite some time, but attributes it to nerves. He has been retired for over 5 years now, and spends his time looking after his two dogs and playing cards and Bingo. He notices that he is getting clumsy and dropping things. When his son came to visit, he noticed his father had a shuffling, propulsive type of gait and made a doctor's appointment for him. Mr. McKee is diagnosed as having Parkinson's disease. The physician tells him that his stooped posture is part of the process, along with the monotonous, indistinct speech that he has recently developed. The physician explains that to get the muscle problems under control he wants to start Mr. McKee on two drugs that work well together. He prescribes levodopa (Larodopa) 2 g BID and amantadine (Symmetrel) 100 mg BID.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Tremors, gait.	Impaired physical mobility, related neuromuscular impairment and decreased strength.	Client maintains current level of functioning.	Arrange home assessment. Arrange for a companion to assist with daily activities. Physical and occupational therapy consults to facilitate activities of daily living, safe ambulation, and muscle strengthening. Remove environmental barriers.	Client demonstrates no regression in current level of functioning and experiences no injuries.
Drooling, speech patterns.	Impaired verbal communication related to dysarthria.	Client communicates needs adequately.	Teach client to speak slowly and distinctly. Use hand signals. Arrange for speech therapy consult, if necessary.	Client demonstrates decreased frustration due to an improvement in the ability to express himself.
Activities of daily living.	Risk for self-care deficit syndrome related to neuromuscular impairment.	The client will demonstrate ability to participate physically in feeding, dressing, toileting, and bathing activities.	Evaluate ability to participate in self-care activities. Encourage client to continue with practical activities. Refer client to occupational therapy for needed assistance as disease progresses.	Client participates in activities of daily living and demonstrates optimal hygiene and the ability to meet nutritional needs.
Impaired balance.	Risk for injury related to neuromuscular impairment.	Client will remain free of injury.	Encourage client to change positions slowly, plan ahead, and ambulate with handrails. Watch where and how walking occurs. Remove environmental barriers. Assess gait and balance.	Client moves about safely and experiences no falls or injuries.
Difficulty in eating, swallowing.	Imbalanced nutrition: less than body requirements related to difficulty swallowing (dysphagia).	Client will demonstrate adequate nutritional status as evidenced by weight gain and adequate oral intake.	Client should eat slowly and chew food well. Provide well-balanced, high fiber diet; supplements as needed. Teach client and caretaker about diet. Weigh weekly.	Client maintains body weight and good nutritional status.

Bowel habits.	Constipation related to neurogenic disorder.	Client will maintain adequate patterns of bowel function.	Teach client to maintain adequate roughage and fluid intake. Use stool softeners as needed.	Client is maintaining daily bowel habits with use of stool softener.
Urinary habits.	Impaired urinary elimination related to autonomic dysfunction.	Client will maintain adequate patterns of urinary function.	Teach client to maintain fluid intake at 2,000 mL daily. Assess urine for sediment, color, and odor.	Client is maintaining fluid intake and output of 2,000 mL daily. Client knows to report changes in urine color and odor.
Self-concept, support systems.	Situational low self-esteem related to changes in body image and dependence.	Client verbalizes positive expressions of self-worth.	Explore strengths and resources with client. Clarify misconceptions and provide accurate information.	Client demonstrates and verbalizes increased feelings of self-concept.
Anxiety.	Anxiety related to change in health status.	Client will verbalize a reduction in the level of anxiety experienced.	Encourage client to verbalize anxieties and fears and how they relate to self-esteem. Clarify client's misconceptions and provide accurate information.	Client is able to verbalize anxieties and reduction of fear.
Disease symptoms and usual progression.	Deficient knowledge (disease process and medication necessary to help control disease).	Client will verbalize understanding of disease process and medication routine.	Teach client that the disease progresses slowly. Instruct client to avoid fatigue, stress, and foods high in vitamin B6. Inform client that medication may darken urine. Levodopa will reduce tremors and rigidity. Report nausea, vomiting, dizziness. Assess vital signs. Take levodopa and amantadine with food.	Client describes disease process and progression. Client adheres to medication routine. Client verbalizes that foods high in vitamin B_6 interfere with the effectiveness of levodopa. Client lists foods high in vitamin B_6.

HOME CARE / CLIENT TEACHING

1. The treatment of Parkinson's disease involves therapies other than drugs. Clients should be advised about the multitherapy approach and encouraged to actively participate in the treatment program to function at a maximum level. An environmental assessment should be conducted to ensure the safety of persons with impaired mobility and self-care deficits.
2. Clients taking levodopa should be cautioned to rise slowly from bed or chair to help avoid orthostatic hypotension.
3. Clients taking levodopa should be instructed to avoid foods and medications high in Pyrodoxine (vitamin B_6).
4. Clients should be informed to avoid becoming dehydrated by drinking at least 8 glasses of water a day.
5. Clients should be warned about side effects of anti-Parkinson drugs and to report these to their physician if they occur.
6. Clients taking anticholinergics should be cautioned concerning potential drowsiness and to avoid activities requiring mental alertness until stabilized on these medications.
7. Clients should be instructed on the importance of compliance with medications, as well as other supportive therapies including physical, occupational, and speech.

CASE STUDY

Nora Calabash is a 64-year-old woman who complains of anxiety, nervousness, and weakness in the right hand. Within the last 3 weeks she has also developed some mild hand tremors. When originally seen by the physician two months ago, chlordiazepoxide (Librium), an antianxiety agent, was prescribed. This relieved her nervousness, but did not alter her hand weakness.

A current physical examination of the client reveals tremors in both hands, as well as moderate muscular rigidity in both arms. The client states that she has recently been told by her friends that her voice is changing.

The physician diagnoses the client as having Parkinson's disease and prescribes physical therapy, as well as levodopa 250 mg QID. After 2 days of therapy, the client's symptoms subside but she develops nausea and vomiting, which gradually disappear after several days. Her dose of levodopa is slowly increased and she is discharged with the following medications:

- Carbidopa-levodopa 300 mg/day
- Selegiline HCl 5 mg bid
- Levodopa 500 mg QID
- Stress formula vitamin tablets #100, 1 daily

After 1 week the client calls to report the development of tremors, nausea and vomiting.

Questions for Discussion

1. Are the client's original symptoms consistent with the diagnosis of Parkinson's disease? Explain.
2. Why could the client have developed a relapse after her discharge?
3. What changes should be made in the client's therapy to reduce Parkinson's symptoms and the adverse effects of levodopa?
4. What nursing interventions would be appropriate in caring for a client with Parkinson's disease?

CRITICAL THINKING EXERCISES

1. Prepare a visual aid which could be used to explain the pathology and treatment of Parkinson's disease to clients and their families.
2. Prepare a nursing care plan for Nora Calabash. It should cover the period from establishing the diagnosis of Parkinson's disease through the client's discharge from the hospital.
3. List nursing assessments for a client taking tolcapone.

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22 Anticonvulsants

OBJECTIVES

After studying this chapter, the student will be able to:

- List the common signs and symptoms of seizure disorders
- Distinguish between generalized and partial focal seizures
- List five possible causes of seizure disorders
- List the most commonly used anticonvulsants and indicate their major side effects
- Identify the important aspects of a client education program for a person just diagnosed as having a seizure disorder and started on anticonvulsants
- Identify factors to be assessed in monitoring the effectiveness of anticonvulsant drug therapy
- List three factors which can decrease the seizure threshold, thereby increasing the likelihood of seizures
- Discuss techniques of oral care that may decrease gum problems due to phenytoin (Dilantin) therapy
- Recognize the major classes of drugs that may interact with anticonvulsants
- Apply the nursing process for clients taking anticonvulsants
- Identify special nursing needs of clients receiving treatment for status epilepticus

EPILEPSY

Epilepsy refers to many types of recurrent seizures characterized by excessive electrical discharge of nerves in the cerebral cortex. It is a set of symptoms, rather than a disease entity itself. Epilepsy may lead to *seizures*, which may be characterized by one or more of the following:

- abnormal electroencephalogram (EEG)
- abnormal motor function
- loss of consciousness
- interference with sensory function
- psychic changes

From the beginning of human history, records show that the human race has been afflicted with epilepsy. It is noted in the New Testament of the Bible (Matthew 17:14–21) as well as in Greek and Roman records. During ancient times, people with epilepsy were seen as having special powers and were revered. During modern times, however, a social stigma developed concerning people with epilepsy, which involved both a belief that epilepsy is associated with lack of intelligence and that

these people were mentally unstable. This, no doubt, stemmed from a lack of understanding about epilepsy and a fear of the unknown. Epilespy, however, does NOT cause cognitive impairment (except ***during*** the actual seizure activity), a decrease in creative ability, impeded judgment, or mental instability. Some examples of people who have made contributions in history who were afflicted by epilespy include Julius Ceasar, Alexander the Great, Charles Dickens, and Vincent Van Gogh (the artist).

In the early 1800s, John Hughlings Jackson, a British neurologist, first postulated that epilepsy was caused by intermittent, excessive, and disorderly discharges of cerebral neurons. Modern *electroencephalography* has borne out the validity of his theory.

According to the Epilepsy Foundation, more than 2 million people in the United States have recurrent seizures. It is estimated that as many as 10% of the total population may have at least one seizure in their lifetime.

Most clients with seizure disorders first exhibit symptoms during early childhood (at age 2 to 5 years) or adolescence. Generally, seizures that begin after age 20 occur because of a primary lesion of the central nervous system (CNS) or some other causative incident or disease involving the CNS, (Box 22–1).

Although the exact cause of seizures is difficult to define, it is apparent that the excessive and uncontrolled electrical discharge generally starts in a localized area of the CNS. This is called the *focal* lesion. The discharge may remain localized and cause only partial seizures or it may spread from the focal region and involve the entire cerebrum, thereby causing generalized seizures.

The currently and most widely means of classifying seizures is consistent with those identified by the Epilepsy Foundation. *Generalized tonic-clonic seizures* (formerly called grand mal seizures) involve both hemispheres of the brain at onset. These types of seizures are characterized by a sudden cry, falling, and rigidity followed by muscle jerks, shallow breathing, or temporary apnea (absence of breathing) and possible loss of bladder and bowel control (due to relaxation of sphincter muscles). These seizures usually only last a couple of minutes, however the person does not remember the seizure activity. Some people describe an "aura" just prior to the seizure. Following the seizure, the client usually sleeps soundly for a period of time.

Absence seizures (formerly called petit mal seizures) are characterized by staring, sometimes accompanied by fluttering of the eyes, that begins and ends abruptly. Although the person experiencing an absence seizure is unaware of the seizure events, there is no unconsciousness. In children, these seizures can be mistaken as "daydreaming," thus delaying the diagnosis and treatment of this type of seizure disorder.

Complex partial seizures (also called psychomotor or temporal lobe seizures) usually start with a blank stare followed by random activity. The person appears unaware of the surroundings and may seem dazed. The actions are clumsy and the person is unresponsive. Automatism (lip smacking, picking at clothing, mumbling, fumbling) may be seen. Behavior such as struggling or flailing at restraint is also frequently seen. Once the pattern of behavior is established, the same sets of behaviors usually occur with each seizure.

Simple partial seizures usually begin in one area, such as the arm, leg, or face, but the individual remains awake and aware. Jerking may progress from one area to another and proceed to a convulsive seizure. The person experiences a distorted view of the environment. Frequently, he/she also experiences changes in the senses, especially of taste and smell. This may cause nausea.

A person experiencing *atonic seizures*, which are also called drop attacks, will collapse and fall. After 10 seconds to a minute, the person recovers, regains consciousness, and is able to ambulate

BOX 22–1
Possible Causes of Seizure Disorders

- increased intracranial pressure
- CNS infection (e.g., meningitis, encephalitis)
- metabolic disorders (e.g., hypoglycemia)
- vascular accidents (e.g., thrombosis)
- fever—particularly in children
- chemical toxicity (e.g., carbon monoxide poisoning)
- aneurysms
- tumors or cysts in the CNS
- head trauma
- drug therapy (e.g., withdrawal from barbiturates or alcohol)
- growth of scar tissue in the CNS
- severe hypoxia

without assistance. These types of seizures may be seen in children, as well as adults.

People exhibiting a sudden, brief, massive jerking motion of the muscles that may involve the entire body or parts of the body experience *myoclonic seizures*. They may drop a glass or silverware or even fall from a chair or stool. They do not lose consciousness.

Febrile seizures are experienced by children and result from body temperature elevations secondary to infections that cause irritation to the brain cells, resulting in generalized seizure activity. Children's bodies have varying degrees of ability to handle elevated body temperature, thus one can't specifically identify a universal seizure threshhold for all children. As a result of this danger, children should be treated aggressively when they experience a febrile state.

Infantile seizures are seen in children between the ages of 3 months and 2 years, who exhibit clusters of jerking movements. Regardless of the child's position, his or her head will flex forward. If the child is sitting, the arms will flex. If the child is lying down, he or she will draw up his knees in a flexed position. All seizures should be reported immediately to the physician for further diagnostic testing.

The term *intractable seizures* is currently used to describe seizures that do not respond to traditional pharmacologic anticonvulsant therapy. Clients experiencing these seizures are usually hospitalized and placed on electroencephalography monitoring. These clients may require surgical intervention. According to the Epilepsy Foundation, clients must meet certain criteria to qualify for this delicate and complicated surgery. For surgery to be considered a client must (1) have tried the standard medications without positive results, (2) have seizures that consistently begin in just one part of the brain, and (3) have seizures in a part of the brain that can be successfully removed without damage to speech, memory, or vision. Surgeries can be performed to either remove a small area in the brain where the seizures originate or be done to interrupt the spread of electrical hyperactivity in the brain.

In addition to listed epileptic seizures, some clients may experience a phenomenon known as *status epilepticus*. This may be defined as a series of tonic-clonic seizures without a return of consciousness between seizures. Such an event requires prompt parenteral anticonvulsant therapy in a hospital or emergency department, where life-support equipment is available. Clients who remain comatose may develop exhaustion and hyperthermia; death may follow.

Proper diagnosis of these disorders is generally dependent upon careful study of the EEG patterns during and between episodes of seizure activity. Although occasional spontaneous remission may occur in some clients with seizure disorders, there is currently no permanent cure for epilepsy.

Anticonvulsant drugs can effectively prevent and control most epileptic seizures. The drug to be employed is selected based on the type of seizure experienced by the client, the therapeutic goal to be achieved, and the adverse effects the drug is likely to produce. In most cases, the therapeutic goal is not simply to eliminate seizure activity, but rather to maximally reduce seizure activity with the lowest level of drug-induced toxicity.

Selection of the appropriate dosage regimen for an anticonvulsant drug is also important. Proper dosage selection and consistent client compliance with the prescribed regimen are essential to maintain serum drug concentration within the therapeutic range. Once a client has been stabilized on an anticonvulsant drug, periodic measurement of the serum drug concentration permits precise dosage adjustment and prevention of adverse drug effects. Such serum samples should be drawn just prior to the morning dose of anticonvulsant for consistency in measurement. Although established therapeutic ranges are useful guidelines for monitoring a client, some clients will be successfully controlled with serum drug concentrations below or above the usual therapeutic range.

Anticonvulsants are believed to act by preventing the excessive electrical discharge of the seizure focus in the CNS, while also exerting a protective effect on surrounding cells to prevent their discharge. Several classes of drugs are used in the treatment of epileptic seizures.

Barbiturates

These agents are nonspecific CNS depressants that interfere with impulse transmission in the cortex of the brain. Their action is generally nonselective and, therefore depending on their dosage, they may produce sedation, hypnosis, or respiratory depression. Phenobarbital is the most useful anticonvulsant in this group and may be used either alone or in combination with other drugs for treating virtually all forms of epilepsy. When used properly, barbiturates are among the safest forms of long-term anticonvulsant therapy.

Hydantoins

Phenytoin (Dilantin) and a chemically related drug, such as **ethotoin** (**Peganone**) are primarily used in preventing and treating generalized tonic-clonic and psychomotor seizures. The hydantoins also are sometimes used to prevent and/or treat seizures that may occur during or after neurosurgery. These agents act by reducing spontaneous electrical impulses in the brain, possibly by promoting the passage of sodium out of the neuron. They appear to exert a somewhat selective action on hyperactive synapses. Unlike the barbiturates, the hydantoins exert their anticonvulsant activity without causing sedation or hypnosis. They do, however, cause a higher incidence of side effects than the barbiturates and may participate in the development of drug interactions when combined with other drugs.

Oral **phenytoin sodium** products currently available in the United States must be labeled as being prompt or extended in action. Those products labeled as *extended* phenytoin sodium will dissolve more slowly in the gastrointestinal tract and may be used to provide the entire daily dosage in a single administration. Those phenytoin sodium products labeled as being *prompt* acting should not be used for once-a-day dosing.

The rate and extent of absorption of phenytoin from the GI tract may vary widely among different dosage forms (suspension, chewable tablets, capsules) and even in the same dosage form produced by different manufacturers. Caution must therefore be exercised when administering a phenytoin product that is in a different dosage form and/or from a different manufacturer than were previous doses administered to a given client.

Succinimides

The succinimides are a group of chemically related drugs of particular use in the treatment of absence seizures. Although each of the drugs in this class has the potential for producing hematological, hepatic, and renal dysfunction, **ethosuximide** (**Zarontin**) is generally considered to be the safest agent in this group.

Oxazolidinediones

The oxazolidinediones are used in treating absence seizures when safer drugs have been incapable of controlling them. Their use, particularly during the first year of therapy, may cause blood dyscrasias and/or severe hepatic and renal dysfunction. Proper monitoring of clients on these drugs is therefore essential for safe therapy. **Paramethadione** (Paradione) and **trimethadione** (Tridione) are the most widely used drugs in this class.

Fosphenytoin Sodium (Cerebyx) is one of the newest anticonvulsants and is a water-soluble *prodrug* of phenytoin. It is converted rapidly to phenytoin when administered parenterally. It is designed for short-term parenteral administration primarily to treat status epilepticus and to treat or prevent seizures during neurosurgery. It has also been approved for use as a short-term substitute for phenytoin when oral administration of phenytoin is not appropriate, such as for clients who temporarily cannot receive anything by mouth. One of the main reasons for the development of fosphenytoin was to decrease some of the adverse effects associated with parenteral administration of phenytoin, particularly phenytoin's high irritability to vein walls during administration. Because fosphenytoin is water-soluble, is it less alkaline than phenytoin and, thus, does not cause local irritation and pain at the infusion site. Phenytoin has a pH of 12, whereas, fosphenytoin's pH is between 8.6 and 9. Dosing of fosphenytoin is based on phenytoin sodium equivalents (PE). As with phenytoin, use of intravenous administration of a benzodiazepine is recommended concommitantly for the treatment of status epilepticus. Because of fosphenytoin's rapid conversion to phenytoin with parenteral administration, it is contraindicated in client situations where phenytoin is not advisable for use. Fosphenytoin carries the same types of side effects as phenytoin including hepatic, hematologic, and dermatologic, as well as the potential for hyperglycemia. Major adverse effects associated with rapid IV administration include bradycardia, cardiac arrest, heart block, and ventricular fibrillation, so care must be taken not to exceed the recommended dosing of no more than 100–150 mg PE over a minimum of 1 minute. In addition, the multiple drug interactions associated with phenytoin are also present with fosphenytoin.

Benzodiazepines

The benzodiazepines are chemically related agents shown to be effective in the treatment of absence seizures, as well as other seizure disorders. They appear to exert multiple actions on the brain

and limit the spread of seizure electrical discharges from their point of origin. Their use as anticonvulsants often causes CNS depression, and clients on these drugs should be cautioned against engaging in hazardous activities requiring mental alertness, e.g., operating machinery or driving a motor vehicle. Prolonged use of these drugs may also result in physical and/or psychological dependence on abrupt withdrawal. Symptoms of withdrawal may include convulsions, tremor, vomiting, and sweating. Because of their CNS depressant activity, these agents are likely to produce drug interactions when used with other CNS depressants, e.g., alcohol, narcotics, barbiturates, and tranquilizers. Benzodiazepines used as anticonvulsants include diazepam (Valium), **clonazepam** (**Klonopin**) and **clorazepate** (**Tranxene**). Diazepam administered intravenously is usually the drug of choice for treating status epilepticus. Because of the difficulty of starting an intravenous infusion during seizure activity, diazepam may be given rectally during status epilepticus.

Clonazepam has been used to treat a variety of seizure disorders, including akinetic and myoclonic seizures.

Valproic Acid (Depakene) and Divalproex Sodium (Depakote)

These agents are not chemically related to any other anticonvulsant currently in use in the United States. Their mechanism of action is still unclear, although their use appears to increase brain levels of gamma-aminobutyric acid (GABA), a substance that appears to inhibit electrical impulse transmission in nerve cells. These agents are effective in treating absence seizures and may be used alone or in combination with other anticonvulsant drugs. **Valproic acid** and **divalproex sodium**, a valproic acid derivative that is converted to valproate in the GI tract, appear to have some CNS-depressant activity and must be used with caution when other CNS depressant drugs are to be administered. Several cases of hepatic dysfunction have been reported in clients using valproic acid or its derivatives in combination with other anticonvulsants, particularly during the first 6 months of treatment. It is important therefore, that liver function tests be performed prior to the initiation of therapy, as well as at 2-month intervals during therapy.

The use of enteric-coated divalproex sodium tablets (Depakote) instead of valproic acid may reduce the likelihood of GI upset in some clients.

Carbamazepine (Tegretol)

This drug has been used for some time in treating *trigeminal neuralgia* (*tic douloureux*). It has also been approved for use in the treatment of convulsive disorders, such as partial seizures and generalized tonic-clonic seizures that have not responded to phenytoin, phenobarbital, or **primidone**, or when the side effects of these other agents cannot be tolerated. **Carbamazepine** is not chemically related to other anticonvulsant drugs, but appears to exert a selective action in reducing spontaneous electrical discharges in the brain. It has the potential for causing a wide variety of serious adverse effects, including blood cell abnormalities, such as aplastic anemia, agranulocytosis and electrolyte imbalances. Because carbamazepine acts by decreasing synaptic transmission in the CNS by affecting sodium channels in neurons, clients with fragile serum sodium levels may experience severely decreased sodium blood levels. This could lead to potentially life-threatening fluid and electrolyte imbalances and the potential for cardiac arrhythmias. Clients with a history of adverse hematological reactions to other drugs may be particularly at risk.

Felbamate (Felbatol)

Felbamate is a relatively new anticonvulsant that is useful in treating certain partial seizures in adults and as an adjunct in the treatment of seizures associated with *Lennox-Gastaut syndrome* in children. Lennox-Gastaut syndrome is characterized by a combination of frequent myoclonic and tonic seizures with interictal slow spike waves on the EEG. Although its mechanism of action is unknown, felbamate appears to increase the seizure threshold in some clients.

Clients receiving felbamate should be cautioned to avoid ultraviolet light or sunlight, because the drug may cause photosensitivity. In addition, when felbamate is added to other anticonvulsant therapies, the dose of other agents should be lowered by about 20%–30% to reduce the likelihood of adverse effects.

The use of felbamate has been associated with serious aplastic anemia and liver toxicity. Its use is discouraged, except when safer drugs have not been tolerated or have not been effective.

Gabapentin (Neurontin)

This is a relatively new anticonvulsant drug that is chemically related to the neurotransmitter GABA. It is used as an adjunct to other drugs in the treatment of partial seizures. Because it may cause CNS depression, clients using **gabapentin** should be monitored for the development of dizziness and drowsiness and warned to avoid driving and other hazardous tasks until they are aware of how the drug will affect their behavior.

Lamotrigine (Lamictal)

Lamotrigine is an anticonvulsant that is chemically unrelated to other anticonvulsants. It is used in combination with other anticonvulsant drugs (e.g., valproic acid) in the treatment of partial seizures in adults. It has also been shown to be useful in treating generalized tonic-clonic, absence and myoclonic seizures in adults as well as Lennox-Gastaut syndrome in infants and children.

Clients receiving lamotrigine should be monitored for the development of dizziness, visual disturbances, nausea and vomiting, headache, and skin rash. They should also be cautioned about driving or engaging in any other tasks that require alertness and coordination.

Other Drugs

Several other drugs may also be occasionally used in the treatment of epileptic seizures. One of these is **acetazolamide** (**Diamox**), which is a diuretic and *carbonic anhydrase* inhibitor. Acetazolamide also appears to potentiate the action of other anticonvulsants in the treatment of absence seizures and nonlocalized seizures. **Phenacemide** (**Phenurone**) is a potentially toxic drug used in severe forms of epilepsy, generally after safer drugs have been shown to be ineffective. It can cause hepatotoxicity as well as precipitate psychiatric disorders, particularly in clients with a history of such diseases. Magnesium sulfate may be used orally or parenterally to control seizures, particularly in severe *pre-eclampsia* or *eclampsia* or in situations in which seizures are believed to be due to low plasma levels of magnesium.

Paraldehyde may be used in the emergency treatment of tetanus, eclampsia, status epilepticus, and poisoning by convulsant drugs.

Table 22–1 reviews the properties of anticonvulsants in current use in the United States.

Table 22-2 presents three of the most frequently used anticonvulsants and the multiple drug interactions that can occur with each.

APPLYING THE NURSING PROCESS

ASSESSMENT

Monitoring therapy is an important function of the nurse. Because of the long-term treatment required, nurses are involved with assessing the effects of drug therapy and also may be responsible for the primary care of stabilized clients. In monitoring clients taking anticonvulsants, there are two major areas of concern. The first concern is determining if the client is experiencing side effects as a result of therapy. The second concern is determining the occurrence, nature, and duration of seizures and the relationships between seizures and daily activities. This would include compliance with drug therapy.

The initial dosage for some anticonvulsant medications is based on the client's body weight. The nurse is responsible for obtaining the current, accurate weight of the client for calculation of drug dosage. Once therapy has begun, the drug dosage is often based on serum drug levels. The nurse monitors laboratory reports and notifies the prescriber about the results of laboratory studies.

NURSING DIAGNOSES

Including but not limited to:

- Risk for injury, falls related to seizure activity
- Risk for injury, falls related to drowsiness, sedation side effects of drug therapy
- Risk for injury, drug interactions with anticonvulsant medications
- Deficient knowledge related to medication regimen and administration

TABLE 22–1

Anticonvulsants in Current Use

Note: Encourage client to carry identification and medical information.

Carefully monitor seizure activity in all clients.

Teach client and family that anticonvulsants should not be increased, decreased, or discontinued without discussion with the prescriber.

Provide information about epilepsy to client and family.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
acetazolamide *(ah-**set**-ah-**ZOH**-lah-myd)* (Diamox, Novo-Zolamide ✱)	oral, IM, IV	8–30 mg/ kg daily in divided doses	—	paresthesias, loss of appetite, polyuria, acidosis	IM route is painful. Parenteral solutions must be used within 24 hours after preparation. Best results have been seen in treating absence seizures in children. May cause hypersensitivity reaction in clients with sulfonamide hypersensitivity. Monitor client for signs of hypokalemia (e.g., muscle weakness) or metabolic acidosis.
carbamazepine *(kar-bah-**MAZ**-eh-peen)* (Mazepine ✱, Novocarbamaz ✱, Tegretol)	oral	200 mg twice a day on first day, gradually increased weekly by 200 mg/ day in divided doses at 6–8 hour intervals, not to exceed 1,000 mg/ day for children 12–15 years and 1,200 mg/day for clients over 15	4–12 mcg/mL	blood abnormalities, hepatotoxicity, dizziness, drowsiness, nausea and vomiting	Client should be monitored for hematological disorders and should be instructed to report any evidence of fever, sore throat, mouth ulcers, or easy bruising. When used in treating seizures, carbamazepine administration should not be abruptly discontinued. Drug is also indicated for the treatment of trigeminal neuralgia. Client should be advised not to engage in hazardous tasks, as drug may cause dizziness and drowsiness. Take with food. Multiple drug interactions.
clonazepam *(kloh-**NAH**-zeh-pam)* (Klonopin, Rivotril ✱)	oral	*Adults:* Initially dose should not exceed 1.5 mg/day, divided into 3 doses; dosage may be increased in increments of 0.5–1 mg every 3 days, not to exceed 20 mg/ day, until seizures are controlled or side effects occur *Infants and Children:* 0.01–0.05 mg/kg/ day in divided doses	0.02–0.08 mcg/mL	CNS depression, behavioral changes, confusion, anorexia, muscular weakness, increased salivation	Abrupt withdrawal of drug may precipitate status epilepticus. Should be used with caution in clients with chronic respiratory disorders. Drowsiness, ataxia, and unsteadiness of gait produced by this drug often improve with prolonged use of the drug. Clients should be advised not to engage in hazardous tasks, as drug may cause dizziness and drowsiness. Should not be used in clients with a history of hypersensitivity to other benzodiazepines (e.g., chlordiazepoxide).

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
clorazepate dipotassium *(klor-**AZ**-eh-payt **dye**-poh-**TASS**-ee-um)* (Novoclopate 🍁, Tranxene)	oral	*Adults:* Initially, not more than 7.5 mg 3 times daily; increase dosage by not more than 7.5 mg/week, not to exceed 90 mg/day *Children (9–12 years):* Initially not more than 7.5 mg twice daily; increase dosage by not more than 7.5 mg/ week, not to exceed 60 mg/day	—	See clonazepam	See clonazepam. Not recommended in clients under 9 years.
diazepam *(dye-**AYZ**-eh-pam)* (E-Pam 🍁, Meval 🍁, Valium, Vivol 🍁)	oral, IM, IV, gel	*Adults:* Oral: 15–30 mg daily Parenteral: 5–10 mg initially and at 10–15-min intervals to maximum dose of 30 mg (IV preferred) Status epilepticus: 1–2 mg/ min by IV infusion until seizure is controlled *Children:* Oral: 1–2.5 mg 3–4 times daily Parenteral: 0.2–1 mg (IV preferred) every 2–5 min to maximum of 5 mg in children under 5 years, 10 mg in older children	—	See clonazepam	See clonazepam. If IM route is used, injection should be made deeply into muscle. Care must be taken in administering drug to the elderly or very ill clients, because of the danger of apnea and/ or cardiac arrest. When administered by IV, respirations should be monitored every 5–15 minutes and drug should not be mixed with other drugs or IV fluids.
ethosuximide *(**eth**-oh-**SUCK**-sih-myd)* (Zarontin)	oral	Initial— *Children 3–6 yrs:* 250 mg/day *Adults and Children 6 and over:* 500 mg/day Increase dose by 250 mg every 4–7 days until seizures are controlled or until side effects develop	40–100 mcg/mL	blood dyscrasias, nephrotoxicity, hepatotoxicity, nausea and vomiting, drowsiness, dizziness	Take with food if GI upset occurs. Abrupt withdrawal may precipitate seizures. Client should be cautioned against engaging in hazardous activities while on this medication. Hematological status should be monitored regularly. Complete blood count should be obtained every 3 months.

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
felbamate *(**FELL**-bah-mayt)* (Felbatol)	oral	*Adults and Children over 14:* Initially, 1,200 mg/day in 3–4 divided doses. Increase dose in 600-mg increments every 2 weeks to a maximum of 3,600 mg/day *Children (2–14 years):* 15 mg/kg/day in 3–4 divided doses as adjunct to other therapy	—	photosensitivity, GI distress, insomnia, headache, fatigue, anxiety	Monitor client's hematological status. Caution client to avoid unprotected exposure to sunlight. Shake suspension well before using.
fosphenytoin sodium *(fos-**FEN**-ih toyn)* (Cerebyx)	IV	IV: Loading dose: 15–20 mg/kg Maintenance: 4-6 mg/kg/day *Older clients:* 14 mg/kg *Children:* 15–20 mg/kg	—	cardiovascular collapse, CNS depression, pruritis, dizziness, somnolence, nystagmus	Developed to reduce the problems associated with parenteral administration of phenytoin. Frequently monitor vital signs during loading dose with continuous monitoring of heart rhythm. Caution when used with clients on phosphate restrictions. Continue seizure precautions.
gabapentin *(gah-bah-**PEN**-tin)* (Neurontin)	oral	*Adults and Children over 12:* 300 mg on day 1, 300 mg twice daily on day 2, 300 mg 3 times daily on day 3 and thereafter. Dose may be increased to 3,600 mg/day if needed. *Older adults:* Dose must be determined by physician, but it is usually not more than 400 mg three times a day.	—	drowsiness, dizziness, ataxia, nystagmus, tremor	Advise client to avoid driving or other tasks that require alertness until they are aware of how the drug will affect them. Antacids decrease bioavailability of drug.
lamotrigine *(lah-**MOHT**-rih-jean)* (Lamictal)	oral	*Adults and Children over 12:* 25–150 mg daily in one or two doses *Children 2 to 12:* 1–5 mg/kg/day	—	dizziness, visual disturbance, skin rash, sedation, nausea, and vomiting	Advise client to avoid driving or other tasks that require alertness. Drugs may increase sensitivity to ultraviolet or sunlight.

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
magnesium sulfate *(mag-**NEE**-see-um **SUL**-fayt)*	IM, IV	*Adults:* 4–5 g of a 25–50% solution IM 6 times a day as necessary. 4 g of a 10–20% solution IV; do not exceed 3 mL/min of 5% solution *Children:* 20–40 mg/kg in 20% solution. Repeat as necessary.	4–7 mEq/L	Adverse effects are related to magnesium intoxication: hypotension, depressed reflexes, hypothermia, flaccid paralysis	Carefully monitor clients for signs of overdosage, including a sharp drop in blood pressure, respiratory paralysis, and ECG changes.
mephobarbital *(**mef**-oh-**BAR**-bih-tal)* (Mebaral)	oral	*Adults:* 400–600 mg/day *Children under 5:* 16–32 mg 3–4 times daily *Children over 5:* 32–64 mg 3–4 times a day	—	CNS and respiratory depression, skin rash, nausea and vomiting, hepatotoxicity	Client should be cautioned against engaging in hazardous activities while on this medication. Prolonged use may cause physical and/ or psychological dependence. Drug should never be abruptly discontinued. Monitor prothrombin time closely in clients receiving oral anticoagulant drugs with this agent. Contraindicated for use in clients with obstructive pulmonary disease.
methsuximide *(meth-**SUCK**-sih-myd)* (Celontin, Zarontin)	oral	Initially 300 mg/day; if needed, increase by 300 mg/ day at weekly intervals to a maximum of 1.2 g/day	—	See ethosuximide	See ethosuximide.
paramethadione *(**pair**-ah-**meth**-ah-**DYE**-ohn)* (Paradione)	oral	*Adults:* 900–2,400 mg daily in 3–4 equally divided doses *Children:* 300–900 mg daily in 3–4 equally divided doses	—	hematological disorders, hepatotoxicity, nephrotoxicity, nausea and vomiting, skin rash, photophobia	Observe client for signs of hematological, hepatic, renal or dermatological disorders, particularly during first year of therapy. Drug should never be abruptly discontinued. Advise client to report any evidence of fever, sore throat, mouth ulcers or easy bruising.

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
phenacemide *(fen-**ASS**-eh-myd)* (Phetylureum)	oral	*Adults:* Initially 1,500 mg daily in 3 divided doses; increase gradually to a maximum of 5 g daily *Children 5–10:* ½ adult dose	—	hematological disorders, hepatotoxicity, nephrotoxicity, personality changes	Monitor client's hematological, hepatic, and renal status closely. Advise client to report any evidence of fever, sore throat, mouth ulcers, or easy bruising. Observe client for signs of personality changes, particularly during early stages of therapy. Because of the toxicity of this drug, it is generally used only after safer drugs have proven to be unsuccessful.
phenobarbital, phenobarbital sodium *(**fee**-noh-**BAR**-bih-tal, **fee**-noh-**BAR**-bih-tal **SOH**-dee-um)* (Luminal, etc.)	oral, IV	*Adults:* Oral: 100–320 mg daily at bedtime Parenteral: 100–320 mg IM or IV *Children*: 1–6 mg/kg/day	10–40 mcg/mL	See mephobarbital	See mephobarbital. Do not mix injectable solution with acidic drugs.
phensuximide *(fen-**SUCK**-sih-myd)* (Milontin)	oral	0.5–1 g 2 or 3 times daily	—	See ethosuximide	See ethosuximide. May produce reddish discoloration of the urine.
phenytoin, phenytoin sodium *(**FEN**-ih-toyn, **FEN**-ih-toyn **SOH**-dee-um)* (Dilantin, etc.)	oral, IM, IV	*Adults* Oral: Initially 100–125 mg 3 times daily: dose may be gradually increased for maintenance therapy to 600 mg/day Parenteral: 300–400 mg daily Status epilepticus: 10–15 mg/kg IV slowly, then 100 mg every 6–8 hours if necessary *Children:* Initially 5 mg/kg/day in 2–3 equally divided doses; for maintenance therapy, dose may be increased to a maximum of 300 mg/day Parenteral: 4–7 mg/kg/day	10–20 mcg/mL	See ethotoin	See ethotoin. May interfere with 1 mg dexamethasone suppression and metyrapone tests. Oral products containing phenytoin sodium extended may be used for once-a-day dosing when seizure control has been established with divided doses. Clients may experience variable response from oral phenytoin sodium products obtained from various manufacturers. Rapid IV administration may cause cardiovascular arrest. Do not exceed an IV infusion rate of 50 mg/minute in adults or 1–3 mg/kg/minute in neonates. Do not infuse IV with dextrose, because glucose forms a precipitate; infuse with normal saline only. Clients receiving continuous tube feedings administered by way of gastric (or nasogastric) tube must have the feedings turned off for at least 1 hour prior and 1 hour after the administration of phenytoin suspension through the G or NG tube, because many tube feeding solutions interfere with phenytoin absorption.

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
					Solutions of phenytoin sodium to be administered parenterally must be clear. Monitor client for signs of gingival hyperplasia. Clients should be encouraged to practice good oral hygiene. Monitor client for signs of folate deficiency. If receiving folate supplementation, client should be cautioned not to discontinue folate administration without the physician's knowledge. Phenytoin sodium contains 92% phenytoin. Must use with caution—IV.
primidone *(**PRIM**-ih-dohn)* (Mysoline, Sertan ✱)	oral	*Adults and Children over 8:* Day 1–3: 100–125 mg at bedtime Day 4–6: 100–125 mg twice daily Day 7–9: 100–125 mg 3 times daily Day 10 on: 250 mg 3–4 times daily Not to exceed 2 g/day *Children under 8:* Day 1–3: 50 mg at bedtime Day 4–6: 50 mg twice daily Day 7–9: 100 mg twice daily Day 10 on: 125–250 mg 3 times daily	5–12 mcg/mL	See mephobarbital	See mephobarbital. Primidone is partially converted to phenobarbital in the body.
trimethadione *(**try**-meth-ah-**DYE**-ohn)* (Tridione)	oral	300 mg tid	—	See paramethadione	See paramethadione.

continues

TABLE 22–1 *continued*

See **Note** at beginning of Table 22–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	THERAPEUTIC SERUM LEVEL	COMMON ADVERSE EFFECTS	NURSING IMPLICATIONS
valproic acid *(val-**PROH**-ick **AH**-sid)* (Depakene, Depakote)	oral	Initially 15 mg/ kg/ day increasing at 1-week intervals by 5–10 mg/ kg/ day, not to exceed 60 mg/ kg/ day, until seizures are controlled or side effects occur *Children:* 15–45 mg/kg	50–100 mcg/mL	nausea and vomiting, CNS depression, hepatotoxicity, weakness	Caution against engaging in hazardous activities while on this medication. Monitor for signs of hepatotoxicity. GI irritation can be minimized by administering drug with food. Capsule form should be swallowed without chewing to avoid local irritation of mouth or teeth. Drug should never be abruptly discontinued. May alter thyroid function tests and interfere with urine ketone tests. Multiple drug interactions.

PLANNING/GOALS

- Client will not sustain injury during seizure activity and seizure activity will decrease as a result of anticonvulsant therapy.
- Client will not experience drug interactions while taking anticonvulsants.
- Client will verbalize understanding of medication regimen including dosage, adverse effects and drug interactions, and signs and symptoms to report to his/her physician.
- Client will demonstrate ability to safely self-administer medications.
- Client will state the importance of taking medication as ordered.

IMPLEMENTATION

Because drug therapy plays a critical role in the treatment and well-being of people with seizure disorders, one of the most important functions of the nurse is client education. It is important for the client and family members to have an accurate understanding about the nature of this health problem. Once clients understand the health problem, they should be instructed about the medication they will be taking and about the relationship between drug therapy and seizure control. Clients and families need to know that long-term drug treatment or multidrug therapy may be required and that the major cause of status epilepticus, a period of uncontrolled seizures, is failure to take the prescribed medication regularly.

There are many factors affecting cooperation with prescribed treatment, but two of the most important are misconceptions about the health problem and the social stigma associated with having a seizure disorder. Clients and families, as well as the general public, often have misconceptions about seizure problems. They may view seizures as a form of mental illness or as a sign of mental retardation. They may also be convinced that once seizures are controlled by the medication, there will no longer be any need to take

KEY NURSING IMPLICATIONS 22–1

Assessment and Client Education

1. Nursing assessment is focused on determining the occurrence of side effects of drug therapy and the nature, occurrence, and duration of seizures.
2. An accurate body weight should be available for all clients.
3. Client and family education is critical in controlling seizures. Accurate information is needed about the problem and its treatment. Misconceptions must be corrected.
4. Medication should be scheduled to foster cooperation whenever possible, e.g., once a day in the evening.
5. Teach significant others to recognize preseizure activity and to provide for the person's safety during a seizure.

TABLE 22–2

Drug Interactions with Common Anticonvulsants

DRUG	INTERACTION
carbamazepine	*Acetaminophen* / ↑ Acetaminophen breakdown → ↓ effect and ↑ risk of hepatotoxicity *Bupropion* / ↓ Bupropion effect due to ↑ liver breakdown *Charcoal* / ↓ Carbamazepine effect due to ↓ GI tract absorption *Cimetidine* / ↑ Carbamazepine effect due to ↓ liver breakdown *Contraceptives, oral* / ↓ OC effect due to ↑ liver breakdown *Cyclosporine* / ↓ Cyclosporine effect due to ↑ liver breakdown *Danazol* / ↑ Carbamazepine effect due to ↓ liver breakdown *Diltiazem* / ↑ Carbamazepine effect due to ↓ liver breakdown *Doxycycline* / ↓ Doxycycline effect due to ↑ liver breakdown *Erythromycin* / ↑ Carbamazepine effect due to ↓ liver breakdown *Felbamate* / Possible ↓ serum levels of either drug *Felodipine* / ↓ Felodipine effect *Fluoxetine* / ↑ Carbamazepine levels → possible toxicity *Fluvoxamine* / ↑ Carbamazepine levels → possible toxicity *Grapefruit juice* / ↑ Peak levels of carbamazepine *Haloperidol* / ↓ Haloperidol effect due to ↑ liver breakdown *Isoniazid* / ↑ Carbamazepine effect due to ↓ liver breakdown; also, carbamazepine may ↑ risk of drug-induced hepatotoxicity *Lamotrigene* / ↓ Lamotrigene effect; also, ↑ levels of active metabolite of carbamazepine *Lithium* / ↑ CNS toxicity *Macrolide antibiotics (e.g., Clarithromycin, Troleandomycin)* / ↑ Carbamazepine effect R/T ↓ liver breakdown *Methylphenidate* / ↓ Blood levels of methylphenidate *Muscle relaxants, nondepolarizing* / Resistance to or reversal of the neuromuscular blocking effects *Phenobarbital* / ↓ Carbamazepine effect due to ↑ liver breakdown *Phenytoin* / ↓ Carbamazepine effect due to ↑ liver breakdown; also, phenytoin levels may ↑ or ↓ *Primidone* / ↓ Carbamazepine effect due to ↑ liver breakdown *Propoxyphene* / ↑ Carbamazepine effect due to ↓ liver breakdown *Ticlopidine* / ↑ Carbamazepine effect due to ↓ liver breakdown *Tricyclic antidepressants (TCA)* / ↓ TCA effects due to ↑ liver breakdown; also, ↓ levels of TCAs *Valproic acid* / ↓ Valproic acid effect due to ↑ liver breakdown; half-life of carbamazepine may be ↑ *Vasopressin* / ↑ Vasopressin effect *Verapamil* / ↑ Carbamazepine effect due to ↓ liver breakdown *Warfarin sodium* / ↓ Anticoagulant effect due to ↑ liver breakdown
phenytoin	*Acetaminophen* / ↓ Acetaminophen effect R/T ↑ liver breakdown; hepatotoxicity may ↑ *Alcohol, ethyl* / ↓ Phenytoin effect in alcoholics R/T ↑ liver breakdown *Allopurinol* / ↑ Phenytoin effect R/T ↓ liver breakdown *Amiodarone* / ↑ Phenytoin or amiodarone effect R/T ↓ liver breakdown *Antacids* / ↓ Phenytoin effect R/T ↓ GI absorption *Anticoagulants, oral* / ↑ Phenytoin effect R/T ↓ liver breakdown. Also, possible ↑ anticoagulant effect R/T ↓ plasma protein binding *Antidepressants, tricyclic* / ↑ Risk of epileptic seizures or ↑ phenytoin effect by ↓ plasma protein binding *Barbiturates* / Phenytoin effect may be ↑ , ↓ , or not changed; possible ↑ effect of barbiturates *Benzodiazepines* / ↑ Phenytoin effect R/T ↓ liver breakdown *Carbamazepine* / ↓ Phenytoin or cabamazepine effect R/T ↑ liver breakdown *Charcoal* / ↓ Phenytoin effect R/T ↓ absorption from GI tract *Chloramphenicol* / ↑ Phenytoin effect R/T ↓ liver breakdown *Chlorpheniramine* / ↑ Phenytoin effect

continues

TABLE 22–2 *continued*

DRUG	INTERACTION
phenytoin *(continued)*	*Cimetidine* / ↑ Phenytoin effect R/T ↓ liver breakdown *Clonazepam* / ↓ Plasma levels of clonazepam or phenytoin; ↑ risk of phenytoin toxicity *Contraceptives, oral* / Estrogen-induced fluid retention may precipitate seizures; also, ↓ effect of contraceptives R/T ↑ liver breakdown *Corticosteroids* / ↓ Corticosteroid effect R/T ↑ liver breakdown; also, corticosteroids may mask hypersensitivity reactions due to phenytoin *Cyclosporine* / ↓ Cyclosporine effect R/T ↑ liver breakdown *Diazoxide* / ↓ Phenytoin effect R/T ↑ liver breakdown *Dicumarol* / ↓ Dicumarol effect R/T ↑ liver breakdown *Digitalis glycosides* / ↓ Digitalis effect R/T ↑ liver breakdown *Disopyramide* / ↓ Disopyramide effect R/T ↑ liver breakdown *Disulfiram* / ↑ Phenytoin effect R/T ↓ liver breakdown *Dopamine* / IV phenytoin → hypotension and bradycardia; also, ↓ dopamine effect *Doxycycline* / ↓ Doxycycline effect R/T ↑ liver breakdown *Estrogens* / See *Contraceptives, oral* *Fluconazole* / ↑ Phenytoin effect R/T ↓ liver breakdown *Folic acid* / ↓ Phenytoin effect *Furosemide* / ↓ Furosemide effect R/T ↓ absorption *Haloperidol* / ↓ Haloperidol effect R/T ↑ liver breakdown *Ibuprofen* / ↑ Phenytoin effect *Isoniazid* / ↑ Phenytoin effect R/T ↓ liver breakdown *Levodopa* / ↓ Levodopa effect *Levonorgestrel* / ↓ Levonorgestrel effect *Lithium* / ↑ Risk of lithium toxicity *Loxapine* / ↓ Phenytoin effect *Mebendazole* / ↓ Mebendazole effect *Meperidine* / ↓ Meperidine effect R/T ↑ liver breakdown; toxic effects of meperidine may ↑ due to accumulation of active metabolite (normeperidine) *Methadone* / ↓ Methadone effect R/T ↑ liver breakdown *Metronidazole* / ↑ Phenytoin effect R/T ↓ liver breakdown *Metyrapone* / ↓ Metyrapone effect R/T ↑ liver breakdown *Mexiletine* / ↓ Mexiletine effect R/T ↑ liver breakdown *Miconazole* / ↑ Phenytoin effect R/T ↓ liver breakdown *Milk thistle* / Helps prevent liver damage from phenytoin *Nitrofurantoin* / ↓ Phenytoin effect *Omeprazole* / ↑ Phenytoin effect R/T ↓ liver breakdown *Phenothiazines* / ↑ Phenytoin effect R/T ↓ liver breakdown *Primidone* / Possible ↑ primidone effect *Pyridoxine* / ↓ Phenytoin effect *Quinidine* / ↓ Quinidine effect R/T ↑ liver breakdown *Rifampin* / ↓ Phenytoin effect R/T ↑ liver breakdown *Salicylates* / ↑ Phenytoin effect R/T ↓ plasma protein binding *Sucralfate* / ↓ Phenytoin effect R/T ↓ absorption from GI tract *Sulfonamides* / ↑ Phenytoin effect R/T ↓ liver breakdown *Sulfonylureas* / ↓ Sulfonylurea effect *Theophylline* / ↓ Effect of both drugs R/T ↑ liver breakdown *Trimethoprim* / ↑ Phenytoin effect R/T ↓ liver breakdown *Valproic acid* / ↑ Phenytoin effect R/T ↓ liver breakdown and ↓ plasma protein binding; phenytoin may also ↓ effect of valproic acid R/T ↑ liver breakdown
valporic acid	*Alcohol* / ↑ Incidence of CNS depression *Carbamazepine* / Variable changes in carbamazepine levels with possible loss of seizure control *Charcoal* / ↓ Valproic acid absorption from the GI tract *Chlorpromazine* / ↓ Clearance and ↑ $t_{1/2}$ of valproic acid → ↑ pharmacologic effects *Cimetidine* / ↓ Clearance and ↑ $t_{1/2}$ of valproic acid → ↑ pharmacologic effects

continues

TABLE 22–2 *continued*

DRUG	INTERACTION
valporic acid *(continued)*	*Clonazepam* / ↑ Chance of absence seizures (petit mal) and ↑ toxicity *CNS depressants* / ↑ Incidence of CNS depression *Diazepam* / ↑ Diazepam effect R/T ↓ plasma binding and ↓ metabolism *Erythromycin* / ↑ Serum valproic acid levels → valproic acid toxicitiy *Ethosuximide* / ↑ Ethosuximide effect R/T ↓ metabolism *Felbamate* / ↑ Mean peak valproic acid levels *Lamotrigine* / ↓ Valproic acid serum levels and ↑ lamotrigine serum levels; reduce dose of lamotrigine *Phenobarbital* / ↑ Phenobarbital effect R/T ↓ liver breakdown *Phenytoin* / ↑ Phenytoin effect R/T ↓ liver breakdown or ↓ effect of valproic acid R/T ↑ metabolism *Salicylates (aspirin)* / ↑ Effect of valproic acid R/T ↓ plasma protein binding and ↓ metabolism *Warfarin sodium* / ↑ Effect of valproic acid R/T ↓ plasma protein binding. Also, additive anticoagulant effect *Zidovudine* / ↓ Clearance in HIV-seropositive clients

medication. The function of the medication is seen as curative, rather than as control of the disorder. Compounding the problem of misconceptions is that people with epilepsy are generally aware of the social stigma associated with seizure disorders. They are often hesitant to inform friends, employers, teachers, and others that they have a seizure disorder. They may also be reluctant to take the medication during working hours for fear that other employees or their employer will discover the health problem. This concern with public reaction is often most acute in children who do not want to be identified as being different, especially if it means having a health problem. They fear that being seen taking medication will cause them to be rejected by their peers. Some school-age children are sensitive about taking medication during school hours, because they do not want to be identified as drug users. The nurse should find out what medications are being taken and when. Suggestions can then be offered for rescheduling doses. For example, phenobarbital and phenytoin sodium products that have extended actions may be taken once daily, rather than several times a day. Helping to schedule medications for times that are least disruptive in relation to activities of daily living may improve cooperation.

Another reason why clients fail to take their medications regularly is because of the adverse side effects of the drugs, particularly those when therapy is initiated. Some clients experience drowsiness when they first take phenytoin (Dilantin). They may also complain about an upset stomach early in the course of therapy with this drug. It may be reassuring for them to know that these problems tend to lessen as therapy is continued. Also, the nurse can suggest that taking the medication with meals may decrease the severity of gastric upset. Another drug with distressing side effects that are dose-related and often decrease with continued use is clonazepam (Klonopin). It is reassuring for clients to know that the drowsiness, ataxia, and unsteadiness of gait that may accompany use of this drug will usually decrease with continued use of the drug.

A final aspect of client and family education is assuring client safety during seizures. Clients should be assisted in identifying preseizure symptoms or situations in which seizures most often occur. Clients should be taught to rest in a secure place to avoid injury when these situations or symptoms occur. Family members should be taught to recognize preseizure and early seizure behavior. In doing so, they can help the client by maintaining a patent airway, providing for safety, and minimizing public exposure whenever possible to avoid embarrassing the client. It is important for family members to know that they should not attempt to physically restrain a person having seizures. In fact, they should guide the person's limbs to avoid injury that could occur from thrashing against a solid object.

Particular nursing activities are focused on preventing or minimizing the impact of the

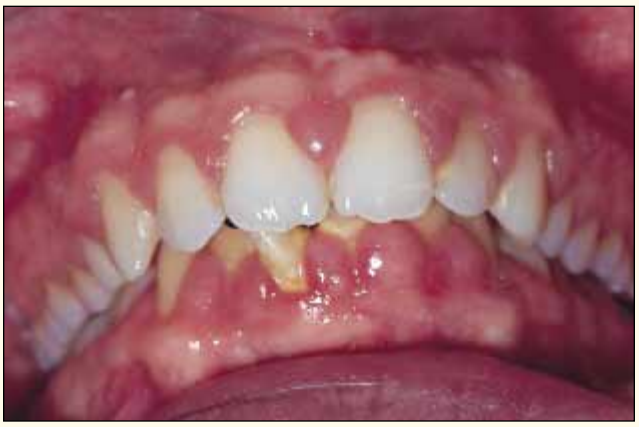

Figure 22–1 Note how the gum tissue has grown over the teeth in this client on long-term phenytoin therapy. *(Courtesy of Joseph L. Konzleman, Jr. DDS)*

adverse effects of drug therapy. One side effect of phenytoin (Dilantin) therapy requiring special nursing measures is gingival hyperplasia (Figure 22–1). This overgrowth of gingival tissues may become so severe as to interfere with eating. The condition occurs more frequently in children and is believed to be dose-related. Clients who are on higher doses of phenytoin are, therefore, particularly prone to develop this condition. The nurse should inspect the mouth regularly in all children receiving this drug. Inspection of the oral cavity should also be done routinely in adults. It is important to stress that frequent brushing of the teeth removes food particles and helps to prevent infections in clients with gingival hyperplasia. In addition, it is believed that the incidence and severity of gingival hyperplasia may be decreased by frequent gum massage. For this reason, brushing of the teeth should include gentle strokes beginning at the base of the gums and working toward the crowns of the teeth. In cases of severe hyperplasia, local applications of anti-inflammatory drugs or surgery may be necessary. Regular dental care is an important part of maintaining a healthy oral cavity.

Another problem that may develop with phenytoin (Dilantin) therapy is anemia. The anemia is often due to folic acid deficiency and may be associated with mental deterioration. For this reason **folic acid** supplements are often given to clients at the beginning of phenytoin therapy. If therapy is initiated without a folic acid or multiple-vitamin supplement, the nurse must carefully observe the client for pale mucous membranes, fatigue, mental deterioration, and other indications of anemia. Particular care must also be taken when clients have been stabilized on phenytoin therapy, as introducing folic acid supplementation in such a client may increase the frequency of convulsions. Withdrawal of folic acid supplementation or failure of the phenytoin-stabilized client to continue the folic acid may produce drug intoxication. Clients who are taking both phenytoin and folic acid must be instructed to continue to take both drugs and be told why they must not stop the folic acid. Client instruction should stress the reasons for simultaneous therapy and the consequences of failure to continue taking the drugs as ordered.

Another pair of drugs often administered together are phenytoin and phenobarbital. Although beneficial for controlling seizures, the phenobarbital may cause a decrease in the blood level of phenytoin. If phenobarbital is then discontinued, phenytoin toxicity can occur. As a general rule, the nurse must carefully observe all clients receiving anticonvulsants whenever any drug is added to or removed from the treatment program.

When administering phenytoin it is important to remember that it is poorly absorbed from muscle. For this reason, it is usually given orally or intravenously (IV). When given intravenously, it must be given slowly, no more than 50 mg per minute and must be given by IV push, rather than being mixed with other solutions to be administered by IV infusion. The IV push method is used because phenytoin precipitates easily. After administering the phenytoin through an established intravenous line, the nurse flushes the needle or catheter with sterile saline solution for injection, as phenytoin is incompatible with dextrose and some other solutions. **Note:** Phenytoin must never be mixed with solutions containing dextrose. Whenever phenytoin is given intravenously, the nurse should observe the injection site for signs of phlebitis because this drug is irritating to blood vessels. The protocol of many facilities specifies that IV phenytoin should only be administered with a free-flowing normal saline IV solution to decrease the possibility of vein wall irritation. The primary reason for IV administration of phenytoin is to rapidly increase the serum phenytoin level to achieve a therapeutic level. Because phenytoin also is available in suspension, the nonparenteral route is preferred in most situations.

KEY NURSING IMPLICATIONS 22–2

Persons Taking Phenytoin

1. Frequent mouth care, gum massage, and dental care may decrease the incidence and severity of gingival hyperplasia.
2. Folic acid supplements may be used to prevent folic acid deficiency, which is characterized by fatigue and mental deterioration.
3. Clients should not begin to take or discontinue any drug without consulting the primary care provider.
4. With clients receiving combination therapy, such as phenobarbital and phenytoin, the nurse must carefully monitor clients for phenytoin toxicity if phenobarbital is discontinued.
5. If using suspension form of phenytoin, be sure to shake thoroughly to ensure an adequate dose is taken.
6. Give intravenous phenytoin very slowly by IV push. Do not exceed 50 mg/minute in adults or 1–3 mg/kg/minute in neonates.
7. Do not mix parenteral preparations of phenytoin with dextrose. Flush all IV catheters and needles with normal saline before and after phenytoin has been given.
8. Clients receiving phenytoin and enteral feedings by nasogastric or gastrostomy tube may require a higher dose of phenytoin. Assess the client carefully.

Some clients who receive anticonvulsants are also receiving enteral feedings by nasogastric or gastrostomy tube. These clients may receive phenytoin suspension through their tube. The nurse shakes the suspension well, flushes the tube with 50 mL normal saline, administers the phenytoin suspension, and again flushes the tube with 50 mL of normal saline. The client should be carefully monitored for seizures. These clients often develop subtherapeutic blood levels of phenytoin and may require an increased dose of medication. Evidence of the need for a higher dose of medication should be discussed with the prescriber.

Another thing to remember when administering anticonvulsants is that drug interactions can occur. Some of these interactions, such as those involving phenytoin and phenobarbital, are beneficial, producing enhanced therapeutic effects. Other interactions, such as those between isoniazid (INH), **disulfiram** (**Antabuse**), chloramphenicol (**Chloromycetin**) and anticoagulants like **dicumarol** and warfarin (Coumadin), may be detrimental. Careful assessment and modification of the drug dosages may be required. Interactions between phenobarbital and CNS depressants, such as alcohol or meprobamate (**Miltown**, **Equanil**), may increase CNS depression. Diazepam (Valium), clonazepam (Klonopin) and valproic acid (**Depakene**) may also produce CNS depression, particularly when taken with other drugs known to produce CNS depression.

An important aspect of drug monitoring is concerned with female clients who may become or are pregnant. Most of the drugs used for seizure control should not be taken by pregnant women. However, these women should be instructed not to stop their medication abruptly. Women who have been taking drugs for seizure control and who become pregnant or who plan a pregnancy should inform the physician of this. Modifications may be made in the treatment program and more intensive monitoring may be indicated.

A final aspect of drug monitoring that has become critical is the ability to detect the level of anticonvulsants in the blood with laboratory tests. Clients with partial control of seizures should have their drug blood level monitored as frequently as monthly, and those with full control need to be checked only once a year. Results of these tests are reviewed with the client to determine if significant interactions are occurring with other drugs the client may be taking. This meeting also provides an opportunity to discuss problems in cooperating with the requirements of the drug regimen.

Laboratory tests also figure prominently in monitoring carbamazepine (**Tegretol**) treatment. This drug may cause blood abnormalities, including the possible development of fatal aplastic anemia. Clients taking this drug are followed with regularly scheduled laboratory work and should be instructed to report any evidence of fever, sore throat, mouth ulcers, and easy bruising. Also of particular concern with carbamazepine therapy is the interaction of erythromycin with carbamazepine. This interaction may result in carbamazepine toxicity. The nurse

NURSING CARE PLAN

A Child with Epilepsy Taking Phenytoin (Dilantin) and Phenobarbital

Tony Francis is a 9-year-old who is active in little league. While attending ball practice with his father, he had a generalized tonic-clonic seizure. He was drooling and comatose when he was taken by ambulance to the local hospital. A brain scan was negative for infarction. Tony regained consciousness with no memory of what has happened. He was scheduled for further diagnostic workup. The EEG showed brain wave changes and he was diagnosed as having epilepsy and placed on medication for seizure control. Phenytoin (Dilantin) 100 mg BID and phenobarbital 15 mg BID were ordered to be taken together for an enhanced therapeutic effect. After 2 days of treatment, Tony was discharged. Since returning home, he is very self-conscious about his health problem and tells his friends he was hospitalized for a "ball injury."

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Seizure activity, breathing patterns, secretions.	Risk for injury related to seizure activity.	Child will not have injury during seizure activity. Frequency of seizures will decrease as medication is continued.	Teach care during seizure to family. Maintain airway during seizure. Control secretions by suctioning or turning head to side. Tell family to not restrict child's movement, but to move furniture away from child. Record location, duration, and direction of muscle activity. Stay with child until he regains consciousness.	Child has no injury. Only one seizure has occurred since starting drug therapy.
Anxiousness.	Anxiety related to change in health status and associated changes in role function.	Child discusses feelings and identifies ways to handle them.	Encourage child to talk about feelings and how to resolve them. Explain what to do when he feels an attack coming on.	Child is talking about his reluctance to have his friends know his problem.
Coping mechanism.	Risk for ineffective individual coping related to parents' attitude and restrictions.	Child and family identify personal support and adequate coping mechanisms.	Encourage child and family to develop positive attitude toward control. Emphasize need to prevent overprotection.	Family and child have identified some ways to cope with seizures.
Knowledge of disease process.	Risk for ineffective health maintenance related to not understanding the disease.	The child and family will demonstrate understanding of disease prior to discharge.	Instruct family regarding the nature of a seizure disorder. Remind them that seizure activity can be controlled with medication. It is possible for child to grow out of seizure activity at adolescence. Provide informational material on epilepsy and refer family to other sources of information, e.g., Epilepsy Foundation of America.	Family and child verbalize understanding of disease process.
Knowledge of drug therapy.	Deficient knowledge (medication regimen).	Child and family will demonstrate understanding of drug regimen. Client and family will understand the importance of follow-up laboratory tests prior to discharge.	Teach family to give drugs as ordered and not skip doses. Teach family adverse reactions of drug therapy and what to report. Teach family about importance of laboratory studies.	Family and child adhere to drug regimen and can identify the common side effects likely to occur. Appointments for laboratory tests are kept.

Lifestyle.	Deficient knowledge related to necessary changes in lifestyle to prevent attacks.	Child and family will be able to identify and implement necessary lifestyle changes within 1 week of discharge.	Teach child and family the importance of avoiding colds, infections, stress. Physical activity should be moderated. Encourage well balanced diet and no over-the-counter drug use without contacting the physician. Educate about safety measures and available support groups.	Family has identified ways to avoid stress and has implemented safety measures. Family has initiated contact with a local support group.
Integrity of mucous membranes. Gum hyperplasia.	Impaired oral mucous membrane related to phenytoin therapy.	Child and family describe good oral hygiene procedures prior to discharge.	Teach child and family importance of routinely assessing the oral cavity and of routine dental care. Teach oral care to decrease likelihood of gingival hyperplasia.	Good oral hygiene is practiced and gingival hyperplasia does not occur.

KEY NURSING IMPLICATIONS 22–3

Persons Taking Other Anticonvulsants

1. Many drug interactions may occur between anticonvulsants and other drugs. Monitor the client's response to therapy carefully.
2. Blood levels of anticonvulsant medications should be monitored routinely.
3. Carbamazepine use may be associated with blood abnormalities. Report evidence of fever, sore throat, mouth ulcers, and easy bruising.
4. A temporary increase in anticonvulsant dosage may be needed during periods of emotional or physical stress.
5. During status epilepticus the nurse ensures a patent airway and provides for client safety. Oxygen, suction, and intravenous medications may be used in treatment.

advises the client or parents to inform all health care personnel about carbamazepine therapy, so that an appropriate choice of antibiotic can be made when one is needed.

Another aspect of nursing care is for clients experiencing status epilepticus. This condition is a medical emergency. If the person is not hospitalized, arrangements must be made for transfer to a hospital. During the seizures, the nurse ensures a patent airway and provides for safety by protecting the client against self-injury. The physician is notified, and the nurse prepares equipment for intravenous administration of anticonvulsants, such as phenobarbital and diazepam. Diazepam is usually given by IV push, no faster than 1–2 mg/min. If it cannot be administered directly IV, it may be injected slowly via the infusion tubing as close as possible to the vein insertion. Equipment for nasopharyngeal suctioning and oxygen administration must be available for use if necessary.

EVALUATION

- Client verbalizes and demonstrates effectiveness of anticonvulsant therapy by a decrease in seizure activity,
- Client does not sustain injury from seizure activity or as a result of anticonvulsant therapy.
- Client verbalizes understanding of medication regimen, including importance of remaining compliant with therapy.
- Client demonstrates safe administration of self-medication.
- Client verbalizes understanding of importance of medical follow-up including periodic serum drug blood levels.

Monitoring the effectiveness of drug therapy also includes assessing the frequency, nature, and duration of seizures. Interviewing the client or parents of a child with seizures should obtain the information:

- the frequency, number, and duration of seizures
- description of the aura (a preseizure phenomenon that sometimes appears—often a vision or sound)
- state of consciousness
- continence or incontinence
- nature of the seizure
- condition of the client after the seizure; for example, the emotional state
- compliance with the medication schedule

Special attention must be given to assessing the effects of drug treatment in children. A number of behavior problems have been reported in children taking anticonvulsants. Children taking phenobarbital, for example, may experience sleep disturbances, irritability, depression, or excitability. Those taking phenytoin may experience drowsiness, agitation, or irritability, with ethosuximide use possibly associated with lethargy or euphoria. In discussions with parents, the nurse should elicit information about the child's behavior, including sleep patterns and general temperament, as well as any behavior problems. It is important to remember that behavior problems may be associated with organic brain involvement in some clients or be a response to the perceived stigma of the illness and its treatment. The nurse should always review normal growth and development with parents, as what they might interpret as a behavior problem could be characteristic behavior for children at a particular developmental stage. The child's growth is checked carefully when long-term phenytoin therapy is used, as bone mass may decrease. Many children are given supplemental vitamin D to prevent low serum calcium levels and interference with bone development.

Factors such as stress, premenstrual fluid accumulation, and the use of alcohol and other drugs are known to decrease the seizure threshold. They may be associated with an increase in the frequency of seizures. Clients need to be instructed to be especially careful to take their medication under these conditions. The physician may suggest a temporary increase in anticonvulsant drug dosage during times of physical or emotional stress.

In summary, most convulsive disorders are chronic and require lifelong medication regimens and often lifestyle modifications. The nurse, through drug monitoring, counseling, and client or parent education, plays an important role in helping a client adjust to this health problem and its treatment. It may be helpful to the client to provide them with the address of the Epilepsy Foundation of America (4351 Garden City Drive, Suite 406, Landover, MD 20785). Their Web site is *http://www.efa.org*. In Canada, clients may be referred to Epilepsy Canada (1470 Peel St. Suite 745, Montreal, Quebec H3A 1T1; 1-800-860-5499). Their Web site is *http://www.epilepsy.ca*. Educational and assistance aids are available through these organizations.

KEY NURSING IMPLICATIONS 22–4

Evaluation

1. Assess the frequency, nature, and duration of seizures in all persons taking anticonvulsants.
2. Question parents about their child's behavior, sleep patterns, and general temperament.
3. Monitor children's growth and development while receiving anticonvulsants.
4. If seizure control changes, assess whether medication compliance and factors known to decrease seizure control such as stress, use of alcohol, or premenstrual fluid accumulation may be relevant factors.

CASE STUDY

Jennifer Justcavage, a 13-year-old girl, has been referred to a neurologist by her family physician. About 6 years ago, she suffered a slight concussion as the result of a fall from her bicycle. There were no further neurologic problems until 2 weeks ago when she reported that she experienced a strange sensation. This was followed by a tonic-clonic seizure.

The neurologist diagnoses epilepsy and initiates treatment with anticonvulsant medication. The client is started on 300 mg phenytoin (Dilantin) P.O. daily. After several weeks of therapy, the client has another tonic-clonic seizure and phenobarbital 150 mg P.O. daily is added to the treatment program. This brings the seizures under control.

About 6 months after starting the treatment program, Jennifer tells her mother that her gums seem to be increasing in size and are covering more of her teeth. Her mother believes this could be related to the drug therapy and schedules a visit to the neurologist.

Questions for Discussion

1. What factors known to decrease the seizure threshold may have been responsible for the first seizure Jennifer experienced?
2. What kind of client instruction could the nurse offer Jennifer and her parents during and immediately following the first visit to the neurologist?
3. How many times a day should the phenytoin (Dilantin) and the phenobarbital be taken?
4. Is the gingival hyperplasia likely to be related to the use of either phenytoin or phenobarbital? If so, which drug is responsible and what advice should be given to the client and her parents?

HOME CARE / CLIENT TEACHING

1. The nurse making a home visit ensures that caregivers have provided a safe environment for persons with seizure disorders.
2. Persons taking phenytoin are examined for gingival hyperplasia and are advised about the importance of gum massage, mouth care, and routine dental care.
3. Teachers and school nurses should be advised about children experiencing seizure disorders and should be instructed in appropriate management techniques.
4. Nurses and other health care professionals need to be actively involved in efforts to educate the public about seizure disorders to decrease the possible stigma associated with this health problem.
5. Clients and families should be advised that long-term treatment with anticonvulsant drugs may be necessary.
6. Clients with seizures should be provided with sufficient teaching to gain a knowledge of their health problem unencumbered by myths and misconceptions, including the information that anticonvulsant medications are not curative.
7. Clients taking anticonvulsants should be instructed concerning dosage, side or adverse effects, including drug interactions, and the importance of compliance with drug therapy.
8. Clients should check with physician and/or pharmacist before taking over-the-counter medications.
9. Clients should be encouraged to wear medical identification to alert others of their seizure condition in the event of an emergency.
10. Clients should be assisted in identifying pre-seizure symptoms, auras, and need to rest in a secure place to avoid injury; and family members need to be taught this information, as well.
11. Clients taking phenytoin and fosphenytoin should be instructed about examination of oral tissues for gingival hyperplasia and potential for bleeding gums.
12. Clients taking phenytoin and fosphenytoin should be informed of need to take folic acid supplements.
13. Clients need to be reminded of the importance of having serum blood levels drawn routinely and to keep follow-up appointments.

CRITICAL THINKING EXERCISES

1. Prepare an outline on the appropriate treatment of febrile seizures in children.
2. Prepare a handout containing basic information about epilepsy and its treatment that can be given to recently diagnosed clients being discharged from the hospital.
3. Design an oral hygiene program for a client on long-term phenytoin therapy.
4. Prepare a brief report about the myths regarding the cause of epilepsy, as well as the past treatment of seizure disorders.

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SECTION 6

Agents Used to Treat Respiratory Disorders

MAJOR NURSING DIAGNOSES

- Airway Clearance, Ineffective
- Ineffective Breathing Patterns
- Impaired Gas Exchange
- Deficient Knowledge (Illness and Its Treatment)
- Risk for Aspiration

23 Antihistamines and Nasal Decongestants

OBJECTIVES

After studying this chapter, the student will be able to:

- State the pathophysiological changes that occur in clients with the common cold and with allergic rhinitis
- State the mechanisms by which antihistamines exert their pharmacological effect
- List five adverse effects commonly caused by antihistamines
- Name three types of clients who should not use antihistamines or who should use them only with great caution
- Identify antihistamines that are effective in preventing or countering motion sickness, nausea, and vomiting
- State the mechanism by which nasal decongestants exert their pharmacological effects
- Describe the cause of rebound congestion
- List five diseases in which the use of oral nasal decongestants is contraindicated
- List the steps by which nasal sprays and nose drops are administered
- Apply the nursing process related to the administration of antihistamines and nasal decongestants
- State factors to be assessed in persons with allergic rhinitis and the common cold

Antihistamines and nasal decongestants are drugs used to treat the common cold and *allergic rhinitis*, conditions that collectively cause more discomfort and lost work time than all other known illnesses combined. Although the symptoms of these two illnesses are often quite similar, their pathophysiology is quite different. Nasal decongestants may be used in treating nasal congestion associated with sinusitis, middle ear infections, and upper respiratory tract infections.

The common cold is caused by a viral infection. More than one hundred different viruses have been isolated capable of producing cold symptoms. When a virus invades the respiratory tract, it injures local cells and initiates an inflammatory response in the affected area. Symptomatically, the inflammatory response is manifested as an increase in blood flow to the area, local edema, and nasal discharge. This may be followed by secondary bacterial infection and nasal congestion that may cause sneezing and further discomfort. Irritation of the *pharyngeal* mucosa may also cause coughing and the development of *pharyngitis*.

Dust, pollen, and animal *dander* are environmental allergens. Allergic rhinitis is a condition caused by an immunological response resulting from the contact of one or more environmental allergens with the nasal mucosal tissue of an allergy-prone individual. An inflammatory response of the nasal mucosa results in the release of histamine and other chemical agents that are powerful vasodilators. The effect of this histamine-induced vasodilation is increased secretion of mucus, as well as congestion and sneezing. When allergen particles enter the eye, redness and tearing may result.

A distinction can, therefore, be made between the cause of the nasal discharge seen with the common cold and the cause of that seen in allergic rhinitis. In the common cold, extensive viral-induced cell injury causes the local response, with allergic rhinitis, histamine release is part of a local immunological reaction responsible for most nasal symptoms.

ANTIHISTAMINES

Histamine is a naturally occurring substance in the body released in response to tissue damage and the presence of microorganisms and allergens invading body tissue. Histamine dilates arterioles to allow increasing blood supply to capillaries and the tissues supplied by capillaries. As a result of this flooding of tissues, they become red and large amounts of fluids leak into interstitial tissues. The swelling is designed to prevent the microorganisms from traveling to other tissues and organs. This inflammatory response allows for leukocytes (white blood cells) to rush to the area to deactivate and absorb the microorganisms. Many of the discomforts associated with upper respiratory congestion and infections is a result of this swelling from the histamine release, including increased mucus production. Another manifestation of histamine is itching common at the site of insect bites or other sources of contact inflammation (poison ivy, poison oak, etc.)

Antihistamines do not affect the release of histamine, but act primarily to block the action of histamine at the H_1 histamine receptor sites (Figure 23–1). They are, therefore, most useful in the treatment of allergic rhinitis. Their usefulness in the treatment of the common cold is controversial, because of the minimal contribution of histamine to the pathological state of the common cold. The action of antihistamines in the treatment of the common cold, however limited, is believed to be the result of the ability of these agents to exert a feeble anticholinergic action that reduces the amount of mucus secretion.

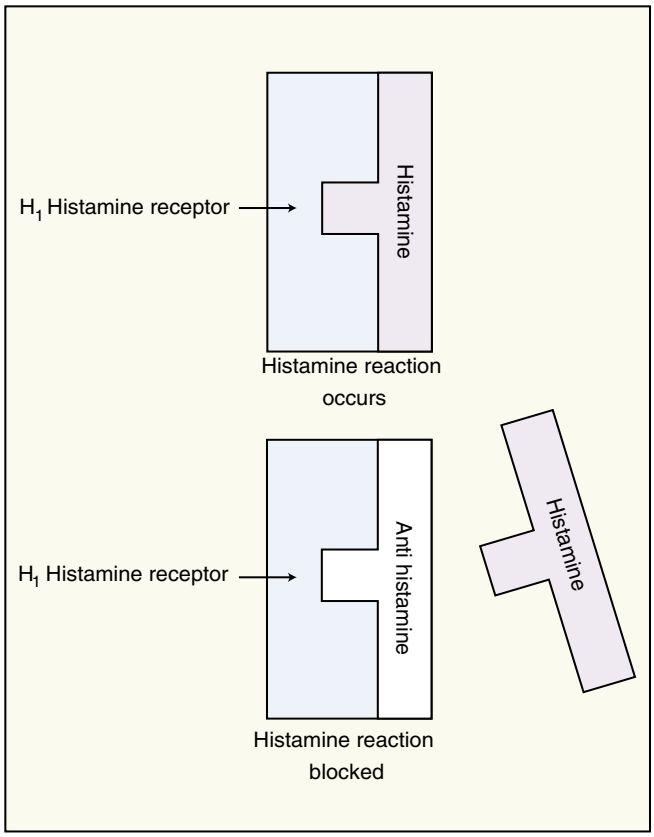


Figure 23–1 Mechanism of antihistamine action

Antihistamines are capable of causing a wide variety of adverse effects. Many of these agents will produce varying degrees of sedation, particularly when used in combination with other depressant drugs or alcoholic beverages.

Because of their chemical similarity to anticholinergic drugs, many antihistamines will cause dry mouth, constipation, blurred vision, and urinary retention. The effects are most prominent and troublesome in the elderly, particularly those with glaucoma or prostatic hypertrophy, as these conditions may be worsened by direct drug action. The drying effect of antihistamines on the respiratory tract may thicken respiratory tract secretions and increase breathing difficulty in persons with respiratory disorders, such as asthma or *emphysema*.

Antihistamine use is contraindicated in nursing mothers because they may inhibit lactation. Also, they can be secreted in breast milk and endanger a nursing infant. Young children may exhibit signs of hypersensitivity or overdosage to antihistamines.

These signs include central nervous system (CNS) depression or stimulation and atropine-like effects such as dry mouth, fixed dilated pupils, and flushing (see Chapter 15).

Some antihistamines (e.g., **cyproheptadine**) exert a local anesthetic action and may be useful in the treatment of pruritus. Others (e.g., cyclizine, **trimeprazine**, **methdilazine**, meclizine, and promethazine) are effective in preventing or countering motion sickness, as well as nausea and vomiting.

Three antihistamines currently available in the United States (trimeprazine, methdilazine, and promethazine) are similar in chemical structure to the phenothiazine antipsychotic agents, e.g., chlorpromazine. These agents are contraindicated in comatose clients and others in a state of CNS depression from drugs such as barbiturates, narcotic analgesics, or alcohol. They should also be avoided in clients with hepatic disorders and those who are known to be sensitive to phenothiazine drugs.

The most recently introduced antihistamines, **astemizole** (Hismanal), and loratadine (Claritin), **fexofenadine** (**Allegra**), and **cetirizine HCl** (**Zyrtec**) have been shown to be more specific in blocking peripheral H_1 histamine receptors than those located in the CNS. This specificity results in a lower incidence of sedation than is commonly seen with other antihistamine products.

Fexofenadine was approved in 1997 and then in December of that year the prescription combination of **fexofenadine/pseudoephedrine** (**Allegra-D**) was given FDA approval at the same time the FDA began proceedings to remove terfenadine (**Seldane**) from the market. Fexofenadine was found to have all of the beneficial effects of terfenadine without causing the potentially fatal heart condition associated with the use of Seldane. The use of either the terfenadine or astemizole (**Histamal**) with the antimicrobial agent erythromycin or the antifungal agents ketoconazole (Nizoral) or itraconazole (Sporanox) may result in serious cardiovascular toxicity that may include ventricular arrhythmias, cardiac arrest, or death. This is believed to be due to the inhibition of the metabolic breakdown of the antihistamines by these drugs and their subsequent accumulation in the body.

Fexofenadine has become one of the most effective antihistamine/antiallergy medications in use today. Fexofenadine/pseudoephedrine is not recommended for persons with hypertension, diabetes, ischemic heart disease, glaucoma, hyperthyroidism, renal impairment, or prostate disease. Like other products in this drug class, it may stimulate the nervous system, causing cardiac collapse.

One of the most recent antihistamines to be approved is cetirizine (Zyrtec). Ceterizine is a potent H_1 antagonist and is an active metabolite of hydroxyzine. Like fexofenadine and loratidine, cetirizine in indicated for the treatment of year-round allergies, as well as seasonal allergies. Another similar characteristic with the other two newest antihistamine agents is that drowsiness is not considered a side effect.

Although most antihistamines are administered orally or by injection, several are available for rectal or topical administration. Rectal administration may be useful for agents having antiemetic properties with which oral administration may not be feasible. Topical use of antihistamines has diminished during the last several years because the use of this route may be more likely to elicit a hypersensitivity reaction than oral administration.

Tolerance may develop when some antihistamines are used for long periods. This can frequently be managed by using a different antihistamine.

DECONGESTANTS

Nasal decongestants are agents that constrict dilated blood vessels in the nasal *mucosa* by stimulating alpha$_1$-adrenergic nerve receptors in vascular smooth muscle. This reduces the flow of blood in the edematous area, slows the formation of mucus, permits better drainage, and relieves the client's discomfort.

Nasal decongestants are administered either topically, by inhalation, or orally. Topically used decongestants are effective and act rapidly. Duration of action varies from several minutes to several hours after a single application. A common problem in the use of these agents is rebound nasal congestion. This occurs in clients who overuse topical decongestants. Excessive use causes local *ischemia* and irritation of the nasal mucosa that may lead to extensive secondary vasodilation and congestion. Rebound congestion can generally be avoided by limiting the use of these agents to several days and by not exceeding recommended doses. Although topical administration of decongestants results in only minimal absorption of drug through the nasal mucosa, adverse systemic effects, such as elevation of blood pressure and CNS stimulation may occur if the decongestant solution drains through the nasal passage and is swallowed by the client.

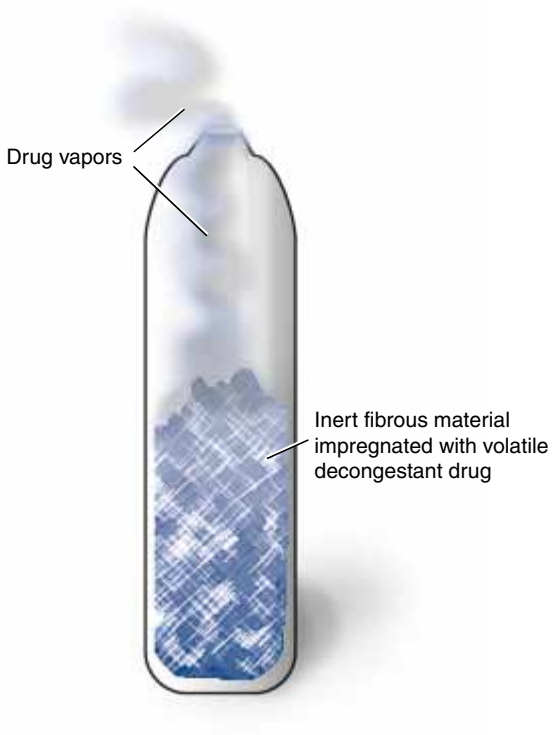


Figure 23–2 Nasal inhaler

Some decongestant drugs are administered by inhalation using specially designed inhalers. Such inhalers are generally plastic containers containing an inert fibrous material impregnated with a volatile decongestant drug (Figure 23–2). When the container is opened and inhaled through the nostrils, vapor containing the decongestant drug comes in contact with the nasal mucosa and produces a decongestant action. Although still quite popular, such products tend to be easily contaminated and to lose their potency rapidly, if exposed to heat or if not closed tightly after each use. In addition, dosage control is virtually impossible with the use of such devices.

Oral decongestants also act by constricting blood vessels in the nasal mucosa. They generally have a longer duration of action than the topical agents, but tend to have less constrictive effect. Oral decongestants may affect vascular beds other than those found in the nasal mucosa. The use of such drugs may also precipitate or aggravate high blood pressure, cardiac arrhythmias, ischemic heart disease, diabetes mellitus, and hyperthyroidism. In infants and small children, the use of aspiration techniques is often preferable to the use of drugs.

It is important to realize that antihistamines and decongestants exert only a palliative effect on symptoms of the common cold and allergic rhinitis and are not curative. Symptomatic treatment of nasal congestion is useful, however, because it relieves discomfort and prevents blowing of the nose, which may further irritate the nasal mucosa. Excessive blowing may force infected fluid into the nasal sinuses and *eustachian tubes*. **Beclomethasone dipropionate** (**Beconase**) and **fluticasone propionate** (**Flonase**) are local corticosteroids increasingly being used in conjunction with antihistamines and decongestants to address congestion associated with allergies. These are applied nasally, but rather than as a spray, they are administered as vapors. These medications work by decreasing the edema in the nasal membranes and sinuses through steroid action; however, these substances are not associated with the rebound congestion of the medications in the decongestant class. Fluticasone propionate is packaged in 50 mcg metered dosing and is safe for persons 4 years old and older. Beclomethasone propionate's inhalers provide 42 mcg metered doses, with approximately 200 doses per inhaler. Beclomethasone can be used in children as young as 6 years old, as well as in adults. Tables 23–1 and 23–2 list common antihistamines and nasal decongestants.

When symptoms of seasonal or perennial rhinitis do not respond well to conventional forms of therapy, intranasal corticosteroid administration may be advisable. Unlike nasal decongestants, intranasal steroid administration does not produce immediate effects. Regular use is required to attain full therapeutic benefit from such products. These products must be used with caution in the presence of active respiratory tract infection, as corticosteroids may suppress normal immunological defense mechanisms. Although rare systemic corticosteroid effects may occur with prolonged use (see Chapter 12 for a review of adverse corticosteroid effects). Table 23–3 lists the intranasal steroid products and nursing implications related to them. The use of saline nose drops has proven quite successful both for those clients taking other decongestants, as well as those using just the saline drops for nasal congestion. Advantages to the saline drops include that they are not habit-forming, can be used more often during the day than most decongestants, and are inexpensive.

Cromolyn sodium has also proven to be effective in the prevention and treatment of allergic rhinitis. Although it exerts no antihistaminic, bronchodilator, or anti-inflammatory activity, cromolyn does inhibit histamine release and the release of other chemical agents liberated as a result of an allergic response by stabilizing mast cells. It can, therefore, reduce the severity and frequency of acute episodes of allergic rhinitis.

TABLE 23–1

Antihistamines

Note: These agents must be used with caution in clients with bronchial asthma, increased intraocular pressure, prostatic hypertrophy, and in the elderly. Their use with other CNS depressants (e.g., alcoholic beverages) may cause drowsiness and affect alertness. They may be administered with food or milk to reduce GI upset. Their administration should be discontinued at least 4 days prior to allergy skin testing since they may reduce the accuracy of the test.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
astemizole *(ah-**STEM**-ih-zohl)* (Hismanal)	oral	*Adults and children 12 and over:* 10 mg daily *Children 6–12:* 5 mg once a day *Children under 6:* 0.2 mg/kg	Less sedating than most antihistamines. Should be administered 2–3 hours after a meal. Drugs or conditions that inhibit astemizole metabolism may cause serious cardiovascular effects.
azatadine maleate *(ah-**ZAT**-ah-deen **MAL**-ee-ayt)* (Optimine)	oral	*Adults:* 1–2 mg 2 times daily *Children 12 and older:* 0.5–1 mg 2 times daily	Not intended for children under 12.
brompheniramine maleate *(**brohm**-fen-**IR**-ah-meen **MAL**-ee-ayt)* (Dimetane, etc.)	oral, IM, IV, SC	*Adults:* 16–24 mg/day *Children over 2:* 4–12 mg/day	Timed-release dosage form available. Cooling drug solution below 0°C (32°F) may produce crystals. If this occurs, warm solution to 30°C (85°F) to dissolve crystals.
carbinoxamine maleate *(kahr-bin-**OCKS**-ah-meen **MAL**-ee-ayt)* (Clistin)	oral	*Adults:* 4–8 mg 3 or 4 times daily *Children:* 0.2–0.4 mg/kg/day	—
cetirizine hydrochloride *(she-**TIH**-rah-zeen)* (Zyrtec)	oral	*Adults and children over 6 years old:* 5–10 mg once a day *Children 2–6:* 2.5–5 mg once a day	Possibility of somnolence, dry mouth, fatigue, pharyngitis, dizziness Dosage is decreased to 5 mg/day in clients with hepatic impairment. Monitor effectiveness. Because of possibility of drowsiness, initially clients should avoid activities requiring mental alertness.
chlorpheniramine maleate *(**klor**-fen-**IR**-ah-meen **MAL**-ee-ayt)* (Chlor-Trimeton, Chlor-Tripolon ✱)	oral, IM, IV, SC	Parenteral: 5–40 mg as a single dose Oral: *Adults:* 4–24 mg/ day *Children 6–12:* 2–12 mg/ day *Children 2–6:* 1 mg/ day	Timed-release tablets available.
clemastine fumarate *(**KLEM**-as-ten **FYOU**-mah-rayt)* (Tavist)	oral	*Adults:* 1.34–2.68 mg 2–3 times daily to maximum 8.04 mg *Children 6–12:* 0.67–4.02 mg daily	—

continues

TABLE 23–1 ***continued***

See **Note** at beginning of Table 23–1, page 466.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
cyclizine HCl, cyclizine lactate *(**SIGH**-klih-zeen **hy**-droh-**KLOR**-eyed, **SIGH**-klih-zeen **LACK**-tayt)* (Marezine, Antivert)	oral	*Adults:* 50 mg every 4–6 hours *Children over 6:* ½ adult dose	Used exclusively for prevention and treatment of motion sickness. Adult dose should not exceed 200 mg daily.
cyproheptadine HCl *(**sigh**-proh-**HEP**-tah-deen **hy**-droh-**KLOR**-eyed)* (Periactin)	oral	*Adults:* 4–20 mg daily *Children 6–14:* 4 mg 2–3 times daily (16 mg maximum/day) *Children 2–6:* 2 mg 2–3 times daily (12 mg maximum/day)	Primarily used for symptomatic relief of pruritus.
dexchlorpheniramine maleate *(**decks**-klor-fen-**IR**-ah-meen **MAL**-ee-ayt)* (Polaramine, etc.)	oral	*Adults:* 2 mg every 4–6 hours *Children 6–12:* 1 mg every 4–6 hours *Children 2–5:* 0.5 mg every 4–6 hours	Timed-release tablets available, but should not be used in children under 6.
dimenhydrinate HCl *(**dye**-men-**HIGH**-drih-nayt **hy**-droh-**KLOR**-eyed)* (Dramamine, Gravol, Nauseatol)	oral, IM, IV	*Adults:* Oral: 50–100 mg every 4–6 hours IM, IV: 50 mg *Children 6–12:* Oral: 25–50 mg every 6–8 hours *Children 2–6:* Oral: 12.5–25 mg every 6–8 hours	May mask ototoxicity of other drugs. Used exclusively for prevention and treatment of symptoms caused by motion sickness (e.g., nausea, vomiting, dizziness, or vertigo).
diphenhydramine HCl *(**dye**-fen-**HIGH**-drah-meen **hy**-droh-**KLOR**-eyed)* (Allerdryl, Benadryl, etc.)	oral, IM, IV	*Adults:* Oral: 25–50 mg 3–4 times daily Parenteral: 10–50 mg *Children over 10 kg* Oral: 12.5–25 mg 3–4 times daily Parenteral: 5 mg/kg/day in 4 divided doses	Used for antihistaminic, antiemetic, anti-Parkinson, and antitussive effect.
loratadine *(lohr-**AT**-ah-deen)* (Claritin)	oral	*Adults and children 6 and over:* 10 mg once daily *Children 2–5:* 5 mg once daily	Taken with some antibiotics will increase heart rate. In patients with hepatic impairment, a dose of 10 mg every other day may be used.
meclizine HCl *(**MECK**-lih-zeen **hy**-droh-**KLOR**-eyed)* (Antivert, Bonine)	oral	25–50 mg/ day in divided doses	Primarily indicated for the treatment of motion sickness and vertigo. Not to be used in children under 12 years of age.
methdilazine HCl *(meth-**DYE**-lah-zeen **hy**-droh-**KLOR**-eyed)* (Tacaryl)	oral	*Adults:* 8 mg 2–4 times daily *Children over 3:* 4 mg 2–4 times daily	Primarily used for symptomatic relief of pruritus. Available as a chewable tablet.

continues

TABLE 23–1 *continued*

See **Note** at beginning of Table 23–1, page 444.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
phenindamine tartrate *(feh-**NIN**-dah-meen **TAR**-trayt)* (Nolahist)	oral	*Adults:* 25 mg every 4–6 hours *Children 6–12:* 12.5 mg every 4–6 hours	Adult dosage should not exceed 150 mg in 24 hours.
promethazine HCl *(proh-**METH**-ah-zeen **hy**-droh-**KLOR**-eyed)* (Histantil ✱, Phenergan, etc.)	oral, IM, IV, rectal	*Adults:* 12.5–50 mg *Children:* 12.5–25 mg	Used as an antiemetic, sedative, and as adjunct to analgesics.
pyrilamine maleate *(peer-**ILL**-ah-meen **MAL**-ee-ayt)*	oral	*Adults:* 25–50 mg every 6–8 hours	Included as an ingredient in many non-prescription antihistamine and sleep-aid products.
trimeprazine tartrate *(try-**MEP**-rah-zeen **TAR**-trayt)* (Panectyl ✱, Temaril)	oral	*Adults:* 2.5 mg 4 times daily *Children 2–3:* 2.5 mg 3 times daily or at bedtime	Primarily used for symptomatic relief of pruritus. Available in sustained-release dosage form.
tripelennamine HCl *(**try**-pih-**LEN**-ah-min **hy**-droh-**KLOR**-eyed)* (PBZ, Pyribenzamine ✱, etc.)	oral	*Adults:* 25–50 mg every 4–6 hours *Children:* 5 mg/kg/day divided into 4–6 doses, not to exceed 300 mg/day	Available in sustained-release dosage forms.
triprolidine HCl *(try-**PROH**-lih-deen **hy**-droh-**KLOR**-eyed)* (Actidil)	oral	*Adults:* 2.5 mg every 4–6 hours *Children 6–12:* 1.25 mg every 4–6 hours	Frequently used in combination with pseudoephedrine HCl (Actifed) to relieve allergic rhinitis.

TABLE 23–2

Decongestants

Note: Oral decongestant drugs are contraindicated in clients with hypertension, heart disease, diabetes mellitus, or hyperthyroidism. Topical nasal decongestants must be used precisely as directed by the physician or the package instructions. Overuse may result in rebound nasal congestion. Clients should be instructed in the appropriate technique for administration of the product to be used. In infants and young children, topical decongestants should be administered about 20 minutes before meals, so that nasal passages will be clear for breathing during sucking or eating.

Monitor clients using oral or topical decongestants for development of headaches, insomnia, nervousness, or cardiac palpitations. Avoid the use of these agents in clients receiving monoamine oxidase (MAO) inhibitors.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
ephedrine	topical	Topical: Instill 0.5% solution every 3–4 hours	May cause CNS stimulation. Do not use in children under 6 years.
epinephrine HCl *(ep-ih-**NEF**-rin **hy**-droh-**KLOR**-eyed)* (Adrenalin Chloride)	topical	*Adults and children 6 and over:* 1–2 drops or sprays of 0.1% solution in each nostril every 4–6 hours	Do not use in children under 6. Do not use solution if it is pink to brown in color or if it is cloudy.

continues

TABLE 23–2 ***continued***

See **Note** at beginning of Table 23–2, page 468.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
l-desoxyephedrine *(el-**des**-ock-see-ef-**EH**-drin)* (Vicks Inhaler)	inhaler	Whenever necessary	Failure to replace cap tightly will result in loss of medication due to volatilization.
oxymetazoline HCl *(**ock**-see-met-**AZ**-oh-leen **hy**-droh-**KLOR**-eyed)* (Afrin, Duration, etc.)	topical	*Adults and children 6 and over:* 2–3 drops or sprays of 0.05% solution in each nostril 2 times daily *Children 2–5 yrs:* 2–3 drops of 0.025% solution in each nostril 2 times daily	Long-acting agent. Do not use longer than 5 days.
phenylephrine HCl *(**fen**-ill-**EF**-rin **hy**-droh-**KLOR**-eyed)* (Neo-Synephrine, etc.)	topical	*Adults:* 0.25–1.0% solution in each nostril every 4 hours *Children over 6 yrs:* 0.25% solution used as above *Infants and children over 6 months:* 0.16% solution every 3 hours	May irritate nasal mucosa. Do not use solution if it is brown or contains a precipitate.
propylhexedrine *(**proh**-pill-**HECK**-seh-dreen)* (Benzedrex Inhaler)	inhaler	Whenever necessary 2 sprays each nostril every 2 hours	See l-desoxyephedrine. Propylhexedrine has been extracted from inhalers by abusers and injected IV as an amphetamine substitute.
pseudoephedrine HCl *(**soo**-doh-eh-**FED**-rin **hy**-droh-**KLOR**-eyed)* (Sudafed, etc.)	oral	*Adults:* 60 mg every 4–6 hours *Children 6–12 yrs:* 30 mg every 6 hours *Children 2–5 yrs:* 15 mg every 6 hours	Chemically and pharmacologically related to ephedrine, but produces less central nervous system stimulation. Sustained-release products are administered every 12 hours. Monitor for hypertension, tachycardia, palpitations.
pseudoephedrine sulfate *(soo-doh-eh-**FED**-rin **SUL**-fayt)* (Afrin tablets, etc.)	oral	*Adults and children 12 yrs and over:* 120 mg of sustained-release product every 12 hours	See pseudoephedrine HCl.
xylometazoline HCl *(**zy**-loh-**met**-ah-**ZOH**-leen **hy**-droh-**KLOR**-eyed)* (Otrivin, etc.)	topical	*Adults and Children 12 and over:* 2–3 drops or sprays of 0.1% solution in each nostril every 8–10 hours *Children 2–12 yrs:* 2–3 drops or sprays of a 0.05% solution in each nostril every 8–10 hours	Long-acting agent.

Note: In December 2000, the Food and Drug Administration (FDA) began taking steps to remove **phenylpropanolamine hydrochloride** (PPA) from all drug products, based on mounting evidence that it increases the risk of hemorrhagic stroke. Because many commonly used over-the-counter (OTC) cold and cough medications have contained PPA, the FDA also requested that drug companies discontinue marketing products containing PPA during the removal process, which can take a long time.

TABLE 23–3

Intranasal Steroid Products

Note: Clients with blocked nasal passages who use intranasal steroid products should be advised to use a decongestant shortly before administration to permit adequate distribution of spray.

Monitor clients for the development of nasal irritation and dryness, as well as for systemic steroid effects such as fluid retention, congestive heart failure, weight gain, menstrual irregularities, muscle weakness, and increased susceptibility to fractures and infection. These products may decrease effectiveness of immunizations due to steroidal effect.

DRUG	USUAL DOSE	NURSING IMPLICATIONS
beclomethasone dipropionate *(**beck**-loh-**METH**-ah-sohn dye-**PROH**-pee-on-ayt)* (Beconase, Vancenase)	*Adults and children 12 yrs and over:* 1 inhalation in each nostril 2–4 times daily *Children 6–12 yrs:* 1 inhalation in each nostril 3 times daily	Administration should be discontinued if significant improvement is not evident after 3 weeks of therapy.
budesonide *(byou-**DESS**-oh-nyd)* (Rhinocort)	*Adults and children 6 yrs and over:* 2 sprays in each nostril in morning and evening or 4 sprays in each nostril in the morning	Container should be stored with valve facing downward. Shake canister well before using.
dexamethasone sodium phosphate *(**deck**-sah-**METH**-ah-sohn **SOH**-dee-um **FOS**-fayt)* (Decadron Phosphate Turbinaire)	*Adults:* 2 sprays in each nostril 2–3 times daily *Children 6–12 yrs:* 1–2 sprays in each nostril 2 times daily	Discontinue therapy as soon as symptoms subside.
flunisolide *(floo-**NIS**-oh-lyd)* (Nasalide, Rhinalar ✱)	*Adults:* 2 sprays in each nostril 2–3 times daily *Children 6–14 yrs:* 1 spray in each nostril 2–3 times daily	Administration should be discontinued, if significant improvement is not evident after 3 weeks of therapy. Some clients may be successfully maintained on as little as 1 spray in each nostril per day.
fluticasone propionate *(flu-**TIH**-kah-sohn)* (Flonase)	*Adults and children over 4 years old:* one 50-mcg spray in each nostril once a day	Possible epistaxis, nasal burning, irritation to nasal mucous membranes, headache. Contraindicated in clients experiencing bronchospasms. Monitor effectiveness.
triamcinolone acetonide *(**try**-am-**SIN**-oh-lohn ah-**SET**-oh-nyd)* (Nasacort Spray)	*Adults and children over 12 yrs:* 2 sprays in each nostril once daily	Re-evaluate client, if improvement is not evident after 2–3 weeks.

APPLYING THE NURSING PROCESS

ASSESSMENT

The nurse has contact with people who are taking antihistamines and decongestants for a number of different health problems. Some of these persons have minor upper respiratory infections; some have allergies, influenza, or asthma. Because these drugs account for a sizeable proportion of the nonprescription drugs sold, many of the people with whom the nurse has contact will be outpatients, neighbors, and friends. Some will be seeking information about the type of preparation they should use. The

nurse can take this opportunity to offer health guidance about self-medication. When approached for information, the nurse makes an initial assessment of the health problem to determine if it requires medical treatment and supervision. Persons with chronic diseases, such as hypertension, diabetes mellitus, hyperthyroidism, heart diseases, and respiratory diseases, should be referred to a physician. In addition, clients with fever and prolonged or acute respiratory problems should also be referred. Age plays an important part in the decision to refer a person for medical treatment. Very young children and elderly persons may suffer serious consequences from seemingly minor upper respiratory infections.

NURSING DIAGNOSES

Including but not limited to:

- Breathing pattern ineffective because of congestion
- Risk for injury related to adverse effects of antihistamines and potential overuse
- Risk for injury related to adverse effects of decongestants and potential overuse
- Deficient knowledge related to antihistamines and decongestants

PLANNING/GOALS

- Client will experience respiratory rate within normal limits.
- Client will verbalize decreased congestion.
- Client will not experience injury due to use of antihistamines.
- Client will not experience injury due to use of decongestants.
- Client will verbalize understanding of appropriate use of antihistamines and decongestants.

IMPLEMENTATION

Because many of these drugs are sold without a prescription, some people doubt their potency and effectiveness. They may therefore tend to misuse them, taking the drugs more frequently or for a longer period of time than recommended. Such actions may result in undesirable outcomes. For example, overuse of nasal sprays may actually result in nasal congestion. The nurse should reinforce the directions and warnings printed on a package or its insert. These warnings usually identify the health problem or symptoms of persons who should not take the medication. The length of time the medication can be taken before a physician should be consulted is also included. In addition, relevant safety precautions are listed; for example, avoid driving vehicles and operating dangerous equipment, if the drug is known to cause drowsiness. Caution statements often stress significant drug interactions to be avoided, for example, the use of antihistamines with alcohol or barbiturates.

Many of the cold and allergy preparations on the market contain a number of different substances designed to relieve multiple symptoms a person might have. A given medication may contain, for example, substances with *antitussive*, antihistaminic, *expectorant*, analgesic, and/or decongestant actions. For this reason prospective users should be instructed to read the label carefully to avoid taking products containing a substance to which they are sensitive or that may interact with other drugs they are taking. Clients who cannot take aspirin because of hypersensitivity, possible drug interactions, gastric intolerance, or ulcers should be alerted that some common cold preparations contain aspirin.

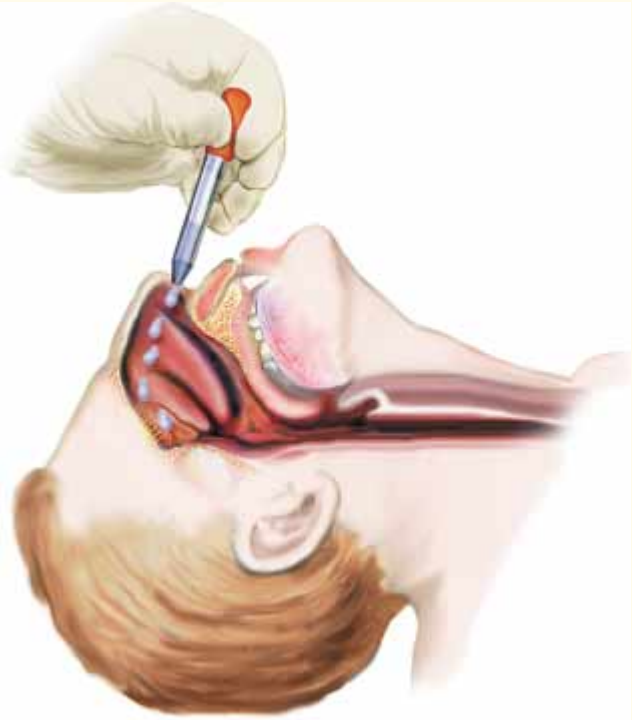
Some commonly used preparations contain substances that can elevate blood pressure. All hospitalized clients should have their blood pressure checked before decongestant therapy is initiated. It should continue to be taken every other day until therapy is discontinued or the client is discharged. Clients known to have hypertension who are taking such drugs must have their blood pressure monitored more frequently. In all cases, steadily increasing blood pressure readings, when compared to the pretreatment reading, must be reported to the physician.

To maximize the effectiveness of drugs administered topically, the nurse needs to use appropriate techniques in administering nasal sprays, nose drops, and inhalers. Clients should also be instructed in these techniques (Figures 23–3, 23–4, and 23–5). Proper administration of topical solutions, particularly nose drops, is necessary to prevent the solution from going into the sinuses or running down the throat and

The nurse provides the client with the following instructions for the use of nasal sprays:

1. Have a supply of tissues on hand.
2. Blow your nose.
3. Keep the head and nasal spray container upright.
4. Quickly and firmly squeeze the container the appropriate number of times into a nostril.
5. With each spray, sniff the spray upward.
6. Repeat with the other nostril PRN.
7. To avoid rebound congestion, do not use more than the recommended dosage of the spray.
8. Because viruses may colonize the tip of the container, the use of each spray container should be limited to one person and one episode of illness and should be cleaned with warm water before each use.

Figure 23–3 Clients should be instructed in the proper technique for self-administration of nasal sprays.



1. Have the client clear his/her nasal passages.
2. a. To treat the ethmoid and sphenoid sinuses, as shown above, position the client's head at the edge of the bed or examining table on which he/ she is lying. The head should extend over the edge of the supporting surface at a 90° angle, with the jaw pointed toward the ceiling.
   b. To treat the frontal and maxillary sinuses and the nasal passages, position the client's head so that it extends over the edge of the supporting surface at a 90° angle, if possible, with the ear opposite the treated nostril toward the ceiling.
3. Fill the dropper with the desired amount of medication.
4. Insert the dropper a short distance (a little more than ¼ inch) into the nostril. **Note:** To prevent contamination, the dropper should not come in contact with the nasal mucosa or nose.
5. Position the dropper with the bulb slanted toward the jaw.
6. Squeeze the dropper to deliver the desired amount of medication.
7. Repeat with the other nostril PRN.
8. Provide the client with tissues and advise him/her to remain in the head-down position for a minute or two.
9. Instruct the client to avoid swallowing the medication.

Figure 23–4 Correct technique for the administration of nose drops

1. Have client gently blow nose to clear nasal passages.
2. Shake inhaler well.
3. Snap open the cover of the actuator and hold the inhaler between the thumb and index finger.
4. Carefully insert the nasal piece on the actuator into one nostril and close the other nostril with one finger.
5. While gently breathing in through the nostril, press down on the top of the canister with the index finger and release the medication.
6. Client should then breathe out through the nose.
7. Shake the inhaler well again and repeat steps 2–6.
8. Close the actuator cover.

Figure 23–5 Correct technique for use of nasal inhaler

being absorbed in the system. Clients should be instructed to expectorate medication running down the throat rather than swallowing it. Changing the customary position for administration of nose drops may be necessary with young children and elderly or debilitated persons. Young children can be held on the nurse's lap with the neck hyperextended over the nurse's knees. Older and debilitated clients may be placed in a supine (dorsal recumbent) position in bed, with the neck hyperextended over a support made of pillows or sandbags.

Timing the administration of these medications is important, particularly in very young children and debilitated clients. Medication should be given about 20 minutes before meals, so that the nasal passages will be clear for breathing during sucking or eating.

Special nursing measures are required for persons with profuse sinus drainage. Such clients may have a tendency to swallow this drainage, especially while sleeping. Stomach upset with nausea and loss of appetite results. They should be taught to take a dose of the decongestant shortly before retiring. Clients are encouraged to expectorate into tissues, which are disposed of in a sanitary manner. Mouth care is to be provided frequently, especially before meals.

Persons with acute upper respiratory infections should be instructed in ways to minimize the likelihood of spreading their infection. This includes avoiding social gatherings, covering sneezes and coughs, handwashing, and disposing of secretions properly. In particular, clients should avoid contact with chronically ill and elderly persons to prevent the spread of infections to those with an impaired immune response.

Persons using antihistamines and/or nasal decongestants because of allergies should be referred to a physician for possible *desensitization*. When taking a history from such persons every effort should be made to determine the offending allergen(s). Once the allergen is identified, the nurse can provide a valuable service by suggesting ways to minimize contact with the offending substance. Nurses functioning in environments without a physician (for example, summer camps for children) ought to be aware of the life-threatening allergies of their clients. Emergency supplies, including epinephrine, diphenhydramine HCl (Benadryl), and corticosteroids should be on hand for use, if such a reaction does occur. Treatment of such emergency situations should be based on previously established protocols.

EVALUATION

- Client experiences respiratory rate within normal limits between 12–20 breaths/minute.
- Client verbalizes decreased congestion.
- Client does not experience injury due to use of antihistamines.
- Client does not experience injury due to use of decongestants.
- Client verbalizes understanding of appropriate use of antihistamines and decongestants and safely self-administers.

NURSING CARE PLAN

A Client with a Cold Taking Pseudoephedrine HCl (Sudafed)

Emilia Hoza, age 38, is a nurse's aide with a very active lifestyle. She has a history of bronchitis and she frequently experiences acute bronchitis attacks, particularly at change of seasons. She works full time and, with the current nursing shortage, is reluctant to take sick time. She has two teenagers who are always on the go. Both teenagers developed colds after being at a baseball game in the rain. Emilia gets up the next morning with the sniffles and reports to the employee health nurse at her place of employment. She is referred to a physician who confirms that she has a cold and orders pseudoephedrine HCl (Sudafed) 60 mg q4h for her.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Nasal discharge, "stuffed up feeling."	Ineffective airway clearance related to presence of secretions and nasal discharge.	Client will verbalize understanding of treatment regimen. Nasal stuffiness is reduced.	Encourage client to use medication as ordered. Encourage increased fluid intake (8 oz. every hour).	Client takes pseudoephedrine as ordered and breathes easily without obstruction.
Cough.	Impaired gas exchange related to coughing mechanism interfering with breathing.	Client will have adequate oxygenation as evidenced by good skin color.	Encourage client to take deep breaths. Monitor temperature to be sure that bacterial infection is not occurring. Report presence of elevated temperature or cough.	Client demonstrates deep breathing techniques. Skin color good, skin warm and dry.
Back pain.	Acute pain acute related to repeated coughing.	Client will verbalize comfort following comfort measures.	Use of pseudoephedrine will decrease nasal secretions, increasing comfort. Suggest use of aspirin and heat to scapular area.	Client verbalizes pain relief following comfort measures.
Loss of appetite.	Imbalanced nutrition: less than body requirements related to loss of appetite.	Client maintains an adequate intake of food as evidenced by no weight loss.	Encourage client to eat a balanced diet with emphasis on vitamin C and plenty of fluids. Suggest small, frequent meals.	Client eats a balanced diet consisting of mostly soups and juices. Client maintains present weight.
Tiredness.	Disturbed sleep pattern related to nasal stuffiness and discomfort secondary to upper respiratory infection.	Client achieves optimal level of sleep as evidenced by rested appearance and verbalization of feeling rested.	Encourage client to get extra sleep while recuperating from an upper respiratory infection. Client should nap in addition to 8 hours of nighttime sleep. If central nervous stimulation occurs, advise client not to take dose before retiring. A topical nasal decongestant may be used to decrease systemic effects.	Client is taking short naps in addition to nighttime sleep. Client appears rested and verbalizes feeling rested.
Understanding of over-the-counter (OTC) medications.	Deficient knowledge (pseudoephedrine and over-the-counter (OTC) medications).	Client will be able to identify how OTCs and pseudoephedrine interact.	Teach client that some OTC medications contain nasal decongestants that might increase the action of the pseudoephedrine. Advise client to withhold medicine if extreme restlessness occurs and not to take it at bedtime.	Client is taking pseudoephedrine as scheduled and is not taking any OTC preparation that could interact with it.

KEY NURSING IMPLICATIONS 23–1

Antihistamines and Decongestants

1. Clients with acute upper respiratory infections and chronic illnesses, significant fever, and prolonged or very acute respiratory ailments should be referred to a physician. Very young children and the elderly are at particular risk of complications.
2. Encourage the client to read the directions for use and the warnings on over-the-counter products and to follow the instructions.
3. Teach clients the proper way to administer nasal sprays and nose drops.
4. Topical nasal decongestants should be given about 20 minutes before meals, so that the nasal passages will be clear for breathing during eating or sucking.
5. Emergency supplies for the treatment of acute allergic reactions should always be available.

HOME CARE / CLIENT TEACHING

1. Nurses visiting a client's home should provide information about how acute respiratory infections are spread and how they can be minimized.
2. Persons at risk of adverse responses to acute respiratory infections, such as the elderly and those with chronic respiratory diseases, should be advised to speak with their physician about the use of flu vaccines.
3. Persons uncertain about what over-the-counter cold or allergy preparations to purchase should be encouraged to consult with the pharmacist.
4. The nurse should reinforce the proper techniques of administering nasal sprays and nose drops.
5. Home visits provide an opportunity for the nurse to identify the presence of possible allergens in clients with a history of allergic diseases. Allergen control measures can be discussed with the client or parent.
6. Clients taking both over-the-counter medications for congestion, as well as those taking prescription drugs should be directed to follow the directions and warnings printed on the package or its insert.
7. Clients using nasal sprays should be cautioned that many of these, such as **oxymetazoline HCl**, should not be used for more than 5 days, because they can cause rebound congestion.
8. Parents should be reminded to read labels on over-the-counter medications, as they are frequently not for use with very young children. If they have questions, they should be referred to the child's pediatrician.
9. Clients taking antihistamines should be encouraged to drink at least 3,000 ml of fluid per day, unless contraindicated because of other health problems, as antihistamines can have a drying effect on mucous membranes.
10. Clients who cannot take aspirin because of hypersensitivity should be alerted that many cold preparations contain aspirin, as well as the antihistamine ingredients.
11. Parents should be cautioned not to use cold preparations containing aspirins for their children because of risk of Reye's syndrome.
12. Clients taking cold preparations containing acetaminophen should be instructed not to take other products containing acetaminophen, because of risk of acetaminophen toxicity.
13. Clients with hypertension, glaucoma, or prostate problems should be cautioned that some antihistamines and decongestants can aggravate these conditions.
14. Clients using nasal sprays should be instructed to expectorate medication running down the throat rather than swallowing these substances.

CASE STUDY

Tim Talbot is a 15-year-old high school student. Although there is a strong family history of allergies, Tim has never shown any signs of allergy. Shortly after his family acquired a kitten, Tim began to experience nasal congestion, sneezing, and itchy, watery eyes. Subsequent allergy testing revealed that Tim was allergic to the dander of horses, dogs, and cats; chicken feathers; dusts; molds, and ragweed pollen.

His physician prescribed the regimen:

- Desensitization to dusts, molds, and ragweed pollen
- Oxymetazoline HCl (**Afrin**) nasal spray, BID prn
- **Dexbrompheniramine maleate** and **pseudoephedrine sulfate** (**Drixoral**) BID, 1 tablet in the morning and 1 at night

Following 2 years of hyposensitivity injections and drug therapy, Tim's allergies seem to be under good control.

Questions for Discussion

1. Why is the combination of dexbrompheniramine maleate and pseudoephedrine a useful combination for treatment of Tim's allergic problems?
2. What instructions should be given to Tim and his mother concerning the use of oxymetazoline hydrochloride (Afrin)?
3. What additional nursing measures would enhance the effectiveness of the medical regimen?

CRITICAL THINKING EXERCISES

1. Visit a local pharmacy and count the number of antihistamine and nasal decongestant products available. Remember to check the liquid preparations available for children.
2. Read the labels on several of the over-the-counter preparations, noting the cited precautions and the contents of each preparation.
3. Visit an allergy clinic and observe the treatment being given. Take special note of the measures used to prevent acute allergic (anaphylactic) reactions.
4. Write a report on the emergency treatment of insect stings.
5. Develop a nursing plan to prevent spread of respiratory infection in day care centers.

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Expectorant and Antitussive Agents

24

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify agents currently in clinical use as antitussives or expectorants
- State the mechanisms by which expectorant and antitussive agents produce their therapeutic effects
- Identify factors to be assessed in clients taking expectorants or antitussives
- State when the use of expectorants and/or antitussive agents is clinically desirable
- Apply the nursing process related to the administration of expectorant and antitussive agents
- List three nondrug measures which can promote comfort in clients with chronic cough

A number of different drugs may be used to alleviate involuntary cough and respiratory tract congestion caused by the accumulation of mucus. Expectorants decrease the viscosity of sputum and facilitate expectoration. Cough suppressants or antitussive agents decrease the frequency of involuntary cough.

EXPECTORANTS

Expectorants are agents administered orally to stimulate the flow of secretions in the respiratory tract. In doing so, the viscosity of *endobronchial* secretions and accumulated phlegm is reduced and removal by coughing and ciliary action is facilitated. Greater secretory activity in the respiratory tract also aids in the hydration of dry, irritated tissue and provides a soothing coating to protect against further trauma.

There is considerable controversy regarding the therapeutic efficacy of expectorants. This stems from the absence of reliable data to substantiate the reduction of sputum viscosity by expectorants as compared to a placebo. Expectorants continue to be used, however, on the basis of subjective evidence that they have a useful therapeutic effect.

Guaifenesin is the most popular expectorant in current use and is an ingredient in many commercial cough preparations. Guaifenesin is well tolerated by most clients and can be formulated into a palatable syrup. It may cause stomach upset or nausea on rare occasions, because of its stimulatory effect on the production of gastric secretions.

Ammonium chloride may also be used as an expectorant. The FDA does not classify ammonium chloride as an effective agent for removing secretions from the

airways, and basically believes that increasing fluid intake works just as effectively without the adverse effects associated with this agent. It can cause serious adverse effects, particularly in clients with renal, hepatic, or chronic heart disease. In such clients doses as low as 5 g have caused severe poisoning. High doses of ammonium chloride can acidify the urine and may cause nausea and vomiting. Its use in commercial products is also limited by its unpleasant salty taste.

Iodides, particularly **potassium iodide** and **sodium iodide**, have long been used for their expectorant properties, because of their ability to increase the secretion of respiratory tract fluids. Their clinical use, however, is limited by possible hypersensitivity reactions and the development of *iodism* exhibited by some clients. **Note:** The American Academy of Pediatrics recommends that iodide-containing products not be used in children because they may produce iodism, hypothyroidism, and goiter. Iodides are also contraindicated in pregnancy, nursing mothers, and in clients with hyperkalemia or hyperthyroidism.

Ipecac syrup contains chemical agents that can stimulate the flow of gastric and respiratory tract secretions. In low doses (0.25–1 mL) it is used as an expectorant. In higher doses (15 mL), it is a potent *emetic* commonly used in the emergency treatment of some poisonings. Because the main ingredients in ipecac are potentially toxic, ipecac should not be used as an expectorant in children under the age of 6.

Terpin hydrate acts as an expectorant by stimulating the secretory glands directly to increase natural respiratory tract secretions. **Terpin hydrate and codeine elixir** is also used as an expectorant.

Table 24–1 reviews the properties of the expectorants.

ANTITUSSIVES

A cough is a physiological mechanism useful in removing foreign material and excessive secretions from the respiratory tract. A cough may be productive or nonproductive, i.e., it may or may not result in the removal of excess respiratory secretions. Involuntary cough should not, therefore, be suppressed unless it causes respiratory discomfort or sleep disturbance, or if the cough does not facilitate removal of excess secretions from the respiratory tract.

Both narcotic and nonnarcotic cough suppressants are available. The narcotic agents, particularly codeine and **hydrocodone**, are considered to be the most effective and are reasonably safe to use for most clients. They act in suppressing the cough reflex by a direct depressant effect on the cough center in the medulla of the brain. An example of combination narcotic and nonnarcotic cough agents is **guiafenesin and codeine** (**Robitussin A-C**), which combines an expectorant with an antitussive, respectively. This drug is used for temporary relief of cough due to throat irritation. This irritation can lead to a more serious condition—bronchitis—so physicians may choose to use this combination therapy in certain clients.

The major drawback in using narcotic cough suppressants is their ability to cause dependence, as well as respiratory depression, bronchial constriction, central nervous system (CNS) depression, and constipation. They must be used with great caution, therefore, in clients with preexisting pulmonary distress, as well as in those using most psychotropic agents, sedative-hypnotics, alcohol, or other CNS depressants.

The most widely used nonnarcotic cough suppressant is **dextromethorphan HBr**, a chemical derivative of the opiate narcotics. This agent also acts on the cough center in the medulla, but does not cause respiratory depression, analgesia, or dependence. Because its usefulness and relative safety have been well documented, dextromethorphan is used in most nonprescription cough syrups intended for adults and children. Popular products containing this drug include **Cheracol D**, **Robitussin DM**, and **Benylin DM**.

Benzonatate (**Tessalon**) is a derivative of **procaine**. It is believed to act by providing local anesthetic action, which impairs sensation of the stretch receptors located in the respiratory tract, thereby interfering with the cough reflex. It does not impair respiration, nor does it have an analgesic effect.

Diphenhydramine HCl (Benadryl), a potent antihistamine, has also been approved for use as an antitussive. Because of its anticholinergic properties it must be used with caution in clients with glaucoma, prostatic hypertrophy or obstructive pulmonary diseases. When used with alcohol or other CNS depressants, excessive sedation may occur. The client should, therefore, be made aware of possible impairment of physical and/or mental capabilities while on the drug.

Table 24–2 reviews the properties of the antitussives.

TABLE 24–1

Expectorants

Note: Clients taking expectorants should be taught to cough effectively. This includes sitting in an upright position and taking several slow, deep breaths before coughing. Secretions must be disposed of properly.

Sufficient humidification must be added to the air.

Encourage fluid intake to help liquefy secretions.

May be used with percussion and vibration to help eliminate secretions.

DRUG	COMMON ADVERSE EFFECTS	DOSE	NURSING IMPLICATIONS
ammonium chloride *(ah-**MOH**-nee-um **KLOR**-eyed)*	nausea, vomiting	*Adults:* 300 mg every 2–4 hours *Children 6–12:* 150 mg as above *Children 2–6:* 75 mg as above	Should be used with caution in clients with hepatic renal, coronary, or pulmonary disease. May intensify symptoms of peptic ulcer disease. With prolonged use, observe client for impaired consciousness, tremor, etc. To diminish gastric irritation, best given in solution form.
guaifenesin, glyceryl guaiacolate *(gwhy-**FEN**-eh-sin, **GLIS**-er-ill gwhy-**ACK**-oh-layt)*	gastric upset	*Adults:* 100–400 mg every 4 hours, not to exceed 2,400 mg/day *Children 6–12:* 100–200 mg as above, not to exceed 1,200 mg/day *Children 2–6:* 50–100 mg as above, not to exceed 600 mg/day	Most commonly used expectorant in over-the-counter products.
iodide, potassium *(**EYE**-oh-dyd, poh-**TASS**-ee-um)* (Saturated Solution of Potassium Iodide [SSKI])	metallic taste, fever, skin rash, nausea and vomiting, salivary gland swelling	*Adults:* 300–600 mg 4 times daily	Each mL of SSKI contains 1 g of potassium iodide. Dilute SSKI in water or fruit juice before administering. Do not administer to clients with hyperthyroidism or hyperkalemia or if skin eruption occurs. Avoid use in pregnant women, as iodide may alter thyroid function of fetus. Avoid use in clients who are hypersensitive to iodine.
iodinated glycerol *(eye-**OH**-dih-nay-ted **GLIS**-er-ohl)* (Organidin)	gastric upset, rash, hypersensitivity	*Adults:* 60 mg (30 mg of organically bound iodine) 4 times daily	Do not use in clients sensitive to iodides or in pregnant women.
terpin hydrate *(**TER**-pin **HIGH**-drayt)*	GI upset	*Adults:* 200 mg every 4 hours	Terpin hydrate elixirs contain 85 mg of terpin hydrate per 5 mL. Do not give on an empty stomach. Avoid use in alcoholics, diabetics, and those with peptic ulcer disease.

TABLE 24–2

Antitussives

Note: Teach client to cough effectively. This includes sitting in an upright position and taking several slow deep breaths before coughing. Secretions must be disposed of properly.

Encourage fluid intake.

Do not give water after administration of cough syrups.

Cough should not be suppressed, when it is productive or beneficial; for example, after surgery (with support).

Assess the frequency and nature of cough, as well as the nature of secretions produced.

May be used with percussion and vibration to help eliminate secretions.

DRUG	COMMON ADVERSE EFFECTS	DOSE	NURSING IMPLICATIONS
benzonatate *(ben-**ZOH**-nah-tayt)* (Tessalon)	sedation, headache, dizziness, pruritus and skin eruptions, GI upset, constipation, burning of the eyes, hypersensitivity	*Adults and children over 10:* 100 mg 3 times daily; if necessary, up to 600 mg/day may be given	Product must be swallowed without chewing, because it may cause temporary local anesthesia of the oral mucosa.
codeine, codeine phosphate, codeine sulfate *(**KOH**-deen, **KOH**-deen **FOS**-fayt, **KOH**-deen **SUL**-fayt)*	respiratory and circulatory depression, lightheadedness, dizziness, sedation, nausea and vomiting, sweating, constipation, hypersensitivity	*Adults:* 10–20 mg every 4–6 hours, not to exceed 120 mg/day *Children 6–12:* 5–10 mg every 4–6 hours, not to exceed 60 mg daily *Children 2–6:* 2.5–5 mg as above, not to exceed 30 mg/day	Observe client for signs of dependency. Use with caution in clients with preexistent pulmonary distress. May impair mental and/or physical abilities, particularly if taken with other CNS depressants. Warn clients about engaging in activities that require mental alertness.
dextromethorphan HBr *(**deck**-stroh-meth-**OR**-fan **hy**-droh-**BROH**-myd)*	drowsiness, nausea, dizziness	*Adults and children over 12:* 10–30 mg every 4–8 hours to a maximum of 120 mg daily *Children 6–12:* 5–10 mg every 4 hours or 15 mg every 6–8 hours to a maximum of 60 mg daily *Children 2–6:* 2.5–7.5 mg every 4–8 hours to a maximum of 30 mg daily	Do not use in clients taking MAO inhibitors (see Chapter 18). Most common cough suppressant in OTC products.
diphenhydramine HCl *(**dye**-fen-**HIGH**-drah-meen **hy**-droh-**KLOR**-eyed)* (Benylin Cough Syrup, etc.)	sedation, anticholinergic effects (dry mouth, constipation, urinary retention, etc.)	*Adults:* 25 mg every 4 hours, not to exceed 150 mg/day *Children 6–12:* 12.5 mg as above, not to exceed 75 mg/day *Children 2–6:* 6.25 mg as above, not to exceed 25 mg/day	May impair mental and/or physical abilities, particularly if taken with other CNS depressants. Do not use in clients taking MAO inhibitors. Use with caution in asthmatic clients and in those with narrow angle glaucoma. Dryness of the mouth can be relieved with sour hard candy, ice chips, mouth care, or increased fluid intake.
hydrocodone bitartrate *(**high**-droh-**KOH**-dohn by-**TAR**-trayt)*	See codeine	*Adults:* 5 mg 4–6 times daily	See codeine.

APPLYING THE NURSING PROCESS

Most persons taking expectorant and antitussive drugs fall into two categories: those who have acute respiratory infections and those with chronic lung problems. In the chronic lung problem group are those with chronic obstructive pulmonary disease (COPD), which includes emphysema, chronic bronchitis, and asthma, and those with chronic diseases that may affect the lungs, such as *cystic fibrosis*.

Coughing is a universal experience. A cough is a reflex that helps to protect the respiratory tract from foreign materials. When coughing becomes frequent, however, it is both annoying and may interfere with daily activities. In such cases, many people seek relief by purchasing over-the-counter cough preparations. These preparations can increase a client's comfort and permit eating and sleeping without interruption. However, the nurse should encourage persons with a chronic cough to visit a physician, rather than continuing to medicate themselves. Chronic cough may indicate serious health problems, such as tumors or emphysema, which require a particular medical regimen. Persons with a cough lasting more than 1 week and those with high fevers, rash, or persistent headache and cough should be referred to a physician.

ASSESSMENT

The nurse carefully describes the characteristics of cough and/or respiratory secretions of all clients receiving expectorants and antitussives. The nature, duration, frequency, and productivity of cough are recorded as well as the color, odor, amount, and viscosity of sputum.

Clients receiving expectorants and/or antitussives are frequently taking several other drugs. They may be taking antibiotics for treatment or prophylaxis of respiratory infections. In addition, they may be taking bronchodilators, antihistamines, and/or nasal decongestants. Because of such multiple-drug therapy, the nurse must carefully monitor the client, observing for therapeutic and untoward effects, sensitivity to any drug, and drug interactions.

NURSING DIAGNOSES

Including but not limited to:

- Ineffective airway clearance related to respiratory secretions.
- Risk for injury related to adverse effects of expectorants and antitussives
- Deficient knowledge related to expectorants and antitussives

PLANNING/GOALS

- Client will experience effective cough reflex and clear breath sounds.
- Client will verbalize improvement in respiratory secretions and ability to remove them.
- Client will not experience injury due to use of expectorants.
- Client will not experience injury due to use of antitussives.
- Client will verbalize understanding of antihistamines and decongestants and will safely self-administer.

IMPLEMENTATION

Syrups are commonly used as vehicles for antitussive and expectorant medications. Many of these have a soothing effect on the mucosa of the pharynx. For this reason, when administering several oral medications, the syrup should be given last, when its purpose is to provide this soothing effect. It should not be immediately followed by water or other liquids or foods. Like all medications, these syrups must be kept out of the reach of children when not in use. Because they are often pleasantly flavored, syrup medications are a potential source of accidental poisoning.

In addition to drug therapy, nursing measures promote comfort in persons with chronic cough. Elevating the client's head and providing an environment with sufficient humidity can help to control cough. During winter in cold climates, when the air is particularly dry, the client with a cough should wrap a scarf around the nose and mouth before going outside. Breathing

NURSING CARE PLAN

A Child with Bronchitis Taking Guaifenesin (Robitussin) Syrup

Julie Koehler is an 18-month-old whose older sister is in kindergarten. The sister comes home with a cold, which lasts for a few days. Shortly after, her mother notices that Julie is sneezing, no appetite and a dripping nose. The next day she develops a hacking cough that does not resolve. Her mother takes Julie to the pediatrician. Julie cries and clings to her mother in the pediatrician's office. Examination indicates tachycardia, fine moist rales, and wheezing on expiration. The pediatrician prescribes guaifenesin (Robitussin) syrup. The doctor explains that usually only supportive therapy is needed for this condition but that the mother should call, if respiratory distress develops. He tells her to observe the child carefully for signs of nasal flaring, circumoral cyanosis, and subcostal retractions, which indicate respiratory distress. None of these symptoms develop and the cough goes away in about 4 days.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Crying in pediatrician's office.	Anxiety related to unfamiliar environment.	Child will be kept with mother to reduce anxiety.	Mother will stay with child throughout examination and continue to talk to child soothingly.	Child demonstrated reduced anxiousness with mother in attendance during examination.
Breathing rate and rhythm.	Ineffective breathing pattern related to retained secretions and inflammation.	Child will demonstrate normal respirations and breath sounds within 48 hours.	Keep head elevated to assist breathing. Give expectorant to soothe dry mucous membranes and reduce hacking cough. Provide humidification to decrease viscosity of secretions.	Child does not develop respiratory distress. Airway is open.
Temperature.	Risk for hyperthermia related to dehydration or secondary bacterial infection.	Child will have temperature below 101°F throughout illness.	Instruct mother to take client's temperature. If it elevates above 101°F, sponge with tepid water and give acetaminophen. Encourage clear liquids.	Child does not develop high temperature. If temperature elevates above 101°F parents intervene appropriately.
Skin color, warmth.	Risk for impaired gas exchange related to inadequate breathing pattern or obstructed bronchioles.	Child will maintain adequate oxygenation as evidenced by blood gases within normal limits.	Instruct mother to observe for signs of respiratory distress and report immediately. Make sure skin stays warm and dry.	Child has no circumoral cyanosis, or nasal flaring. Skin is warm and dry.
Intake and output, tissue turgor.	Deficient fluid volume related to decreased intake or elevated temperature.	Child will maintain fluid intake and output of 1,000 mL daily.	Instruct mother to give fluids and juices and omit solid foods from regular diet. Decrease milk intake due to milk's thickening effect on secretions. Observe urine output for adequacy by judging wetness of diapers.	Child does not develop dehydration as evidenced by normal vital signs, skin turgor, electrolytes, and specific gravity.
Fatigue.	Disturbed sleep pattern related to cough and restlessness.	Child sleeps for 4 uninterrupted hours within first 24 hours.	Instruct mother to plan rest periods around taking temperature and giving medication so child can sleep without disturbance.	Child does not become overtired and is able to sleep at increasing intervals.

Crying, restlessness.	Fear related to maturational age and illness.	Child will demonstrate an increase in psychological comfort by decreased crying, ability to sleep, and playing.	Mother will be encouraged to talk to child, soothe fearfulness, and employ distraction.	Child cries less, sleeps at longer intervals, plays, and smiles. Provide information and support for mother to permit her to attend to child's needs.
Eating patterns.	Imbalanced nutrition: less than body requirements related to loss of appetite and cough.	Child will increase her dietary intake to 100% of a regular diet by day four.	Mother will provide child with nutritious liquids, offer small, frequent feedings, and gradually increase to the child's regular diet by day 4.	Child eats small, frequent feedings and progresses to her regular diet by day 4.
Medical treatment, expectorant ordered.	Deficient knowledge (medication and therapy).	Mother will discuss proper administration of drug and list potential side effects and what to report.	Teach mother to give ½ teaspoonful of guaifenesin syrup q4h as ordered. Notify physician if agitation, dizziness, insomnia, or nausea occurs.	Child receives the recommended dose and does not develop any side effects.

through the nose is preferred to mouth breathing. The nasal turbinates help to warm inspired air, thereby minimizing distress of the respiratory tract caused by drastic temperature change. Humidification of air in the home can be accomplished by purchasing a humidifier or vaporizer. Children with chronic lung disease sometimes sleep in a tent with piped-in mist and/or humidified oxygen. Vaporizers, particularly older models, may result in burns and must be kept out of the reach of children and others who might be burned from accidental contact. Humidifiers, other than ultrasonic models, may be a source of infection. All humidifiers should be cleaned regularly according to the manufacturer's directions. No medications should be added to the water used in cool mist humidifiers.

Environmental irritants, such as smoke and pollution, which may initiate a coughing spasm, should be controlled or avoided as much as possible. A client with chronic lung disease is taught about the harmful effects of smoking and supported in efforts to stop smoking.

Suppression of coughing is not always indicated. A productive cough can help to clear the bronchial tree of dust and bacteria. Clients are instructed how to cough productively. This is particularly true in clients with COPD. These clients should sit with shoulders slightly forward and the head and spine slightly flexed when coughing. To be effective, cough must come from the diaphragm, not the throat.

Clients with frequent nonproductive coughs may be given narcotic cough suppressants, particularly at night. These clients should be observed carefully for slowing of respirations and/or difficulty in coughing up secretions. Of course, postoperative clients and other immobilized clients receiving narcotics for relief of pain are subject to suppression of their cough reflex and need to be closely observed and encouraged to cough.

Many persons with coughs, especially those with COPD or cystic fibrosis, have very thick sputum. Bronchial secretions are excreted most easily when they are of low viscosity. It is important, therefore, to assure a high fluid intake 3,000 u per day to keep secretions liquid. Clients are instructed to sip liquids slowly to prevent cough. Fluids should be given slowly to infants and children to prevent coughing spasms and aspiration of the liquid.

KEY NURSING IMPLICATIONS 24–1

Expectorants and Antitussives

1. Persons with a cough lasting more than 1 week and those with high fever, rash, or persistent headache should be referred to a physician.
2. Assess the nature, duration, frequency, and productivity of cough.
3. Cough syrups given for their local soothing effect should not be followed immediately by food or water.
4. Teach clients about environmental modifications that may decrease cough and/or aid in expectoration of respiratory secretions.
5. Productive coughs should not be suppressed. Clients should be instructed in how to cough productively.
6. Sufficient fluid intake is beneficial in aiding the expectoration of respiratory secretions.
7. Saturated solution of potassium iodide (SSKI) is measured in drops and can be mixed in fruit juices or beverages to disguise its taste. Do not administer this drug to clients allergic to iodine.
8. Teach the client about disposing of secretions properly and preventing respiratory infections.
9. As with all medications, these should be kept out of the reach of children. Syrup of ipecac and the number of the local poison control center should be available if a child accidently ingests an overdose.

The nurse observes a client on forced fluids for overhydration. Indications include moist respirations, edema, and a full bounding pulse. Overhydration occurs most commonly in young children, the elderly, and those with cardiac or renal disease.

Additional measures which can assist in expectoration of respiratory secretions include aerosols and pulmonary hygiene procedures, including postural drainage and cupping. Medicated aerosols are used to deliver medications including mucolytic agents, bronchodilators, and expectorants. Postural drainage and cupping

following aerosol treatment will facilitate the expectoration of bronchial secretions.

Some expectorants, such as **saturated solution of potassium iodide** (**SSKI**), are measured in drops and administered in fluids. Because they tend to have an unpleasant taste, mixing such drugs in fruit juices or other beverages helps to make them more palatable. Care must be taken to be sure that the selection of a particular fluid is not contraindicated by the client's health problem or medical regimen. Drinking the liquid through a straw helps decrease the burning sensation in the mouth and prevents staining of the teeth.

All clients receiving iodides should be questioned about allergy to iodine before administration of the first dose. The client is always asked about sensitivity to dyes used in X-ray procedures, as many of these dyes are iodine-based. Observation for allergic reactions, most frequently demonstrated by a skin rash, is continued throughout the course of therapy. Other indications of hypersensitivity include mucosal hemorrhage, lymph node enlargement, and edema.

EVALUATION

- Client demonstrates effective cough and clear breath sounds.
- Client verbalizes decrease in respiratory secretions and ability to remove them.
- Client does not experience injury due to use of expectorants.
- Client does not experience injury due to use of antitussives.
- Client verbalizes understanding of appropriate use of expectorants and antitussives and safely self-administers.

HOME CARE / CLIENT TEACHING

1. Nurses visiting client's homes should provide information about how acute respiratory infections are spread and how they can be minimized.
2. Persons at risk of adverse responses to acute respiratory infections, such as the elderly and those with chronic respiratory disease, should be advised to speak with their physician about the use of flu vaccines.
3. Persons uncertain about what over-the-counter cough preparations to purchase should be encouraged to consult with the pharmacist.
4. Refer to Key Nursing Implications 24–1.

CASE STUDY

Clifford Green is a 50-year-old former coal miner, now receiving disability payments for COPD. He has been hospitalized for 2 weeks because of pneumonia. His temperature has returned to normal, and his physician believes Mr. Green has recovered sufficiently to be discharged tomorrow. The following discharge orders are written:

- Postural drainage BID followed by coughing
- Cold mist humidifier while sleeping
- Potassium Iodide 300 mg TID, p.o.
- Guaifenesin (Robitussin) syrup 1 teaspoonful every 4 hours PRN

As Mr. Green's nurse you are responsible for providing the instruction about his care at home.

Questions for Discussion

1. What other measures besides the cold mist humidifier will you suggest to liquefy respiratory secretions?
2. What is the purpose of potassium iodide?
3. What signs and symptoms might indicate hypersensitivity to iodides?
4. What suggestions should you offer Mr. Green about the administration of the guaifenesin syrup?

CRITICAL THINKING ACTIVITIES

1. Give a class demonstration on one of the following pulmonary hygiene techniques: postural drainage, cupping, pursed lip breathing, or effective coughing.
2. Write a report on the treatment for cystic fibrosis.
3. Visit the respiratory therapy department of the hospital to learn about the various equipment and procedures used in administering aerosol medication.
4. Attend a smoking cessation program and report your observations to the class.
5. Design a program on keeping your lungs healthy for a group of children.
6. Design a public education program on preventing the common cold.

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Bronchodilators and Other Respiratory Agents

25

OBJECTIVES

After studying this chapter, the student will be able to:

- Explain the mechanism by which adrenergic stimulants and xanthine derivatives produce bronchodilation
- List four adverse effects commonly seen in the use of bronchodilator agents
- Identify factors to be assessed in persons with chronic obstructive pulmonary disease
- State nursing interventions appropriate in the administration of bronchodilator and mucolytic agents
- State the mechanism by which cromolyn sodium and beclomethasone dipropionate act in preventing asthmatic attacks
- State the appropriate method of administration, adverse effects and nursing actions used in the administration of cromolyn sodium and beclomethasone dipropionate
- State one advantage and one disadvantage in the use of analeptic agents for the treatment of respiratory depression
- List four nondrug methods by which ease of breathing can be promoted in a client with chronic obstructive pulmonary disease
- Describe the proper method of using an oral inhaler

There has been a virtual explosion in the number of new products intended for use in the treatment of chronic obstructive pulmonary disease (COPD). These agents, which include bronchodilators, mucolytics, and drugs intended for the *prophylaxis* of breathing difficulty are, to a great extent, the product of research on the physiology, immunology, and pharmacology of the respiratory tract.

BRONCHODILATORS

Bronchodilation can often make the difference between comfort and discomfort or even life and death of a client with an obstructive pulmonary disease. To understand how these drugs work, it is useful to review the processes involved in bronchoconstriction and bronchodilation.

When an antigen is introduced into the body of an *atopic* individual, the antigen combines with a mast cell to form a sensitized mast cell. When this cell is reexposed to the antigen, it responds with the formation and release of a number of chemical substances, including histamine and leukotrienes. Such chemical substances act either directly to cause bronchoconstriction or indirectly to stimulate the release of acetylcholine, which may cause smooth muscle contraction.

Sympathomimetic Agents

Within the mast cell are specialized adrenergic receptors—known as beta$_2$ receptors—which control bronchial smooth muscle tone. When these are stimulated by certain sympathomimetic agents, such as albuterol, **bitolterol**, epinephrine, **ethylnorepinephrine**, **ephedrine**, **isoetharine**, isoproterenol, metaproterenol, **pirbuterol**, **salmeterol** or terbutaline, there is an increase in the formation of cyclic adenosine monophosphate (AMP). This is associated with smooth muscle relaxation and bronchodilation. When these receptors are blocked by a drug such as propranolol (Inderal), bronchoconstriction takes place. This is why beta-adrenergic blocking agents such as propranolol are contraindicated in clients with COPD.

Because some of the drugs that stimulate beta$_2$ receptors also stimulate beta$_1$ receptors located in the heart, many of these drugs may be dangerous to use in a client with COPD who also suffers from heart disease. Some of the newer drugs that have been introduced (e.g., albuterol, bitolterol, isoetharine, metaproterenol, pirbuterol, salmeterol, and terbutaline) exert a more selective action on beta$_2$ receptors and do not pose as significant a threat to a client with heart disease.

Any client, particularly the elderly, using sympathomimetic drugs should be monitored for changes in cardiac function and blood pressure while on these agents. In addition, central nervous system (CNS) stimulation with resultant insomnia, nervousness, anxiety, tremor, and GI disturbances is a possible consequence of the use of these drugs.

Clients on sympathomimetics should not use MAO inhibitors, as these agents may potentiate sympathomimetic activity and cause hypertensive crisis. Likewise, clients using tricyclic antidepressants, antihistamines and **sodium levothyroxine** (a thyroid hormone) may experience greater sympathomimetic activity in their use of this class of bronchodilators. Table 25–1 lists sympathomimetic bronchodilators in current use. Note that some of these agents can be used orally, parenterally, or by direct inhalation as an aerosol or a *nebulized* form. The appropriate use of administration devices (e.g., inhalers) is essential for successful therapy (see Figures 25–2, page 496 and 25–3, page 497).

Xanthine Bronchodilators

Another class of bronchodilators commonly used in this country contains the xanthines. This is a chemical class of agents that includes caffeine, theophylline, **theobromine**, and their derivatives. There is evidence that such drugs have been used since ancient times for their therapeutic effects.

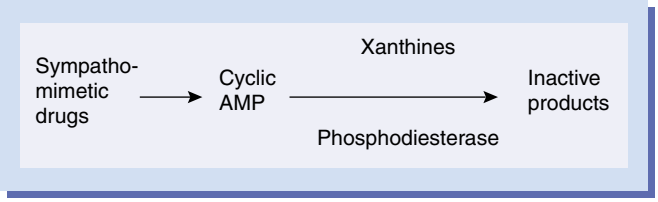

Figure 25–1 Sympathomimetic drugs promote cyclic AMP production whereas xanthines inhibit cyclic AMP destruction by phosphodiesterase.

The use of the xanthines, particularly theophylline and its derivatives, is based on the observation that these agents interfere with the action of phosphodiesterase, an enzyme that breaks down cyclic AMP to inactive products (Figure 25–1). By interfering with this enzyme, an increase in intracellular cyclic AMP (cAMP) and bronchodilation is promoted.

In addition, the increased levels of cAMP have the potential for life-threatening side effects of tachycardia and other dysrhythmias due to altered intracellular calcium ion movement causing both positive inotropic and chronotropic effects. (Refer to Chapter 28 for more in-depth explanation of these effects.) Because this action stimulates the beta-adrenergic cells of the bronchi, it also stimulates the beta cells located in the cardiac muscle. **Xanthines** have also been found to produce *diuresis*. The loss of potassium ions due to the diuresis further threatens the neurotransmission in cardiac muscle.

Because of the threat of tachycardia leading to more severe cardiac dysfunction, to ensure client safety many inpatient facilities have adopted a policy that any time aminophylline is administered by intravenous infusion, the medication is to be infused using a continuous intravenous infusion pump to ensure that the rate does not exceed 25mg/minute. The client should have his/her pulse monitored every 4 hours. This is of particular concern in the elderly and in children. Many facilities that treat children have protocols stating that during intravenous infusions of xanthines, the child must be placed on a cardiac monitor to ensure continuous monitoring for cardiac rate and rhythm.

Xanthines have also been found to stimulate the CNS. Clients on these drugs must, therefore,

TABLE 25–1

Sympathomimetic Bronchodilators

Note: Client education is very important and must include instruction in ways to decrease environmental irritants, improve humidification of air, and use medication properly, including inhalers. Multiple inhalation medications should not be used, unless ordered by the physician.

To use an inhaler properly, the client is instructed to follow the directions in Figure 25–2.

The client is advised to use the inhaler at the first sign of distress or tightness of the chest and to routinely wash, dry, and replace the mouthpiece.

Monitor changes in cardiac function and blood pressure, especially in the elderly.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
albuterol *(al-**BYOU**-ter-ohl)* (Proventil, Ventolin)	oral, inhalation	Oral: *Adults and children over 4:* 2–4 mg 3–4 times daily. Total daily dose should not exceed 32 mg Inhalation: *Adults and Children 12 and over:* 2 inhalations every 4–6 hours	Safety and efficacy for use in children under 12 years has not been established. Some inhalation products may be used in children 4 and over.
bitolterol mesylate *(by-**TOL**-ter-ohl **MES**-ih-layt)* (Tornalate)	inhalation	*Adults and children over 12:* 2 inhalations every 8 hours for prevention of bronchospasm. In treatment of bronchospasm, the 2 inhalations are administered at least 1–3 minutes apart, with a third inhalation if needed	See albuterol. Use of bitolterol may cause allergic reaction in some clients. Epinephrine 1:1000 injection should be available.
ephedrine sulfate *(eh-**FED**-rin **SUL**-fayt)*	oral, SC, IV	*Adults:* 25–50 mg 2–3 times daily not to exceed 24 mg *Children:* 3 mg/kg/day divided into 4–6 doses	May be used in combination with barbiturates to relieve CNS stimulation. Must be used carefully by clients with cardiac disease. IV injections must be administered slowly while monitoring the pulse rate and rhythm.
epinephrine HCl *(ep-ih-**NEF**-rin **hy**-droh-**KLOR**-eyed)* (Adrenalin, Primatene, Vaponefrin, etc.)	SC, IM, IV inhalation	Parenteral: *Adults:* IV: *Adults:* 0.1-0.25 mg of 1:10,000 solution injected slowly *Infants:* 0.05 mg; may be repeated at 20-30 min intervals to manage asthma attacks *Neonates:* 0.01 mg/kg Nebulizer: *Adults and Children over 12:* 0.5 ml (8-10 drops) of racemic epinephrine 0.3–0.5 mg SC or IM (0.3–0.5 mL of 1:1000 solution) as needed *Children:* 0.01 mg/kg or 0.3 mg/m^2 as a single dose every 20 minutes to 4 hours; do not exceed 0.5 mg in a single pediatric dose	IV route preferred for acute care use. Especially in children, IM route should be used only if IV access not available. If client intubated, IV dose can be given via the endotracheal tube directly into the bronchial tree. Repeated local injections can result in vascular necrosis at injection site. Massage after injection. Protect solutions of drug from light. Solution should not be used if it is brown or contains a precipitate. Client should wait 1–2 minutes between inhalations. Client and family may be instructed in giving subcutaneous injection. Monitor blood pressure, as it may rise.

continues

TABLE 25–1 *continued*

See **Note** at beginning of Table 25–1, page 489.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
isoetharine HCl *(**eye**-soh-**ETH**-ah-reen **hy**-droh-**KLOR**-eyed)* (Bronkosol, Bronkometer, Arm-a-Med, etc.)	inhalation	1% hand nebulizer 1–7 inhalations depending on inhalation device used; usually not repeated more often than every 4 hours	Client should wait 1 full minute after each inhalation to be certain another dose is necessary.
isoproterenol HCl, isoproterenol sulfate *(**eye**-soh-proh-**TER**-eh-nohl **hy**-droh-**KLOR**-eyed, **eye**-soh-proh-**TER**-eh-nohl **SUL**-fayt)* (Isuprel, Medihaler-Iso, etc.)	IV, inhalation	Parenteral: 0.01–0.02 mg IV as needed Inhalation: 1–2 inhalations 4–6 times daily, not to exceed 2 inhalations at one time or more than 6/hour	Do not use solutions, if drug is discolored or contains a precipitate. Drug may turn sputum and saliva pink when used by inhalation. Use of drug at bedtime may produce difficulty in sleeping. Contraindicated for clients with arrhythmias.
metaproterenol sulfate *(**met**-ah-proh-**TER**-eh-nohl **SUL**-fayt)* (Alupent, Metaprel)	oral, inhalation	Oral: *Adults:* 20 mg 3–4 times daily *Children over 9 or over 27 kg:* 20 mg as above *Children 6–9 or less than 27 kg:* 10 mg as above *Children under 6:* 1.3–2.6 mg/kg/day in divided doses Inhalation: 2–3 inhalations every 3–4 hours, not to exceed 12 inhalations/day	Inhalation form not recommended in children under 12. Inhaler product contains about 300 doses in each container. Use carefully in clients with cardiac disease or diabetes (may increase blood glucose level).
pirbuterol acetate *(peer-**BYOU**-ter-ohl **AH**-sih-tayt)* (Maxair)	inhalation	*Adults and children 12 and over:* 1–2 inhalations every 4–6 hours	Do not administer more than 12 inhalations/day.
salmeterol *(sahl-**MEH**-ter-ohl)* (Serevent)	inhalation	*Adults and children 12 and over:* 2 inhalations twice daily approximately 12 hours apart	Shake canister well before using. Administer at room temperature.
terbutaline sulfate *(ter-**BYOU**-tah-leen **SUL**-fayt)* (Brethaire, Brethene, Bricanyl)	oral, SC, inhalation	Oral: *Adults and children over 15:* 2.5–5 mg 3 times daily during waking hours, not to exceed 15 mg/day *Children 12–15:* 2.5 mg 3 times daily not to exceed 7.5 mg/day Parenteral: 0.25 mg SC into lateral deltoid area. If improvement does not occur within 15–30 minutes, a second dose of 0.25 mg may be given. A total dose of 0.5 mg should not be exceeded within a 4-hour period Inhalation: *Adults and Children 12 and over:* 2 inhalations separated by a 60-second interval, every 4–6 hours	Not intended for children under 12 years of age. Do not use solutions, if discolored. Use carefully in clients with cardiac disease or diabetes.

be monitored carefully for insomnia, hyperexcitability, and the potential for seizure activity.

Clients receiving xanthine drugs (particularly theophylline) for prolonged periods must have their dosage individualized for maximal relief with minimal adverse effects. Such individualization requires the regular determination of theophylline serum levels in order to maintain drug levels in the therapeutic range of 10–20 mcg/mL. Levels above 20 mcg/mL and perhaps even as low as 15 mcg/mL in some clients, are associated with the development of toxicity.

Serum samples to be used for theophylline determinations should generally be drawn at the time of peak drug absorption. This occurs about 1–2 hours after administering an immediate-acting theophylline product and about 4 hours after administering a sustained-release product. For the measured serum concentration to be meaningful, the client should not have missed any doses during the 48 hours preceding the sampling. In addition, dosing intervals during the 48-hour period should correspond to those normally employed by the client. Once the client has been stabilized on a specific theophylline dosage, serum levels tend to remain fairly constant. They should, however, be rechecked at 6–12-month intervals.

The administration of xanthine drugs is facilitated by their availability in oral, rectal and parenteral dosage forms. Table 25–2 lists the xanthine bronchodilators in current use.

Leukotriene Receptor Antagonists

Approved by the Food and Drug Administration (FDA) in 1997, **zafirlukast** (**Acculate**) was the first of the leukotriene receptor antagonists developed to treat asthma. In 1999, **montelukast** (**Singulir**) was developed as the newest of the agents in the arsenal to treat asthma. These agents act by blocking leukotriene-mediated bronchoconstriction. Leukotrienes contribute to airway edema, smooth muscle constriction, and altered cellular activity. As a result of montelukast's antagonistic effect, the client has decreased bronchial edema and inflammation, which are characteristic of the asthmatic process. It has been shown to decrease the frequency and severity of acute asthma attacks. The dosage for zafirlukast is 20 mg twice a day for adults. Montelukast is prescribed 10 mg (tablet) once daily for chronic stable asthma and to prevent exercise-induced asthma attacks in adults. Children ages 6–14 years old should take a 5 mg chewable tablet once daily in the evening. The side effects of this agent include occasional headaches, drowsiness, fatigue, and GI disturbances. The popularity of this agent is that the side effects are infrequent. Clients taking zafirlukast who are also taking warfarin should be monitored to adjust the anticoagulant as needed.

Anticholinergics

Upon inhalation, anticholinergic drugs such as atropine and **ipratropium bromide** (**Atrovent**), antagonize the action of acetylcholine, thereby resulting in bronchodilation. As relatively little systemic absorption of these drugs takes place after inhalation, it is unlikely that systemic anticholinergic symptoms, such as dry mouth or constipation, will occur with these products. They should, however, not be used in clients with glaucoma.

MUCOLYTICS

Mucolytics reduce the thickness and the stickiness of pulmonary secretions, so that removal by ciliary action and cough is facilitated and pulmonary ventilation can be improved. They are used in the treatment of obstructive pulmonary diseases, such as chronic bronchitis and emphysema, as well as in other diseases, such as cystic fibrosis and pneumonia, in which purulent or nonpurulent respiratory blockage may be present.

The most commonly used mucolytic agent is **acetylcysteine** (Mucomyst). The action of this drug is attributed to its ability to break chemical bonds responsible for the high viscosity of mucus.

Acetylcysteine may be administered by nebulization using a tent, croupette, face mask, or mouthpiece. It may also be administered by direct instillation of the solution into an *intratracheal* catheter. Although acetylcysteine solutions may be mixed with certain antibiotics, bronchodilators, or other agents, it should not be mixed with many other drugs. These include **tetracycline HCl**, **oxytetracycline HCl**, **erythromycin lactobionate**, sodium ampicillin, **chymotrypsin**, **trypsin**, and hydrogen peroxide. Acetylcysteine is also capable of reacting with certain materials used in the construction of nebulization equipment. The most reactive of these are iron, copper, and rubber. Every attempt should be made to use only glass, plastic, aluminum, or stainless steel parts in equipment that will come into contact with this drug.

TABLE 25–2

Xanthine Bronchodilators

Note: With orally administered dosage forms, product should be taken with food, if GI upset occurs.

Enteric-coated or sustained-release products should not be crushed or chewed.

Monitor clients for tachycardia.

Monitor client for development of toxicity, i.e., nausea, vomiting, GI pain, convulsions, restlessness, or irregular heartbeat.

Client should not consume large amounts of xanthine-containing beverages or foods, e.g., cola drinks, coffee, tea, cocoa, or chocolate.

Observe clients for central nervous stimulation, diuresis, changes in cardiac functioning, or convulsive activity.

Smokers may require more frequent dosing.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
aminophylline *(am-in-**OFF**-ih-lin)*	oral, rectal, IV	Oral: 200 mg 3–4 times daily Rectal: 250–500 mg 3–4 times daily IV: Loading dose of 6 mg/kg followed by a continuous infusion of 0.5–0.7 mg/kg/hr	IV dilution is necessary (25 mg/mL). Infusion rate should not exceed 25 mg/min. Monitor pulse rate and rhythm. Warm solution to room temperature prior to IV administration. With oral use, observe client for GI distress. Give with milk or at mealtimes. If rectal irritation occurs after prolonged use of suppositories, Desitin Ointment or a similar product may give relief. Use caution in elderly clients.
dyphylline *(**DYE**-fih-lin)* (Lufyllin, Protophylline ✱, etc.)	oral, IM	Oral: *Adults:* Up to 15 mg/kg 4 times daily IM: *Adults:* 250–500 mg injected slowly every 6 hours	Drug should not be administered by IV route.
oxtriphylline *(ox-**TRY**-fih-lin)* (Choledyl, Norotriphyl ✱)	oral	*Adults:* 4.7 mg/kg every 8 hours *Children 9–16:* 4.7 mg/kg every 6 hours *Children 1–9:* 6.2 mg/kg every 6 hours	Claimed to cause less gastric distress than aminophylline.
theophylline *(thee-**OFF**-ih-lin)* (Elixophyllin, Theolair, Slo-Phyllin, etc.)	oral	*Adults and children:* Loading dose of 5 mg/kg followed by 2–4 mg/kg every 6–8 hours; lower doses may be required in debilitated clients	With oral use, observe client for GI distress. Give with meals or milk to reduce distress. Controlled-release products may be administered only 1–3 times daily.

Acetylcysteine is well tolerated by most clients. Some clients may, however, develop bronchospasm as a result of the aerosol administration technique. This can be reversed by discontinuing use of the drug. The administration of mucolytic agents may result in the formation of large volumes of liquified bronchial secretions. Adequate means of removal (suction, open airway, etc.) must be provided for clients unable to remove these secretions by coughing.

Acetylcysteine is available as a 10% and a 20% solution. When administered by nebulization into a face mask, mouthpiece, or tracheostomy, 1–10 mL of the 20% solution or 2–20 mL of the 10% solution may be given every 2–6 hours. When nebulized into a tent or croupette, up to 300 mL of a 10% or 20% solution may be required for each treatment. When administered by direct instillation, 1–2 mL of a 10% or 20% solution may be given as frequently as every hour.

MISCELLANEOUS RESPIRATORY DRUGS

Several respiratory drugs are used in specialized circumstances where prophylaxis is called for rather than treatment of respiratory disease.

Cromolyn Sodium (Intal, Fivent, Gastrocrom, Nasalcrom) and Nedocromil Sodium (Tilade)

Cromolyn sodium and **nedocromil sodium** are most commonly used for the prophylactic treatment of bronchial asthma in clients who require long-term therapy to control their disease and whose attacks follow a predictable pattern. These drugs have no bronchodilator activity, but are believed to inhibit the release of histamine and other substances from sensitized mast cells. These agents are poorly absorbed from the gastrointestinal tract, so they are generally administered only by inhalation as a solution prepared for administration with a nebulizer or as a metered aerosol spray.

Cromolyn or nedocromil sodium should not be used in the treatment of acute asthmatic attacks, especially *status asthmaticus*, because of their inability to work quickly to reverse breathing difficulty. Some clients on these drugs may experience cough and/or bronchospasm following inhalation of the drug. This reaction may subside, or make the regular use of this agent impossible.

The usual starting dose for adults and children using the metered aerosol cromolyn or nedocromil sodium products will generally receive two sprays 4 times a day. Failure to follow a regular regimen or proper administration technique may yield unsuccessful results. Clients about to begin therapy with cromolyn or nedocromil sodium should, therefore, be properly instructed in the method of administration and impressed with the need for adhering to the prescribed regimen.

Cromolyn sodium may also be administered orally in the treatment of *mastocytosis*. Although it is not absorbed well from the GI tract, cromolyn does exert a local action on the mast cells within the GI tract.

Corticosteroids

Corticosteroids are also used in the prophylactic treatment of bronchial asthma. These agents may be administered systemically or in an aerosol form inhaled directly into the respiratory tract. In either form, the corticosteroids appear to decrease the number and activity of inflammatory cells in the respiratory tract while inhibiting bronchoconstriction. They also enhance the activity of bronchodilator sympathomimetic drugs described previously, but are rarely used long-term.

When administered systemically, e.g., as prednisone tablets, the corticosteroids may produce a broad spectrum of adverse effects, including increased susceptibility to infection, as well as fluid and electrolyte disturbances. The student is referred to Chapter 12 for a detailed discussion of the systemic corticosteroids. **Solumedrol** is frequently used intravenously to establish a dose for the exacerbation of COPD.

Administration of corticosteroids by inhalation appears to be useful in controlling bronchial asthma, particularly in clients who cannot be adequately controlled by bronchodilators and other, safer forms of therapy. Inhaled corticosteroids tend to provide useful local effects within the respiratory tract without producing serious systemic effects. Even though their use is safer than the use of systemic corticosteroids, an inhaled corticosteroid may still produce many of the adverse effects associated with systemic corticosteroid use.

Corticosteroids administered by inhalation are frequently used to wean clients from systemic corticosteroids. When used in this way, there is a possibility of adrenal insufficiency during and after transfer of clients from the systemic corticosteroid to the inhalational corticosteroid. Clients undergoing such treatment must be observed carefully, particularly during times of stress or severe asthmatic attack. Routine tests of adrenal function must be performed periodically on such clients.

Table 25–3 lists the inhalational corticosteroid products that are currently employed in the treatment of bronchial asthma.

Analeptic Agents

Several drugs (e.g., caffeine, **doxapram**) have been used for many years under the broad category of analeptic agents. These are agents that stimulate the CNS by direct action on the medullary center, which stimulates respiration. Although they have been traditionally used in the treatment of drug-induced respiratory depression, analeptics are now rarely used, because airway management and ventilation support is a safer and more effective treatment. The development of specific narcotic antagonists (discussed in Chapter 10) has also contributed to the diminished use of analeptics in the treatment of narcotic-induced respiratory depression.

TABLE 25–3

Corticosteroids Used by Inhalation in the Treatment of Bronchial Asthma

Note: Products are to be used only to prevent attacks, not to abort an acute asthmatic attack.
At least 1 minute must be allowed to elapse between inhalations.
If client is to use inhalational bronchodilator as well as inhalational corticosteroid, bronchodilator should be used several minutes before the corticosteroid to enhance distribution of the corticosteroid in the respiratory tract.
Mouth should be rinsed with water or mouthwash after each use to reduce dry mouth and hoarseness.
Observe oral cavity for development of fungal infections.
Monitor client for signs of systemic adverse effects related to corticosteroid use, for example, adrenal insufficiency, masking of infection, hypertension, and developmental delays.

DRUG	USUAL DOSE	NURSING IMPLICATIONS
beclomethasone dipropionate *(**beck**-loh-**METH**-ah-sohn dye-**PROH**-pee-on-ayt)* (Beclovent, Vanceril)	*Adults:* 2 inhalations 3–4 times daily, not to exceed 20 inhalations daily *Children 6–12:* 1–2 inhalations 3–4 times daily, not to exceed 10 inhalations daily	Products contain about 200 metered doses per inhaler.
dexamethasone sodium phosphate *(**deck**-sah-**METH**-ah-sohn **SOH**-dee-um **FOS**-fayt)* (Decadron Phosphate Respihaler)	*Adults:* 3 inhalations 3–4 times daily, not to exceed 12 inhalations/day *Children:* 2 inhalations 3–4 times daily, not to exceed 8 inhalations/day	See note above.
flunisolide *(floo-**NIS**-oh-lyd)* (AeroBid, Bronalide ✱)	*Adults and children over 6:* 2 inhalations twice daily, in the morning and evening	See note above.
triamcinolone acetonide *(**try**-am-**SIN**-oh-lohn ah-**SEE**-toh-nyd)* (Azmacort)	*Adults:* 2 inhalations 3–4 times daily, not to exceed 16 inhalations daily *Children 6–12:* 1–2 inhalations 3–4 times daily, not to exceed 12 inhalations daily	See note above.

Beractant (Survanta) and Colfosceril Palmitate (Exosurf Neonatal)

Development of neonatal respiratory distress syndrome (RDS) is connected to a deficiency of *surfactant* in newborn infants. The direct administration of lung surfactants relieves the disease, improving oxygenation and restoring surface activity to the lungs.

Beractant is a natural lung surfactant derived from the lungs of cows. It is administered into the trachea via a catheter inserted into the infant's endotracheal tube. Uniform distribution of the surfactant is assured by dividing the dose into four parts and administering each quarter-dose while the infant is in a different position.

Beractant contains phospholipids, fatty acids, neutral lipids, and surfactant proteins. It replenishes the surfactant and restores surface activity. The dosage is 4ml/kg (100 mg phospholipids/kg birth weight).

Colfosceril palmitate is a synthetic lung surfactant also administered directly into the trachea. The drug is first reconstituted with preservative-free sterile water for injection to form a milky-white suspension. This suspension is then administered via the infant's endotracheal tube as was described for beractant.

Colfosceril palmitate contains dipalmitoylphosphatidylcholine (DPPC), which reduces the surface tension in the lungs, as well as cetyl alcohol, which acts to spread the DPPC on the air-fluid surface. The dosage of colfosceril palmitate is 5ml/kg with two 2.5 ml doses administered as soon as possible after the diagnosis of RDS. For newborns on mechanical ventilation, this dose is then followed by a second 5 ml dose after 12 hours.

APPLYING THE NURSING PROCESS

ASSESSMENT

Assessment of the person with chronic obstructive pulmonary disease focuses on the signs and symptoms of respiratory distress such as dyspnea, on signs of the adequacy of gas exchange such as cyanosis, and on activity tolerance. The developmental stage of the individual is important in guiding assessment. For example, sternal retraction indicates respiratory difficulty in newborns, but is not present in older children. Laboratory tests, including pulmonary function studies and blood gas determinations, provide useful information about a client's condition and response to therapy.

Monitoring the effectiveness of therapy is an important nursing function. The nurse assesses changes in cough, ease of respiration, skin and mucous membrane color, nature and quantity of respiratory secretions, activity tolerance, breath sounds, and oxygen saturation. Side effects associated with various classes of drugs are observed, recorded, and reported. As noted earlier, for example, sympathomimetic drugs may cause insomnia, nervousness, tremor, and gastrointestinal disturbances. Side effects associated with each class of drug discussed in this chapter are detailed in the drug tables.

NURSING DIAGNOSES

Including but not limited to:

- Ineffective airway clearance related to bronchoconstriction
- Impaired gas exchange related to disease process (obstructive airway disease, RDS)
- Risk for injury related to adverse effects of respiratory drugs
- Deficient knowledge related to disease process and medication regimen

PLANNING/GOALS

- Client will experience effective cough reflex and clear breath sounds.
- Client's oxygen saturation readings from pulse oximetry will be greater than 90%.
- Client will verbalize improvement in respiratory secretions and ability to remove them.
- Client will not experience injury due to adverse effects of respiratory drugs.
- Client will verbalize understanding of disease process, medication regimen, and need for compliance with therapy and avoidance of risk factors.

IMPLEMENTATION

Supportive nursing care for persons with COPD can make a significant difference in their comfort, independence and longevity. One of the primary efforts of the nurse should be client and family education with the goal of preventing unnecessary hospitalization and improving the quality of life. The nurse should not assume that clients who have had COPD for years understand their illness and its treatment. Assessment of knowledge precedes development of the teaching plan. The educational program should include:

- knowledge of the nature of the disease and the relationship between the disease and specific treatment measures
- knowledge of ways to facilitate therapy (for example, general health measures, breathing exercises, and drug therapy)
- skill in carrying out special treatments, such as the use of *inhalers* and *postural drainage*
- recognition of and appropriate intervention for early signs and symptoms that indicate a worsening of the respiratory state

Client compliance with drug therapy and other treatment measures is important because of the chronic nature of COPD. Compliance can be improved by explanation of the reasons for using different drugs. The client and family members should be provided with simple explanations of what bronchodilators and expectorants do and why antibiotics might be given prophylactically. In addition, the effectiveness of treatment can be improved through instruction in the proper techniques of drug administration. Ways to use a nebulizer or other type of inhaler should be included (Figure 25–2). Various types of nebulizers are available for hospital or home use to deliver moist air containing medication via a face mask. Nebulizers must be cleaned after use and may be stored in the refrigerator between uses to decrease the risk of bacterial infection. Some

1. Review with the client the purpose of each prescribed medication. Some clients are ordered several inhalant medications and need to be taught the correct sequencing. For example, fast-acting bronchodilators (albuterol sulfate) are taken before slower-acting bronchodilators (iprotropium bromide).
2. Explain that the inhaler must be shaken before each use to mix the medication and the aerosol propellant.
3. Remove the mouthpiece and cap from the bottle and insert the metal stem of the bottle into the small hole on the flattened portion of the mouthpiece.
4. Instruct the client to exhale, place the mouthpiece into the mouth, and ensure that the lips form a tight seal around the mouthpiece.
5. Instruct the client to firmly push the cylinder down against the mouthpiece only once and to inhale slowly until the lungs feel full.
6. Ask the client to remove the mouthpiece while holding the breath for several seconds to allow the medication to reach the alveoli, and then to exhale slowly through pursed lips.
7. Inform the client that a mouthwash can be used to remove the taste of medication.
8. Show the client how to wash the mouthpiece under tepid running water to remove sections.

Figure 25–2 Instructions for use of an oral inhaler.

clients, particularly those lacking coordination between hand and inhalation, may use an extender or spacer device. These devices are attached to the medication canister and separate the administration of the medication into two steps: activation of the aerosol and inhalation of medication. These steps may be separated by 3 to 5 seconds. Use of extender or spacer devices also has the advantage of causing less deposition of medication at the back of the throat. This may decrease the likelihood of candidiasis infections of this area. There are a number of extender devices available. Figure 25–3 illustrates a metered-dose inhaler and spacer. Clients are always instructed to follow the physician's instructions about the number of doses to take daily. Overuse of some products may produce tachycardia, palpitations, headache, restlessness, and insomnia.

Some clients, particularly asthmatics, will need to be instructed in the subcutaneous administration of epinephrine. Clients should thoroughly practice such techniques beforehand, so they may perform them easily and quickly under stress.

Some clients will be using a mucolytic agent at home. It may be administered by a device such as the Medi-Mist delivery system. The mucolytic agents generally have an unpleasant smell and have a corrosive effect on rubber and metal. Because of the expectoration of mucus produced by these treatments, tissues need to be provided. Mouth care should be offered frequently. It is desirable to offer mouth care before meals to prevent loss of appetite.

The preferred time for administration of bronchodilators is on first rising in the morning, because of the tendency for secretions to collect during the night. Therapy should also be provided at bedtime to prevent or reduce wheezing and respiratory obstruction during sleep. Many bronchodilators are also cardiac and CNS stimulants. These agents may cause tachycardia and arrhythmias, particularly if multiple-drug therapy is being used with such agents. As bronchodilators with CNS stimulating properties may produce insomnia, it is important to provide comfort measures at bedtime to encourage sleep. Backrubs, warm baths, music and warm noncaffeine beverages can promote relaxation. Avoid warm milk, however, because it contributes to thickening of the respiratory secretions. Reading to children and helping to relieve their night fears may be effective in promoting sleep. If inability to sleep is not alleviated by comfort measures, the nurse may want to discuss the problem with the physician. At bedtime, a product containing a sedative may be ordered to help counteract the stimulation produced by ephedrine.

Many bronchodilators are irritating to the gastrointestinal tract. Drugs known to cause gastric distress, such as ephedrine and theophylline, should be given with food or milk. The regular use of aminophylline suppositories can cause irritation in the anal area. The use of a bland ointment, such as Desitin, can help to promote comfort.

Figure 25–3 A metered-dose inhaler and spacer reduces side effects from inhaled medication.

A very important nursing measure in caring for clients with COPD is helping the client control breathing. Learning to breathe through pursed lips may help maintain airway patency during expiration. To teach clients, suggest they relax and inhale through the nose. They should then pause and exhale slowly through pursed lips. The onset of bronchospasms is often accompanied by a feeling of suffocation. The client is afraid of becoming unable to breathe. This anxiety results in shallow, rapid, and inefficient breathing causing deficient oxygen, which creates further anxiety. It is important to get the client to relax and breathe slowly and rhythmically. It may help if the nurse places one hand lightly behind the client's shoulder and one hand on the abdomen. When the client exhales, the nurse pushes the hand on the abdomen upward toward the diaphragm. The pressure exerted is relaxed when the client inspires. The client can be taught to exert this pressure on the diaphragm. Clients should always be instructed to breathe in through the nose and out through the mouth. In addition, clients should learn to use their PRN bronchodilators at the first sign of an attack of shortness of breath. Use of drugs at this time, in conjunction with control of breathing, helps to decrease anxiety-induced inefficient breathing.

Some clients will be receiving low levels of oxygen in the hospital or at home. It is important for the nurse to teach the client and family about safety factors when oxygen is used. Clients with COPD are instructed not to increase the flow rate without discussing it with the physician. Increasing the flow rate may decrease the body's natural mechanism (hypoxia) to stimulate breathing. Clients with COPD have air trapping and high CO_2 levels, thus, if too much oxygen is given (usually considered greater than 2 liters), their drive to breathe is reduced. This is not the same as people without COPD who breathe in response to high CO_2 levels. Clients also must avoid open flames and be advised to avoid the use of hair dryers, electric shavers, and electric toothbrushes while connected to oxygen.

Acquiring a respiratory infection can produce a serious worsening of a client's respiratory state. Many clients with COPD routinely take antibiotics, especially during the cold and flu season, to try to prevent respiratory infections.

These clients are instructed to watch for overgrowth by nonsusceptible organisms and for allergic reactions to these drugs (see Chapter 7). The nurse instructs the client in ways to prevent infections, such as handwashing and avoiding crowds and persons known to be infected. Staff members with upper respiratory infections should never be assigned to care for clients with COPD. The nurse also encourages the client to continue performing the bronchial hygiene measures at home; for example, coughing and postural drainage learned in the hospital. Clients should know that these measures are important in ridding the body of respiratory secretions, which, if retained, provide a medium for infection. Early treatment of all infections is encouraged.

Preventing overuse of bronchodilators is important. One of the ways the PRN use of these drugs can be decreased is through elimination of bronchial irritants in the environment. Common irritants include smoke, home-cleaning agents, insecticides, dust, and all aerosols. When possible, the installation of dust filters or electrostatic precipitators on home heating systems will reduce the concentration of airborne irritants. Known allergens should be avoided whenever possible, as should environments where air pollution is a serious problem—for example, tunnels and heavily industrialized areas. During cold weather, a mask or scarf should be worn over the mouth and nose when going outside. This helps to warm and filter the air and decreases the likelihood of coughing spasms.

An additional nursing measure is to encourage a high fluid intake (3,000–4,000 mL daily for adults), unless the client has cardiac or renal health problems, when fluids should be offered in more moderate amounts. High fluid intake helps to liquefy respiratory secretions and facilitate their expectoration. Room humidification, particularly at night, can also help to keep secretions liquid. However, excessive humidification is to be avoided in asthmatic clients who may develop bronchospasms in such an environment. Also, clients should be encouraged to maintain home humidification devices properly. Failure to do so may result in the accumulation of mold and/or bacteria, which could be dispersed into the environment. This is of less concern with newer ultrasonic devices.

Finally, conservation of energy is an important principle of care. The environment and the daily schedule of the client should be adapted to conserve energy. Rest periods are important. Heavy meals should be avoided. Use of supportive measures, in conjunction with drug therapy, can significantly improve the client's longevity and tolerance for activities.

KEY NURSING IMPLICATIONS 25–1

Bronchodilators and Other Respiratory Drugs

1. Assessment focuses on signs and symptoms of respiratory distress, adequacy of gas exchange, and activity tolerance.
2. Clients should be instructed in medication administration procedures (use of an oral inhaler, extender device, and Medi-Mist device) and care of equipment.
3. Mucolytic agents usually have an unpleasant taste, and mouth care should be provided frequently.
4. Bronchodilators may cause tachycardia, cardiac arrhythmias, and gastrointestinal symptoms. Monitor the client carefully.
5. Bronchodilators with central nervous system stimulating effects may cause insomnia. Provide appropriate comfort measures.
6. Bronchodilators such as theophylline, which are irritating to the gastrointestinal tract, should be given with food or milk.
7. Teach clients with COPD to control breathing, to avoid respiratory infections, and to modify their environment to decrease bronchial irritants.
8. Do not wear perfume or colognes when working with clients, especially those with respiratory conditions.
9. Do not use talc or bath powder around these clients.

EVALUATION

- Client experiences effective cough reflex and diminished adventitious breath sounds.
- Client's oxygen saturation readings from pulse oximetry range from 90%–95%.
- Client verbalizes improvement in respiratory secretions and ability to remove them.
- Client does not experience injury due to adverse effects of respiratory drugs.
- Client verbalize understanding of disease process, medication regimen, need for compliance with therapy, and risk factors and how to avoid them.

NURSING CARE PLAN

A Client with Asthma Using Cromolyn Sodium (Intal) and Terbutaline Sulfate (Brethine)

Michael Shanker, a 16-year-old high school student, is admitted to the emergency room at 1 PM with shortness of breath and tachycardia. He appears wide-eyed and anxious, with audible expiratory wheezes. Inspiratory wheezes can be heard on auscultation. Mike says shortness of breath and cough began after his routine aerosol inhalation dose of cromolyn sodium. When he became short of breath, he used the terbutaline inhaler to relieve spasms and cough unsuccessfully. In the emergency room, his physical exam reveals a client 5'5"-140 lb with a harsh nonproductive cough. Routine medications at home include theophylline (Theodur) 200 mg BID, cromolyn sodium (Intal) aerosol spray QID, and terbutaline (Brethine) inhaler 2 puffs following cromolyn and prn. He has been asthmatic since age 2. Emergency room treatment includes administration of epinephrine 1:1000 0.6 mL SC, laboratory determination of theophylline level which was 7 mcg/ mL (normal is 10–20 mcg/mL). He has an intravenous infusion started. Aminophylline is given in a bolus dose followed by a drip at 30 mg/hr. Solu-Medrol 100 mg IV q4h is ordered.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Breathing patterns, breath sounds.	Ineffective breathing pattern related to bronchospasm, secondary to too rapid administration of cromolyn.	Client will have respiratory rate, rhythm, and depth within normal limits.	Position client in sitting position. Teach client to rest between activities. Assess ventilation for chest expansion and pursed-lip breathing. Assess breath sounds q1h.	Client returns to normal breathing pattern. Breath sounds present and clear.
Oxygenation, skin color, wheezing.	Impaired gas exchange related to narrowing of bronchial tree.	Client will maintain adequate oxygenation as evidenced by blood gases within normal limits.	Assess skin color, temperature, cyanosis. Watch for restlessness, and confusion, which may indicate an oxygen lack. Arterial blood gases as ordered.	Client has normal color with skin that is warm and dry. Respirations and blood gases within normal limits. Breath sounds present and clear.
Secretions, coughing.	Ineffective airway clearance related to increased secretions.	Client will have respiratory rate rhythm and depth within normal limits. Breath sounds present and clear.	Give fluids to help liquefy secretions. Encourage coughing and expectoration of retained secretions. Assess respirations and breath sounds.	Client is taking at least 2000 mL of fluid daily. Secretions are easily expectorated. Breath sounds are improving. Respirations are within normal limits.
Appetite, body weight.	Imbalanced nutrition: less than body requirements related to fatigue, hypoxia, and developmental stage.	Client will maintain body weight.	Provide well-balanced diet in high-protein liquid form during acute attack. Space feedings throughout day. Between attacks, ensure nutritious diet designed to facilitate growth during this stage of rapid growth.	Client is continuing normal growth pattern for this age level.
Speech patterns.	Impaired verbal communication related to inability to breathe.	Client will demonstrate ability to communicate needs.	Encourage client to use one-word comments when short of breath. Ask yes or no questions.	Client is communicating effectively.

continues

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Knowledge of factors that cause attacks.	Deficient knowledge related to disease process.	Client will verbalize understanding of disease and precipitating factors of attacks.	Assess client's understanding that asthma is precipitated by stress, fatigue, and specific allergens, such as dust, pollen, etc. Teach ways to conserve oxygen. Inform client that evening exercise may be better than morning, as pollens and molds are at lower level then.	Client is able to list causes of attacks.
Client's response to attack.	Ineffective individual coping related to acute process.	Client will be able to identify methods of disease management and prevention of future attacks prior to discharge.	Ensure that client and family understand disease. Remind them that his teen growth has probably changed his medication dosage needs.	Client can describe changes that will be made in his usual routine.
Knowledge of drug therapy.	Deficient knowledge related to drug therapy and Cromolyn inhaler.	Client will verbalize understanding of drug therapy routines and signs or symptoms of side effects to report.	Client understands that cromolyn may irritate throat and should be followed with water. Report promptly rapid heart rate, headache, dizziness, increased blood pressure. Ensure that he knows proper use of inhaler.	Client adheres to medication routine and has demonstrated proper inhaler use. Reports adverse reactions promptly.
Knowledge of special health and hygiene measures.	Ineffective health maintenance related to chronic illness and risk-taking lifestyle.	Client will verbalize understanding of lifestyle changes.	Client teaching includes avoiding stress, heavy exercise, colds, smoking, infections. Stay indoors on high humidity or high pollution days. Eliminate dust, house plants, pets.	Client understands and can describe lifestyle changes he is making.

HOME CARE / CLIENT TEACHING

1. The nurse should reinforce the proper techniques of administering medication by inhalation and the appropriate care of the equipment.
2. The nurse should conduct an environmental assessment and suggest ways in which environmental irritants can be decreased in the home of a person with chronic respiratory disease.
3. Persons at risk of adverse responses to acute respiratory infections, such as those with chronic respiratory disease, should be advised to speak with their physician about the use of flu vaccines.
4. Nurses visiting the home of a client with a chronic respiratory illness should provide information about how acute respiratory infections are spread and how they can be minimized.
5. The nurse should help the client with asthma identify the conditions and circumstances that trigger exacerbations and how to avoid them.
6. Clients with chronic pulmonary disorders need to be instructed on the importance of remaining compliant with medication regimen and avoidance of risk factors, such as smoke, aerosols, insecticides, dust, home cleaning products, etc.
7. Clients should be advised of potential adverse effects of drug therapy and discuss the risks involved in overusing bronchodilators. They need to be told that, even though they may get immediate relief from difficulty breathing, bronchodilators cause bronchoconstriction if overdose or toxic levels are reached.
8. Clients taking xanthine bronchodilators need to be encouraged to keep their follow-up visits with the physician and have periodic blood levels drawn to ensure that the drug has reached a therapeutic level and not a toxic level.
9. Clients need to be instructed on proper techniques to facilitate therapy, such as breathing exercises, general health measures, chest physiotherapy, or postural drainage.
10. Clients with asthma requiring the use of subcutaneous epinephrine need to be taught the proper technique for subcutaneous injections.
11. Clients receiving oxygen need to be advised of the safety factors related to its use.

CASE STUDY

Walter Poukopolis is a 63-year-old cook who has had a 10-year history of chronic obstructive pulmonary disease (COPD) and has required hospitalization on three separate occasions. Up to 4 years ago, Mr. Poukopolis smoked two packs of cigarettes daily, but has entirely stopped smoking. The COPD has been well controlled for about 3 years by the occasional use of a metaproterenol metered dose inhaler for acute episodes of bronchospasm.

During the winter, the client is admitted with severe breathing difficulty and a temperature of 39.1°C (102.2°F). He weighs 80 kg. The physician diagnoses his condition as pneumonia caused by a *Klebsiella* organism and prescribes the following:

- **Sodium cephalothin** (**Keflin**), an antibiotic, 1 g by IV in 30 mL normal saline q6h
- Aminophylline 40 mg per hour continuous IV infusion per IV infusion pump for dyspnea
- Chest physiotherapy QID
- Albuterol treatment QID for 15 minutes with 0.5 mL albuterol 2 mL sodium chloride in the nebulizer

After 10 days the client's temperature is within normal limits and his breathing is improved.

continues

Questions for Discussion

1. How does aminophylline relieve dyspnea?
2. What circumstances could have promoted the development of pneumonia in this client? What preventive measures could have been taken?
3. What aspects of the metaproterenol therapy should the nurse review with Mr. Poukopolis before his discharge from the hospital?

CRITICAL THINKING EXERCISES

1. Attend a meeting of the local chapter of the American Lung Association.
2. Discuss the problems of asthmatic children in school and what can be done to assist them.
3. Obtain a metered dose inhaler and an extender device. Examine their method of operation.
4. Spend a morning or afternoon with a respiratory therapist at a local hospital.
5. Identify bronchodilator drugs that are relatively selective for beta$_2$ adrenergic receptor sites.
6. Prepare a client education program for an adult or a child of a particular age who has just developed asthma and is using an inhaler with an extender device.

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SECTION 7

Agents Used in the Eye

MAJOR NURSING DIAGNOSES

- Disturbed Sensory Perception: Visual
- Deficient Knowledge Related to the Illness and Its Treatment
- Impaired Home Maintenance Management Related to Visual Impairment
- Anxiety Related to Risk for Loss of Vision
- Risk for Injury

26 Agents Used in the Treatment of Glaucoma

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the production and flow of aqueous humor
- State the pathophysiology of glaucoma
- Distinguish between narrow-angle and open-angle glaucoma
- List three classes of agents that decrease the formation of aqueous humor
- List two classes of agents that increase the outflow of aqueous humor from the eyes
- Identify one class of agents that decreases the formation of aqueous humor and increases its outflow
- Identify therapeutic effects and side effects of each of the classes of agents used to treat glaucoma
- Apply the nursing process related to the administration of agents to clients being treated for glaucoma
- Describe the nursing assessment of persons with glaucoma
- List the steps in the administration of eye drops

Glaucoma is characterized by an increase in intraocular pressure. The disorder can be caused by an acquired structural defect within the eye (primary glaucoma); it may be the consequence of another ocular disease or trauma (secondary glaucoma); or it may be the result of a genetic defect (congenital glaucoma). In any case, if left untreated, glaucoma may lead to optic nerve degeneration, loss of *visual field* and eventual blindness. Glaucoma affects 100 in 100,000 persons in the United States, predominantly in ages 55 to 70 years old. It is more common in African Americans and Asians than Europeans; and more in females than males.

Aqueous humor is constantly being produced by the ciliary process in the eye's anterior chamber located behind the iris (Figure 26–1). Its production is controlled by the enzyme carbonic anhydrase, as well as other enzyme systems. Once the aqueous humor has entered the eye, it passes from the posterior chamber through the pupillary aperture of the iris and into the anterior chamber. There it is drained from the eye through a sponge-like substance known as the trabecular meshwork into the canal of Schlemm and out through several channels connected to the venous system.

When there is a balance between the production and outflow of aqueous humor, intraocular pressure generally remains within normal limits (usually less than 20 mm). In glaucoma, increased intraocular pressure is usually caused by a blockage of the outflow mechanism. If the pressure elevation persists and is unrelieved, the optic nerve is eventually injured and destroyed. This degeneration is evidenced

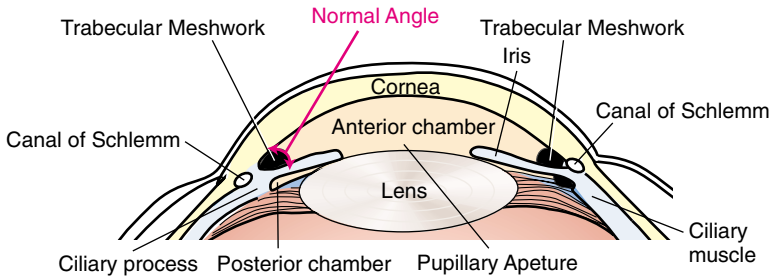


Figure 26–1 The normal flow of aqueous humor.

symptomatically—first by a loss of visual field and then by loss of central visual *acuity*—followed eventually by total blindness.

If the iris occludes the anterior chamber angle structures (trabecular meshwork and canal of Schlemm), normal outflow is prevented and the client is said to have narrow-angle glaucoma (Figure 26–2). In such an eye disorder, dilation of the pupil may precipitate an acute glaucoma attack by causing the bunched-up iris to block the outflow of aqueous humor. Treatment of narrow-angle glaucoma generally requires a surgical procedure known as an iridectomy, which creates a new opening for aqueous humor to enter the anterior chamber.

In open-angle glaucoma, the most common form of this disease, there is no change in the chamber angle of the eye. However, because of local degenerative changes, aqueous outflow is impeded. This disease is quite insidious, as symptoms often do not appear until after severe degeneration of the optic nerve. It is also the form of glaucoma most amenable to drug therapy.

Several approaches may be used to treat glaucoma with drugs. Some agents may decrease the formation of aqueous humor, some may increase its outflow from the eye by causing miosis and thereby drawing the iris away from the anterior chamber angle, while others may both decrease production and increase outflow of aqueous humor.

AGENTS THAT DECREASE THE FORMATION OF AQUEOUS HUMOR

Drugs that affect production of the aqueous humor fall into three major categories: carbonic anhydrase inhibitors, osmotic diuretics, and beta-adrenergic-blocking agents. In some situations, a client may receive two or more of these agents simultaneously.

Carbonic Anhydrase Inhibitors

These drugs inhibit the action of the enzyme carbonic anhydrase. This reduces the amount of aqueous humor produced and thereby decreases intraocular pressure. Such agents are of greatest value in the treatment of open-angle glaucoma and in the preoperative management of acute narrow-angle glaucoma. Carbonic anhydrase inhibitors are generally used in conjunction with, but do not replace, topical therapy.

All of the drugs in this category are diuretics that can increase the excretion of sodium, potassium, bicarbonate, and water. Therefore, clients should be observed for signs of potassium depletion, particularly if using digitalis glycosides (see Chapter 28).

As all of the carbonic anhydrase inhibitors currently available are derivatives of the sulfonamide antibiotics, any person known to be sensitive to these agents should be carefully observed for

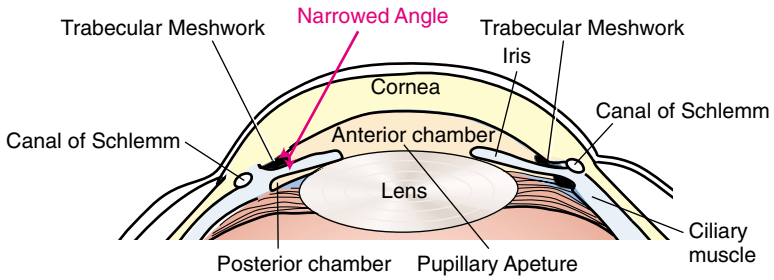


Figure 26–2 In narrow-angle glaucoma the outflow of aqueous humor is impeded, resulting in an increase in intraocular pressure.

TABLE 26–1

Carbonic Anhydrase Inhibitors Used in Glaucoma

Note: Monitor clients for fluid and electrolyte imbalances, especially for hypokalemia.
Client should receive information about glaucoma and its treatment.
Initiate routine assessment of blood pressure and weight.
Observe clients hypersensitive to sulfonamides for allergic reactions.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
acetazolamide *(**as**-eh-tah-**ZOHL**-ah-myd)* (Diamox, Novo-Zolamide ✱)	oral, IM, IV	Chronic open-angle glaucoma: 250 mg–1 g; in divided doses for amounts over 250 mg Secondary glaucoma and pre-operative treatment: 250 mg every 4 hours or 250 mg twice a day for short-term therapy	Sustained-release dosage form available. IM injection is painful. May be used with miotics or mydriatics. Injectable solution should be used within 24 hours of preparation. Monitor fluid intake and output. May cause false positive test for urine protein.
dichlorphenamide *(**dye**-klor-**FEN**-ah-myd)* (Daranide)	oral	Initial dose: 100–200 mg followed by 100 mg every 12 hours until desired response has been obtained Maintenance dose: 25–50 mg 1–3 times daily	May be used with miotics and/or osmotic agents.
dorzolamide *(door-**ZOHL**-ah-mide)* (Trusopt)	ophthalmic solution	1 drop 2–3 times/day	See note at top of table. Fluid/electrolyte imbalances possible.
dorzolamide and timolol (Cosopt)	ophthalmic solution	1 drop in affected eye 2 times/day	Monitor closely if taking beta-adrenergic blockers, calcium channel blockers, cardiac glycosides, quinidine, and/or catecholamine-depletion drugs. If used in client with diabetes, monitor closely, as this can cover up signs of hypoglycemia. Blurred vision, itching, redness, photosensitivity possible.
methazolamide *(**meth**-ah-**ZOH**-lah-myd)* (Neptazane)	oral	50–100 mg 2–3 times daily	May be used with miotic or osmotic agents. Contraindicated in severe glaucoma.

allergic symptoms such as fever, rash, hemolytic anemia and edema. Neurological effects, such as a "tingling" feeling in the extremities or at the lips, mouth, or anus, may occur after even short courses of therapy. Longer therapy may cause flaccid paralysis, convulsions, and a wide variety of other symptoms.

Table 26–1 provides a comparison of the carbonic anhydrase inhibitors currently available.

Osmotic Diuretics

Osmotic diuretics may be used orally or parenterally to withdraw fluid from the body (see Chapter 31). By doing so, they rapidly reduce the production of aqueous humor in the eye and thereby reduce intraocular pressure. Osmotic diuretics are primarily used to treat acute attacks of narrow-angle glaucoma or in preparation for

TABLE 26–2

Osmotic Diuretics Used in Glaucoma

Note: Monitor fluid and electrolytes for imbalances, especially hypokalemia.
Record fluid intake and output.
Initiate routine assessment of blood pressure and weight.
Client should receive information about glaucoma and its treatment.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
glycerin *(**GLIS**-er-in)* (Osmoglyn)	oral	1–1.5 g/kg, 1–1½ hours prior to surgery then 500 mg/kg every 6 hours	Not for injection. Mix with soft drinks or fruit juice. May produce hyperglycemia.
isosorbide *(**eye**-soh-**SOR**-byd)* (Ismotic)	oral	1.5 g/kg 2–4 times daily	A dose of 220 mL contains 4.6 mEq of sodium and 0.9 mEq of potassium. Pour over ice and sip for better palatability.
mannitol *(**MAN**-ih-tol)* (Osmitrol, etc.)	IV infusion	1.0–1.5 mg/kg	In clients with severe renal impairment a test dose must be used. When exposed to low temperatures, mannitol solutions may crystallize. If this occurs, the solution should be warmed in a hot water bath or oven and then cooled to body temperature before administering. When infusing 15–25% mannitol solutions the administration set should include a filter. Infiltration could result in tissue damage and necrosis.
urea *(you-**REE**-ah)* (Ureaphil)	IV infusion	*Adults:* 1–1.5 g/kg, not to exceed 120 g/day *Children:* 0.5–1.5 g/kg	Use only freshly prepared solutions. Discard any unused solution within 24 hours after reconstitution. May cause irritation at the site of injection. Infiltration could result in tissue damage or necrosis. Do not administer into leg veins; could cause thrombophlebitis. Administer only by IV infusion of a 30% solution at a rate not to exceed 4 mL/min.

surgery of glaucoma and other eye disorders. They are not for chronic use.

These agents must be used with extreme caution in clients with renal impairment. They may also cause headaches, nausea, and vomiting, plus possibly phlebitis and *thrombosis* near the site of injection.

Table 26–2 lists the properties of osmotic diuretics in current use.

Beta-Adrenergic Blocking Agents

Timolol maleate (**Timoptic**), **betaxolol HCl** (**Betoptic**), **levobunolol HCl** (**Betagan**), **carteolol** (**Ocupress**), and **metipranolol HCl** (**OptiPranolol**) are beta-adrenergic-blocking agents used to treat glaucoma. When applied topically, these drugs lower intraocular pressure by a mechanism believed to result in reduced formation of aqueous

humor. Unlike most other agents applied directly to the eye for the treatment of glaucoma, the beta-adrenergic-blocking agents have little effect on pupil size or visual acuity; therefore, they do not cause blurred vision or night blindness.

The onset of action of these drugs can usually be detected with ½ hour after a single dose. Although their maximum effect generally occurs within 2 hours, the effects of these drugs are apparent for as long as 12–24 hours after a single dose has been administered.

Beta-adrenergic-blocking agents are used either alone or in combination with other drugs for the treatment of open-angle glaucoma. They are usually administered with an initial dose of 1 drop of the solution in the affected eye twice daily. There is no evidence that any further pressure reduction occurs by increasing this dosage level.

The most important danger in the use of the beta-adrenergic-blocking agents is their ability to be absorbed into systemic circulation and to interfere with the therapy of clients with bronchial asthma and congestive heart failure and others susceptible to the use of such agents (see Chapter 27). These drugs may also cause ocular irritation and slightly reduce the resting heart rate of some clients.

Timolol maleate, levobunolol HCl, carteolol HCl, and metipranolol HCl are blockers of both $beta_1$- and $beta_2$-adrenergic receptors (see Chapter 15), while betaxolol HCl is cardioselective and primarily blocks $beta_1$ receptors. This would make the use of betaxolol HCl less likely to cause bronchospasm and increased risk of cardiac symptoms than the others.

AGENTS THAT INCREASE THE OUTFLOW OF AQUEOUS HUMOR

Direct-acting miotics and cholinesterase inhibitors act by increasing the outflow of aqueous humor. Tables 26–3 and 26–4 outline dosage information and nursing considerations.

Direct-Acting Miotics

The direct-acting miotics are agents that mimic the action of the neurotransmitter acetylcholine and act to constrict the pupil (miosis) and contract the ciliary muscle. In narrow-angle glaucoma, miosis opens the anterior chamber angle and facilitates the outflow of aqueous humor. In chronic open-angle glaucoma, contraction of the ciliary muscle increases outflow by an indirect effect on the trabecular meshwork.

Pilocarpine is the most popular agent in this group. It may be administered as an eye drop or as a longer-acting gel form. **Carbachol** is useful in clients who experience irritation with pilocarpine or who no longer respond to it. Acetylcholine may also be used, but it has a very short duration of action and is used primarily to induce miosis during surgery.

The Ocusert Therapeutic System is a dosage form for the administration of pilocarpine. This device releases pilocarpine continuously at a fairly constant rate for 1 week before being replaced by the client. It provides a more convenient form of therapy than the use of drops or gel and appears to produce a lower incidence of adverse effects. The Ocusert Therapeutic System is, however, considerably more costly for the client than the other forms.

The most common adverse effect of the direct-acting miotics is their ability to reduce visual acuity, particularly with poor illumination. They may also cause systemic effects such as flushing, sweating, gastric distress, diarrhea, and headache. When the first few doses are administered, these agents may cause stinging. Table 26–3 compares the direct-acting miotics available in the United States.

Miotics That Inhibit Cholinesterase Activity

These drugs prevent the enzymatic destruction of acetylcholine within the eye by inhibiting the enzyme cholinesterase. This results in greater acetylcholine activity, the production of miosis, and contraction of the ciliary muscle.

Because they are more toxic and longer acting than the direct-acting miotics, the cholinesterase inhibitors are generally reserved for use in clients with open-angle glaucoma who fail to respond to other forms of drug therapy.

Cholinesterase inhibitors may cause local or systemic adverse effects. Locally, they may cause stinging, burning, lacrimation, lens opacities, and ocular inflammation. Systemically, they may precipitate salivation, urinary incontinence, sweating, diarrhea, muscle weakness, and a multitude of other adverse effects. Clients on these drugs must be carefully monitored to avoid serious toxicity. In cases of poisoning with cholinesterase-inhibiting drugs, appropriate doses of atropine sulfate or **pralidoxime chloride** (PAM) may be used as antidotes. Table 26–4 lists the cholinesterase inhibitors in current use.

TABLE 26–3

Direct-Acting Miotics Used in Glaucoma

Note: Client is provided with information about glaucoma and its treatment. This includes instruction on administration of eye drops.

Do not use any preparation that has changed color, become cloudy, or appears different in any way.

Avoid drugs that increase intraocular pressure or dilate the pupil. This includes corticosteroids and sympathomimetic drugs.

Drugs may cause temporary blurring of vision.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
acetylcholine chloride (*as-eh-till-**KOH**-leen **KLOR**-eyed*) (Miochol Intraocular)	intraocular solution	0.5–2 mL of a 1% solution instilled into anterior chamber	Used only for preoperative treatment. Solution must be prepared immediately before use. Any solution that is not immediately used should be discarded.
carbachol (*KAR-bah-kol*) (Miostat Intraocular, Isopto Carbachol)	intraocular solution, ophthalmic solution	Intraocular: up to 0.5 mL of a 0.01% solution instilled into anterior chamber Ophthalmic: 1 drop of a 0.75–3% solution in each eye 1–3 times daily	Miosis is usually maximal within 2–5 minutes after instillation. Advise client about momentary stinging following use. Aching of eyes, brow pain, sensitivity to light and blurred vision may occur following use, but these symptoms usually decrease with continued use of medication.
pilocarpine HCl, pilocarpine nitrate (*pie-loh-**KAR**-pin **hy**-droh-**KLOR**-eyed, **pie**-loh-**KAR**-pin **NIGH**-trayt*) (Isopto Carpine, Pilocar, Ocusert Pilo, Pilopine HS, etc.)	ophthalmic solution, ophthalmic gel, ocular therapeutic system	Ophthalmic solution: 1 drop of 0.25–10% solution up to 6 times daily Ocular therapeutic system: one system (20 or 40 mcg/hr) each week Ophthalmic gel: applied once daily, at bedtime	During the first few hours after Ocusert administration, myopia may occur. Client should be instructed to check for the presence of the Ocusert unit before retiring at night and upon arising. If an Ocusert unit drops out of the eye, it can be rinsed off and reinserted. Observe clients with asthma and lung disorders for respiratory difficulties.

AGENTS THAT DECREASE FORMATION AND INCREASE OUTFLOW OF AQUEOUS HUMOR

Prostaglandin-Inhibiting Agents

Flurbinprofen (**Ocufen**) and **latanoprost** (**Xalatan**) are two relatively new antiglaucoma medications. Flurbiprofen facilitates the outflow of aqueous humor by inhibiting prostaglandin synthesis, thereby increasing vascular permeability. It is used prior to eye surgery and is administered at 1 gram every 30 minutes beginning 2 hours before surgery.

Latanoprost is an F2-b analogue of prostaglandin and also reduces intraocular pressure by increasing aqueous humor outflow. It is used for open-angle glaucoma and ocular hypertension. It is considered a second-line treatment because of its tendency to change the color of the iris. Because the ophthalmic solution of latanoprost contains benzalkonium that may be absorbed by contact lenses, it is advised that contact-wearing clients remove their contacts prior to instillation of this solution. The solution is a 0.005% solution and the client instills one drop (1.5 mcg) in affected eye once daily in the evening.

Sympathomimetic Agents

Sympathomimetic agents, such as epinephrine, stimulate adrenergic receptors within the eye. Initially, this may result in a reduction of aqueous

TABLE 26–4

Cholinesterase Inhibitors Used in Glaucoma

Note: Provide client with information about glaucoma and its treatment. This includes instruction about administration of eye drops and ointments.

Avoid drugs which increase intraocular pressure or dilate the pupil, including corticosteroids and sympathomimetic drugs.

May cause temporary blurring of vision.

Do not use any preparation that has changed color, become cloudy, or changed in any way.

Some products contain sulfites. Observe clients for allergic reactions.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
demecarium bromide *(**dem**-ee-**KAY**-ree-um **BROH**-myd)* (Humorsol)	ophthalmic solution	1 drop of 0.125–0.25% solution from 1–2 times weekly to 1–2 times daily	Duration of effect varies widely from client to client. In some clients, every other day administration may be effective.
echothiophate iodide *(**eck**-oh-**THIGH**-oh-fayt **EYE**-oh-dyd)* (Phospholine Iodide)	ophthalmic solution	1 drop of a 0.03% solution 1–2 times daily	Requires reconstitution of powder into solution. Wash hands after administration. Solutions are unstable. They may be kept refrigerated for 6 months or at room temperature for 1 month.
isoflurophate *(**eye**-soh-**FLOO**-roh-fayt)* (Floropryl)	ophthalmic ointment	¼-inch strip of ointment in the eye every 8–72 hours	Drug loses potency in the presence of moisture. Ointment tube must therefore be kept tightly closed. The tip of the tube should not be washed or allowed to touch the eyelid or other moist surface. Whenever possible, administer upon retiring to diminish blurring of vision. Wash hands after administration.
physostigmine salicylate, eserine salicylate *(**fye**-soh-**STIG**-meen sah-**LIS**-ih-layt, **ES**-er-in sah-**LIS**-ih-layt)* (Isopto Eserine)	ophthalmic solution, ophthalmic ointment	Solution: 1 drop of 0.25–0.5% solution in eye, up to 4 times daily Ointment: small quantity of 0.25% ointment in lower eyelid up to 3 times daily	Do not use solution if it is discolored.

humor production, although prolonged therapy with these drugs may result in an increase in the outflow of aqueous humor.

Epinephrine is generally used in combination with a miotic to produce an additive lowering of intraocular pressure while reducing the loss of visual acuity produced by using miotics alone. It may be used alone in young clients who develop *myopia* or in older clients with lens opacities.

Sympathomimetics, such as epinephrine, must be used with caution in the elderly and in clients with hypertension, diabetes mellitus, hyperthyroidism, or heart disease. Exaggerated adrenergic effects may occur in clients also using monoamine oxidase (MAO) inhibitors (see Chapter 18) and/or other antidepressant drugs. Sympathomimetic agents should only be used in open-angle glaucoma, as their *mydriatic* effect may precipitate an acute glaucoma attack in clients who have narrow-angle glaucoma prior to an *iridectomy*.

Epinephrine is available for ophthalmic use as **epinephrine hydrochloride** (Epifrin, Glaucon) and **epinephrine borate** (Epinal, Eppy/N). These preparations are therapeutically equivalent when they contain equivalent doses of epinephrine. **Dipivefrin HCl** (Propine) is an agent that penetrates the cornea about 17 times faster than epinephrine and, once absorbed, is converted to

epinephrine by enzymes within the human eye. This drug is believed to be less irritating than other forms of epinephrine therapy. Epinephrine-containing ophthalmic solutions are generally administered by placing 1 drop of the drug solution in the eye(s) once or twice daily.

Apraclonidine HCl (Lopidine) is an alpha-adrenergic agonist (see Chapter 15) that reduces intraocular pressure in clients after undergoing various surgical procedures. One drop of a 1% drug solution is instilled into the eye to be treated 1 hour before surgery. A second drop is instilled into the same eye immediately after surgery. Although its mechanism of action is still unclear, it is believed that apraclonidine reduces aqueous humor production.

APPLYING THE NURSING PROCESS

ASSESSMENT

Assessment of persons with glaucoma often includes examination of the eyes for visual acuity and the use of tonometry to determine intraocular pressure. Inquiry should be made about blurring of vision, other visual changes, eye pain, and headache. Blood pressure is measured, as hypertension may be associated with increased intraocular pressure. When the nurse takes a medication history, clients should be specifically asked if they use any medications in the eye or use eye drops. Many people, especially those who have used such medications for lengthy periods, may not consider them medications. If the person is using such medications, determine which are being used, frequency of use, and to which eyes they are being applied. The nurse should always determine what the client with glaucoma knows about the disorder and its treatment to develop the nursing care plan. Also, an assessment should be made about the person's competence in administration of the medication. A further aspect of assessment involves asking clients on admission to the hospital whether they have glaucoma. This is especially important in persons over 40 years of age.

NURSING DIAGNOSES

Including but not limited to:

- Disturbed sensory perception visual problems related to increased intraocular pressure
- Impaired home maintenance management, related to visual impairment
- Risk for injury related to side effects of antiglaucoma medications
- Deficient knowledge related to disease process and medical regimen

PLANNING/GOALS

- Client will verbalize improvement in vision.
- Client will experience intraocular pressure within normal limits (10–21 mm Hg).
- Client will demonstrate independence in home care and accurate administration of antiglaucoma medications.
- Client will not experience side effects from antiglaucoma medications and, if side effects do occur, the client will report them immediately.
- Client will verbalize understanding of disease process and medication regimen.

IMPLEMENTATION

The major nursing goal in providing care for clients with glaucoma is to conserve the client's vision. This is accomplished through client education about the nature of glaucoma and its treatment. When the client is unable to care for himself/herself, another member of the family must be instructed or the nurse provides the required care.

Initially the client should acquire a basic understanding about what glaucoma is and how the drugs used for treatment act to prevent acute attacks and loss of vision. Clients must understand that treatment for glaucoma is lifelong and that failure to continue therapy may mean irreversible loss of vision.

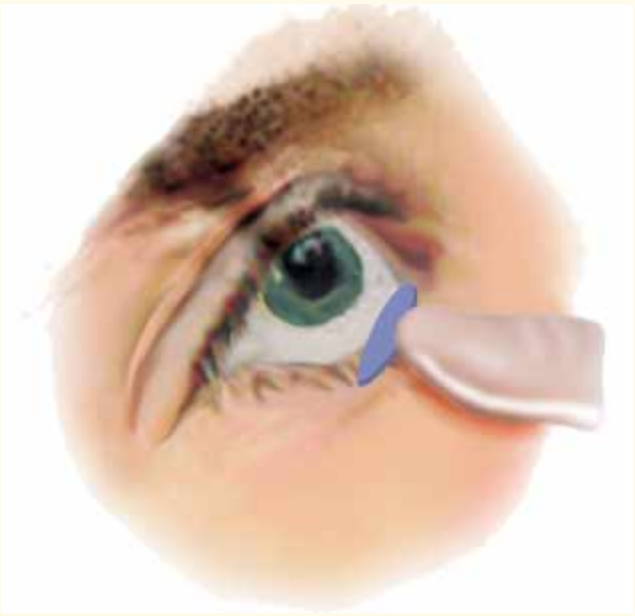
The client is given guidance in the use of both systemic and topical medications used for treatment. If the client is receiving **acetazolamide** (Diamox) he/she is informed that this drug is a diuretic and will increase the urinary volume and frequency. This drug should not be taken near bedtime, as sleep will most likely be

interrupted by trips to the bathroom. If the prolonged-action form of this drug is used, the client is instructed that this is a sustained-release form and that he/she must take the medication as ordered without attempting to break or crush it. Additional instructions include reporting to the physician any side effects, such as tingling in the fingers and toes or urticaria. Skin rash, sore throat, or fever may indicate relatively severe hematological problems and are reported immediately. In addition, the nurse observes the client for confusion, anorexia, and evidence of acid-base, sodium, and potassium imbalances. Increasing the dose of acetazolamide may increase the likelihood of paresthesias (tingling and numbness) and drowsiness without increasing diuresis. The physician is informed if the client experiences these side effects, so that the dosage can be regulated.

Clients with glaucoma will be using eye drops, ophthalmic gels, or a therapeutic system. They need instruction related to the drug itself and to its proper method of administration. Figure 26–3 provides the procedure the nurse uses in inserting and removing an ocular therapeutic system. Clients are given sufficient supervised practice in self-administration, so that the nurse is confident the correct method will be used at home. For clients unable or unwilling to learn self-administration, someone close to the client is given instructions. As a general rule, at least two people are instructed in administration, so that if one person is unable to do it for any reason, another person is always available. Figure 26–4 shows the correct method for the instillation of eye drops.

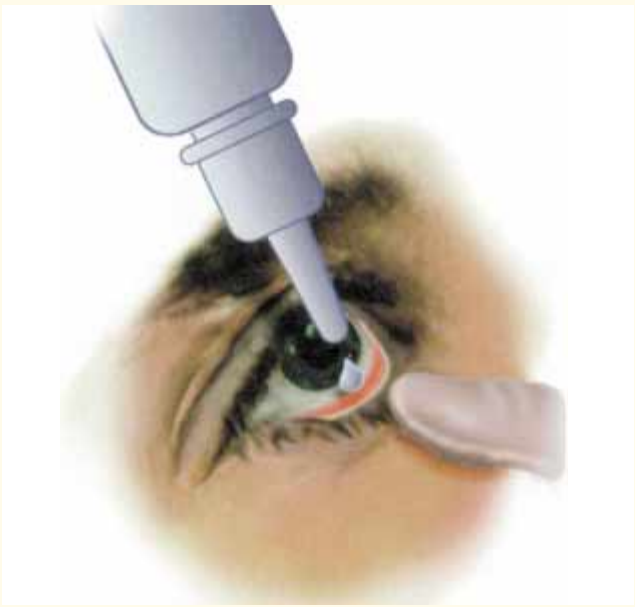
Miotic eye drops are used in the treatment of glaucoma. Clients are informed that the drops may cause temporary dimming or blurring of vision. If the client experiences this, he/she is advised not to drive or engage in other hazardous activities until the problem clears. Visual difficulties seem most pronounced in those with cataracts, as the miosis may make it impossible for them to see around the central lens opacity.

When pilocarpine is used, clients with asthma and lung disease are observed carefully. With prolonged use, this drug may cause systemic



1. Identify the client.
2. Wash your hands and put on powder-free gloves.
3. Examine the system to be certain it is not damaged or deformed.
4. After explaining the procedure to the client, gently lift the system from the package and position the convex part of the system on the tip of the index finger of your dominant hand.
5. Ask the client to look up. With your nondominant hand, gently pull the client's lower eyelid downward. Place the system horizontally in the conjunctival sac so that it is positioned on the sclera between the iris and lower eyelid.
6. Gently pull the client's lower eyelid out, up, and over the system. Ask the client to blink gently several times. The system should be completely covered by the lower eyelid. If it is not covered, position the system again.
7. Remove the gloves, wash your hands, and document the procedure. You should record the date, time, and dosage of medication administered, the eye treated, the client's response to the procedure, and any adverse reactions you noted.
8. To remove the system, wash your hands, put on gloves, and explain the procedure to the client. Then, using your nondominant hand, gently pull down on the client's lower eyelid to expose the system. Using the forefinger and thumb of your dominant hand, gently pinch the system and lift it out of the eye. Discard the system appropriately, remove the gloves, and wash your hands. Document the procedure.

Figure 26–3 Procedure for inserting and removal of an ocular therapeutic system.



1. Assemble the necessary equipment. Wash hands. Put on powder-free gloves.
2. Check the medication label and instructions carefully. Be sure solution is labeled for ophthalmic use. Be certain you know which eye is to be treated.
3. Have the client assume a comfortable position, either lying in bed or seated in a chair with support for the neck.
4. Ask the client to tilt the head back and to look up at the ceiling.
5. Gently pull down the lower lid or pinch the lower lid of the affected eye to form a pouch or conjunctival sac.
6. Approach the eye, holding the dropper near the lid. **Note:** Be careful not to touch the eyelid or lashes with the dropper, as this would contaminate the dropper.
7. Gently drop the prescribed number of drops into the pouch. Placing the drop in the center of the pouch will help decrease systemic absorption.
8. Ask the client to close the eye and blink several times.
9. The client should be instructed not to rub the eye. Gentle pressure may be applied to the bridge of the nose adjacent to the eye to prevent the medication from being drained from the eye.
10. Remove gloves and wash hands.
11. Record the procedure including observations about the eye being treated.

Figure 26–4 When instilling eye drops, the lower lid is pulled down or pinched away from the eye to form a pouch.

effects, including pulmonary edema and precipitation of an asthmatic attack. In addition, pilocarpine may produce headaches, and clients are instructed to report this to their physician. If carbachol (Isopto Carbachol) is used, clients are advised that a momentary stinging may be experienced following administration. This reaction is of little importance and disappears in a short time. Early in the treatment with carbachol, clients may experience spasm of the ciliary body, with aching of the eyes, brow pain, headache, sensitivity to light, and blurred vision. These symptoms generally clear with continued use. If they do not, they must be reported to the physician.

As a general rule, no ophthalmic solution is used if it becomes contaminated, cloudy, or has changed in any way since purchase. The solutions used to treat glaucoma are stored, tightly capped, in an area where they will not be exposed to light.

Clients with glaucoma not only need instruction regarding the medications they are receiving, but should also know that some medications are to be avoided. **Note:** Be sure to assess client's ability to read medication labels. Any drugs which increase intraocular pressure or dilate the pupil are to be avoided. Such a recommendation prohibits the use of corticosteroids, including their topical use for dermatological purposes around the eye. The use of medications with strong anticholinergic effects is also avoided. Clients are instructed to carefully read the labels of over-the-counter medications. Preparations containing atropine, scopolamine, and other drugs with anticholinergic effects must be avoided. Those clients using cholinesterase-inhibiting drugs, for example physostigmine (see Table 26–4), should not receive the muscle relaxant **succinylcholine** (**Anectine**, **Quelicin**, **Sucostrin**) in preparation for intubation before surgery. Use of this drug may cause respiratory depression. Clients are advised to carry an identification card stating that they have glaucoma and must not be treated with mydriatics and other drugs known to increase intraocular pressure. When persons with glaucoma are admitted to the hospital, arrangements must be made for continued treatment during hospitalization. Also, a note concerning the glaucoma is placed in prominent places on the client's nursing care plan, clinical chart, and medication record. The medication record must clearly indicate which eye or eyes are being treated. Even if glaucoma exists in only one eye, both eyes may be treated, as the disease tends to become bilateral. Treatment of the second eye may prevent an acute attack of glaucoma in that eye.

NURSING CARE PLAN

A Client with Glaucoma Using Pilocarpine via Ocusert Therapeutic System

Robert Hays, age 76, visits the ophthalmologist to have his glasses changed. He has been having blurred vision, difficulty in close vision, and headaches. During the eye examination, a tonometer test identifies elevated intraocular pressure in the left eye. Mr. Hays also has some changes in the lens of his right eye indicating cataract formation. The physician knows that Mr. Hays lives alone and will have difficulty in administering his own eye drops. Therefore, he prescribes pilocarpine via Ocusert Therapeutic System. Mr. Hays is taught to insert the product once a week.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Blurred vision.	Risk for self-care deficit syndrome related to impaired vision.	Client will verbalize changes needed to maintain self-care prior to discharge.	Encourage client to return for follow-up every 2 months to check on intraocular pressure. Obtain a home care aide to assist in cleaning.	Client is able to maintain independent living.
Lives alone. Vision changes.	Risk for impaired home maintenance related to visual changes and aging.	Client will have assistance in home maintenance to promote independence.	Make arrangements for "meals on wheels" and someone to do outside yard work. Discuss safety factors, i.e., walk carefully to avoid falls.	Client has been able to remain in familiar environment with assistance provided. Client does not experience fall or injury.
Difficulty in close vision.	Risk for injury related to difficulty in reading labels.	Client demonstrates the ability to read labels accurately.	Have medication labels printed large enough for client to see or use color-coded labels. Teach him to read labels carefully.	Client is able to read labels without error.
Headaches, eye pain.	Acute pain related to increased eye pressure.	Client verbalizes relief of headaches within 1 week.	Teach client to relieve headache: he should stop activity and lie in darkened room. Headaches may be a symptom of increased pressure and should be reported to health care provider.	Client has not had headaches since starting medication.
Anxious.	Anxiety related to potential for loss of vision.	Client will be able to verbalize anxiety and methods of relaxation.	Client needs to avoid emotional upsets, worry, anger. Deep breathing and relaxation techniques may help in calming person. Provide information about glaucoma and its treatment.	Client can talk about fears and verbalizes reduced anxiety.
Knowledge of medication routine.	Deficient knowledge (new condition and drug therapy regimen).	Before leaving the office, client will demonstrate proper pilocarpine Ocusert Therapeutic System administration.	Teach client to pull down lower lid and insert Ocusert. If it comes out it can be rinsed and reinserted. Teach client to change Ocusert Therapeutic System weekly. Identify someone else who can be instructed about client's treatment.	Client properly inserts pilocarpine Ocusert Therapeutic System.

Knowledge of disease process.	Deficient knowledge related to glaucoma and its treatment.	Client will verbalize understanding of disease process and methods of control.	Teach client that he should avoid exertion, upper respiratory infections, and emotional upsets, as these increase pressure in the eye. Client instructed to carry an identification card stating he has glaucoma. Teach client to read labels on nonprescription drugs and to avoid those containing atropine, scopalamine, and other drugs with strong anticholingeric effects. Teach client to check with pharmacist for drug interactions.	Client verbalizes how intraocular pressure increases and ways to keep it under control. Client adheres to treatment regimen. Intraocular pressure remains within normal limits.
Social support.	Risk for impaired social isolation related to fear of injury and difficulty in obtaining transportation.	Client will identify diversional activities.	Consult social services to provide transportation to medical appointments. Contact senior services in local community about arrangements for shopping and social activities.	Client is cooperative in keeping appointments. Participates in outings.

Finally, clients are encouraged to see their ophthalmologist regularly. Close family members are advised to have periodic visual examinations, as this condition occurs more frequently in family members of an individual with glaucoma.

Recently a new technique of photocoagulation using an argon laser has been developed. This procedure results in increased drainage of aqueous humor and may decrease the need for lifelong drug therapy or other surgical procedures.

Although the nursing care for clients with uncomplicated glaucoma is not very technical or difficult, the care and client instruction provided can be invaluable in preserving the client's vision.

EVALUATION

- Client verbalizes improvement in vision.
- Client experiences intraocular pressure within normal limits (10–21 mm Hg).
- Client experiences independence in health maintenance at home including demonstrating ability to accurately self-administer optic medications.
- Client does not experience side effects from intraocular medications.
- Client verbalizes understanding of disease process and medication regimen.

KEY NURSING IMPLICATIONS 26–1

Glaucoma

1. Assessment includes determination of visual acuity and intraocular pressure, inquiry about visual changes and headaches, and specific questioning about the use of medications in the eye.
2. Acetazolamide (Diamox) should not be taken near bedtime. Have the client report tingling in the fingers and toes, urticaria, and evidence of hematological problems.
3. Never use an ophthalmic solution that is cloudy or has changed in any way.
4. Miotic eye drops may cause a temporary dimming or blurring of vision. Provide for client safety.
5. Clients with asthma who are taking pilocarpine must be monitored for pulmonary edema and asthmatic attacks.
6. Always be certain that the proper medication is being used in the correct eye.

HOME CARE/CLIENT TEACHING

1. Drugs used in the treatment of glaucoma are prescribed for use over many years. Nurses working outside of inpatient settings should periodically assess the person's response to the medication, offer an opportunity for the person to ask questions about drug treatment, and ensure that the medication is stored and administered correctly.
2. Encourage close relatives of persons with glaucoma to have routine periodic screening for this health problem.
3. Clients should be instructed on the cause and treatment of glaucoma and the consequences of failing to treat the illness properly.
4. Clients receiving the antiglaucoma medication dorzolamide and timolol should be informed about the potential drug interactions with cardiac medications.
5. Clients should be instructed about self-administration of ophthalmic drops and ointments, as well as insertion and removal of ocular medication disks.
6. Clients need to be informed that eye solutions should always be clear and should be kept sterile.
7. Clients with glaucoma should be instructed to avoid corticosteroids, succinylcholine, and anticholinergics.
8. If client is using more than one eye drop drug, clients need to be instructed about the proper order of instilling the drops.

CASE STUDY

Georgette McClune, age 56, visits the ophthalmologist for an eye examination. During the course of this examination the physician tests the pressure in the eye with a *tonometer*. The reading and associated visual defects indicate that Mrs. McClune has open-angle glaucoma. She expresses surprise at this as she expected glaucoma to be associated with pain.

The physician prescribes pilocarpine ophthalmic solution 0.25% gtt i, OU qid and requests that the nurse instruct Mrs. McClune in the proper method of administration of these drops. A return visit is scheduled in 3 months.

Mrs. McClune begins using her drops at home. After several weeks her daughter-in-law, who is a nurse, comes to visit and notices that the solution of pilocarpine has become cloudy.

Questions for Discussion

1. Is Mrs. McClune's lack of pain from glaucoma unusual?
2. To what class of drugs does pilocarpine belong? How does it function in the treatment of glaucoma, and what nursing actions are associated with its use?
3. What are the advantages of using an Ocusert Therapeutic System in the treatment of glaucoma?
4. What are the steps in administration of eye drops which the nurse should teach Mrs. McClune?
5. What advice should Mrs. McClune's daughter-in-law give her about the continued use of the cloudy pilocarpine solution?

CRITICAL THINKING EXERCISES

1. Help to plan and conduct a glaucoma screening program in your community.
2. Prepare a poster or other visual aid showing the pathophysiology of glaucoma and how miotics work to prevent the buildup of intraocular pressure.
3. Prepare a client instruction sheet for a client who has just experienced a first acute attack of glaucoma.
4. Visit a pharmacy and make a list of commonly used over-the-counter medications that should not be used by the client with glaucoma.
5. Prepare a report on the surgical treatment of glaucoma.

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27 Other Agents Used in the Eye

OBJECTIVES

After studying this chapter, the student will be able to:

- List four purposes for which mydriatic agents are used
- Describe two major classes of mydriatic agents and provide an example of each
- List the three classes of ophthalmic anti-infective agents and give an example of an agent in each class
- List two purposes for which corticosteroid ophthalmic preparations may be used
- Describe the usual method of applying fluorescein sodium
- List, in stepwise fashion, the procedure used in the administration of ophthalmic ointments
- List four types of clients who may require an eye patch following administration of medications to the eye
- Explain the meanings of OS, OD, and OU
- Apply the nursing process related to the administration of ophthalmic medications

In addition to the agents described in the preceding chapter, other agents are used in the treatment of eye disorders. Some dilate the pupil, others paralyze the ciliary muscle, fight infection, reduce inflammation, or relieve eye discomfort.

MYDRIATIC AGENTS

Mydriatic drugs are agents that dilate the pupil. They are used to:

- facilitate thorough examination of the eye
- relieve inflammation associated with *uveitis* and keratitis
- break or prevent formation of adhesions between the iris and the lens. To accomplish this, the use of a mydriatic may be alternated with a miotic, i.e., a drug that constricts the pupil
- prepare a client for ocular surgery

There are two major classes of mydriatic drugs, the sympathomimetic and the anticholinergic agents.

Sympathomimetic Mydriatics

These agents have several uses in ophthalmology. They produce pupillary dilation, increase the outflow of aqueous humor, cause vasoconstriction, relax the ciliary muscle, and decrease the formation of aqueous humor.

Those preparations with strong alpha-adrenergic agonist properties (e.g., phenylephrine 2.5% and 10% solutions) are used to cause vasoconstriction and dilation of the pupil for eye examinations and ocular surgery. Those solutions of moderate strength (e.g., epinephrine HCl 0.5–2%) are used in the management of narrow-angle glaucoma, with weaker solutions of sympathomimetic drugs (e.g., epinephrine 0.1% and phenylephrine 0.125%) used as ophthalmic decongestants for symptomatic relief of minor eye irritations.

All sympathomimetic agents used in the eye must be administered with caution to clients with narrow-angle glaucoma because of the ability of these agents to precipitate an acute glaucoma attack. Although there are few reports of serious adverse effects with the ophthalmic use of sympathomimetic agents, they should be used with caution in clients with hypertension, hyperthyroidism, diabetes mellitus, and heart disease. Table 27–1 lists the properties of the sympathomimetic/mydriatic agents.

Anticholinergic Mydriatics

A number of anticholinergic drugs are used in ophthalmology. By blocking the response of the sphincter muscle of the iris and the muscle of the ciliary body to cholinergic stimulation, these agents produce dilation of the pupil (mydriasis) and may interfere with the ability of the eye to focus properly. This latter property is sometimes called paralysis of accommodation or cycloplegia. These properties are useful in allowing unobstructed measurements of refractive errors for determination of proper corrective lens to be used. They are also useful in the relief of inflammation associated with uveitis and keratitis.

If administered for prolonged periods, systemic effects such as blurred vision, dry mouth, fever, and urinary retention may occur. Because of their mydriatic effect, these agents can impair the outflow of aqueous humor from the eye and cause intraocular pressure to increase. They should not, therefore, be used in clients with glaucoma. Table 27–2 compares the anticholinergic mydriatic agents used in the eye.

OPHTHALMIC ANTI-INFECTIVES

The eye is susceptible to a wide range of bacterial, fungal, and viral infections. Some are quite superficial and respond to conservative therapy, with others threatening the functional capacity of the eye that must be treated aggressively. The use of proper diagnostic techniques, as well as drug therapy, is therefore extremely important.

Antibiotics

Antibiotics are used in the eye to treat superficial infections caused by strains of microorganisms susceptible to the antibiotic in the product. Chapter 7 provides a detailed discussion of the properties of antibiotics.

Clients using antibiotics in the eye must be carefully monitored for the development of hypersensitivity. Except in very superficial infections, systemic therapy should accompany ophthalmic antibiotic therapy to rapidly control the disease and to prevent the overgrowth of nonsusceptible organisms, such as fungi.

One to two drops of solution or a small amount of antibiotic ointment is generally administered into the affected eye or eyes 2–4 times daily or more often if the infection is severe. The duration of therapy should be based on the clinical response of the client.

Antibiotic-containing products may not be very stable. Storage conditions listed on the product label must be closely adhered to in order to preserve the potency of these products.

Most antibiotics used in ophthalmic preparations (Table 27–3) are those not normally administered systemically, so that serious hypersensitivity reactions can be avoided in clients previously sensitized to an antibiotic by its topical or ophthalmic administration. Note that in addition to these single-drug products, many commercial preparations contain more than one antibiotic (e.g., bacitracin, polymyxin). This is done to obtain a broader spectrum of antimicrobial activity than would be seen if each drug were used alone.

Antifungal Agents

A number of fungi are known to be capable of infecting the eye. For many years, there was no effective agent that could be applied topically to combat these infections. **Natamycin** (**Natacyn**) is an agent appearing to be effective in the treatment of *blepharitis*, conjunctivitis, and keratitis caused by certain fungal organisms. The initial dose of this drug in treating fungal keratitis is 1 drop of a 5% suspension instilled into the *conjunctival sac* at 1 to 2-hour intervals. This frequency may be reduced after 3 to 4 days to 1 drop 6–8 times daily.

TABLE 27–1

Sympathomimetic Mydriatic Drugs

Note: Client and caregivers must be instructed in administration of ophthalmic solutions.

Warn client that vision may be affected temporarily after administration and to wear sunglasses because of light sensitivity.

Activities such as driving should be avoided after administration.

Store all solutions in tightly closed containers and do not use if the solution becomes cloudy, changes color, or is different in any other way.

Avoid touching tip of solution container to eye or lashes.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
epinephrine HCl *(**ep**-ih-**NEF**-rin **hy**-droh-**KLOR**-eyed)* (Glaucon, Epifrin)	ophthalmic solution	1 or 2 drops of 0.1–2% solution	Protect solutions from heat and light. Discard if solution turns brown or contains precipitate. Keep container tightly sealed. May stain soft contact lenses. May produce elevation of blood pressure and other systemic effects.
hydroxyamphetamine HBr *(hy-**DROCK**-see-am-**FET**-ah-meen **hy**-droh-**BROH**-myd)* (Paredrine)	ophthalmic solution	1–2 drops of 1% solution	Ocular overdosage may be treated with pilocarpine 1%.
naphazoline HCl *(naf-**AZ**-oh-leen **hy**-droh-**KLOR**-eyed)* (Albalon Liquifilm, ClearEyes, Naphcon, etc.)	ophthalmic solution	1 drop of 0.012–0.1% solution every 6 hours	Used in prescription and nonprescription products as topical ocular vasoconstrictor.
oxymetazoline HCl *(**ock**-see-met-**AZ**-oh-leen **hy**-droh-**KLOR**-eyed)* (OcuClear, Visine L.R.)	ophthalmic solution	1–2 drops of 0.025% solution every 6 hours	Used in nonprescription products as topical ocular vasoconstrictor.
phenylephrine HCl *(**fen**-ill-**EF**-rin **hy**-droh-**KLOR**-eyed)* (Neo-Synephrine, Isopto Frin, etc.)	ophthalmic solution	1 drop of 0.12–10% solution	10% solution used as decongestant, vasoconstrictor and for pupillary dilation. 2.5% solution used for refraction, diagnostic procedures, and prior to intraocular surgery. 0.12% (1⁄8%) solution used as a decongestant for temporary relief of minor eye irritation. Monitor client for elevation of blood pressure that may occur after administration of 10% solution. 10% solution may cause rebound miosis. Contraindicated in clients using soft contact lenses.
tetrahydrozoline HCl *(**tet**-rah-high-**DROH**-zoh-leen **hy**-droh-**KLOR**-eyed)* (Murine Plus, Visine, Soothe, etc.)	ophthalmic solution	1–2 drops of 0.05% solution 2–3 times daily	Primarily used in nonprescription products as a decongestant for relief of minor eye irritation.

TABLE 27–2

Anticholinergic Mydriatic Drugs

Note: Client and caregivers must be instructed in the administration of ophthalmic solutions and/or ointments.

Warn client that vision may be affected temporarily after administration and wear sunglasses due to light sensitivity.

Activities such as driving should be avoided during this time.

These drugs are contraindicated in clients with glaucoma.

Store all solutions in tightly closed containers and do not use if it has become cloudy, changed color or has changed in any other way.

Avoid touching tip of ointment or solution container to eye or lashes.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
atropine sulfate *(**AT**-roh-peen-**SUL**-fayt)* (Isopto Atropine, Atropisol, etc.)	ophthalmic solution, ophthalmic ointment	1 drop of 0.5–2% solution or a small amount of ointment up to 3 times daily	Dark glasses may be worn to decrease discomfort from photophobia.
cyclopentolate HCl *(**sigh**-kloh-**PEN**-tah-layt **hy**-droh-**KLOR**-eyed)* (Cyclogyl, etc.)	ophthalmic solution	1 drop of 0.5–2% solution followed by a second drop in 5–10 minutes if necessary	May cause psychotic reaction and behavior disturbances in children. May cause ataxia, hallucination, disorientation, and tachycardia. Warn client that drug may burn when instilled.
homatropine HBr *(hoh-**MAT**-roh-peen **hy**-droh-**BROH**-myd)* (Isopto Homatropine, etc.)	ophthalmic solution	*Refraction:* 1 or 2 drops of 2.0–5% solution; repeat in 5–10 minutes if necessary *Uveitis:* 1 or 2 drops of 2.0–5% solution 2–3 times/day	Physostigmine is an antidote for homatropine HBr poisoning.
scopolamine HBr, hyoscine HBr *(skoh-**POL**-ah-meen **hy**-droh-**BROH**-myd, **HIGH**-oh-sin **hy**-droh-**BROH**-myd)* (Isopto Hyoscine)	ophthalmic solution	*Refraction:* 1 or 2 drops of 0.25% solution 1 hour before refracting *Uveitis:* 1 drop up to 4 times a day	May be used in clients sensitive to atropine. Observe for systemic effects including disorientation and delirium.
tropicamide *(troh-**PICK**-ah-myd)* (Mydriacyl, Tropicacyl, etc.)	ophthalmic solution	*Refraction:* 1–2 drops of 1% solution in the eye(s) repeated in 5 minutes *For fundus examination:* 1–2 drops of a 0.5% solution 15–20 minutes prior to examination	May cause psychotic reaction and behavior disturbances and/or cardiopulmonary collapse in children. Monitor carefully when given to children or elderly clients.

Therapy should be continued for about 14 to 21 days.

An initial dose of 1 drop of a 5% suspension used 4–6 times daily may be adequate for the treatment of fungal blepharitis and conjunctivitis. If no improvement is evident after 7 to 10 days of therapy, one can conclude that the infection is caused by an organism not susceptible to natamycin.

Antiviral Agents

Viral infections of the eye may cause considerable discomfort. If not treated effectively, these disorders may lead to scarring of the retina and loss of vision. Drugs that may be used to treat such infections generally block the reproduction of the viral agent by altering its normal pattern of DNA synthesis.

TABLE 27–3

Antimicrobials Used to Treat Eye Infections

Note: Clients and families need to be instructed on proper instillation technique.
Reinforce need to wash hands before and after instilling eye preparations.
Eye preparations should be instilled in conjunctival sac of affected eye.
Never place medication directly on cornea.
Important to avoid contaminating the tip of the administration container.

DRUG	CLASSIFICATION	ROUTE(S)	DOSE	USE
bacitracin *(bass-i-**TRAY**-sin)* (AK-Tracin)	polypeptide	ophthalmic ointment	Apply 1–2 times daily	Bacterial infection
chloramphenicol *(klor-am-**FEN**-ih-kole)* (Chloromycetin)	miscellaneous	ophthalmic ointment ophthalmic solution	Apply ointment or 1–2 gtts 4–6 times daily	Bacterial infections
chlortetracycline HCl *(klor-tet-rah-**SYE**-kleen)* (Aureomycin)	tetracycline	ophthalmic ointment	Apply ointment 1–2 times daily Apply within 1 hour of delivery	Bacterial or chlamydial infections Ophthalmia neonatorum
ciproflaxin *(**SIH**-pro-flax-in)* (Cipro)	fluroquinolone	ophthalmic solution	Apply 1–2 gtts every 15 min.–4 hours depending on type of bacterial infection	Bacterial infections
erythromycin *(e-rith-ro-**MYE**-sin)* (AK-Mycin)	macrolide	ophthalmic ointment	Apply ointment 4–6 times daily Apply to newborn's eyes within 1 hour after delivery	Bacterial and chlamydial infections Ophthalmia neonatorum
gentamicin *(jen-ta-**MYE**-sin)* (Garamycin)	aminoglycoside	ophthalmic ointment or ophthalmic solution	Apply ointment or 1–2 gtts 4–6 times daily	Bacterial infections
norfloxacin *(nor-**FLOX**-ah-sin)* (Noroxin)	fluroquinolone	ophthalmic solution	Apply 1–2 gtts 4–6 times daily	Bacterial infections
oxytetracycline *(ox-ih-tet-ra-**SYE**-kleen)*	tetracycline	ophthalmic ointment	Apply ointment 2–4 times daily	Bacterial or protozoal infections
polymycin B *(poh-lee-**MYE**-sin)*	polypeptide	ophthalmic solution	Apply 1–3 gtts 4–6 times daily	Bacterial infections
silver nitrate *(sil-ver ni-trate)*	Inorganic metal salt	ophthalmic solution	Instill 2 gtts within 1 hour of delivery	Ophthalmia neonatorum
sulfacetamide *(sul-fah-**SEE**-tah-mide)* (AK-Sulf)	sulfonamide	ophthalmic ointment	Apply ointment 4–6 times daily	Bacterial infections

continues

TABLE 27–3 *continued*

See **Note** at beginning of Table 27–3, page 522.

DRUG	CLASSIFICATION	ROUTE(S)	DOSE	USE
sulfisoxazole diethanolamine *(sul-fih-**SOX**-ah-zole)* (Ocu-Sul)	sulfonamide	ophthalmic ointment ophthalmic solution	Apply ointment or 1–2 gtts 1–3 times daily	Bacterial infections
tetracycline *(tet-rah-**SYE**-kleen)* (Achromycin)	tetracycline	ophthalmic ointment ophthalmic solution	Apply ointment or 1–2 gtts 2–4 times daily	Bacterial and chlamydial infections
tobramycin *(to-broh-**MYE**-sin)* (AK-Tob)	aminoglycoside	ophthalmic ointment ophthalmic solution	Apply ointment 2-3 times daily; Instill 1 drop every 4 hours	Bacterial infections

Idoxuridine (Herplex) is a potent antiviral agent indicated for the treatment of keratitis caused by the herpes simplex virus. One drop of a 0.1% solution is usually placed in the eye every hour during the day and every 2 hours at night, until improvement has taken place. The dosage is then reduced to 1 drop every 2 hours during the day and every 4 hours at night. This regimen is continued for 3 to 5 days after healing appears to be complete. It is important to monitor the progress of the disease carefully to determine if the client is responding. Toxicity may be manifested in the form of hypersensitivity symptoms (e.g., edema, increased redness) or as irritation, pain, and/or photophobia.

Vidarabine (Vira-A) is a drug that is active against herpes simplex types 1 and 2, varicella zoster, and several other viruses. It is administered as a 3% ophthalmic ointment 5 times daily at 3-hour intervals. If no sign of improvement is evident after 7 days, other forms of therapy should be considered. The client should be monitored for the development of burning, irritation or any other adverse changes in the eye while using this medication.

Trifluridine (Viroptic) is an agent that may also be used to treat viral infections of the eye. It is particularly effective in the treatment of herpes simplex types 1 and 2 infections. Some clients who do not respond to vidarabine therapy may respond to trifluridine. This drug is administered by instilling one drop of the solution onto the cornea of the affected eye every 2 hours while awake for a maximum daily dosage of 9 drops, until the corneal ulcer has completely re-epithelialized. After remission, administration of 1 drop every 4 hours while awake for a minimum daily dosage of 5 drops is continued for 7 days. Ocular toxicity may result if this drug is administered for longer than 21 days. Trifluridine Ophthalmic Solution must be stored at 2°–8°C (36°–46°F).

ANTISEPTICS

The use of antiseptic agents in the eye has declined sharply as new and more potent anti-infective agents have been developed. Solutions of boric acid, **zinc sulfate**, and some of the surface-active wetting agents are used primarily as ocular irrigants. Solutions of silver nitrate or **mild silver protein** are used to precipitate and remove accumulated mucus from the eye. Their antiseptic action may be attributed to precipitation of bacterial protein by liberated silver ions. **Yellow mercuric oxide** has been used to treat irritations and minor infections of the eyelids. Frequent or prolonged use should be avoided because it may lead to serious mercury poisoning.

LOCAL ANESTHETICS

These agents are used in procedures where a topical ophthalmic anesthetic is required (e.g., *tonometry*, *gonioscopy*, removal of foreign objects, or stitches from the cornea or any other surgical procedure of short duration). Solutions of these drugs (Table 27–4) are generally administered by placing 1–2 drops into the eye shortly before the measurement or procedure is to be initiated.

The blinking reflex is temporarily eliminated while the eye is in the anesthetized state. Therefore, it is important to protect the anesthetized eye from irritating chemicals, foreign objects and

TABLE 27–4

Local Anesthetics Used in the Eye

Note: Avoid contamination of the tip of the administration container.
May interfere with wound healing. Use sparingly and carefully follow the directions of the prescriber.
Instruct client or caregiver in method of administration.
Store solutions in tightly closed containers.
Do not use if the solution has changed in any way.
An eye patch may be used to protect the eye after administration of the drug.

DRUG	DOSAGE FORMS	USUAL DOSE	NURSING IMPLICATIONS
benoxinate HCl *(ben-**OCK**-sih-nayt **hy**-droh-**KLOR**-eyed)*	ophthalmic solution	*Removal of foreign objects and sutures, tonometry:* 1–2 drops of a 0.4% solution before procedure *Deep ophthalmic anesthesia:* 2 drops of a 0.4% solution in each eye at 90-second intervals for 3 instillations	Available only in combination with fluorescein sodium (Fluress).
proparacaine HCl *(proh-**PAR**-ah-kayn **hy**-droh-**KLOR**-eyed)* (AK-Taine ✱, Alcaine, Ophthaine, etc.)	ophthalmic solution	1–2 drops of 0.5% solution as needed	May cause allergic contact dermatitis involving fingertips, corneal epithelium and conjunctiva.
tetracaine, tetracaine HCl *(**TET**-rah-kayn, **TET**-rah-kayn **hy**-droh-**KLOR**-eyed)* (Pontocaine, etc.)	ophthalmic solution, ophthalmic ointment	1–2 drops of 0.5% solution or 0.5–1 inch of ointment as needed	Tetracaine HCl is not compatible with silver or mercury salts.

friction from rubbing. Clients should also be monitored for the development of symptoms of hypersensitivity. If such symptoms develop, the use of the drug should be discontinued.

CORTICOSTEROIDS

Corticosteroids are used in the eye to exert an anti-inflammatory action (refer to Chapter 12). They are useful in relieving pain and discomfort that may accompany ocular infection, trauma, and allergic disorders. They may also be used to inhibit scar formation after ocular surgery.

The use of corticosteroids in the eye is contraindicated in the presence of most fungal and viral infections, as steroids may facilitate their spread. When steroids are used in the eye, they should be applied only for short periods, as their prolonged use may result in glaucoma, damage to the structure of the eye including the optic nerve, cataract formation, and increased susceptibility to infection. Clients using these drugs should have their eyes examined frequently and they should be closely monitored for the development of increased intraocular pressure.

Corticosteroids may be administered in the form of a solution, suspension, or as an ophthalmic ointment. As initial therapy, 1–2 drops of the solution or suspension (shaken well before use) are instilled into the conjunctival sac every hour during the day and every 2 hours during the night. When the client begins to respond favorably, the dose may be reduced to 1 drop every 4 hours. This may be further reduced to 1 drop 3–4 times daily to control symptoms.

A thin coating of the corticosteroid ointment is generally applied to the affected area 3–4 times daily. Once a favorable response is observed, applications can be reduced to 1–2 times daily.

One of the newest of the ophthalmic corticosteroids is **loteprednol etabonate** (**Alrex**, **Lotomax**). It is available in two strengths 0.2% (Alrex) and 0.5% (Lotomax). The lower strength is designed for seasonal allergy manifestations and the higher strength is used to treat steroid-responsive inflammatory conditions. One of the unique characteristics

of loteprednol is that it does not increase intraocular pressure which is a problematic tendency of most ophthalmic corticosteroids. The recommended dosage is 1–2 gtts in the affected eye. Because loteprednol contains benzalkonium as a preservative, clients who wear contact lenses need to be instructed to remove lenses before instilling loteprednol.

Box 27–1 lists products that contain corticosteroids and those combining corticosteroids with other drugs.

NONSTEROIDAL ANTI-INFLAMMATORY AGENTS

Four nonsteroidal anti-inflammatory drugs (NSAIDs) are available for ophthalmic use. **Flurbiprofen sodium** (Ocufen) is administered as a 0.03% ophthalmic solution to inhibit the miotic (pupillary constriction) response often produced during ocular cataract surgery. Also, it has been used to reduce edema and inflammation after ocular surgery and for other forms of ocular inflammation. When used to prevent miosis during ocular surgery, one drop of the flurbiprofen sodium solution is administered every 30 minutes beginning 2 hours before surgery.

Suprofen (**Profenal**), available as a 1% ophthalmic solution, also is indicated to inhibit miosis during cataract surgery. Both flurbiprofen sodium and suprofen should not be used in clients with epithelial herpes simplex keratitis.

Diclofenac sodium (**Voltaren**) 0.1% ophthalmic solution treats inflammation that often occurs after cataract extraction procedures. Use of this product is contraindicated in clients who wear contact lenses. All NSAIDs may cause hypersensitivity reactions in clients who have a history of hypersensitivity to aspirin or other nonsteroidal anti-inflammatory agents.

Ketorolac tromethamine is an agent that is indicated for the relief of ocular itching caused by seasonal allergic conjunctivitis. It is administered as a 0.5% solution 4 times daily for up to 1 week. It should also not be used in clients wearing soft contact lenses.

MISCELLANEOUS AGENTS

Other drugs used in the eye include several prescription and nonprescription agents. These include **fluorescein sodium**, **fluorexon**, **lodoxamide tromethamine**, **levocabastine HCl**, chymotrypsin, **dapiprazole HCl**, and **artificial tears**.

BOX 27–1 Corticosteroids Used in the Eye

dexamethasone	loteprednol etabonate
dexamethasone phosphate	medrysone
fluorometholone acetate	prednisolone acetate
hydrocortisone	prednisolone phosphate
hydrocortisone acetate	prednisolone sodium phosphate

Fluorescein Sodium (Ak-Fluor, Fluor-I-Strip, Ful-Glo, Etc.)

This agent is a dye permitting the detection of internal or surface ocular defects, including defects involving the blood vessels of the eye. It may also be used in the fitting of hard contact lenses. Depending on its use, fluorescein may be applied directly to the corneal surface of the eye or it may be injected intravenously. Topical application is generally performed by instilling a fluorescein sodium solution to the eye or by touching a dye-impregnated paper strip, which has been previously moistened with sterile water, to the eye. Parenteral administration of this agent permits more effective examination of the blood vessels of the eye.

Fluorexon (Fluoresoft)

Fluorexon is a chemical modification of fluorescein used as a diagnostic and fitting aid for clients wearing hydrogel (soft) contact lenses. Fluorexon use is preferred in such procedures, as it is less likely to stain hydrogel lenses than is fluorescein.

Lodoxamide Tromethamine (Alomide)

Lodoxamide tromethamine is a mast cell stabilizer that inhibits increases in the permeability of blood vessels in the eye in response to increased levels of histamine and other substances that may be released in inflammatory disorders of the eye. Lodoxamide is particularly used in the treatment of keratoconjunctivitis and keratitis. Generally 1 to 2 drops of a 0.1% solution are administered to the affected eye(s) 4 times daily. The safety of the drug has not been established in children under the age of 3.

Levocabastine HCl (Livostin)

Levocabastine HCl is an antihistamine used to relieve the signs and symptoms of seasonal allergic conjunctivitis. It is administered to adults and children 12 and over in a dose of 1 drop in the affected eyes 4 times daily. Because the product is a suspension, it must be shaken well before each administration.

Chymotrypsin (Alpha Chymar, Zolyse, Catarase)

This is a proteolytic enzyme which is used to facilitate cataract removal. A dosage of 1–2 mL of a 1:5000 solution is injected into the posterior chamber of the eye and allowed to dissolve the filaments, or *zonules*, which hold the lens in place. Once the lens has been removed, the area is irrigated with sodium chloride solution to remove residual drug.

A transient increase in intraocular pressure may occur temporarily after therapy. This can be treated by the use of an appropriate pilocarpine solution.

Dapiprazole HCl (Rev-Eyes)

Dapiprazole HCl is an alpha-adrenergic blocking agent (see Chapter 15) used to constrict the pupil when reversal of mydriasis is desired after mydriatic drugs have been used in the eye. When it is employed, 2 drops of a 0.5% solution are administered initially. This is followed 5 minutes later by an additional 2 drops. The product should not be used more than once each week in the same client.

Artificial Tears (Isopto Tears, Lacril, Tearisol, Tears Naturale, Etc.)

A number of products which provide tear-like lubrication are available for the treatment of dry eyes and irritation caused by deficient tear production (e.g., in comatose clients, those with neurological disorders). These products may be used for the lubrication of contact lenses and artificial eyes. Most contain an *isotonic* mixture of salts and buffers as well as agents which increase the viscosity of the solution to prolong contact time with the eye.

APPLYING THE NURSING PROCESS

ASSESSMENT

A host of ophthalmic drugs are used for various purposes. It is important for the nurse to be familiar with the product being used, the therapeutic goal, and the client's medical history. Product information packaged with the medication can refresh the nurse's knowledge before the drug is administered.

In caring for clients with ophthalmic disorders, the nurse examines the eyes for discharge, redness, presence of foreign objects, corneal ulceration, or bleeding. Clients are questioned about pain, photophobia, blurred vision, and other visual changes. In some cases, a complete eye examination may be indicated. Refer to Chapter 6.

NURSING DIAGNOSES

Including but not limited to:

- Disturbed sensory visual perception related to infection, inflammation
- Impaired home maintenance management related to visual impairment
- Risk for injury related to side effects of ophthalmic medications
- Deficient knowledge related to disease process and medical regimen

PLANNING/GOALS

- Client will verbalize improvement in vision.
- Client will demonstrate independence in home care and accurate administration of ophthalmic medications.
- Client will not experience side effects from ophthalmic medications.
- Client will verbalize understanding of disease process and medication regimen.

IMPLEMENTATION

Knowledge about the proper method of administering ophthalmic preparations is important. In some cases, the nurse will be responsible

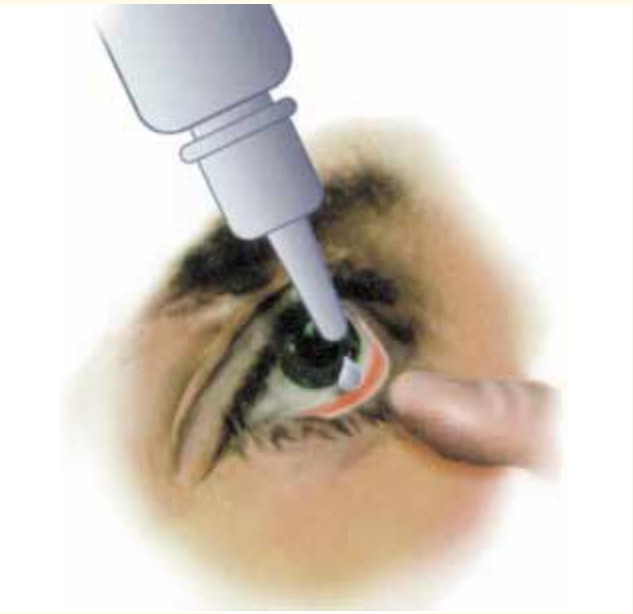
for administering the medication; in other cases the nurse will be instructing the client or family member in the administration of drops or ointments. The administration of eye drops was illustrated and discussed in Chapter 26. The administration of eye ointment is illustrated in Figure 27–1.

An eye patch may be applied following administration of ophthalmic medication to:

- children and individuals not fully conscious who may rub or irritate the eye
- clients who have received local anesthetics and who temporarily have no blinking reflex
- clients with sensitivity to light (photosensitivity)
- clients with a considerable amount of drainage from the eye

In applying a patch, be certain to maintain sterility of the side placed next to the eye. Place the underside of the patch (without seams) over the eye. Use nonallergenic tape to secure the patch. Inquire about the comfort of the patch after it is secured. If it is uncomfortable, the client will not keep it in place. Adjust the tape to provide for comfort. Advise the client of when the patch is to be removed or replaced. When administering eye medication to anyone who is already wearing a patch, discard the patch. The hands are washed and the lids and lashes are gently cleansed with water or saline, using a gauze pad, if there is drainage present. Following this, proceed with the instillation of the medication as outlined. Never reuse an eye patch.

There are several other general guidelines the nurse uses in the administration of topical ophthalmic medications. First, it is important to be absolutely certain about which eye is being treated with which drug. In preparation for surgery or other procedures or in treatment of various eye conditions, clients may receive several drugs. Sometimes each eye is receiving a different treatment. The medication order *must* be checked carefully. In addition, the nurse must remember that OS refers to the left eye, OD to the right eye and OU to both eyes. In some cases—particularly if the client has glaucoma—mistakes can be detrimental to the client's vision and/or recovery. When the client is being treated for infection in both eyes, administer medication to the least affected eye first to avoid cross-contamination.



1. Assemble the necessary equipment. Wash your hands and put on powder free gloves.
2. Open the affected eye and tilt the head back toward the ceiling.
3. Gently pull down the lower lid to form a pouch.
4. Squeeze the drop into the conjunctival sac. Be careful not to touch the eye or eyelid with the tube.
5. Instruct the client to close the eye and blink several times. Do not rub the eye. Elbow restraints may be necessary to prevent infants and young children from rubbing the affected eye.
6. Instruct the client that vision may be blurred temporarily after applying this medication, and tasks such as driving should be avoided until the vision clears.
7. Remove gloves and wash hands.
8. Chart the name and dosage of the medication given, the eye treated, the time of administration, and observations about the eye and/or the client's tolerance of the procedure.

Figure 27–1 Instillation of eye drops

Another routine nursing action consists of telling clients whether their vision will be affected by the use of the medication. They are instructed not to operate automobiles or engage in hazardous activities during the time their vision is impaired. The safety of the elderly, particularly, must be assured, and they are to be assisted with ambulation until their vision clears.

Clients receiving eye medications, particularly those receiving anti-infectives or corticosteroids, may be tempted to stop treatment

NURSING CARE PLAN

A Client with an Eye Infection Using Vidarabine Ointment (Vira-A)

Mary Walker, age 26, has had repeated bouts of upper respiratory infection this last year. She gets extremely congested and has a postnasal drip that causes a productive cough. She frequently gets "cold sores" at the same time. For the past week, she has noticed redness and tear formation in her right eye. Yesterday, she awakened with pain in her eye. She went immediately to an eye specialist. After slit-lamp examination she was diagnosed as having herpes simplex type I in her right eye. The physician prescribed vidarabine ophthalmic ointment 3% (Vira-A). She was told to administer approximately ½ inch of the ointment into the lower conjunctival sac five times daily at 3 hour intervals for the next 7 days. She was also instructed to call the physician if burning, pain, or extreme lacrimation occured. A return office visit was scheduled for day 8 to evaluate the effects of the medication.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Vision changes.	Disturbed sensory visual perception related to infectious process.	Client maintains optimal functioning within limits of visual impairment as evidenced by ability to care for self and to navigate safely.	Evaluate client's ability to function within limits of visual impairment. Modify environment to promote safety. Describe surroundings if necessary. Don't rearrange furniture. Provide diversional activity such as radio, audio-tapes, talking.	Client cares for self and navigates environment without an injury.
Eye pain.	Acute pain related to tissue trauma secondary to herpes simplex.	By day 3, client will verbalize relief of pain after following drug therapy.	Encourage client to take medication as ordered every three hours. Eye pain will start to diminish and should be totally gone in 3 days.	Client no longer has eye pain.
Photophobia.	Risk for impaired home maintenance management related to vision changes.	Client will verbalize understanding of home adjustments. Client identifies available resources.	Review home safety measures pertinent to deficits. Client who lives alone may need companion until vision improves. Drug may cause photophobia, sunglasses should be worn.	Client lives alone. Social services provides a home health aide to assist with cleaning and meals.
Knowledge of drug routine.	Deficient knowledge related to new drug therapy, vidarabine (Vira-A).	Client will verbalize understanding of drug therapy, potential side effects.	Teach client to wash hands before and after drug instillation. Drug blurs vision on contact; avoid driving and other dangerous activity. Burning or eye irritation should be reported.	Client demonstrates the proper administration; places medication in lower conjuctival sac from inner to outer aspect.
Respiratory infections.	Ineffective health maintenance related to lack of knowledge of preventing repeated infections.	Client will identify the health care changes necessary to prevent repeated respiratory infections.	Teach client to avoid cold and being in a draft. Also avoid exposure to persons who have upper respiratory infections. Teach importance of handwashing in preventing infections. Balanced diet and enough rest to maintain resistance important.	Client is able to state methods of avoiding respiratory infections. Number and frequency of respiratory infections decrease.

Health care practices.	Ineffective individual coping related to perceived changes in lifestyle based on vision changes.	Client will identify methods of coping and how to use problem-solving skills in her situation.	Listen to client's concerns. Encourage client to develop problem-solving skills.	Client is able to verbalize concerns and methods of coping.
Activity. Visual deficit.	Risk for injury related to visual changes.	Client will not have accident or injury.	Provide client with assistance for ambulation. Review home safety measures, such as removing throw rugs. Instruct client not to drive or engage in other activities requiring clarity of vision during periods of blurred vision.	Client made changes in home and activities to lessen chances of injury.

prematurely. These clients are to be encouraged to continue therapy as ordered beyond the relief of symptoms to prevent recurrence of the problem.

As stated previously, clients receiving ophthalmic preparations containing corticosteroids must be observed carefully. Intraocular pressure may increase, causing headache and blurred vision, with an acute attack of glaucoma possibly being precipitated in susceptible individuals.

Both the nurse and the client who is treated outside the hospital must be familiar with the storage requirements for ophthalmic preparations. In addition, no ophthalmic drug or solution is used if it has become contaminated, changed color, or has been altered in any way since it was first obtained.

Many clients will be concerned about losing their vision. Therefore, the nurse performs tasks gently and thoroughly. In addition, simple explanations and calm reassurances are helpful in facilitating a client's recovery.

EVALUATION

- Client verbalizes improvement in vision.
- Client demonstrates independence in home care and accurate administration of ophthalmic medications.
- Client does not experience injury related to side effects from ophthalmic medications.
- Client verbalizes understanding of disease process and medication regimen.

KEY NURSING IMPLICATIONS 27–1

Use of Ophthalmic Preparations

1. Examine the client's eyes for discharge, redness, presence of foreign objects, corneal ulceration, or bleeding and ask about pain, photophobia, blurred vision, and other visual changes.
2. In administering eye ointments, pull down the lower lid to make a pouch and squeeze approximately ¼ to ½ inch of ointment into the pouch, working from the inner to the outer canthus of the eye.
3. Eye patches are indicated for children and for clients not fully conscious, without a blink reflex, with photosensitivity, or with drainage from the eye.
4. Always be certain that the correct medication is being used in the correct eye and that the medication is labeled "For Ophthalmic Use."
5. Provide for the safety of clients whose vision is affected by their illness or its treatment.
6. Encourage the client to continue treatment after symptomatic relief has been obtained.
7. Be aware that an acute attack of glaucoma may be precipitated in susceptible clients using corticosteroids.
8. Never use any ophthalmic preparation that has become contaminated, changed color or been altered in any way.

HOME CARE / CLIENT TEACHING

1. Provide instruction for persons self-administering ophthalmic medications. Be sure to include information about proper storage of the medication.
2. Remind persons using medications affecting vision that driving and other hazardous activities should be avoided until the vision clears.
3. When visiting the home, examine solutions used in the eye to ensure that they have not changed color or altered in appearance since they were obtained.
4. If client or family member is applying a patch, inform about maintaining sterility on the side placed next to the eye and to use nonallergenic tape to secure patch.
5. Clients taking ophthalmic anti-infectives or corticosteroids need to be instructed to continue therapy as ordered even though the conditions may seem to have improved and to discard any medication left after completing prescribed regimen.
6. Clients receiving mydriatics should be encouraged to wear sunglasses to protect the eyes from the light sensitivity that follows the administration of these medications.

CASE STUDY

Casey Stratton, age 3, develops redness and discomfort in his right eye. His mother notices a purulent discharge from the eye and takes him to see the physician. The physician diagnoses a bacterial eye infection and prescribes **Gentamycin** 0.3% ophthalmic ointment. He gives the office nurse the following directions:

- Teach mother to administer the Gentamycin ointment to OD, BID
- Schedule follow-up appointment for 1 week.

Questions for Discussion

1. What are the steps in administering the eye ointment which the nurse should teach Casey's mother?
2. What other nursing actions are appropriate for this client?

CRITICAL THINKING EXERCISES

1. Practice using a fluorescein strip on a practice model.
2. Prepare a visual aid that could be used to instruct clients in the procedures to be used in administering ophthalmic ointments.
3. Attend an eye clinic. Write a brief report on the types of health problems treated and the nature of the treatment.
4. Determine the type of restraining devices used to prevent infants and young children from touching their eyes following surgery or during the treatment of an eye disorder.
5. Prepare a report on cytomegalovirus retinitis in persons with AIDS.

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SECTION 8

Agents Used to Treat Cardiovascular Disorders

MAJOR NURSING DIAGNOSES

- Decreased Cardiac Output
- Ineffective Tissue Perfusion: Renal, Cardiopulmonary, Gastrointestinal, Cerebral
- Activity Intolerance
- Excess Fluid Volume
- Deficient Fluid Volume
- Deficient Knowledge (Illness and Its Treatment)
- Pain Related to Myocardial Ischemia
- Impaired Gas Exchange

28 Cardiac Stimulants and Depressants

OBJECTIVES

After studying this chapter, the student will be able to:

- Distinguish between positive and negative inotropic effects, positive and negative chronotropic effects, and positive and negative dromotropic effects of agents on the heart
- Discuss the mechanisms by which cardiac glycosides provide effective treatment for congestive heart failure
- List three factors affecting the selection of an appropriate cardiac glycoside for a particular client
- Define a digitalizing dose
- List the most common gastrointestinal, neurological, and cardiac symptoms indicative of cardiac glycoside intoxication
- List three factors that may predispose a client to the development of cardiac glycoside toxicity
- Describe the mechanism of action and adverse effects related to the use of inamrinone and milrinone
- Describe the mechanism of action and adverse effects related to the use of calcium channel antagonists
- Apply the nursing process for clients receiving cardiac drugs
- Describe three ways in which antiarrhythmic drugs act to diminish or obliterate rhythm disturbances of the heart
- Identify the most common adverse effects associated with antiarrhythmic agents
- Apply the nursing process for clients taking antiarrhythmic agents
- Identify the mechanism of action and common adverse effects and apply nursing measures related to the use of the cardiac stimulants most commonly employed in the treatment of shock

The heart is a complex blood-pumping organ which contains specialized cardiac muscle and a unique system for generating and conducting electrical impulses. The most powerful generator of electrical impulses in the heart is the sinoatrial (SA) node (Figure 28–1). When the SA node generates an electrical impulse, a contraction of the atrium occurs. The impulse then proceeds through the atria to the atrioventricular (AV) node, which usually acts to coordinate atrial and ventricular contraction. However, the atrioventricular node can act as a pacemaker when the generator of impulses from the SA node is suppressed. Rhythms generated by the SA node are referred to as sinus rhythms. Those emanating from the AV node are called nodal rhythms. Electrical activity through the SA and AV nodes is dependent, to a great extent, on the influx of calcium through channels in the cardiac cell

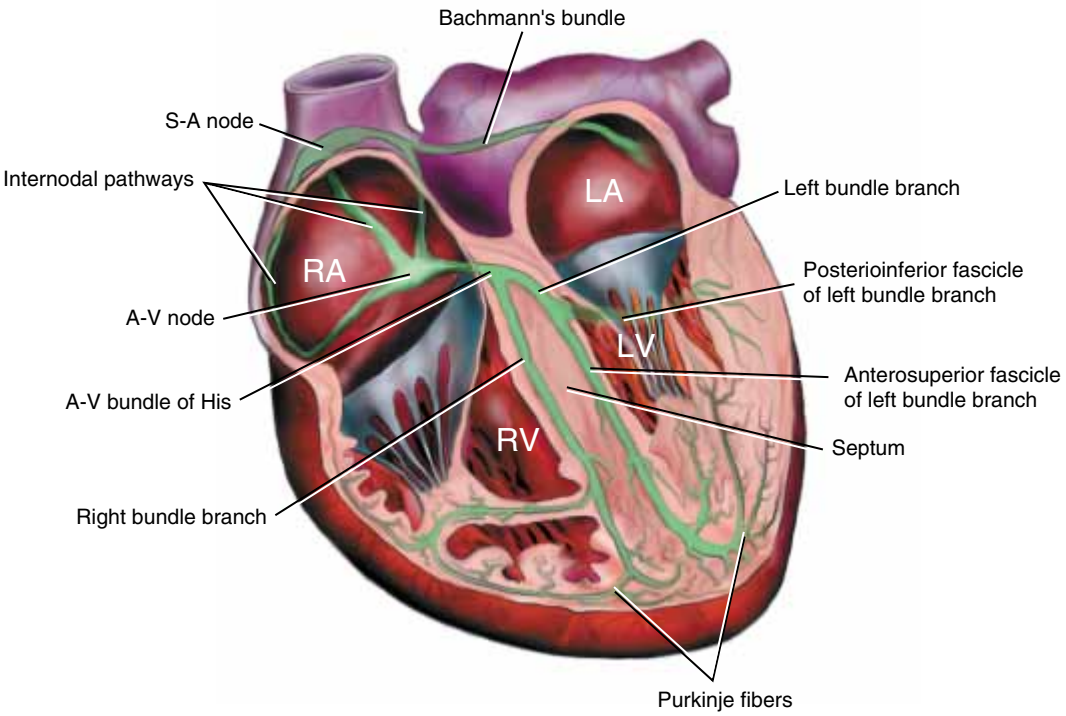

Figure 28–1 Location of the sinoatrial (SA) node and the atrioventricular (AV)node

membrane into the cell. The entire contraction of the heart is known as a systole. Although both the atria and the ventricles have systole and diastole periods (the atria in systole when the ventricles are in diastole and the atria in diastole when the ventricles are in systole), the systole in the ventricles is considered the heartbeat, because it is audible and palpable. Systole occurs about 60–100 times each minute in adults and more rapidly in children and infants, depending on their age. For example, infants have a normal heart rate of 120–160 beats per minute, with the normal rate for toddlers being 90–140 beats, for preschoolers 80–110 beats, school-age children 75–100 beats, and adolescents 60–90 beats. Each systole is normally followed by a period of cardiac muscle relaxation known as diastole.

Heart rate is primarily controlled by the autonomic nervous system (ANS). Parasympathetic (cholinergic) nerve endings (vagal fibers) are located in close proximity to the SA node and other areas of the atria and ventricles. With stimulation of these nerves (vagal stimulation), the neurotransmitter acetylcholine is released at the junction of the nerve and the cardiac muscle (myocardium). This acts to slow the heart rate by inhibiting impulse formation and electrical conduction in the heart.

Sympathetic (adrenergic) nerve fibers also *innervate* various portions of the heart. When these are stimulated, the neurotransmitter norepinephrine is released. This action tends to increase heart rate by promoting impulse formation and electrical conduction in the heart. Sympathetic stimulation also tends to reduce the time interval between consecutive generations of impulses. It therefore reduces the duration of the refractory period, i.e., the time between consecutive muscle contractions.

Drugs can change several aspects of cardiac action. They can:

- increase or decrease the force of myocardial contraction. Drugs that increase the force of contraction are said to exert a positive *inotropic* effect on the heart. Those that reduce the force of contraction are said to exert a negative inotropic effect.
- increase or decrease heart rate by altering the rate of impulse formation at the SA node. Drugs that increase heart rate are said to exert a positive *chronotropic* effect. Those slowing heart rate are said to exert a negative chronotropic effect.
- increase or decrease the conduction of electrical impulses through the myocardium. Drugs that increase the rate of electrical conduction are said to exert a positive *dromotropic* effect. Those that slow conduction are said to exert a negative dromotropic effect.

CARDIAC GLYCOSIDES

Digoxin and similar drugs belong to a chemical class usually referred to as the *cardiac glycosides*. They are all derived from natural sources and have been recognized for centuries for their medicinal qualities. Although commonly employed in ancient civilizations as emetics, *diuretics*, heart tonics, and even as rat poisons, the cardiac glycosides have emerged during the last century as popular and effective agents for the treatment of congestive heart failure. This condition is often the result of the sustained presence of one or more underlying cardiovascular diseases in the client.

Congestive heart failure is often characterized by:

- cardiac distention resulting from the inability of the ventricles to pump the entire volume of blood with which they are presented
- cardiac *hypertrophy* caused by the heart's adaptation to prolonged stretching
- sodium and water retention caused, in part, by diminished renal blood flow

These effects result in weight gain, edema, shortness of breath, pulmonary congestion, and a variety of other symptoms.

Cardiac glycosides usually provide effective treatment for congestive heart failure by exerting a positive inotropic action on the heart. In so doing, they increase the force of myocardial contraction and thereby improve the mechanical efficiency of the heart as a blood-pumping organ. This ultimately results in a reduction in heart size and increased blood flow to the kidneys. Improved renal blood flow causes a diuretic effect, which eventually reduces the concentration of sodium and water in the body. Cardiac glycosides also tend to exert negative chronotropic and dromotropic actions on the heart, thereby making them potentially useful agents in the treatment of various cardiac arrhythmias.

The actions of cardiac glycosides are still not completely understood. Their actions are believed to be the consequence of an ability to cause the release of free calcium within the cardiac muscle cell, thereby potentiating the action of *actin* and *myosin*, the major myocardial proteins responsible for muscle contraction. In addition, these drugs also change the electrical behavior of the myocardium. They tend to decrease the velocity of electrical conduction and prolong the refractory period in the atrial-ventricular conduction system. The ability of the cardiac glycosides to slow the heart has also been attributed to their ability to increase vagal tone.

Cardiac glycosides, including digoxin and **digitoxin**, are isolated in their pure form from the foxglove plant. Although all cardiac glycosides have similar pharmacological properties and toxic effects, they differ in their rates of absorption and elimination from the body, as well as their onset and duration of action.

Proper use of cardiac glycosides is dependent on:

- selection of the proper drug product
- optimal dosing of the drug
- careful monitoring of the client during therapy

Drug Selection

Selection of the proper cardiac glycoside is generally based on the route of administration to be used and the duration of action desired. The oral route is most desirable, because it is the safest and most convenient and economical form of therapy. All orally administered cardiac glycosides tend to cause gastric irritation. Although this can be minimized by administering the drug with or immediately following meals, there is evidence that food and certain adsorptive drug products, such as antacids and adsorbent antidiarrheal agents, e.g., **kaolin-pectin suspension**, can interfere with the absorption of cardiac glycosides. Proper timing of an oral cardiac glycoside dose will usually prevent this effect. Differences in the availability of drug from tablets made by different manufacturers have also been reported. Providing a client with a reliable brand of drug from the same manufacturer will diminish the possibility of tablet variation.

Digoxin has evolved as the most popular cardiac glycoside in the United States, because it has a shorter duration of action than digitoxin and similar agents. It is less likely, therefore, to result in the cumulative development of toxic effects. Table 28–1 lists the properties of some of the most popular cardiac glycosides. Nursing implications are the basis for planning client care and education.

Dosing

Because most of the cardiac glycosides have a fairly long duration of action, a loading or "digitalizing" dose may be initially administered to rapidly bring serum levels of the drug up to a desirable therapeutic level. This is followed by daily maintenance doses intended to replace medication that has been metabolized or eliminated from the body. To establish an optimal dosing regimen, due consideration must be given to the client's physical size, other drugs the client is

TABLE 28–1

Cardiac Glycosides in Current Use

Note: Taking digitoxin or digoxin with meals may decrease gastric irritation.

Do not administer if pulse is less than 60 beats per minute (adults), 90 beats per minute (infants), or 70 beats per minute (children up to adolescence).

Report heart rates below these levels to the physician. Also report heart rates of 100 or more per minute.

Report any evidence of irregular rhythm.

Observe client for toxicity, including symptoms of headaches, visual disturbances, nausea, vomiting, anorexia, or disorientation.

Clients taking diuretics other than potassium-sparing diuretics are at particular risk of developing toxicity.

Monitor potassium levels and encourage intake of potassium-rich foods.

Client education is especially important. This includes instruction in taking a radial pulse, as well as directions to notify the physician if indications of toxicity occur.

Hypothyroid clients are particularly sensitive to these drugs.

Monitor drug level.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DIGITALIZING DOSE	USUAL MAINTENANCE DOSE	NURSING IMPLICATIONS
digitoxin *(**dij**-ih-**TOCK**-sin)*	oral, IV	Oral and IV: 0.6 mg initially followed by 0.4 mg and then 0.2 mg at 4–6-hour intervals or 0.2 mg 2 times daily for 4 days	0.05–0.3 mg daily *Children:* 1/10 of digitalizing dose (0.3–0.45 mg/kg)	Has slowest onset and longest duration of action of any cardiac glycoside. Do not change brands without consulting the physician. Therapeutic blood level: 14–26 ng/ml Monitor dosage carefully, as it can be ordered or sent from pharmacy as either milligrams (mg) or micrograms (mcg).
digoxin *(dih-**JOCK**-sin)* (Lanoxin, Lanoxicaps, etc.)	oral, IV	Rapid digitalization: Oral: 0.5–0.75 mg* initially, then 0.25–0.5 mg every 6–8 hours until therapeutic levels are reached IV: 0.4–0.6 mg initially, then 0.25 mg every 4–6 hours as above	0.125–0.5 mg* daily	Best absorbed orally in solution-filled capsule (Lanoxicaps) form. Do not change brands without consulting the physician. Gradual digitalization may be achieved by administering 100–500 mcg (0.1–0.5mg) of digoxin orally each day depending on body weight and drug clearance. Therapeutic blood level: 0.5–2 ng/ml.

*Lanoxicaps have a greater bioavailability than tablets: 0.2 mg capsules are equivalent to 0.25 mg tablets and 0.1 mg capsules are equivalent to 0.125 mg tablets.

taking, and the presence of factors that could slow the rate of the drug's elimination from the body (e.g., renal or hepatic impairment, advanced age, and other illnesses). In place of a digitalizing dose, conventional maintenance doses can be used from the very onset of therapy, particularly when a relatively short-acting cardiac glycoside, such as digoxin, is used. In most clients with normal renal function, such dosing usually results in attaining a drug concentration plateau in the serum within about 7 days of therapy.

Monitoring

All cardiac glycosides have a low therapeutic index; that is, the therapeutic dose is very close to the toxic dose. This requires close client monitoring throughout treatment and skill in identifying toxic manifestations of therapy.

Cardiac glycosides cause a variety of symptoms of intoxication when given in high doses or when allowed to accumulate in the client taking regular maintenance doses. Toxicity can be life-threatening

and occurs in 10–20% of clients. The most common of these effects are:

- *gastrointestinal distress*—Nausea, vomiting, anorexia, and/or diarrhea are among the earliest signs of cardiac glycoside intoxication. These symptoms may be accompanied by excessive salivation and abdominal pain. They usually subside rapidly when the dose is reduced or the drug is discontinued.
- *neurological effects*—Cardiac glycoside toxicity may be manifested as restlessness, irritability, headache, weakness, *lethargy*, drowsiness, and/or confusion. Visual disturbances such as blurred or colored vision, halo vision, *amblyopia*, and *diplopia* are also commonly seen. Some of these neurological effects may be missed, because of their similarity to manifestations of aging. So particular care must be taken to carefully monitor the use of cardiac glycosides in elderly clients.
- *cardiac effects*—Cardiac glycoside toxicity has been associated with the development of virtually every known cardiac arrhythmia. The most frequent of these is the development of extrasystoles (extra beats). A form of extrasystole, the "bigeminal" rhythm, is typically a sign of cardiac glycoside toxicity in adults. It is characterized by a normal beat followed closely by a second beat. Bradycardia and primary atrial-ventricular (A-V) block are the most common adverse cardiac effects.

Several factors may predispose a client to the development of cardiac glycoside toxicity:

- *hypokalemia*—Potassium loss, often the consequence of diuretic action, extensive diarrhea or vomiting, or the prolonged administration of potassium-free intravenous fluids, generally increases the chance of cardiac glycoside toxicity. The potassium depletion increases the sensitivity of cardiac muscles to the effects of cardiac glycosides.
- *renal impairment*—As 60–90% of a cardiac glycoside dose is excreted unchanged by the kidneys, even modest renal impairment can dramatically hasten the accumulation of toxic drug concentrations in the body. Assessment of renal function prior to therapy is, therefore, an important means of determining the proper dosing regimen for the client. This is particularly important in elderly clients for whom renal impairment may be the rule rather than the exception.
- *intravenous drug administration*—Although the intravenous route may be more desirable to use in emergency situations, its use may rapidly result in the accumulation of toxic concentrations of a cardiac glycoside in the blood. This may lead to severe toxicity or death.

Successful treatment of cardiac glycoside toxicity can often be best accomplished by withdrawal of the drug. In clients exhibiting cardiac glycoside-induced arrhythmias (dysrhthmias), potassium administration may be indicated, especially when low serum potassium levels are determined. In some situations, the use of antiarrhythmic drugs, such as lidocaine, phenytoin, and/or propranolol, may be useful.

In situations where digoxin intoxication is potentially life-threatening, **digoxin immune fab** (**Digibind**) may be used. This product contains antigen-binding fragments (fab) that can combine with digoxin to neutralize its action.

AMRINONE LACTATE (INOCOR) AND MILRINONE LACTATE (PRIMACOR)

Note: Because of medication errors, **amrinone lactate**'s name has been changed to **inamrinone lactate**.

Inamrinone lactate and **milrinone lactate** (**Primacor**) are relatively new drugs, which, like the cardiac glycosides, exert a positive inotropic effect on the heart. They also produce a direct relaxant effect on vascular smooth muscle, thereby resulting in vasodilation. The combination of a positive inotropic effect and vasodilation results in increased cardiac output and decreased myocardial oxygen consumption. Unlike the cardiac glycosides, inamrinone does not appear to be likely to cause arrhythmias, even when administered in large doses. It does, however, appear to cause thrombocytopenia, drug fever, and/or gastrointestinal disturbances in some clients. The use of milrinone may result in the development of ventricular arrhythmias, hypotension, and/or headaches.

Inamrinone and milrinone are currently indicated only for the short-term management of congestive heart failure. Inamrinone should only be used in those clients who have not adequately responded to cardiac glycosides, diuretics or vasodilators. It is administered intravenously, initially as an IV bolus of 0.75 mg/kg over 2–3 minutes and then as an infusion at a rate of 5–10 mcg/kg/min. Daily inamrinone dosage should not exceed 10 mg/kg. Milrinone is initially administered in a 50 mcg/kg loading dose over a period of 10 minutes.

It is then infused at a rate of 0.375–0.75 mcg/min/kg with close monitoring of the client.

As a chemical reaction occurs slowly between inamrinone and dextrose solutions, it is important not to dilute the drug in dextrose solutions prior to injection. It must be injected into a running dextrose infusion, either through a Y-connector or directly into the tubing. When furosemide (Lasix) is injected into an IV line of inamrinone or milrinone infusion a precipitate immediately forms. Furosemide should, therefore, not be administered in the same IV line as these drugs. Ampules containing inamrinone should be protected from light, and diluted inamrinone solutions should be used within 24 hours.

ANTIARRHYTHMIC AGENTS

Although the rhythm of the heart is generally controlled by its principal pacemaker, the SA node, spontaneous electrical discharge or *automaticity* may occur anywhere in the heart under certain conditions. Any electrical activity initiated by such a spontaneous discharge is considered to be a rhythm disturbance, or arrhythmia.

Some arrhythmias do not require treatment. Many others must be aggressively treated or they will result in death. The use of an externally induced electrical impulse to restore normal cardiac rhythm (cardioversion) is a popular technique used in treating *atrial fibrillation*, *atrial flutter*, ventricular tachycardia, *ventricular fibrillation*, and many other arrhythmias. Other arrhythmias, particularly *bradyarrhythmias*, can be effectively treated by the use of artificial pacemakers, which are either surgically implanted in the client or carried with the client as a portable unit. Drug therapy remains, however, one of the most useful means of controlling a wide variety of cardiac arrhythmias.

Antiarrhythmic drugs act to diminish or obliterate rhythm disturbances by:

- decreasing the automaticity of cardiac tissues distant from the SA node (i.e., at ectopic sites)
- altering the rate of conduction of electrical impulses through the heart
- altering the refractory period of cardiac muscle between consecutive contractions

The selection of the most appropriate antiarrhythmic agent is dependent on the type of arrhythmia treated, the presence of other pathological conditions (e.g., heart failure, pulmonary disease), the relative safety of the drug as compared to other means of therapy, and the onset and/or duration of action of the drug. Most antiarrhythmic agents are administered intravenously (inamrinone lactate, milrinone lactate, digoxin, **adenosine**, **diltiazem HCl**, and others) until the heart has converted to normal sinus rhythm (NSR). Oral doses are used to maintain NSR.

Moricizine HCl (Ethmozine)

Moricizine is an antiarrhythmic that has potent local anesthetic and membrane stabilizing activity. Moricizine has been used to treat life-threatening ventricular arrhythmias. Because this agent can worsen existing arrhythmias or cause new arrhythmias, therapy should be begun in the hospital under careful supervision. Other adverse effects associated with using moricizine include dizziness, nausea, headache, dyspnea, chest pain, and peripheral edema anxiety.

Antiarrhythmic agents are generally grouped together according to their similar actions. Table 28–2 depicts currently available antiarrhythmic drugs and the corresponding group in which they are classified.

Quinidine (Quinidex, Duratab)

Quinidine is among the oldest antiarrhythmic agents. Like quinine, it is derived from cinchona bark and was used for many years in the treatment of malaria. On observing that some malarial clients who had atrial fibrillation improved while taking quinidine, it was deduced that quinidine possessed excellent antiarrhythmic properties.

Quinidine is a depressant of cardiac function. It reduces the excitability of cardiac muscle to electrical stimulation, decreases the velocity of electrical conduction through the myocardium, and prolongs the refractory time between consecutive cardiac contractions. These actions enable quinidine to decrease heart rate and reduce or obliterate *ectopic pacemaker* activity. This latter action enables the SA node to regain control over the rhythm of the heart, thereby eliminating ectopic arrhythmias. Quinidine also exerts an anticholinergic (vagal blocking) action on the heart, thereby promoting the generation of impulses by the SA node. In some clients, quinidine may produce tachycardia. Quinidine is most commonly used in the treatment of atrial tachycardia, flutter and fibrillation.

A wide range of toxic effects often accompany quinidine therapy. It has been estimated that therapy must be discontinued in about one-third of all clients on the drug because of these effects.

TABLE 28–2

Antiarrhythmic Drugs

GROUP	DRUG
I	moricizine[1]
IA	quinidine procainamide disopyramide
IB	lidocaine phenytoin tocainide mexiletine
IC	flecainide encainide propafenone
II	propranolol esmolol acebutolol
III	bretylium amiodarone sotalol[2]
IV	verapamil
	digoxin[3]
	adenosine[3]

[1] Moricizine shares some of the actions of groups IA, IB, and IC.

[2] Sotalol has both group II and group III properties.

[3] Digoxin and adenosine are not currently classified in any group.

The most prevalent adverse effects of quinidine are:

- *gastrointestinal distress*—Quinidine commonly causes nausea, vomiting, anorexia, and diarrhea. It is not clear whether or not these effects are the result of local GI irritation by quinidine or its effects on the central nervous system (CNS).
- *cardiovascular disorders*—Severe hypotension, ventricular tachycardia and/or fibrillation as well as AV block (interference with impulse conduction through the AV node) and arterial embolism have been reported.
- *hypersensitivity and idiosyncratic reactions*—Cinchonism, a syndrome produced by quinine and quinidine (both cinchona bark derivatives) is a serious reaction occasionally seen in some clients even after the administration of a single dose. It is characterized by ringing in the ears (tinnitus), nausea, headache, dizziness, impaired vision, and vertigo. Other hypersensitivity reactions to quinidine include skin rashes, as well as life-threatening disorders, such as respiratory arrest, vascular collapse, hemolytic anemia, and agranulocytosis.

Many of the adverse effects caused by quinidine can be avoided or diminished in severity by observing several precautions. Quinidine should be used with extreme caution in clients with congestive heart failure, as its depressant effect on cardiac contractility can further impair cardiac efficiency. In addition, quinidine has been reported to cause an elevation of digoxin blood levels when used in clients maintained on digoxin therapy. Insufficient monitoring of such clients, therefore, may result in digoxin intoxication. The nurse should be aware that the antiarrhythmic effect of quinidine is diminished if the client is hypokalemic and enhanced in the *hyperkalemic* client. Serum potassium levels should, therefore, be closely monitored in clients on diuretics, potassium supplements, or those with extensive fluid and electrolyte loss (such as depletion possible with prolonged, severe diarrhea).

Quinidine may be administered either orally or parenterally. Oral therapy should be timed, whenever possible, to coincide with mealtimes, as administration with food may reduce gastrointestinal distress. Intravenous administration should be undertaken with great caution, as rapid administration of quinidine by this route may cause a precipitous fall in arterial blood pressure. It is advisable to administer a test dose of one quinidine tablet prior to initiating therapy to determine whether or not a client will respond adversely to the drug.

Because of the high incidence of adverse effects caused by quinidine, safer and equally effective agents such as procainamide, lidocaine, **mexiletine**, **tocainide**, and **dipyridamole** are often used instead.

Procainamide (Pronestyl, Procan SR)

The cardiac effects of procainamide are essentially the same as those of quinidine. Many clinicians consider them to be therapeutically interchangeable. This drug is of greatest benefit in clients with

ventricular arrhythmias, although it may be used in the treatment of atrial fibrillation and paroxysmal atrial tachycardia (PAT).

Although procainamide generally produces fewer adverse cardiovascular effects than quinidine, it may also frequently cause GI distress, ventricular tachycardia, hypotension and occasional hypersensitivity reactions. Sensitivity reactions are particularly likely in clients who have demonstrated a sensitivity to procaine (**Novocaine**) and similar "caine" local anesthetic agents. Fatal blood dyscrasias, particularly agranulocytosis, as well as the development of a lupus erythematosus-like syndrome has also been reported to occur in some clients on prolonged procainamide therapy. Any evidence indicating the development of such disorders may require the discontinuation of therapy (e.g., development of a positive antinuclear antibody [ANA] test).

Disopyramide (Norpace, Rythmodan)

This drug is used for the oral treatment of cardiac arrhythmias. It is similar in action to quinidine and procainamide. The primary advantage claimed for the use of **disopyramide** is a lower incidence of adverse effects than quinidine or procainamide. As it has also been reported to cause hypotension, *tachyarrhythmias*, and other quinidine- and procainamide-like effects, the use of disopyramide is generally reserved for clients who cannot tolerate the other agents.

Disopyramide may cause anticholinergic effects in some clients. It should, therefore, be used with caution in clients with urinary retention, glaucoma, or myasthenia gravis.

Lidocaine (Xylocaine, Xylocard)

Lidocaine is widely used as a local anesthetic and has been shown to have useful antiarrhythmic properties. Although somewhat similar in action to the drugs that have thusfar been discussed, lidocaine does not appear to slow the rate of conduction of electrical impulses in the heart. It offers the advantage of providing a very rapid antiarrhythmic action when administered intravenously. Its action is also very brief, thereby enabling more precise control of the client's cardiac status and less likelihood for development of cumulative drug toxicity than with quinidine or procainamide.

As lidocaine does not depress myocardial contractility or electrical conduction as much as procainamide, it is currently considered to be the drug of choice for the treatment of premature ventricular contractions (PVCs), particularly those following an acute myocardial infarction. It is also commonly used in treating cardiac glycoside-induced tachyarrhythmias and is used in conjunction with cardioversion for the treatment of ventricular tachycardia and coarse ventricular fibrillation.

Constant electrocardiographic (ECG) monitoring is essential during the administration of lidocaine. During therapy with lidocaine, excessive depression of electrical conductivity in the heart may occur. This is generally avoidable by the use of appropriate doses of the drug and particularly the use of low doses in clients with a history of congestive heart failure and in the elderly. Other adverse effects related to the administration of lidocaine include hypotension, bradycardia, lightheadedness, and other CNS effects. In addition, the administration of lidocaine has been associated in some clients with the development of the acute onset of the hypermetabolism of skeletal muscle known as malignant hyperthermia. Appropriate corrective measures should be employed at the first sign of this disorder.

Because lidocaine is predominantly metabolized in the liver, small doses should be used in clients with hepatic impairment and those with diminished hepatic blood flow (e.g., clients with heart failure or who have had recent cardiac surgery). Lidocaine is ineffective when administered orally. As lidocaine is employed as a local anesthetic and may contain catecholamines (e.g., epinephrine) or preservatives, the nurse who is about to administer lidocaine as an antiarrhythmic agent must examine the label carefully to make sure that it is free of preservatives or epinephrine.

Phenytoin (Dilantin)

Phenytoin has been used for decades in the treatment of convulsive disorders. It has also been shown to have useful antiarrhythmic properties, particularly in the treatment of arrhythmias caused by cardiac glycoside intoxication.

Phenytoin depresses the automaticity of cardiac muscle, as do the other drugs that have been discussed. Unlike the other drugs, however, phenytoin dramatically increases the rate of conduction of electrical impulses in the heart. The drug should

only be administered intravenously for the treatment of arrhythmias.

The most common adverse effects of phenytoin are neurological disturbances, such as peripheral neuropathy, double vision (diplopia), ataxia, vertigo, drowsiness, and confusion. These generally appear with prolonged administration. Gastrointestinal distress, skin rash, and a variety of other effects have also been associated with phenytoin use. (See Chapter 22 for a more complete discussion of the adverse effects of phenytoin.) Although phenytoin is employed in the treatment of cardiac glycoside-induced arrhythmias, the Food and Drug Administration has not, to date, approved its use as an antiarrhythmic agent.

Tocainide (Tonocard)

Tocainide is an antiarrhythmic agent very similar to lidocaine in its action. Unlike lidocaine, however, tocainide is administered orally. The use of this drug is associated with a number of serious adverse effects. These include dizziness, nausea, *paresthesia*, numbness, restlessness, tremor, gastrointestinal distress, and blood dyscrasias. Treatment with tocainide requires careful dosage adjustment and regular ECG and clinical evaluation.

Mexiletine HCl (Mexitil)

Mexiletine is an antiarrhythmic drug similar in action to lidocaine that may be administered orally. It is clinically employed in suppressing symptomatic ventricular arrhythmias including PVCs, couplets, and ventricular tachycardia. Adverse effects associated with the use of mexiletine include nausea, vomiting, heartburn, dizziness, tremor, nervousness, and impaired coordination.

Flecainide Acetate (Tambocor) and Encainide HCl (Enkaid)

Flecainide and **encainide** are antiarrhythmic agents that have local anesthetic activity and are, therefore, pharmacologically related to quinidine, procainamide, disopyramide, tocainide, lidocaine, and phenytoin. Flecainide and encainide produce a decrease in intracardiac conduction throughout the heart. They are used orally in the treatment of ventricular arrhythmias, particularly ventricular tachycardia and frequent premature PVCs.

Flecainide and encainide have been reported to cause new or worsened arrhythmias in some clients. Such drug-induced arrhythmias may range from an increase in the frequency of PVCs to more severe ventricular tachycardia. Flecainide and encainide also have a negative inotropic effect on the heart and may cause or worsen congestive heart failure (CHF) particularly in clients with a history of CHF or myocardial dysfunction. Other adverse effects in the use of these drugs include dizziness, visual disturbances, headache, nausea, fatigue, and chest pain.

Because of the wide array of potential adverse effects produced by flecainide and encainide, their use is generally reserved for the treatment of life-threatening ventricular arrhythmias or in clients who do not respond to safer drugs.

Propafenone HCl (Rythmol)

Propafenone is a useful antiarrhythmic agent used to treat life-threatening ventricular arrhythmias. This drug has local anesthetic, membrane stabilizing, and, to a lesser degree, beta-blocking effects. Like many other antiarrhythmics, propafenone can cause new or worsen existing arrhythmias. Therefore, the client should be monitored by ECG and be continuously observed during therapy. This drug should not be used in clients with uncontrolled CHF, bradycardia, bronchospasm, or severe hypotension. Clients may experience dizziness, GI disturbances, and first degree AV block as adverse effects. Elderly clients, in particular, should be carefully monitored during therapy.

Beta-Adrenergic Blocking Agents

Beta-adrenergic blocking agents exert quinidine-like actions in the heart. Their ability to block sympathetic (adrenergic) stimulation produces a reduction in heart rate, reduces the contractility, and slows electrical conduction in the heart. Propranolol (Inderal) is primarily used to control ventricular rate in the treatment of supraventricular tachycardias (e.g., atrial fibrillation, atrial flutter) and ventricular arrhythmias. **Acebutolol** (**Sectral**) is used in managing premature ventricular beats, with **esmolol** (**Brevibloc**) indicated for the treatment of supraventricular tachycardia and sinus tachycardia. **Atenolol** is an antihypertensive beta-adrenergic blocking agent that has demonstrated effectiveness in treating ventricular dysrhythmias, angina pectoris due to hypertension and coronary atherosclerosis, and acute myocardial infarction, as well as prophylactically to decrease the incidence of supraventricular dysrhythmias associated with coronary artery bypass surgery. Because of their adrenergic blocking action, the use of beta-adrenergic

blocking agents is potentially dangerous in clients with heart disease, as the agents can promote congestive heart failure. Such clients may be pretreated with digoxin to minimize this possibility.

As propranolol can cause bronchoconstriction, its use is contraindicated in clients with chronic pulmonary diseases such as asthma or chronic bronchitis. Acebutolol and esmolol, because of their cardioselective action, are relatively safe to use in clients with chronic pulmonary disease. Such clients must, however, still be closely monitored during therapy, particularly when high doses of these beta-adrenergic blockers are used.

Bretylium Tosylate (Bretylate, Bretylol)

This agent is used for the emergency treatment of life-threatening ventricular tachycardia and fibrillation resistant to other forms of therapy (e.g., cardioversion, lidocaine, procainamide).

When administered parenterally, bretylium initially causes the release of norepinephrine from adrenergic neurons. This may cause a rapid and transient increase in heart rate and blood pressure and may intensify some arrhythmias. Subsequently, bretylium prevents the release of further norepinephrine and thereby produces a sympathetic blocking action. This results in stabilization of about 50% of clients with ventricular fibrillation or tachycardia that does not respond to other forms of treatment.

Bretylium, which was originally used only as an antihypertensive agent, commonly causes orthostatic hypotension, nausea, and vomiting. These effects can be minimized by administering the drug intravenously over 10 to 30 minutes and by maintaining the client in a *supine* position.

Amiodarone HCl (Cordarone)

Amiodarone is a relatively new antiarrhythmic agent sharing properties of several of the antiarrhythmic agents previously discussed. It is effective in the treatment of supraventricular, as well as ventricular, dysarrhythmias and appears to be effective in treating arrhythmias resistant to other forms of therapy. Amiodarone may be administered orally or intravenously, depending on the speed of action required. The major limitations of this drug are the numerous adverse effects associated with its use. A significant adverse effect associated with amiodarone use is pulmonary toxicity. Symptoms of amiodarone-induced pulmonary toxicity include persistent nonproductive cough, dyspnea, and chest pain with deep inhalation. With this toxicity, immediate medical treatment is warranted, including oxygen therapy, and may even require intubation and mechanical ventilation. Although more common in clients receiving high doses over prolonged periods, pulmonary assessment must be performed periodically (every 3 to 6 months) during therapy. Many amiodarone users develop yellow-brown granular deposits in the cornea, photosensitivity, hepatic dysfunction, and muscle weakness. Less frequent adverse effects include bradycardia and bluish discoloration of the skin. Amiodarone use may increase the activity of warfarin or digoxin, necessitating a reduction in their dose.

Calcium Channel Antagonists

Calcium ions play an important role in the excitation and contraction of cardiac and vascular smooth muscle. For contraction of such muscle to take place, extracellular calcium must enter the cells through "channels" in the cell membrane. The entry of calcium into the cell facilitates muscle contractility and releases energy required for the contraction.

The calcium channel antagonists reduce the influx of calcium into the cell. Blockage of calcium passage results in relaxation of vascular smooth muscle and lowered blood pressure. This action permits the use of some of these agents to prevent or reverse spasms of coronary blood vessels, to dilate coronary arteries and arterioles, and to reduce myocardial oxygen consumption. These actions are believed to be essential in the successful treatment of clients with angina pectoris.

As the inhibition of calcium passage into myocardial cells tends to slow electrical impulse conduction, some of the calcium channel antagonists are employed in the treatment of various arrhythmias, including supraventricular tachyarrhythmias (SVTs). **Verapamil HCl** (**Calen**, **Isoptin**) and **diltiazem HCl** (**Cardizem**) are currently the only calcium channel antagonists approved for use as antiarrhythmic agents which are administered intravenously. Verapamil is claimed to be capable of converting 90%–100% of supraventricular tachyarrhythmias with the administrations of a single dose of 5 to 10 mg/kg given as an IV bolus.

Diltiazem HCl is initially given as 0.25 mg/kg of body weight, with a second dose of 0.35 mg/kg 15 minutes later. Diltiazem HCL is indicated in treating SVT, with most clients responding to bolus

doses. However, clients experiencing atrial flutter or atrial fibrillation may require intravenous infusion at an initial rate of 10 mg/hour following the initial bolus doses.

Oral verapamil administration, when used with digoxin, is employed in treating chronic atrial flutter or atrial fibrillation. Oral dosage forms of verapamil HCl, **nifedipine** (**Adalat**, **Procardia**), diltiazem HCl (Cardizem), **bepridil** (**Vascor**), **isradipine** (**DynaCirc**), **nimodipine** (**Nimotop**), **felodipine** (**Plendil**), and **nicardipine HCl** (**Cardene**), all of which are calcium channel antagonists, are primarily used in the prevention and treatment of angina pectoris and hypertension.

Adverse effects of the calcium channel antagonists are, in most cases, predictable extensions of their pharmacological effects. Vasodilation produced by these agents may result in the development of hypotension, peripheral edema, dizziness, and headache in some clients. The ability of these drugs to slow myocardial conduction may result in bradycardia and possibly in the development of heart failure in clients with myocardial insufficiency. Other adverse effects reported with the use of these agents include constipation, diarrhea, nausea, and fatigue.

Table 28–3 summarizes some of the properties of the drugs used to treat arrhythmias.

Digoxin (Lanoxin)

Digoxin, in addition to being useful in the treatment of congestive heart failure, is also useful in the treatment of atrial fibrillation, atrial flutter, and PAT. It acts to rapidly reduce the ventricular rate and improve cardiac efficiency. Digoxin acts by slowing AV node conduction, which makes it useful in managing atrial flutter and atrial fibrillation.

Since the dose of digoxin required to treat arrhythmias is considerably higher than that required for the treatment of heart failure, toxicity is more likely to occur. Therefore, close client monitoring is necessary to prevent digoxin intoxication.

Adenosine (Adenocard)

In addition to the two calcium channel antagonists, adenosine is seen to be one of the most effective cardioversion drug for use in terminating paraoxysmal supraventricular tachycardia (PSVT).

Adenosine is a substance that is naturally present throughout the body. This agent is not related to any other antiarrhythmic agent. Adenosine slows the time for electrical conduction traveling through the AV node and, thus, cardioverts paroxysmal supraventricular tachycardia (PSVT). Because agents, such as caffeine and theophylline, can inhibit the effects of adenosine, the client may require larger doses of the drug while taking these agents. Clients receiving adenosine should be monitored for facial flushing, headache, shortness of breath, nausea, and lightheadedness.

CARDIAC STIMULANTS USED TO TREAT SHOCK

Adrenergic or sympathomimetic drugs are agents that mimic the action of the neurotransmitter norepinephrine. They may act to cause:

- vasoconstriction of peripheral blood vessels
- vasodilation of blood vessels in skeletal muscle
- increased heart rate (positive chronotropic effect)
- increase in the force of contraction of the heart (positive inotropic effect)
- increased rate of *glycogenolysis* in the liver and skeletal muscle
- stimulation of the CNS

Not all sympathomimetic agents will produce each of these effects to the same degree. Their action is often dependent on their degree of selectivity for specific adrenergic receptors in the body. Some sympathomimetic agents have a selective action on alpha-adrenergic receptor sites (see Chapter 15). Such agents (e.g., phenylephrine) can be expected to cause profound vasoconstriction of peripheral blood vessels while having little, if any, effect on the heart or respiratory tract. Drugs with a predominant effect on beta-adrenergic receptor sites (e.g., isoproterenol) tend to increase heart rate and force of contraction, as well as causing bronchodilation. They do not, however, have any significant effect on peripheral blood vessels.

Within the last decade, successful attempts were made to develop drugs with greater specificity for some beta-adrenergic sites than for others. For example, metaproterenol (Alupent, Metaprel) selectively acts at $beta_2$-adrenergic receptor sites, thereby providing a bronchodilating effect without causing significant cardiac stimulation. In this chapter the action of sympathomimetic agents used to stimulate the heart is considered.

Beta-adrenergic receptor stimulants are commonly employed to provide treatment for clients who are in a state of *hypoperfusion* and hypotension resulting from cardiac arrest, infarction and/or

TABLE 28–3

Antiarrhythmic Drugs in Current Use

Note: Monitor the apical pulse for 1 minute before administration.
Record rate and rhythm of heartbeat.
Patient should be supine when IV doses are administered to prevent postural hypotension.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE (as antiarrhythmic)	NURSING IMPLICATIONS
acebutolol HCl *(**ah**-see-**BYOU**-toh-lohl **hy**-droh-**KLOR**-eyed)* (Monitan ✤, Sectral)	oral	Initially 200 mg twice daily. Dose is increased gradually until optimal response is obtained. Range 200–1,200 mg/day	Caution client to report breathing difficulty.
adenosine *(ah-**DEN**-oh-seen)* (Adenocard)	IV	6 mg IV over 1–2 seconds	For rapid IV bolus use only. Do not refrigerate. Administer only a clear solution.
amiodarone HCl *(am-ee-**OH**-dah-rohn **hy**-droh-**KLOR**-eyed)* (Cordarone)	oral, IV	400–1,600 mg daily	Monitor client for development of pulmonary toxicity. Monitor client for development of corneal deposits and hepatotoxicity. Advise client to avoid sunlight while using this drug. Onset of therapeutic effect may range from 5–30 days. May produce bluish discoloration of the skin.
atenolol *(a-**TEN**-oh-lol)* (Tenormin)	oral, IV	Oral: 50–100 mg/day IV: 5 mg over 5 minutes followed by 5 mg 10 min. later. Give a 50-mg tablet 10 minutes after last IV dose.	Monitor heart rate continously during IV administration. Place on ECG telemetry during IV administration. IV dose may be diluted with normal saline or 5% dextrose. For dialysis clients, give 50 mg following each dialysis session.
bretylium tosylate *(breh-**TILL**-ee-um **TOZ**-ill-ayt)* (Bretylate ✤, Bretylol)	IM, IV	IM: 5–10 mg/kg as needed IV: 5–10 mg/kg by infusion as needed	Vary injection sites to avoid local irritation. Product must be properly diluted for IV administration.
diltiazem HCl *(dil-tea-**ZEM**)* (Cardizem)	IV	IV: 0.25 mg/kg of body weight initially (approx. 20 mg for average person). A second dose may be given in 15 minutes of .35 mg/kg	Monitor client blood pressure closely. ECG monitoring during IV administration. Over-the-counter antacids with calcium or over-the-counter calcium supplements should be avoided.
disopyramide *(dye-soh-**PEER**-ah-myd)* (Norpace, Norpace CR, Rythmodan ✤)	oral	400–800 mg daily in divided doses every 6 hours in conventional dosage form or every 12 hours in controlled-release form	Drug may cause anticholinergic side effects. Caution client not to omit doses. Monitor client for development of hypotension and arrhythmias.
encainide HCl *(en-**KAY**-nyd **hy**-droh-**KLOR**-eyed)* (EnKaid)	oral	25–50 mg every 8 hours	Drug may worsen existing arrhythmias or induce new ones. Cimetidine administration may raise encainide plasma levels.

continues

TABLE 28–3 *continued*

See **Note** at beginning of Table 28–3, page 545.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE (as antiarrhythmic)	NURSING IMPLICATIONS
esmolol HCl *(**ES**-moh-lohl **hy**-droh-**KLOR**-eyed)* (Brevibloc)	IV	50–500 mcg/kg/min	Caution client to report breathing difficulty. For treatment of SVTs.
flecainide acetate *(fleh-**KAY**-nyd **AH**-sih-tayt)* (Tambocor)	oral	Initially, 100 mg every 12 hours. Increase in 50 mg increments twice daily every four days until effective.	Monitor client for development of dizziness, visual disturbances and syncope. Drug may increase plasma digoxin levels in clients stabilized on digoxin. May increase propranolol serum level. Drug may worsen existing arrhythmias or induce new ones.
lidocaine HCl *(**LIE**-doh-kayn **hy**-droh-**KLOR**-eyed)* (Xylocaine HCl, Xylocard ✱, etc.)	IM, IV	IV: Loading dose: 1–1.5 mg/kg. May repeat 0.5–1.5 mg/kg every 5–10 minutes to total of 3 mg/kg. Not to exceed 200–300 mg/hr. IV Maintenance: 20–50 mcg/kg/min. *Children:* 0.5–1 mg/kg IV or intratracheally IM: 4.3 mg/kg . May be repeated after 60–90 minutes.	Observe client for development of sensitivity reaction. Only preservative-free and catecholamine-free lidocaine HCl solutions should be used for IV administration. Such bottles are generally labeled "Lidocaine for Arrhythmias." Question client about sensitivity to local anesthetics. When given by IM, administer into the deltoid muscle. Use only the 10% solution for IM administration. Check vital signs and watch for hypotension. Notify physician if confusion or convulsions occur.
mexiletine HCl *(mex-**ILL**-eh-teen **hy**-droh-**KLOR**-eyed)* (Mexitil)	oral	200–400 mg every 8 hours	Monitor client for development of adverse GI effects. Administer with food or antacid. Concurrent use of cimetidine may raise mexiletine plasma levels.
moricizine HCl *(mor-**IS**-ih-zeen **hy**-droh-**KLOR**-eyed)* (Ethmozine)	oral	600–900 mg/day	Monitor client for signs of dizziness, nausea, headache, and dyspnea.
phenytoin sodium *(**FEN**-ih-toh-in **SOH**-dee-um)* (Dilantin, etc.)	IV	100 mg repeated every 5 minutes if necessary until either toxicity, control of the arrhythmia or a total dose of 1,000 mg is reached *Children:* 1.25 mg/kg every 5 minutes until arrhythmia has ceased or side effects occur. Not to exceed a total of 15 mg/kg/dose	Do not administer IV drug solutions more rapidly than 50 mg/min. Do not administer with dextrose solutions. Flush IV with normal saline before and after administration.

continues

TABLE 28–3 *continued*

See **Note** at beginning of Table 28–3, page 545.

DRUG	AVAILABLE DOSAGE FORMS	USUAL DOSE (as antiarrhythmic)	NURSING IMPLICATIONS
procainamide HCl *(proh-**KAYN**-ah-myd **hy**-droh-**KLOR**-eyed)* (Pronestyl, Procan, etc.)	oral, IM, IV	Oral: 50 mg/kg/day in divided doses at 3-hour intervals (every 6 hours for sustained-release product) IM: 0.5–1 g every 4–8 hours IV: 100 mg every 5 minutes at rate not exceeding 20 mg/min until response is evident or total dose reaches 1 g; 2–6 mg/min may be administered as maintenance dose *Children:* 2–5 mg/kg/dose	Monitor client for development of positive antinuclear antibody (ANA) test. Caution client to report soreness of mouth, fever, symptoms of upper respiratory infection, joint discomfort, etc. to physician. Drug doses should be administered at evenly divided intervals around the clock. Question client about sensitivity to local anesthetics. Observe client for sensitivity reactions. Sustained-release product should not be used for initial therapy. Notify physician if confusion or convulsions occur.
propafenone HCl *(proh-pah-**FEN**-ohn **hy**-droh-**KLOR**-eyed)* (Rythmol)	oral	450 mg/day. Increase dosage slowly, if needed, at 3–4-day intervals, to a maximum of 900 mg/day	Monitor client for signs of dizziness, AV block, nausea, and constipation.
propranolol HCl *(proh-**PRAN**-oh-lohl **hy**-droh-**KLOR**-eyed)* (Inderal, Novo-Pranol ✱)	oral, IV	Oral: 10–30 mg 3–4 times daily before meals and at bedtime IV: 1–3 mg initially, repeated if necessary in 2 minutes; additional doses should not be administered for at least 4 hours; not to be administered more rapidly than 1 mg/min	Caution client to report breathing difficulty or skin rash. Monitor for hypotension.
quinidine gluconate, quinidine polygalacturonate*, quinidine sulfate *(**KWIN**-ih-din **GLOO**-koh-nayt, **KWIN**-ih-din **pol**-ee-gah-**lack**-tyou-**RON**-ayt, **KWIN**-ih-din **SUL**-fayt)* (Duraquin, Cardioquin, Quinidex, Quinate ✱, etc.)	oral, IM, IV	Oral: 0.2–0.6 g 3–8 times daily as needed, total daily dose not to exceed 3–4 g IM: 600 mg initially, then 400 mg of gluconate form every 2 hours as required IV: 330–750 mg of gluconate form or equivalent as needed	Monitor serum potassium level. Advise client to take oral form with food. Caution client to report dizziness, skin rash, headache, or visual disturbances. Gluconate form is less irritating than sulfate form.
tocainide HCl *(toh-**KAY**-nyd **hy**-droh-**KLOR**-eyed)* (Tonocard)	oral	400 mg every 8 hours	See lidocaine. Monitor client for development of dyspnea, cough, tremor, palpitations, easy bruising or bleeding, fever, sore throat, chills, nausea, vomiting, or diarrhea.
verapamil HCl *(ver-**AP**-ah-mill)* (Apo-Verap ✱, Calan, Isoptin, Verelan)	oral, IV	Oral: 240–480 mg daily divided into 3–4 doses daily IV: Initial dose: 5–10 mg given as an IV bolus over 2 minutes Subsequent dose: 10 mg 30 minutes after the first dose	Inspect drug solution for particulate matter and discoloration prior to administration. Discard if present. Dose should be administered over at least a 3-minute period in elderly clients to minimize the risk of adverse effects. Check blood pressure and monitor cardiac function with electrocardiogram. Administration with quinidine could result in severe hypotension.

*For oral use only

TABLE 28–4

Sympathomimetic Agents Used in the Treatment of Shock

Note: An intravascular line is usually established so that these drugs can be given by IV.
During emergency treatment the nurse must keep track of the names and dosages of drugs administered.
Monitor client's vital signs and condition continuously when drugs are given IV.
Record intake and output on all clients.
Infiltration may result in tissue necrosis.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
dobutamine *(doh-**BYOU**-tah-meen)* (Dobutrex)	IV	2.5–15 mcg/kg/min as needed	Observe client for development of arrhythmia during therapy. Do not mix drug with sodium bicarbonate solution. Reconstituted solution is stable in refrigerator for 48 hours or at room temperature for 6 hours. Treat extravasations with phentolamine.
dopamine HCl *(**DOH**-pah-meen **hy**-droh-**KLOR**-eyed)* (Intropin, Revimine, etc.)	IV	2–50 mcg/kg/min as needed	Combined use of dopamine and phenytoin may cause hypotension and bradycardia. Dilute before use if not prediluted. Do not mix drug with sodium bicarbonate solution. Drug solution should be freshly prepared. Treat extravasations with phentolamine.
ephedrine sulfate *(eh-**FED**-rin **SUL**-fayt)*	IM, IV, SC	25–50 mg as needed, not to exceed 150 mg/day *Children:* 16.7 mg/m2 every 4–6 hours	IV injection should be made slowly. Protect solutions from light.
epinephrine HCl *(**ep**-ih-**NEF**-rin **hy**-droh-**KLOR**-eyed)* (Adrenalin Chloride)	IM, IV, SC, intracardiac, endotracheal tube	IM or SC: 0.2–0.5 mg as needed IV: 0.1–1 mg as needed Intracardiac: 0.1–1 mg as needed Pediatric: 0.005–0.01 mg/kg	Protect solutions from light. Do not use if solution is brown in color or contains a precipitate. Repeated local injections may cause necrosis at injection site.
isoproterenol HCl *(**eye**-soh-proh-**TER**-eh-nohl **hy**-droh-**KLOR**-eyed)* (Isuprel, etc.)	IM, IV, SC, intracardiac, sublingual,	IM, SC: 0.2 mg IV injection: initial dose 0.02–0.06 mg; subsequent dose 0.01–0.2 mg IV infusion: 0.5–5.0 mcg/minute Intracardiac: 0.02 mg Sublingual: 5–50 mg	Excessive doses may cause dramatic drop in blood pressure. Concurrent use with epinephrine may produce arrhythmia. Store in a cool place (8°–15°C) . Do not administer if color of solution is pink to brown.
metaraminol bitartrate *(**met**-ah-**RAM**-ih-nohl by-**TAR**-trayt)* (Aramine, etc.)	IM, IV, SC,	IM, SC: 2–10 mg IV infusion: 15–100 mg infused at rate adequate to maintain blood pressure at desired level IV injection: 0.5–5 mg	Clients with hypertension or hyperthyroidism are more susceptible to toxic effects of drug (i.e., convulsions, arrhythmias, etc.).

continues

TABLE 28–4 *continued*

See **Note** at beginning of Table 28–4, page 548.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
methoxamine HCl *(meh-**THOCK**-sah-meen **hy**-droh-**KLOR**-eyed)* (Vasoxyl)	IM, IV	IM: 10–15 mg IV: 3–10 mg injected slowly	IV administration should only be used in emergency situations. Do not administer IM dose within 15 minutes of previous dose.
norepinephrine, levarterenol *(**nor**-ep-ih-**NEF**-rin, **lev**-ar-**TEER**-eh-nol)* (Levophed)	IV	2–12 mcg/min	Administer in large vein to avoid necrosis of local tissue. Blood pressure may rise rapidly with therapy.
phenylephrine HCl *(**fen**-ill-**EF**-rin **hy**-droh-**KLOR**-eyed)* (Neo-Synephrine)	IM, IV, SC	IM, SC: 2–5 mg IV: 0.2 mg not to exceed 0.5 mg/dose 0.25–0.5 mg IV bolus for PSVT	Use with caution in clients taking digitalis glycosides.

decompensation. They are also used in cases of massive trauma, renal failure, and other conditions causing shock. These agents are useful because of their ability to raise blood pressure (pressor effect) and/or to increase the contractility of the heart.

Isoproterenol (Isuprel), dobutamine (Dobutrex), and dopamine (Intropin) are agents used primarily because of their inotropic action on the heart. They provide little, if any, peripheral vasoconstrictive effect and are used exclusively to improve cardiac output in clients with organic heart disease or during cardiac surgery.

Metaraminol (**Aramine**), **methoxamine** (**Vasoxyl**), and phenylephrine (**Neo-Synephrine**) are used primarily because of their ability to cause peripheral vasoconstriction by their action on alpha-adrenergic receptor sites. They have little or no effect on heart rate or contractility. They are used primarily in the treatment of acute hypotension resulting from hemorrhage, general and spinal anesthesia, reactions to medications and complications of major surgery.

Epinephrine (Adrenalin), norepinephrine (**Levarterenol**, Levophed), **ephedrine sulfate**, and **mephentermine sulfate** (**Wyamine**) provide an inotropic effect and a peripheral vasoconstrictor action, thereby making them desirable in the treatment of hypotensive states as well as impaired cardiac output.

When using any of the sympathomimetic agents described, the client's blood pressure and electrocardiogram must be closely monitored. In addition, evaluation of cardiac and urine output is also important. In treating hypotension caused by diminished circulatory blood volume, plasma expanders or whole blood should be administered prior to therapy. The client must be monitored for the development of CNS stimulation, headache, palpitations, or tremors when on any sympathomimetic drug.

A number of drug interactions may occur in clients receiving sympathomimetic agents. The most common interactions include:

- **Cyclopropane** or **halothane**, when used as general anesthetics, may sensitize the heart muscle to the effects of adrenergic agents. When used together serious arrhythmias may occur (see Chapter 11).
- Monoamine oxidase (MAO) inhibitors and tricyclic antidepressants potentiate the blood pressure-elevating effects of sympathomimetic agents (see Chapter 18). When these drugs are used together, therefore, the initial dose of sympathomimetic agent should be small and administered with great caution.
- Oxytocic drugs, when used with adrenergic stimulants sometimes administered to obstetric clients to correct hypotension or to facilitate the action of local anesthetics, may cause severe and persistent hypertension which could result in rupture of cerebral blood vessels *postpartum*.

Table 28–4 lists the properties of the sympathomimetic agents used in the treatment of shock.

APPLYING THE NURSING PROCESS

Heart disease is the leading cause of death in the United States. Therefore, much attention has been directed toward its prevention and treatment. As a result, nurses in many practice settings and specialties will have contact with individuals receiving drugs affecting cardiac function. The nursing care indicated for these individuals is discussed in three parts: caring for individuals receiving cardiac glycosides, caring for persons receiving antiarrhythmic agents, and caring for clients in shock.

CLIENTS RECEIVING CARDIAC GLYCOSIDES

Assessment

One aspect of care is related to monitoring the effects of therapy. Routinely, before each dose of a cardiac glycoside is given, the nurse checks the client's pulse rate. As a general rule, the *apical* rate should be checked for 1 full minute. Checking the apical pulse is preferred to checking the *radial* pulse, as the former gives a more accurate indication of the rate and rhythm than the radial pulse. If the pulse rate is less than 60 beats per minute in adults, less than 90 beats per minute in infants, or less than 70 beats per minute in children and adolescents, the dose of glycoside should be withheld and the physician should be contacted promptly. A note must be made on the medication record and the client's chart that the dose has been withheld, citing the reasons why. In the absence of electronic monitoring, the pulse rate serves as a warning of possible cardiac glycoside toxicity. Adult pulse rates exceeding 100 beats per minute should also be reported. A low pulse rate does not necessarily mean toxicity, nor does a pulse rate above 60 in adults or 70 in preschool or older children exclude the possibility of toxicity. When such a reading is obtained, however—particularly if obtained on more than one occasion—the physician may wish to have an ECG performed to assess if toxicity is occurring. The nurse should remember to check the pulse rate before administration of cardiac glycosides regardless of the route by which the drug is administered.

While checking the pulse rate, the nurse is also sensitive to the rhythm of the heart. Any indication of bigeminy (the characteristic coupled beat indicative of toxicity) should be reported before the drug is administered. In addition to bradycardia or bigeminy, cardiac glycoside toxicity may be indicated by the development of tachycardia in a person who generally has a normal heart rate, by the relatively sudden development of regularity in a person with a previously irregular rhythm, or by the sudden appearance of an irregular heartbeat in someone whose rhythm has been regular. These changes should be discussed with the prescriber.

Unfortunately, much of the discussion of cardiac glycosides focuses on the determination of toxic effects of these drugs to the exclusion of the assessment of therapeutic effects. The nurse plays a vital role in providing information about therapeutic effectiveness. Notations must be made about whether the pulse rate is becoming slower and the volume stronger. Reports are also made about the client's ability to tolerate activity and subjective perceptions of strength and endurance. The nurse monitors the intake and output of all clients who are beginning therapy with cardiac glycosides. Observations regarding fluid balance are reported, as they may indicate weight reduction due to fluid lost as a result of the increased cardiac output.

In assessing toxicity, the nurse checks the cardiac status (rate and rhythm). In addition, the nurse observes the client carefully for neurological signs, such as headaches and visual disturbances, and for gastrointestinal indicators such as nausea, vomiting, and anorexia. Clients may report a change in color vision. Yellow- or green-tinted vision is not uncommon in clients experiencing toxicity. It is particularly important to be sensitive to signs and symptoms of toxicity in clients taking diuretics and in other clients who are likely to have low blood levels of potassium. If cardiac glycoside toxicity is suspected, serum drug level determination will frequently be ordered. Acute toxicity may be treated by the intravenous administration of Digoxin Immune Fab (Digibind), which are antibodies that bind with digoxin. It is used to treat digoxin toxicity by binding with the digoxin, causing both to be excreted in the urine. Doses of 228 mg is usually sufficient to reverse the digoxin toxicity.

Nursing Diagnoses

Including but not limited to:

- Decreased cardiac output related to ineffective contractility of heart muscle
- Activity intolerance related to increased cardiac workload
- Risk for injury related to side effects of cardiac glycosides
- Deficient knowledge related to health alteration and medication regimen

Planning/Goals

- Client will experience improved cardiac output as evidenced by pulse rate and strength within normal limits (WNL).
- Client will demonstrate ability to engage in activities of choice.
- Client will not experience injury due to side effects of cardiac glycosides.
- Client will demonstrate ability to accurately monitor own radial pulse.
- Client will verbalize understanding of appropriate use of cardiac glycosides, including signs and symptoms to report to physician.

Implementation

An important aspect of nursing care for clients with decreased cardiac output is the administration of digoxin and related drugs. As previously noted, such drugs are likely to result in gastrointestinal irritation when taken orally. Usually these drugs are taken once a day, with this administration scheduled shortly after breakfast in an attempt to minimize the irritation. Absorption of cardiac glycosides may be affected by kaolin-pectin and other adsorbent antidiarrheal products, antacids, and bulk-forming laxatives. It is important not to administer cardiac glycosides orally at the same time those drugs are given. A high fiber diet also may decrease absorption of these drugs. Another factor related to administration concerns the intramuscular injection of these drugs. Although not frequently given intramuscularly, the intramuscular route may be used when digitalizing a client, when a peripheral venous intravenous access cannot be established, or when clients are unable to cooperate with oral administration, for example, those not permitted fluids by mouth and persons not fully conscious. It is important for the nurse to remember that intramuscular preparations of digoxin and related drugs are very irritating; they must be injected into a large muscle mass, such as the gluteus maximus, when administered to adults.

A final aspect of nursing care is the prevention of drug toxicity. This can be accomplished in several ways. The first is through careful monitoring of hospitalized clients, particularly those being digitalized. The second is through encouraging the client to cooperate with orders for routine electrocardiograms and blood studies, particularly the determination of potassium and/or drug levels. The final means of preventing severe toxicity is to remedy any client's deficient knowledge through client education. All clients who are being discharged with a prescription for a cardiac glycoside should be instructed on how to take their pulse. If they are not able to do this, someone close to them must be instructed. Generally, they are taught to take the radial pulse, as this does not require special equipment. The pulse should be checked before daily drug administration. Instructions are given to record

KEY NURSING IMPLICATIONS 28–1

Cardiac Glycosides

1. Always check the client's apical pulse rate for 1 minute before administering these products.
2. Withhold these drugs if the pulse rate is less than 60 beats per minute in adults, less than 90 beats per minute in infants, and less than 70 beats per minute in children and adolescents.
3. Report bigeminy (if on monitoring) or significant deviations in the client's heart rate or rhythm.
4. Assess the client for toxicity by checking the heart rate and rhythm and observing for neurological signs, such as headache, visual disturbances and changes in color vision and gastrointestinal symptoms such as nausea, vomiting and anorexia.
5. Monitor potassium level and report level less than 4 ml.
6. To minimize pain and possible tissue damage, intramuscular preparations must be given deep into a large muscle mass.
7. Teach the client and family members how to recognize signs of toxicity and assess heart rate.

the pulse rate and contact the physician about a pulse rate less than 60 bpm. Clients and/or family members must also be familiar with common gastrointestinal and neurological signs of toxicity and should be instructed to contact the physician, if these develop.

The outpatient administration of cardiac glycosides is particularly troublesome in many older clients, who may take multiple drugs and who may be handicapped by deficient vision or memory. The nurse must tailor an instruction program to their needs. Factors to be taken into account are: (1) how to tell the cardiac glycoside from other medications (perhaps by drawing a heart on the bottle), and (2) how to help persons remember if they have taken their medication as ordered. Use of an easily remembered specific time to take the medication and prompt recording of its administration on a calendar or drug record are suggested.

Evaluation

- Client experiences pulse rate of 60–100 beats/minute with strength WNL.
- Client demonstrates ability to participate in activities with family and provide self-care.
- Client does not experience toxicity related to use of cardiac glycoside.
- Client demonstrates ability to monitor radial pulse using accurate procedure.
- Client verbalizes understanding of appropriate use of cardiac glycosides, signs and symptoms to report to physician, and safe self-administration.

CLIENTS RECEIVING ANTIARRHYTHMIC AGENTS

Assessment

There are a variety of antiarrhythmic agents used to treat decreases in cardiac output due to changes in cardiac rhythm. Each has its own uses, precautions, and associated nursing actions. As a general rule, the apical pulse should be monitored for a full minute before a dose of any of these drugs is given. The nurse records a description of the rate and rhythm of the heart at the time the drug is administered. In addition, the nurse encourages all clients taking these drugs as outpatients to see their physician regularly and to take their medication as prescribed.

If the client is receiving quinidine, the nurse carefully observes for side effects. Many of the gastrointestinal side effects, such as nausea, vomiting, diarrhea, and anorexia, are so common that they are not a cause for discontinuation of therapy, unless they become severe.

Before clients receive a dose of lidocaine, tocainide, or procainamide, they must be questioned about reactions to local anesthetics. If a hypersensitivity reaction has occurred, the dose is withheld and the physician is informed. Clients taking disopyramide (**Norpace**) are monitored for hypotension and arrhythmias. In addition, because of the anticholinergic properties of this drug, clients with glaucoma or problems likely to result in urinary retention (for example, males with an enlarged prostate gland) are observed carefully.

Nursing Diagnoses

Including but not limited to:

- Decreased cardiac output related to ineffective electrical conduction in heart
- Ineffective tissue perfusion, cerebral related to hypotension caused by antiarrhythmic agents
- Risk for injury related to falls secondary to hypotension caused by antiarrhythmic agents
- Deficient knowledge related to cardiac arrhythmias and medication regimen

Planning/Goals

- Client will experience improved cardiac output as evidenced by pulse rate and strength WNL.
- Client's cardiac arrhythmia(s) will be resolved as evidenced by ECG tracing WNL.
- Client will not experience hypotension related to use of antiarrhythmic agents.
- Client will demonstrate ability to accurately monitor own radial pulse.
- Client will verbalize understanding of appropriate use of cardiac arrhythmic agents, including signs and symptoms to report to physician.

Implementation

Administering the oral dose of quinidine near mealtime may help to decrease gastrointestinal distress. If quinidine is to be used intravenously

and a test dose has not been given orally, the nurse should question the physician about this test dose before the drug is administered intravenously. Quinidine can cause a rapid fall in blood pressure when administered intravenously. Therefore, the client must always be lying supine when the dose is administered. Finally, because the effect of quinidine is closely related to serum potassium levels, routine periodic potassium determinations are made. The spacing of these tests will vary depending on the length of time the client has been receiving quinidine and the potential for low serum potassium levels. For example, some clients will require more frequent testing (such as those taking diuretics and subject to low potassium levels).

Although rarely given by the IM route, if lidocaine is being given intramuscularly and rapid production of a therapeutic blood level is desired, the drug should be given into the deltoid muscle. When lidocaine is to be administered intravenously, the nurse must check the label to be certain that no preservatives or catecholamines (such as epinephrine) are present in the preparation. Hypotension may occur in clients receiving either lidocaine or procainamide. For this reason, these clients must be supine when the drug is administered. Vital signs are checked following administration. The physician is informed immediately, if signs of CNS dysfunction occur, such as confusion or convulsion.

The preferred route of administration for procainamide, tocainide, encainide, flecainide, and mexiletine is usually by mouth. It is suggested that these drugs be administered around mealtime, as this may decrease the gastrointestinal distress associated with their use.

The nurse caring for the client receiving amiodarone (**Cordarone**) reports evidence of yellow-brown granular deposits that may develop on the cornea. The client may report a feeling of sand in the eye. These deposits may be prevented by the use of **methylcellulose** eye drops. Evidence of respiratory toxicity must be immediately reported to the prescriber. Nurses should advise clients about the possibility of photosensitivity and suggest protection from the sun by wearing appropriate clothing and using a sunscreen. Careful assessment is necessary when clients are receiving amiodarone and oral anticoagulants, such as warfarin. Prolonged prothrombin times could result and the client may experience hemorrhaging.

Verapamil HCl may produce hypotension and disturbances of cardiac rhythm, particularly in clients with AV node conduction disturbances. Intravenous verapamil is usually stopped if the systolic blood pressure drops below 70–80 mm/Hg and if the pulse drops below 50 beats per minute. Therefore, when verapamil is administered, the client is placed in a supine position and blood pressure and electrocardiographic monitoring are carried out.

Nursing assessment and intervention for clients receiving other, newer antiarrhythmic agents are indicated in Table 28–2. It is important to remember that all clients taking drugs for the treatment of cardiac illnesses need to be provided with information about their illness and its treatment. Continued support is required for the client and family, especially for those persons who have experienced a myocardial infarction or sudden cardiac death.

KEY NURSING IMPLICATIONS 28–2

Antiarrhythmic Agents

1. Assess the client's apical pulse for 1 minute before administration.
2. Clients scheduled to receive lidocaine, tocainide, or procainamide should be questioned about allergy to local anesthetics.
3. Give quinidine at mealtimes to decrease gastrointestinal upset.
4. The client should always be supine when intravenous quinidine is administered.
5. Clients receiving intravenous lidocaine or procainamide should be supine during administration.
6. Check vital signs on all clients following intravenous administration of antiarrhythmic drugs. Report signs of confusion or convulsions in clients following lidocaine or procainamide use.
7. Report evidence of granular deposits on the cornea of clients taking amiodarone.
8. Verapamil HCl may cause hypotension and disturbances of cardiac rhythm. Stop intravenous administration if the systolic blood pressure drops below 70–80 mm/Hg and if the pulse drops below 50 beats per minute.

NURSING CARE PLAN

An Insulin-Dependent Client with Cardiac Arrhythmia Taking Amiodarone HCl (Cordarone)

Margaret Byers, age 62, is admitted to the hospital with shortness of breath, dizziness, and an irregular heartbeat. Margaret is an insulin-dependent diabetic who takes 20 units NPH insulin daily. She says she had a heart attack 3 years ago and has been taking digoxin (Lanoxin), procainamide HCl (Procan), dipyridamole (Persantine), and enteric-coated aspirin (Ecotrin) daily at home. She doesn't smoke or drink alcohol. Her admission weight is 190 pounds and height is 5'5". She says she watches her diet and takes her medication regularly. The physician orders blood work for digoxin level, blood sugar q6h, electrolytes, complete blood count, prothrombin time, and activated clotting time. The physician discontinues all medication, and admits Margaret to a monitored unit where she is found to be having frequent premature ventricular contractions. She is started on IV lidocaine (Xylocaine) therapy with minimal improvement and begins to exhibit ventricular tachycardia. Lidocaine is discontinued and a procainamide (Pronestyl) drip is begun, which slows the frequency of the ventricular tachycardia. The physician then begins Margaret on oral amiodarone HCl (Cordarone) 400 mg q6h. After the second dose is given the intravenous medication is stopped. Twenty-four hours later, the monitor shows normal sinus rhythm.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Irregular heartbeat. Blood pressure.	Decreased cardiac output related to rhythm disturbance.	Client will maintain adequate vital signs throughout hospitalization.	Monitor client for changes in heart rate and rhythm. Maintain systolic blood pressure greater than 100. Palpate peripheral pulses. Observe client for inadequate oxygenation secondary to cardiac dysfunction.	Client's blood pressure maintained above 100 mm Hg. Skin is warm and dry. All pulses palpable. EKG normal sinus rhythm.
Anxious, nervous, history of previous heart attack.	Anxiety related to pain, implications of diagnosis, and treatment.	Client will be able to verbalize feelings of increasing anxiety during hospitalization.	Assist client in identification of feelings. Accept client as she is and maintain calm, confident manner. Remain with client during stressful periods.	Client is able to talk about concerns with nurse. Demonstrates problem-solving skills. Identifies ways to deal with anxieties.
Insulin-dependent diabetic. Blood glucose levels. Self-care.	Risk for ineffective health maintenance related to self-care practices.	Client will be able to maintain proper blood sugar levels by following prescribed routine for diet, activity, and insulin.	Monitor blood glucose levels. Make sure client knows signs and symptoms of hypo- and hyperglycemia. Maintain prescribed diet. Observe for ability to self-administer insulin.	Client has normal glucose levels. Client demonstrates proper insulin administration and other self-care practices.
Knowledge of health care practices. Self-care.	Deficient knowledge related to the relationship of diabetes to heart disease and methods to prevent such disease.	Client will describe health care practices that promote health and compare with personal practices.	Encourage client to talk about her lifestyle. Make certain she understands that being overweight makes her more prone to future attacks. Be certain client has a backup for insulin administration. Discuss risk factors.	Client verbalizes lifestyle changes she feels are necessary.

CLIENTS IN CARDIAC EMERGENCIES AND SHOCK

Assessment

Cardiac emergencies and shock are complex situations requiring rapid assessment and response on the part of all health practitioners. In many cases, the nurse identifies the emergency, summons assistance, and initiates resuscitation measures.

For all clients in shock, the nurse has important monitoring functions, as well as providing supportive nursing care. When sympathomimetic agents are used, the nurse is responsible for monitoring vital signs. Blood pressure determinations are made frequently, often every 5 minutes, and continuous cardiac monitoring is usually carried out.

All clients in shock must have intake and output recorded. Also, observations about the client's condition are made, including the color of skin, nail beds, and mucous membranes; the client's mental state; temperature of body parts; presence of perspiration; and other indicators of body functions. These observations assist the physician in tailoring the treatment, including drug therapy, to the client's needs. Nurses also must be aware of the possibilities of drug interactions, because of the various drugs used in the treatment of shock and because of the possibility of impaired liver and kidney function. These disorders may alter the metabolism and/or excretion of drugs.

Nursing Diagnoses

Including but not limited to:

- Decreased cardiac output related to ineffective cardiac pump mechanism.
- Ineffective tissue perfusion, renal, cardiopulmonary, gastrointestinal function related to hypoperfusion physiology of shock.
- Impaired gas exchange related to hypoperfusion to lungs and ineffective cardiac pump mechanism.
- Excess fluid volume related to ineffective cardiac pump mechanism.
- Deficient fluid volume related to fluid in vascular compartments.
- Risk for injury related to altered perception secondary to hypoperfusion.
- Deficient knowledge related to shock and medication regimen

Planning/Goals

- Client will experience improved cardiac output as evidenced by pulse rate and strength WNL, ECG tracings WNL.
- Client will demonstrate signs of improved perfusion as evidenced by increased urinary output greater than 30 ml/hour, capillary refill less than 2 seconds, improved sensorium.
- Client's gas exchange will show marked improvement as evidenced by pulse oximetry readings of oxygen saturation will be WNL (95%–100%).
- Client will experience return to fluid balance as evidenced by urine output greater than 30 ml/hour, breath sounds clear, no peripheral edema.
- Client will not experience injury.
- Client will verbalize understanding of shock condition and medical regimen to treat it.

Implementation

In nearly all cases, nurses will assist physicians in the preparation for drug administration. An intravenous line is usually established, so that drugs can be administered by this route. This permits rapid drug administration. Also, administration by the IV route may overcome the problem of slow absorption possible if a drug is administered by other routes. For example, absorption from an intramuscular injection site may be inhibited during shock due to vascular collapse. If an intravenous line cannot be established, drugs may be given through an endotracheal tube.

Following establishment of the intravenous line and correction of acid-base imbalances and fluid volume deficits, sympathomimetic drugs (for example, epinephrine, dopamine, and/or metaraminol) are often given. It is important for the nurse to keep a record of the medications

KEY NURSING IMPLICATIONS 28–3

Cardiac Emergencies and Shock

1. Monitor vital signs continuously.
2. An intravenous line is established for the administration of medications & fluids.
3. If an intravenous line cannot be established, drugs may be given through an endotracheal tube.
4. Infiltration of dopamine, norepinephrine, or other sympathomimetic drugs may result in tissue necrosis. This is treated with infiltration of the affected area with phentolamine (Regitine).

administered, including the time, route, and dosage. Following the crisis period, the nurse will also monitor vital signs and make observations about the client's condition and response to drug therapy.

Fatal arrhythmias may result when high doses of sympathomimetic drugs are given, so continuous monitoring of ECG and blood pressure is necessary. The order for sympathomimetic therapy often specifies that the nurse should regulate the intravenous administration of these agents to keep the blood pressure within a certain range. Controlled infusion pumps are used to ensure steady, accurate flow rates. The intravenous infusion must be checked carefully, as infiltration into the tissues of dopamine, norepinephrine bitartrate, or other sympathomimetic drugs may cause tissue necrosis. Local infiltration of the tissues with phentolamine (Regitine) is made as soon as possible after infiltration of infusions containing these drugs. Check the institution's procedure for dosage and use of phentolamine.

Evaluation

- Client experiences improved cardiac output as evidenced by pulse rate of 78 to 90 beats per minute and strength WNL and ECG tracings WNL.
- Client demonstrates signs of improved perfusion as evidenced by increased urinary output greater than 30 ml/hour, capillary refill less than 2 seconds, alertness, and appropriate orientation.
- Client's gas exchange shows marked improvement as evidenced by pulse oximetry readings of oxygen saturation between 95%–98%.
- Client experiences return to fluid balance as evidenced by urine output greater than 30 ml/hour, breath sounds clear, no peripheral edema.
- Client does not experience injury.
- Client verbalizes when able (not intubated) understanding of shock condition and medical regimen to treat it.

HOME CARE / CLIENT TEACHING

1. Because persons taking medication for the treatment of heart disease often take multiple drugs, be certain that they understand the purpose of each drug and how to administer it properly.
2. Review with the client or caregiver the signs of digitalis toxicity, including slow pulse rate, and rhythm disturbances, headache, visual disturbances, changes in color vision, nausea, vomiting, and anorexia.
3. Clients taking cardiac glycosides need to be instructed concerning how to monitor their radial pulse and how important it is to take either radial or carotid pulse before each medication.
4. Clients and their families receiving cardiac glycosides should be informed about signs and symptoms of toxicity, including pulse rate below 60 bpm and rhythm disturbances, headache, visual disturbances, changes in color vision, nausea, vomiting, diarrhea, and anorexia and the importance of immediately reporting these to physician.
5. Clients receiving cardiac glycosides need to be reminded of importance of follow-up visits and monitoring of drug blood levels.
6. Clients taking digoxin should be cautioned not to change brands of digoxin, because manufacturing differences could lead to different serum drug levels.
7. Clients receiving digoxin should be instructed to take their medication at the same time each day and that absorption can be affected by antacids, bulk-forming, kaolin-pectin, and absorbent laxatives.
8. Clients taking quinidine should be informed that taking this medication at mealtime may help decrease gastrointestinal irritation and that they should use sunscreen because of the potential for photosensitivity.
9. Clients receiving amiodarone should be instructed concerning the potential for amiodarone-induced pulmonary toxicity and the signs and symptoms—persistent nonproductive cough, dyspnea, and chest pain with deep inhalation—that should be immediately reported to the physician.
10. Clients experiencing cardiogenic shock and their families need support and instructions concerning the client's condition, treatment modalities, assessment equipment including monitors, and what they reveal.
11. Clients receiving cardiac medications should be encouraged to ask questions, if they have them.
12. Clients receiving diltiazem HCl should be cautioned not to take over-the-counter antacids with calcium or over-the-counter calcium supplements.

CASE STUDY

Bertha Grabowski, 86, a resident of Sunnyside nursing home, has become increasingly short of breath over the last 3 days. The nurse's aide caring for her reports to the charge nurse that Mrs. Grabowski has swelling of the ankles and seems to have less and less tolerance for activities as the days pass.

The charge nurse examines Mrs. Grabowski and notes that pedal edema is present, her color is poor and she does not seem as mentally alert as usual. Her pulse is weak and her respirations are somewhat labored. The physician is contacted, briefly examines the client, and requests transfer to Memorial Hospital for the treatment of congestive heart failure.

In the hospital a cardiologist examines the client, confirms the diagnosis and orders the following:

- Bedrest
- Vital signs, qid
- Sodium-restricted diet (1500 mg)
- Digoxin (**Lanoxin**) 0.125 mg p.o. daily beginning tomorrow
- ECG STAT and tomorrow AM
- Furosemide (Lasix) 20 mg qod

Mrs. Grabowski improves steadily until the 8th day of digoxin therapy. At that time she experiences nausea, vomiting, and anorexia. When the nurse checks her apical pulse before the daily dose of digoxin is administered, the rate is 60 beats per minute. This is a slower rate than that recorded for the past few days.

Questions for Discussion

1. What pathophysiological mechanisms are most likely to be responsible for the symptoms Mrs. Grabowski was experiencing before admission to the hospital?
2. What might the gastrointestinal symptoms experienced on the 8th day of digoxin therapy mean?
3. If you were the nurse who found Mrs. Grabowski's apical pulse rate to be 60 beats per minute, what would you do about administering the daily dose of digoxin?

CRITICAL THINKING EXERCISES

1. Prepare a teaching plan for an 80-year-old woman with poor vision who is being discharged from the hospital with prescriptions for the following:
   digoxin q.d.
   hydrochlorothiazide (a diuretic) q.d.
   multiple vitamins q.d.
   This client lives alone. She has experienced several periods of confusion while hospitalized. Her daughter, who lives about 30 miles away, calls her mother every day.
2. Examine the emergency cart or supply tray in the clinical setting where you work. Make a list of the drugs supplied and indicate their usual dosage, route of administration, and the actions of each.
3. Design an instructional aid to be used in teaching clients and family members about the administration of cardiac glycosides at home.
4. Over time, observe the ECG reports of a client receiving a cardiac glycoside or an antiarrhythmic agent. Note any changes occurring as a result of the drug therapy.
5. List three major characteristics of congestive heart failure.

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Agents That Dilate Blood Vessels

29

OBJECTIVES

After studying this chapter, the student will be able to:

- State two theories that may explain how nitrates reduce anginal pain
- Identify the common routes of nitroglycerin administration and the advantages associated with each
- State the storage requirements necessary for nitroglycerin tablets to retain their potency
- List methods of minimizing the development of tolerance and of producing renewed sensitivity to the action of nitrates and nitrites
- List the major adverse effects associated with the use of nitrates
- Identify the therapeutic effects, side effects, and routes of administration of the major peripheral vasodilating agents
- Describe the procedures to be used in the administration of amyl nitrite and topically applied nitroglycerin products
- Apply the nursing process related to caring for clients receiving coronary vasodilators
- Apply the nursing process related to caring for clients receiving peripheral vasodilators

Drugs that dilate blood vessels are used in a number of clinical applications, the most common being the treatment of coronary artery and peripheral vascular diseases. In each of these disorders, clinical symptoms are caused by the inadequate delivery of blood, nutrients, and oxygen to a specific body tissue, thereby producing an ischemic state. This usually results in localized muscle injury, which may be manifested as pain and discomfort.

CORONARY VASODILATORS

Ischemic heart disease is the number one cause of death caused by disease in this country. The primary cause of this disorder is coronary artery disease (CAD). CAD results from atherosclerosis, which, in turn, results when plaques developing in the lumens of the vessels causes narrowing of the vessels. This creates a decrease in the heart's oxygen and nutrient supply, which it needs to fulfill the demands placed upon it by the body. Pain, often referred to as angina pectoris, is a result of this ischemia. Under conditions when the myocardium is deprived of oxygen, it shifts from aerobic to anaerobic metabolism. This creates an increased level of lactic acid and other metabolic products, which irritate the pain receptors that surround the heart. Drugs that dilate coronary blood vessels are primarily used in the treatment

of angina pectoris and its accompanying pain, which is usually associated with stress or exercise.

Approximately seven to ten out of every thousand persons who are 55 years of age or older are believed to have angina pectoris. Older men have a higher incidence than any other population group. Once diagnosed, the average client with angina generally dies within 10 years. There are poorer prognosis for clients with several coronary vessels in a disease state. Nondrug therapy is often of great value in angina treatment and is discussed later in the chapter. Drug therapy is often used as an adjunct to these methods.

The nitrate group of drugs is useful in angina therapy. Their pharmacological action results in the relief of ischemia in coronary blood vessels. Two theories have been advanced to explain the action of these agents in reducing anginal pain. The first contends that the nitrates improve the delivery of oxygen to ischemic tissue by increasing coronary blood flow and by causing a favorable redistribution of blood flow to ischemic areas. The other theory holds that the nitrates reduce oxygen consumption by coronary blood vessels and thereby relieve the ischemic state. Recent evidence seems to indicate that the latter theory is more likely to be accurate.

Amyl nitrite is a volatile liquid that is packaged in crushable glass capsules surrounded with cotton and gauze. When the capsule is crushed the liquid vaporizes and is directly inhaled by the client.

Nitroglycerin has traditionally been the most important drug used in the symptomatic relief of angina. Several studies have demonstrated that when administered sublingually, nitroglycerin is effective in about 90% of clients in relieving anginal pain within 5 minutes. In actuality, relief of anginal pain generally occurs within a few seconds to 2 minutes after a sublingual nitroglycerin dose has been administered.

Pure nitroglycerin is a volatile and unstable liquid that is highly explosive. It is rapidly inactivated in the presence of light, heat, air, and moisture. A number of different dosage forms of nitroglycerin are currently available. Oral tablet form, however, is stable and poses no explosion risk. Forms of nitroglycerin administered by the sublingual route (e.g., **Nitrostat**) provide a rapid and predictable action appropriate for the treatment of acute anginal attacks, remaining the most common route of administration for nitroglycerin. Nitroglycerin may also be administered as transmucosal tablets or as an aerosol translingual spray. Transmucosal tablets of nitroglycerin are placed under the upper lip or between the cheek and the gum and allowed to dissolve over a 3–5-hour period. The translingual spray is sprayed onto or under the tongue. Sustained-release oral nitroglycerin products (e.g., **Nitro-Bid**, **Nitroglyn**) release the drug in the GI tract over an 8–12-hour period.

Two dosage forms of nitroglycerin are applied directly to the surface of the skin. These agents are primarily used in the prophylactic treatment of angina pectoris. Nitroglycerin ointment (e.g., Nitro-Bid, **Nitrol**) is applied over a 6 × 6-inch area of skin, which is then covered with plastic wrap (Box 29–1). A single administration of this ointment results in a 4–8-hour nitroglycerin action. Several transdermal nitroglycerin products (e.g., **Transderm-Nitro**, **Nitro-Dur**, **Nitrodisc**, **Deponit**) are currently available. These are applied onto the skin surface and gradually release the drug from a patch. The patch is generally worn for a 12–14-hour period each day, followed by a "patch-off" period of 10–12 hours. The "patch-on" period alternated with a "patch-off" period prevents the development of tolerance by the client (Figure 29–1).

Nitroglycerin administered by IV infusion may be effective in treating acute anginal attacks that do not respond to alternative dosage forms of nitrates or other drugs. Once the client has responded to such aggressive therapy, one of the other nitroglycerin dosage forms may be used to continue treatment.

Isosorbide mononitrate and **isosorbide dinitrate** exert about the same pharmacological actions as nitroglycerin. Although some investigators believe that these drugs provide a longer duration of action than nitroglycerin, others feel that when used in comparable doses, their actions in anginal clients are equivalent. Isosorbide dinitrate may be administered as a chewable or as a sublingual tablet as well as in an oral tablet form. Isosorbide mononitrate, an active metabolite of isosorbide dinitrate, is administered only in an oral form.

The greatest controversy associated with the use of coronary vasodilators centers on the use of long-acting nitrates, such as **erythrityl tetranitrate** (**Cardilate**) and **pentaerythritol tetranitrate** (PETN). Some investigators have concluded that these agents are ineffective or less effective than sublingual nitroglycerin or isosorbide products in reducing the frequency of anginal attacks. More recent studies have suggested that these agents are effective, if used in appropriate doses. A possible

BOX 29–1
Method for Applying Nitroglycerin Ointment

1. Identify the client and have the client lie down.
2. Take a baseline blood pressure reading.
3. Wash hands and put on gloves.
4. Measure the prescribed dose along the rectangular piece of ruled paper supplied for measurement and application of the medication.
5. Select a site for application of the ointment. Ideally it should be a nonhairy site to assure client comfort when removing the tape used to secure the paper or dressing. The anterior chest is often a good site, although this site may need to be shaved in very hirsute men. The application area should be rotated to prevent irritation and sensitization.
6. The person administering nitroglycerin ointment should exercise caution to avoid direct contact with the ointment and accidental drug absorption.
7. Place the measured ointment side of the paper down against the client's skin and lightly apply the ointment in a thin layer. DO NOT RUB the ointment into the skin. The ointment should be spread over a 6 × 6-inch (15 × 15-cm) area.
8. Remove gloves.
9. Tape the paper securely in place with nonallergenic tape.
10. Wash hands.
11. After 5 minutes, check the client's blood pressure. If there is a dramatic drop in blood pressure or complaints of headache, notify the physician. If the blood pressure has dropped, but the client experiences no other symptoms, instruct the client to continue to lie down until the pressure returns to normal.
12. Chart the procedure and the client's response.

danger in the use of all nitrites and nitrates and specifically long-acting products is the development of tolerance to the pharmacological effects of these agents. The development of tolerance can be minimized by using the smallest effective dose possible and then increasing the dose as tolerance develops. Discontinuation of the drug for a short period will generally result in renewed sensitivity to its action.

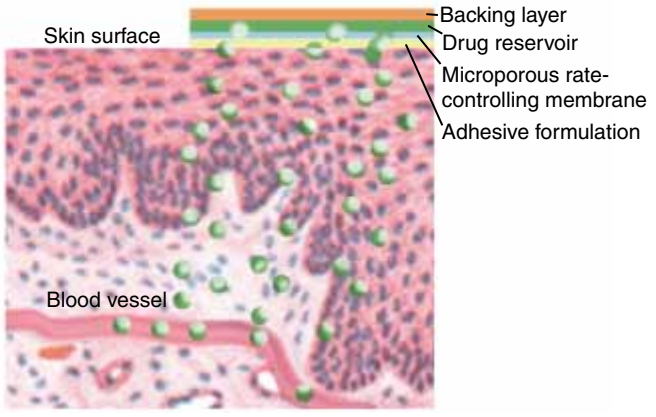

Figure 29–1 Transdermal system for applying nitroglycerin.

Most adverse effects associated with the use of nitrates stem from the pharmacological action of these drugs on the cardiovascular system. Headache and *postural hypotension*, which may be severe at times, are the most common adverse effects and often accompany the initiation of therapy. Nitrate-induced headache is believed to be the consequence of the dilation of cerebral blood vessels. The headache generally diminishes in intensity as therapy progresses or the dose is reduced. Other effects that can be related to nitrate-induced cerebral ischemia are dizziness, weakness, and *syncope*. These actions tend to be magnified by the concurrent use of alcohol, another vasodilator. Nitrates may also increase intraocular and/or intracranial pressure. Their use is, therefore, contraindicated in clients with head trauma, cerebral hemorrhage, hypertension, or glaucoma. Table 29–1 compares the properties of nitrites and nitrates used in the treatment of angina pectoris.

The effective use of beta-adrenergic blocking agents (e.g., propranolol, nadolol) in the treatment of angina pectoris is well documented. They are believed to act by decreasing heart rate and contractility, thereby resulting in a reduction of

TABLE 29–1

Nitrates Used in the Treatment of Angina

Note: Client instruction in proper administration techniques is important.
Clients should carry an identification card which includes the name of the physician and of the drug being taken.
Clients should avoid the use of tobacco because of its vasoconstricting effect.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	DURATION OF ACTION	NURSING IMPLICATIONS
amyl nitrite *(**AM**-ill **NIGH**-tright)*	inhalation	0.3 mL by inhalation as required for acute attack	30 seconds	3–5 minutes	Available in gauze-wrapped glass ampules, which when crushed, release amyl nitrite vapors. Amyl nitrite is very flammable. Extinguish all smoking materials before using this drug. Instruct client to sit down before using drug and to crush ampules in handkerchief. To avoid overdosage, instruct client not to inhale more than 2–3 times . May cause postural hypotension.
isosorbide dinitrate *(**eye**-soh-**SOR**-byd dye-**NIGH**-trayt)* (Coronex, Isordil, Sorbitrate, etc.)	oral, sublingual, chewable tablets	Sublingual: 2.5–5 mg for acute attack or every 2–6 hours Chewable: 5 mg initially for acute attack, then 2.5–5 mg every 2–3 hours prn for prophylaxis. Oral: 5–40 mg qid Sustained-release: 20–80 mg every 8–12 hours	Sublingual and chewable: 2–5 minutes Oral: 15–30 minutes Sustained-release: slow	Sublingual and chewable: 1–2 hours Oral: 4–6 hours Sustained-action: 8–12 hours	Do not administer more than 5 mg initially in chewable or sublingual form, as an occasional severe hypotensive response may occur. Monitor blood pressure during therapy. Clients should avoid the use of alcoholic beverages. Instruct clients to take a sublingual tablet at the first sign of an attack. Oral tablets should be taken on an empty stomach. Store in a tightly closed container in a cool place.
nitroglycerin *(nigh-troh-**GLIS**-er-in)* (NTG, Nitro-Bid, Nitrogard, Nitrol, Nitroglyn, Nitrolingual spray, Transderm-Nitro, etc.	sublingual, transdermal, topical, oral (sustained-release only), translingual, transmucosal, IV	Topical: 1–5 inches spread thinly on skin every 3–4 hours prn Sublingual: 0.3–0.6 mg under tongue or in buccal pouch prn for acute anginal attack Oral (sustained-action): 2.5 mg every 8–12 hours Transdermal: 0.1–0.6 mg	Sublingual: 3 minutes Topical: 30–60 minutes Oral (sustained-action): slow Transdermal: 30–60 minutes Translingual: 2 minutes	Sublingual: 9–11 minutes Topical: up to 3 hours Oral (sustained-action): 8–12 hours Transdermal: 24 hours Translingual: 30–60 minutes	Store nitroglycerin oral products in their original container with a tightly closed cap. Take oral doses on an empty stomach. Rotate sites of topical application to avoid dermal inflammation and sensitization. Burning sensation in mouth with use of sublingual tablets is a positive sign of potency. IV products should only be used with glass IV containers and administration sets provided by the manufacturer. Usual protocol for acute anginal attacks is 1 tablet SL, up to 3 tablets in 5 minutes, and call 911 after 3rd tablet if pain does not subside.

continues

TABLE 29–1 *continued*

See **Note** at beginning of Table 29–1, page 562.

DRUG	ROUTE(S)	USUAL DOSE	ONSET OF ACTION	DURATION OF ACTION	NURSING IMPLICATIONS
		released per hour Translingual: 1 or 2 metered 0.4 mg doses sprayed on to the oral mucosa as needed Transmucosal: one 1 mg tablet placed between lip and gum every 3–5 hours during waking hours IV: initially 5 mcg/minute; this may be increased at 3–5-minute intervals until a response is noted	Transmucosal: 3 minutes IV: immediate	Transmucosal: 5 hours IV: transient	Occurrence of headache usually decreases with increasing use. Client is instructed to avoid alcoholic beverages. Store tablets in a tightly closed container in a cool place. Ointment is spread in a thin layer and covered with plastic film. Instruct client to avoid chewing or swallowing tablets. Client should not inhale translingual spray. Discard unused sublingual tablets 6 months after opening original bottle.
pentaerythritol tetranitrate, PETN *(**pen**-tah-eh-**RITH**-rih-tol teh-trah-**NIGH**-trayt)*	oral	Oral: 10–40 mg tid or qid Sustained release: 30–80 mg every 12 hours	Oral: 30 minutes Sustained release: 30 minutes	Oral: 4–5 hours Sustained release: up to 12 hours	Only for prophylactic treatment. Administer ½ hour before or 1 hour after meals and at bedtime. Monitor blood pressure during therapy. May cause postural hypotension. Store in a tightly closed container in a cool place.

myocardial oxygen consumption. These agents appear to be most effective when used in combination with the nitrates in the prophylaxis of angina attacks. Because of their beta-adrenergic blocking action, these agents are contraindicated for use in clients with obstructive pulmonary diseases, congestive heart failure, heart block, bradycardia, or diabetes mellitus. When used with the nitrates they may also increase the chance of developing hypotensive episodes.

Nifedipine (Adalat, Procardia), diltiazem HCl (Cardizem, **Dilacor XR**), verapamil (**Calan**, Isoptin), bepridil (Vascor), and nicardipine HCl (Cardene) are calcium channel blockers exerting a dilating effect on coronary and peripheral blood vessels by inhibiting the passage of calcium into vascular smooth muscle cells (see Chapter 28). This results in coronary vasodilation and increased coronary blood flow, as well as lowered blood pressure, increased cardiac output, and relaxed coronary artery spasms. The result of these actions is a reduction in cardiac workload and oxygen demand. As these drugs relieve angina by a different mechanism than nitroglycerin, some clients may benefit by the concurrent use of nitroglycerin and calcium channel blockers.

Dipyridamole (**Persantine**) is an agent that has been claimed to decrease coronary vascular resistance and increase coronary blood flow and oxygenation. As it appears to exert its effects primarily on coronary blood vessels, the use of this drug does not generally affect peripheral blood flow or systemic blood pressure. Because its usefulness in the prevention or treatment of anginal attacks is questionable, dipyridamole is not approved by the FDA for the treatment of angina pectoris. Dipyridamole is used in some clients to inhibit platelet aggregation. Table 29–2 lists the properties of the non-nitrate agents used in the treatment of angina pectoris.

TABLE 29–2

Non-Nitrates Used in the Treatment of Angina Pectoris

Note: Clients should carry an identification card that includes the name of his or her physician and of the drug(s) being taken.

Clients should avoid the use of tobacco because of its vasoconstricting effect.

DRUG	DOSAGE FORMS	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
atenolol *(ah-**TEN**-oh-lohl)* (Apo-Atenol, Tenormin)	oral	50 mg daily	Dizziness, flushing, bradycardia, bronchospasm	Use with extreme caution in clients with a history of pulmonary disease, diabetes mellitus, and/or cardiac failure. Client should be advised not to discontinue use of the medication abruptly, as this could precipitate an anginal attack. Beta-adrenic blocker agent.
bepridil HCl *(**BEH**-prih-dill **hy**-droh-**KLOR**-eyed)* (Vascor)	oral	200–400 mg daily	Serious ventricular arrhythmias, agranulocytosis; see diltiazem	Reserved for clients who do not respond to or who cannot tolerate other antianginal agents. Calcium channel blocker.
diltiazem HCl *(dill-**TY**-ah-zem **hy**-droh-**KLOR**-eyed)* (Apo-Diltiaz, Dilacor XR, Cardizem)	oral	120–360 mg daily in 3–4 divided doses	Dizziness, flushing, headache, weakness, edema	Care should be used in administering this drug to clients with renal or hepatic dysfunction. Calcium channel blocker.
dipyridamole *(**dye**-peer-**ID**-ah-mohl)* (Novo-Dipiradol, Persantine, etc.)	oral	75–100 mg 2–4 times daily	Headache, dizziness, nausea, flushing, weakness, syncope, skin rash	Drug is not approved by the FDA for angina therapy. Drug should be administered 1 hour before meals with a full glass of fluid. Clinical response may not be evident for 2–3 months after therapy has begun. Should be used with caution in clients with hypotension. Platelet adhesion inhibitor.
metoprolol *(meh-**TOH**-proh-lohl)* (Betaloc, Lopressor)	oral	100 mg daily in 2 divided doses	See atenolol	See atenolol. Beta-adrenergic blocking agent.
nadolol *(nay-**DOH**-lol)* (Apo-Nadol, Corgard)	oral	Initially, 40 mg once daily; this may be increased by 40–80 mg increments at 3–7-day intervals until desired response is obtained or significant slowing of heart rate occurs; usual maintenance dosage range is 80–240 mg once daily	Bronchospasm, bradycardia, cardiac failure, dizziness, fatigue, mental depression, GI upset, pharyngitis, agranulocytosis	See atenolol. Beta-adrenergic blocking agent.

continues

TABLE 29–2 *continued*

See **Note** at beginning of Table 29–2, page 564.

DRUG	DOSAGE FORMS	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
nicardipine HCl *(nigh-**KAR**-dih-peen **hy**-droh-**KLOR**-eyed)* (Cardene)	oral	20–40 mg 3 times daily	Dizziness, flushing, headache, weakness, edema	Dosage should be reduced in clients with hepatic impairment. Calcium channel blocker.
nifedipine *(nigh-**FED**-ih-peen)* (Adalat, Apo-Nifed 🍁, Procardia)	oral	Initially, 10 mg 3 times daily; dosage may gradually be increased to 120 mg daily divided into 3 doses. Sustained-release tablets: 30–60 mg once daily	Dizziness, flushing, headache, weakness, edema	Client should swallow sustained-release tablet whole. An empty tablet may appear in the stool. This is expected and is no cause for concern. Calcium channel blocker.
propranolol *(proh-**PRAN**-oh-lohl)* (Detensol 🍁, Inderal LA)	oral	Initially, 10–20 mg 3–4 times daily before meals and at bedtime; 80 mg once daily of sustained-release (LA) product; dose may be gradually increased at 3- to 7-day intervals to a maximum of 320 mg daily; most clients are optimally controlled at 160 mg daily	See atenolol	See atenolol. Beta-adrenergic blocking agent.
verapamil *(ver-**AP**-ah-mill)* (Apo-Verap W, Calan, Isoptin)	oral	80–120 mg 3–4 times daily	See nifedipine	May produce an additive blood pressure lowering effect when used with oral antihypertensive agents. Calcium channel blocker.

MYOCARDIAL INFARCTION

Acute myocardial infarctions (AMI) occurs when an area of the heart muscle dies as a result of insufficient oxygen. Nearly 40% of all clients experiencing AMI die before reaching an acute care health facility. Reasons for this insufficient oxygen supply to the myocardium (cardiac muscle) fall into two categories: (1) those that decrease the flow of oxygen-rich blood to the heart muscle, and (2) those that result in an increased demand for oxygen by the myocardium that exceeds what the circulation can supply. Among those in the first category are coronary artery disease, thrombus formation (see Chapter 30) in the coronary artery as a result of a blood clot or the rupture of plaque from the walls of the coronary artery, and coronary artery spasm. Those in the second category include stress, heavy exertion, an abrupt increase in blood pressure.

The goal for care of the client with AMI is to limit damage to the myocardium to preserve enough myocardial function to sustain life by preventing and treating cardiogenic shock (shock resulting from the ineffective pumping of the heart). In addition to intravenous fluids, the first line of treatment for AMI is pharmacotherapeutics. A number of agent classifications are used in combination to sustain life by increasing oxygen-rich blood to the myocardium.

Among the first drugs to be administered in the event of an AMI is aspirin, which prevents further clotting and coronary artery constriction. Nitroglycerin is administered to decrease the heart's workload and increase blood supply to the heart muscle. Intravenous morphine sulfate is a critical adjunct to the nitroglycerin to reduce myocardial oxygen demand. Beta-blockers, such

as metoprolol (Lopressor) or atenolol (**Tenormin**), reduce the heart's oxygen demand by decreasing the heart rate. Platelet glycoprotein IIb and IIIa, such as **eptifibatide** (**Integrilin**) and **tirofiban** (**Aggrastat**), inhibit platelet aggregation (clotting) at the site of the plaque rupture. The platelet glycoproteins are discussed in more depth in Chapter 30. Angiotensin-converting enzyme (ACE) inhibitors are used to reduce myocardial oxygen demands. ACE inhibitors used in AMI include **captopril** (**Capoten**), **lisinopril** (**Prinivil**), **ramipril** (**Altace**), and **trandolapril** (**Mavik**) and help reduce the risk of death or development of congestive heart failure following AMI. Lidocaine, as was previously discussed, is an antiarrhythmic and the drug of choice to treat the arrhythmias that accompany AMI. Adenosine and amiodarone are used to prevent and treat ventricular arrhythmias.

In addition to calcium channel blockers, such as diltiazem (Cardizem) or nifedipine (Procardia), magnesium is also administered to block calcium channels and neuromuscular transmission. By interfering with calcium transport, the calcium channel blockers decrease myocardial oxygen demand and increase oxygen supply. (Nursing care of clients experiencing cardiogenic shock is discussed in Chapter 28.)

PERIPHERAL VASODILATORS

Some vasodilators are used in the treatment of peripheral vascular diseases. These diseases may be classified as obstructive disorders (e.g., *arteriosclerosis obliterans*) or vasospastic (e.g., Raynaud's phenomenon). Obstructive vascular disorders have not been shown to be effectively treated by the use of vasodilator drugs, as these agents reduce blood pressure and may, therefore, actually reduce peripheral blood flow to the obstructed area. Vasospastic disorders are more likely to respond to vasodilator therapy, because the vasoconstriction in these disorders is reversible.

Mibenfradil dihydrochloride (**Posicor**) is one of the newest peripheral vasodilators. It acts by reducing peripheral vascular resistance and lowering blood pressure. Although it is a calcium channel blocker, it more closely resembles nifedipine. However, it acts at different binding sites than nifedipine and is less likely to cause tachycardia and peripheral edema. Like diltiazem and verapimil, mibenfradil may actually lower the heart rate. As a result, mibenfradil is indicated for chronic unstable angina. It has been shown to decrease the number of acute anginal attacks and the need for nitroglycerin.

Peripheral vasodilators may act by affecting the sympathetic nervous system or by a direct action on the vascular smooth muscle. **Reserpine**, **guanethidine**, and **methyldopa** are agents that either block alpha-adrenergic receptors or interfere with the action of norepinephrine at the vascular level. The result of this effect is not only improved peripheral blood flow, but also a reduction in blood pressure (discussed in Chapter 31).

Papaverine, **ethaverine**, **nicotinic acid**, **isoxsuprine**, **nylidrin**, and **cyclandelate** act directly to relax vascular smooth muscle and produce improved peripheral blood flow. Although papaverine has been used for decades as a peripheral vasodilator, there is little evidence that it has any useful effect and it is gradually disappearing from medical practice. Ethaverine HCl is chemically and pharmacologically similar to papaverine and offers no additional useful properties.

Nicotinic acid or **niacin** is a weak vasodilator that predominantly affects cutaneous vessels in the facial area. Although it tends to cause a flushed feeling, it has not proven to be of therapeutic use in peripheral vascular disease. A chemical analog of nicotinic acid, **niacinamide**, or **nicotinamide**, has no vasodilating effects.

Isoxsuprine and nylidrin are sympathomimetic agents that may be used in the treatment of peripheral vascular disease. As they may cause cardiac stimulation, isoxsuprine and nylidrin should not generally be used in clients with a history of angina pectoris and/or myocardial infarction. Their effectiveness in the treatment of peripheral vascular disorders is still questionable.

Cyclandelate acts directly on smooth muscle of blood vessel walls as a *spasmolytic* in a manner quite similar to papaverine. It has been shown to have about three times the spasmolytic activity of papaverine, but has, however, only weak vasodilating effects. It is only marginally useful, therefore, in clients with *intermittent claudication* and Raynaud's phenomenon.

Review of the clinical studies of peripheral vasodilator drugs appears to indicate that these agents have no place in the treatment of obstructive vascular disease. The agents, which act on the sympathetic nervous system, may have a beneficial effect in some clients with persistent vasospasm or Raynaud's phenomenon, but none of these drugs appears to have a dramatic or predictable action in these disorders. Table 29–3 compares the properties of a number of peripheral vasodilators.

TABLE 29–3

Properties of Some Peripheral Vasodilators

Note: Clients are advised to avoid the use of tobacco because of its vasoconstricting effect. Instructions in foot care must be given to clients with peripheral vascular diseases of the lower extremities.

DRUG	DOSAGE FORMS	USUAL DOSE	ADVERSE EFFECTS	NURSING IMPLICATIONS
cilostazol *(sih-**LESS**-tah-zohl)* (Pletal)	oral	100 mg twice a day	tachycardia, GI bleeding	Contraindicated in clients with pacemakers, CHF Use cautiously in elderly clients also receiving beta-blockers concurrently. Monitor pulse. Classified as antiplatelet agent. Safety and efficacy in children has not been determined.
cyclandelate *(sigh-**KLAN**-deh-layt)* (Cyclospasmol, etc.)	oral	Initially, 1,200–1,600 mg in divided doses before meals and at bedtime; when clinical response is noted, dosage is reduced in 200 mg decrements until maintenance dose (usually 400–800 mg/day) is reached	GI distress, headache, weakness, tachycardia	GI distress with this drug can be avoided by administering with an antacid. Use with caution in glaucoma clients. May produce transient hypotension, flushing, and dizziness. Advise client to sit or lie down until these effects are relieved. Hypotension may improve with dosage reduction.
isoxsuprine HCl *(eye-**SOCK**-syou-preen **hy**-droh-**KLOR**-eyed)* (Vasodilan, etc.)	oral	10–20 mg 3–4 times daily	Hypotension, tachycardia, nausea and vomiting	May produce transient hypotension, flushing, and dizziness. Advise client to sit or lie down until these effects are relieved. Hypotension may improve with dose reduction.
mibefradil dihydrochloride *(my-beh-**FRAH**-dil dye-hye-dro-**KLOR**-ide)* (Posicor)	oral	50–100mg	bradycardia	Contraindicated in clients with pacemakers. Use cautiously in elderly clients receiving beta-blockers concurrently. Monitor pulse.
nylidrin HCl *(**NILL**-ih-drin **hy**-droh-**KLOR**-eyed)* (Arlidin, PMS Nylidrin ✤, etc.)	oral	3–12 mg 3–4 times daily	Nervousness, weakness, dizziness, nausea and vomiting	Contraindicated in clients with acute myocardial infarction, paroxysmal tachycardia, angina pectoris, and thyrotoxicosis.
papaverine HCl *(pah-**PAV**-er-een **hy**-droh-**KLOR**-eyed)* (Cerespan, Pavabid, etc.)	oral, IM, IV	Timed-release: 150 mg every 8–12 hours IM, IV: 30–120 mg every 3 hours if needed	Flushing, perspiration, increased heart rate, sedation, GI distress (with oral use)	Use with caution in clients with glaucoma. Observe client for hepatic disorders. IV route is preferred when rapid action is desired. Administer slowly over 1–2 minutes.

APPLYING THE NURSING PROCESS

CLIENTS RECEIVING CORONARY VASODILATORS

Assessment

The nursing care of clients receiving peripheral and coronary vasodilators is quite different, and they will be examined separately. Coronary vasodilators are frequently used as one part of the treatment of coronary disease. They are especially useful when angina occurs. The assessment of clients with coronary artery disease taking vasodilator drugs is focused on determining the frequency, nature, and precipitants of anginal attacks. Such information can be helpful in designing an educational program to help clients modify their lifestyle to minimize attacks. In addition, the nurse assesses the effectiveness of coronary vasodilators in relieving angina and monitors vital signs, particularly blood pressure, to identify untoward effects of the medication.

Nursing Diagnoses

Including but not limited to:

- Ineffective tissue perfusion, cardiac function related to angina pectoris
- Risk for injury related to side effects of coronary vasodilators
- Deficient knowledge related to health alteration and medication regimen

Planning/Goals

- Client will verbalize decrease in anginal attacks.
- Client will not experience injury due to side effects of coronary vasodilators.
- Client will verbalize understanding of appropriate use of coronary vasodilators, including signs and symptoms to report to physician.

Implementation

Nitroglycerin is most commonly used in the treatment of angina pectoris. Because of the variety of available nitroglycerin dosage forms, proper instruction in the use of these products is essential. When nitroglycerin is to be administered sublingually, the client is instructed to take the nitroglycerin at the first sign of an impending angina attack. When such a dosage form is administered, the client should be sitting or lying down, as nitroglycerin may produce hypotension. Clients must know that the hypotension may last for approximately ½ hour, and that they should remain at rest during this time. In addition, clients are informed that nitroglycerin may produce headaches, flushing, and nausea. Most side effects disappear within a short time, approximately 30–60 minutes. The frequency and intensity of headaches decrease with use. The client can be advised to treat the headaches with a mild analgesic such as aspirin or acetaminophen. All nitroglycerin preparations must be used cautiously in clients with glaucoma, as they may increase intraocular pressure.

Clients taking coronary vasodilators are encouraged to maintain close contact with their physician. Physicians should be informed about the frequency of nitroglycerin administration and its effectiveness in relieving angina. As tolerance to nitroglycerin may develop, the dosage may need to be increased or the client may temporarily be given another medication. Often nitroglycerin administration can be successfully reinstituted after it has been discontinued for several weeks. All clients taking coronary vasodilators, and particularly those receiving nitroglycerin, should carry an identification card providing information about their treatment and where to contact their physician.

Sublingual administration of nitroglycerin is a frequent route of administration. Clients using this route are instructed to place a tablet under their tongue as soon as they notice the first indication of pain. They are instructed not to swallow until the taste of the drug disappears. If relief is not observed with the use of one tablet, a second or even a third tablet may be administered at 5-minute intervals until relief occurs. Generally not more than 3 tablets should be used in a short interval without seeking medical advice. Sublingual nitroglycerin tablets may be taken shortly before engaging in physical activities associated with a client's previous angina. This may prevent angina from occurring.

Sublingual nitroglycerin is one of the few drugs permitted at the bedside of hospitalized clients. Their supply of medication in the original

container is placed within easy reach. After each use, the cap must be securely tightened. When a new container of nitroglycerin is opened for the first time, the cotton is removed and discarded. This is because the cotton can absorb some of the drug. The container is checked daily to determine use and to assure that the client has an adequate supply of the drug. In addition, clients are instructed to notify the nurse when they have used a tablet, so the nurse can assess the nature and duration of the pain and the relief offered by the nitroglycerin.

Outpatients are informed that nitroglycerin does not keep well. A fresh supply should be obtained every 3 months. As the medication is relatively inexpensive, the client is encouraged to carry a small supply for emergency use. The container, however, should not be kept next to the body for long periods, as body heat promotes nitroglycerin decomposition. A slight stinging sensation when the client uses sublingual nitroglycerin indicates that the product is fresh.

Nitroglycerin translingual (**Nitrolingual**) spray has also been marketed in the United States. This product works as quickly as the sublingual tablets and offers the advantages of longer stability and ease of use, particularly for arthritic, sight-impaired, and incapacitated clients. Each spray of this product delivers a metered dose of 0.4 mg of nitroglycerin. Clients using this form of nitroglycerin are instructed in proper administration. They are advised to be seated and to hold the spray orifice as close to the mouth as possible. The dose should be sprayed onto the tongue and the mouth closed following each dose. The spray should not be inhaled.

Nitroglycerin is available for use topically and is generally used prophylactically to prevent anginal attacks. When discontinuing treatment with nitroglycerin ointment, both the dosage and frequency of application are gradually reduced over a period of 4–6 weeks to prevent sudden withdrawal reactions. As with nitroglycerin preparations used sublingually, the client should not drink alcoholic beverages soon after taking the nitroglycerin, as vasodilation will be enhanced and unpleasant side effects may be experienced.

Transdermal application systems release nitroglycerin continuously and in a well-controlled manner. The application system consists of a pad impregnated with nitroglycerin applied once daily to a skin site free of hair and not subject to excessive movement. In applying this system, a therapeutic response is generally attained within 1 hour after the pad has been applied. Guidelines for the use of transdermal nitroglycerin systems appear in Box 29–2.

Before administering nitroglycerin intravenously, the drug must be diluted in 5% dextrose injection, USP or 0.9% sodium chloride injection, USP. This must be done prior to its infusion. **Note:** No other drugs are mixed with nitroglycerin infusion solution. Nitroglycerin intended for IV infusion must be used only with glass IV bottles and the administration set provided by the manufacturer or other special administration sets suitable for use with intravenous nitroglycerin. No filters or volume control chambers are used as part of the apparatus, because they will absorb the drug. The solution must be infused within 96 hours of preparation. Vital signs are monitored before beginning therapy to provide baseline readings. The client must be continuously monitored for changes in blood pressure and heart rate while undergoing such therapy. If severe hypotension with sweating, nausea, and vomiting occur, the nurse can elevate the client's legs for 2 to 3 minutes. If this fails to raise the blood pressure, it may be necessary to reduce the rate of flow of the intravenous nitroglycerin solution.

The basic action of isosorbide mononitrate and isosorbide dinitrate is identical to the other nitrates. They are available in a number of dosage forms, including sublingual and chewable forms as well as sustained-release products. The nurse exercises the same precautions in administering oral isosorbide dinitrate products as those used with oral nitroglycerin products.

Finally, one nitrite preparation is available for administration by inhalation. It is important that clients using amyl nitrite be instructed to extinguish smoking materials before using the drug, as this medication could be ignited. The client then sits down, wraps the glass capsule containing the liquid medication in a handkerchief, and crushes it in the palm. The vapors are then inhaled while the client is at rest. Clients are advised, despite its strong pungent odor, to take several deep breaths. This preparation is somewhat more likely to cause throbbing headache, hypotension, flushing, and tachycardia than nitroglycerin. Clients are warned about these possible effects and instructed to remain at rest until they pass.

BOX 29–2
Guidelines for Use of a Transdermal Nitroglycerin System

1. Always wash your hands before and after applying the product. Avoid contact with the pad impregnated with the medication.
2. Properly identify the client.
3. Always apply the unit on a clean, hairless area. Shave the skin, if necessary to create a hairless application site. Ideal sites are on the chest, side, pelvis, or inner arm. Avoid the lower extremities and areas that have been burned, chafed, or scarred.
4. Change the application site daily.
5. Change the unit at the same time every day.
6. Note and record any evidence of skin irritation.
7. If the unit becomes dislodged, discard it and replace it with a new unit.
8. Follow the manufacturer's directions about whether the unit should be replaced after showering or swimming.
9. If the client has an adverse reaction, remove the unit, provide supportive care, and call the prescriber. Sublingual or lingual nitroglycerin may be used, if necessary, until the prescriber is contacted. **Note:** Headaches that may occur on first using these products usually disappear within 2–3 days of use.
10. Some clients require additional sublingual or lingual nitroglycerin during an attack of angina.
11. These products are stored to avoid extremes of temperature and humidity. They should not be refrigerated.
12. Clients are instructed not to discontinue the use of these products suddenly, as severe angina may occur.
13. Clients are instructed to avoid sudden changes in position if they experience hypotension, and to avoid the use of alcoholic beverages which, could enhance hypotension.
14. Transdermal products are always removed from the skin before cardioversion. Some of these products can conduct electricity, and an arcing of current with a flash and sound like an explosion may occur. Also, the cardioversion is unlikely to be successful.
15. Record the procedure, including the date, time, location of transdermal system, and observations about the client.

A number of long-acting coronary vasodilators (e.g., PETN) have been developed. The nursing care of clients taking these drugs is very similar to the care of clients receiving shorter acting coronary vasodilators, such as nitroglycerin and isosorbide products. The nurse should be familiar with the various preparations in use so that the instructions given by the pharmacist and physician can be reinforced. In this regard, it is important to encourage clients to use their medication regularly as prescribed. They should not discontinue the medication simply because they have not experienced angina for some time. Instruction should also be offered regarding proper administration; for example, sustained-acting preparations should not be chewed or crushed. Some clients taking long-acting coronary vasodilators will experience headaches. These can be relieved through the use of aspirin or acetaminophen. Such headaches usually become less frequent with continued therapy.

Occasionally a beta-adrenergic blocking agent, for example propranolol (Inderal), nadolol (Corgard), atenolol (Tenormin), or metoprolol (Lopressor) will be given to clients receiving coronary vasodilators. The purpose of these agents is to slow the heart. This is beneficial, because the prescribed vasodilator may produce tachycardia. When clients are receiving such therapy, it is important to encourage them to take their medication at the times ordered. The beta-adrenergic blocking agent should be administered prior to the nitrate to best prevent vasodilator side effects. (For example, Inderal would be taken before Nitro-Bid).

One type of angina, Prinzmetal's, or variant angina, occurs while the client is at rest. A major nursing diagnosis for this condition is alteration in cardiac output related to coronary artery spasm. The nurse monitors the client's level of comfort and administers medications, primarily calcium channel blockers, to prevent spasm and pain. The nurse monitors the client's response to the medication by assessing alterations in comfort and the development of side effects of therapy. Blood pressure is routinely monitored, as hypotension may occur. Some clients experience gastrointestinal symptoms, such as nausea or

KEY NURSING IMPLICATIONS 29–1

Coronary Vasodilators

1. Assessment focuses on determining the frequency, nature, and precipitants of anginal attacks and the effectiveness of vasodilators in relieving angina.
2. Sublingual or lingual nitroglycerin should be used at the first sign of an attack of angina.
3. Clients using nitroglycerin products, such as sublingual tablets, lingual spray, or ointment, plus those using amyl nitrite are advised to sit or lie down before using the product, as hypotension is possible. Alcohol may intensify hypotensive effects.
4. A fresh supply of sublingual nitroglycerin tablets should be obtained every 3 months. Avoid storage in areas subjected to prolonged heat.
5. Nurses must avoid direct contact with topical preparations of nitroglycerin. Review the procedure for applying nitroglycerin ointment and the guidelines for use of a transdermal nitroglycerin system.
6. Intravenous nitroglycerin must only be administered using glass bottles and special administration sets. Do not mix other drugs with the nitroglycerin.
7. When both a beta-adrenergic blocking agent and a vasodilator are ordered, schedule administration of the blocking agent first.
8. Calcium channel blockers should be taken with meals or milk. Blood pressure should be routinely monitored.

indigestion. Improvement in these symptoms can be obtained by giving the medication with meals or milk. Verapamil (Calan, Isoptin) may cause an increase in digoxin plasma concentrations, so the nurse monitors the client for indications of digoxin toxicity, for example, bradycardia, gastrointestinal upset, and changes in color vision (see Chapter 28 for greater detail about digoxin toxicity and appropriate nursing care). Some physicians may recommend sublingual nifedipine for the relief of angina. To administer nifedipine by this route, the nurse punctures the oral dosage form with a sterile 18-gauge needle and squeezes the liquid under the client's tongue. Vital signs, particularly blood pressure, are checked following administration of the drug, as hypotension may occur. Also, the nurse observes the client for indications of increased cardiac ischemia. Finally, the nurse provides information to alleviate the client's deficient knowledge regarding this type of angina and its treatment with calcium channel blockers.

In addition to the instruction given about drug therapy, clients receiving coronary vasodilators require nursing support in learning how to moderate their activities. Situations frequently resulting in angina should be identified and avoided whenever possible. Clients should be encouraged to discontinue or reduce the use of tobacco, as it has a vasoconstricting effect.

Evaluation

- Client verbalizes decrease in anginal attacks to less than one per month.
- Client does not experience injury due to side effects of coronary vasodilators.
- Client verbalizes understanding of appropriate use of coronary vasodilators including signs and symptoms to report to physician.

CLIENTS RECEIVING PERIPHERAL VASODILATORS

Assessment

Vasodilators are also used in the treatment of peripheral vascular disease as a technique to improve the blood supply to the extremities, particularly the lower extremities.

Health professionals caring for persons with peripheral vascular disease assess the extent of the disease process and the response to therapy in three ways. The first is inspection of the skin for color, hair distribution, lesions, and other abnormalities. A second method of assessment is auscultation using a stethoscope or special equipment to listen for arterial sounds. Finally, palpation is used to check for skin temperature and turgor. It is recommended that the backs of the nurse's fingers, rather than the fingertips, be used to assess skin temperature. Palpation is also used to assess the presence and nature of peripheral pulses. As always, directly questioning a client about response to treatment is an important source of information in assessing effectiveness and untoward responses.

Nursing Diagnoses

Including but not limited to:

- Ineffective tissue perfusion, peripheral related to peripheral vascular disease
- Risk for injury related to side effects of peripheral vasodilators
- Deficient knowledge related to health alteration and medication regimen

Planning/Goals

- Client will verbalize decrease in peripheral discomfort (intermittent claudication).
- Client will not experience injury due to side effects of peripheral vasodilators.
- Client will verbalize understanding of appropriate use of peripheral vasodilators, including signs and symptoms to report to physician.

Implementation

The vasodilators are most frequently used when spasm of blood vessels is contributing to poor circulation. The most commonly used preparations, cyclandelate (**Cyclospasmol**) and **isoxsuprine hydrochloride** (**Vasodilan**), may both produce flushing and a sensation of light headedness or dizziness. Some transient hypotension may occur. Clients taking these drugs should sit or lie down until these side effects pass. If hypotension or dizziness is experienced frequently, clients should be instructed to contact the physician. Often these side effects will diminish with a decrease in dosage. For safety, the client should be advised not to rise or change position rapidly, and not to drive or engage in hazardous activities during an episode of dizziness. Clients taking vasodilators should be advised that these agents may produce flushing or a feeling of warmth because of their vasodilating effect. They should be told that this is a normal reaction to taking the drug, and is not a cause for alarm.

A number of nursing activities are involved in caring for clients with peripheral vascular disease (PVD). A detailed explanation of this care is beyond the scope of this book; however, several points should be stressed. As with many other conditions requiring long-term treatment, client education is important. Many clients with peripheral vascular disease have been smokers for years. These clients should be strongly encouraged to stop smoking or, at least, to cut down the amount of smoking. The nicotine in tobacco is a vasoconstrictor and may counteract the effects of the vasodilator medication taken by the client. Instructions should also be given for care of the feet. Such instructions include avoiding the application of medications not prescribed by the physician or engaging in activities that could injure the extremities, e.g., walking barefoot or careless toenail cutting. Care must be taken in bathing the feet. Warm water is used and the feet must be dried thoroughly after bathing. These guidelines may be remembered best if the client is given a printed instruction sheet containing do's and don'ts. For the treatment of PVD to be effective, clients and those caring for them should become active in the treatment process. Daily care and vigilance are essential in the treatment process.

KEY NURSING IMPLICATIONS 29–2

Peripheral Vasodilators

1. Assessment includes inspection of the skin, auscultation, palpation, and interviewing.
2. Clients experiencing light headedness or dizziness when taking vasodilators should be advised to lie down until these side effects pass.
3. A flushed or warm feeling often results from the use of vasodilators and is not a cause for alarm.
4. Clients with peripheral vascular illnesses require an education program focused on general hygiene and safety.

Evaluation

- Client verbalizes that he/she is able to walk to mailbox and around the block without leg pain.
- Client does not experience injury due to side effects of peripheral vasodilators.
- Client verbalizes understanding of appropriate use of peripheral vasodilators, including signs and symptoms to report to physician and need for being compliant with medication regimen.

NURSING CARE PLAN

A Client with Angina Using Nitroglycerin Transdermal (Nitro-Dur)

Cindy Miller is a 45-year-old travel agent who was admitted to the hospital after suffering chest pains at a card club. The pain was substernal, not accompanied by diaphoresis or radiation, and was relieved with nitroglycerin (Nitrostat) 0.4 mg sublingually. Cindy admits to being 30 pounds overweight. She smokes 2–3 packs of cigarettes daily and drinks alcohol on occasion. This is her first hospitalization and she is anxious. Family history indicates her mother and two overweight brothers have had myocardial infarctions. The physician prescribes Nito-Dur 0.3 mg/hr transdermal patch to be applied for 12 hours each day. Cindy has no chest pain or monitor changes during the next 48 hours. She is scheduled for stress testing and health teaching is begun.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Chest pain. Shortness of breath.	Acute pain related to myocardial ischemia.	Client will have relief of pain within 5 minutes following nitroglycerin administration.	Teach client to use sublingual nitroglycerin at the first sign of chest pain and stop activity. If pain is not relieved after 3 doses taken 5 minutes apart, client should call 911.	Client is pain-free with medication and control of activity.
Vital signs. Shortness of breath.	Ineffective tissue perfusion: cardiopulmonary related to myocardial ischemia.	Client will maintain sufficient oxygenation with no signs of cyanosis.	Client will be taught to observe for cyanosis and shortness of breath; when they occur, will stop activity.	Client is able to maintain normal activity without cyanosis or pain.
Anxious.	Fear related to diagnosis and family history of myocardial infarctions.	Client will demonstrate reduced anxiety before discharge.	Explain situation to client. Encourage her to ask physician questions. Emphasize positive aspects of early treatment.	Client demonstrates methods of coping with anxiety.
Age, family history, activity, diet, body weight, smoking, exercise.	Deficient knowledge related to (cardiac risk factors).	Client will be able to identify own risk factors and name methods of management.	Teach client methods of stress control, need to avoid alcohol, smoking, and stress. Discuss exercise program (walking) with physician.	Client identifies lifestyle changes to reduce modifiable risk factors.
Skin care, headaches.	Deficient knowledge related to transdermal nitroglycerin patchess.	Client will be able to identify action, dosage and side effects of medication and will be able to apply patch correctly.	Teach client to apply patch to different site at same time daily and how to schedule daily "patch-on" and "patch-off" periods. Skin should be free of scars or irritations. If dizziness or faintness occurs, remove patch and call physician.	Client demonstrates proper application of patch. Client can list side effects of medication.

continues

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Smokes cigarettes and drinks alcohol.	Deficient knowledge related to the effects of smoking and alcohol consumption.	Client will be able to identify need and methods to avoid smoking and alcohol consumption.	Teach client that smoking constricts vessels. Help client identify methods to avoid cigarettes. Small amounts of alcohol are acceptable, although its use may potentiate hypotension caused by nitroglycerin.	Client expresses plans to stop smoking and use alcohol in moderation.
Dietary practices. Usual activity.	Imbalanced nutrition: more than body requirements related to intake in excess of metabolic needs.	Client demonstrates appropriate selection of foods to achieve weight reduction goal of 1–2 pounds a week. Client develops an appropriate exercise plan.	Consult with dietician to assist with diet planning. Help client set realistic weight loss goals. Instruct client on elements of an effective exercise program. Explain effects of fat and cholesterol. Encourage client to start daily walks of increasing length as toleration builds. Stop activity if chest pain or undue fatigue occurs.	Client loses 1–2 pounds weekly and begins an appropriate exercise program.

HOME CARE / CLIENT TEACHING

1. Persons taking coronary vasodilators require instruction in the storage and use of these medications. Instruction should include advice about when to contact the physician to discuss the response or lack of response to therapy.
2. Persons with vascular disease are advised to avoid tobacco and are supported during their efforts to discontinue its use.
3. Clients taking nitroglycerin sublingually should be instructed to take the nitroglycerin at the first sign of an impending anginal attack.
4. Clients taking sublingual nitroglycerin should be instructed to sit or lie down, because the drug in this form can cause hypotension that can last approximately 30 minutes.
5. Clients taking coronary vasodilators are encouraged to maintain close contact with their physician, including informing the physician about the frequency of nitroglycerin administration and its effectiveness at relieving anginal pain.
6. Clients taking nitroglycerin translingual spray and transdermal patches, as well as other forms of coronary vasodilators should be instructed on proper administration of their medications.
7. Clients using amyl nitrite should be informed of the importance of extinguishing all smoking materials before using the drug, because it can be ignited.
8. Clients who smoke and are taking coronary vasodilators or peripheral vasodilators should be provided with information about smoking cessation programs and the relationship between tobacco use and vascular disease.
9. Clients taking medications for vascular disease must be encouraged to remain compliant with the medication regimen.
10. Clients being treated for angina should be assisted in identifying and avoiding activities or situations that result in anginal attacks.
11. Clients taking vasodilators should be informed that these drugs have the potential for causing flushing, lightheadedness, and dizziness and that they should sit or lie down until these side effects subside.
12. Clients taking vasodilators should receive instructions concerning foot care, including avoiding application of medications not prescribed by doctor, walking barefoot, careless toenail trimming.

CASE STUDY

Mr. Harold Marx is a 67-year-old male who has been smoking two packs of cigarettes per day for more than 50 years. He is also an adult-onset diabetic who uses 30 mg of **glipizide** (**Glucotrol**), an antidiabetic agent, daily. He visits his physician complaining of a cramping pain in his right calf, experienced after having walked half a block. He indicates that he has been experiencing some leg pain for the previous 10 weeks. Mr. Marx's physician diagnoses his condition as intermittent claudication and prescribes **cilostazol** (**Pletol**) 100 mg p.o., every day. After 6 weeks of therapy the client has experienced no improvement. On reexamination, the physician notes decreased distal pulses in the right lower extremity.

The physician advises Mr. Marx to stop smoking and to begin a program of progressively increasing exercises. Mr. Marx is to be seen at regular intervals to check whether his disease is progressive.

Questions for Discussion

1. As the nurse responsible for providing instructions to new clients with vascular disease, what instructions will you give Mr. Marx about hygienic care?
2. Why should Mr. Marx stop smoking?
3. Mr. Marx tells you that he had several episodes of dizziness while taking the nylidrin (Arlidin). What would you advise the client to do if these episodes should recur?

CASE STUDY

George Greenspoon, a 56-year-old dentist, experienced a major myocardial infarction last June. Since that time, he has been using Transderm-Nitro (nitroglycerin) as prescribed by his physician. He applies one Transderm-Nitro 0.2 mg/hr system each morning. When asked about his drug therapy, Dr. Greenspoon notes that it has been effective in preventing attacks of angina and that he no longer experiences the headaches he once did when using this drug product.

Questions for Discussion

1. Is it usual to experience headaches when using nitroglycerin products? What advice can the nurse give the patient who experiences headaches?
2. Describe the procedure for applying a Transderm-Nitro or other transdermal therapeutic system.
3. What safety factors does the nurse teach the client about when this type of product is used?
4. Why should transdermal products be removed from a client's chest before defibrillation or electrocardioversion is attempted?

CRITICAL THINKING EXERCISES

1. Prepare a client teaching aid concerned with the use of a particular preparation of nitroglycerin.
2. Prepare a teaching guide for a client with peripheral vascular disease. Be sure to include the do's and don'ts of daily care that the client should observe.
3. Prepare a chart that compares the administration methods of various forms of nitroglycerin.
4. Is it unusual for clients taking nitroglycerin to experience headaches? Why? What advice can the nurse give the client who experiences headaches associated with nitroglycerin use?
5. Discuss the precautions the nurse should take when administering nitroglycerin ointment or transdermal patches.

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Agents Affecting Blood Clotting

30

OBJECTIVES

After studying this chapter, the student will be able to:

- List commonly used drugs that may induce bleeding or delay coagulation time
- List commonly used hemostatic agents
- Describe the mechanisms of action of heparin, oral anticoagulants, thrombolytic enzymes, alteplase, and anistreplase
- Identify commonly used drugs that may interact with heparin, oral anticoagulants, thrombolytic enzymes, alteplase, and anistreplase
- List the usual methods of administering heparin
- Describe in a stepwise manner, the technique for subcutaneous administration of heparin
- Discuss safety measures used by nurses in providing care to clients on heparin or oral anticoagulants
- Apply the nursing process used in providing care for clients receiving heparin or oral anticoagulants
- State the general guidelines for safe intermittent administration of heparin using a heparin lock
- Identify the educational needs of clients receiving heparin and/or oral anticoagulants
- Apply the nursing process for a client following intracoronary thrombolysis, employing urdkinase, streptokinase, alteplase, or anistreplase

Thromboemboli in the venous or arterial system contribute to the death of many persons in the United States each year. Anticoagulants, used either to prevent the formation of a *thrombus* or to inhibit the extension of existing ones, are among the most common causes of hospitalization for adverse drug reactions. An understanding of the clotting process, as well as the role of anticoagulant therapy, is essential in providing good client care.

Injury to the wall of a blood vessel triggers a complex series of events, which involves the activation of many different clotting factors (Table 30–1 and Figure 30–1). Such injury and sequelea result in the formation of a fibrin clot. Any defect in the sequence of events can prevent the formation of a clot and, if not properly controlled, may result in a serious hemorrhagic risk.

A number of drugs available in the United States affect the clotting of blood. These include the anticoagulants, the thrombolytic agents, **alteplase**, **anistreplase**, and the hemostatic agents.

TABLE 30–1

Blood Clotting Factors

FACTOR	COMMON NAME
I	Fibrinogen
II	Prothrombin
III	Tissue thromboplastin
IV	Calcium
V	Labile factor, Proaccelerin
VII	Proconvertin
VIII	Antihemophilic globulin (AHG)
IX	Christmas factor (PTC)
X	Stuart factor (Stuart-Prower factor)
XI	Plasma thromboplastin antecedent (PTA)
XII	Hageman factor
XIII	Fibrin-stabilizing factor
HMWK	High molecular weight kininogen
Ka	Kallikrein
PL	Platelet phospholipid

ANTICOAGULANTS

These drugs inhibit the action or formation of one or more clotting factors. None, however, is capable of exerting a fibrinolytic effect on existing clots.

Heparin

Heparin is an agent found in *mast cells* located throughout the body. It has been found to be a potent inhibitor of the clotting process and has been used for more than 40 years in the prophylaxis and treatment of clotting disorders related to coronary occlusion, cerebral thrombosis, cerebral vascular accidents (CVAs), and many other diseases. Heparin indirectly interferes with the conversion of prothrombin to thrombin (Figure 30–2). The resulting deficiency of thrombin prevents the conversion of fibrinogen to fibrin and thereby inhibits clot formation. Heparin is not effective when administered orally, because it is rapidly inactivated by stomach acid. It is active when administered parenterally (SC, IV). Intramuscular injection is not advisable because muscle tissue is very vascular and bleeds easily. An IM injection could result in the development of a *hematoma*.

Heparin acts rapidly and in proportion to its concentration in the blood. By careful dosage adjustment, clients can be treated effectively without subjecting them to any serious danger of hemorrhage. Because of its rapid and predictable action, heparin is generally the first drug used in the initiation of anticoagulant therapy. When a desired prothrombin time has been achieved, the client may be placed on one of the oral anticoagulant drugs for maintenance therapy.

Commercial products containing heparin are prepared from the organs of cows and pigs. The anticoagulant potency of Heparin Sodium Injection, USP is standardized by *bioassay*. Potency is expressed in terms of "units" of heparin activity. As the number of USP units per milligram may vary from product to product, the dosage of heparin should only be expressed in USP units.

Administration of heparin by continuous IV infusion is generally preferable to intermittent IV therapy, because of the difficulty in monitoring a client on intermittent treatment. An IV infusion pump is ideally used to maintain the precision of dosage. When continuous infusion is necessary, coagulation tests should be performed approximately every 4 hours in the early stages of therapy. When heparin is administered by intermittent IV injection or deep SC (intrafat) injection, coagulation tests should be made before each injection during the early stages of treatment and daily thereafter. Table 30–2 lists dosage guidelines for administering heparin.

Heparin must be used with caution with diseases in which there is an increased risk of hemorrhage (e.g., severe hypertension, *dissecting aneurysm*, hemophilia, peptic ulcer, *ulcerative colitis*, threatened abortion). Extreme caution should also accompany the use of heparin in clients undergoing major surgery or in clients using other drugs that may induce bleeding. Some drugs and herbals that may affect heparin are listed in Box 30–1 and Box 30-2.

Because of the animal origins of heparin, clients should be monitored for the development of allergic reactions. A trial dose of 1,000 USP units may be given prior to initiating therapy in a client with a history of allergies. Clients on heparin should be constantly observed for evidence of hemorrhage

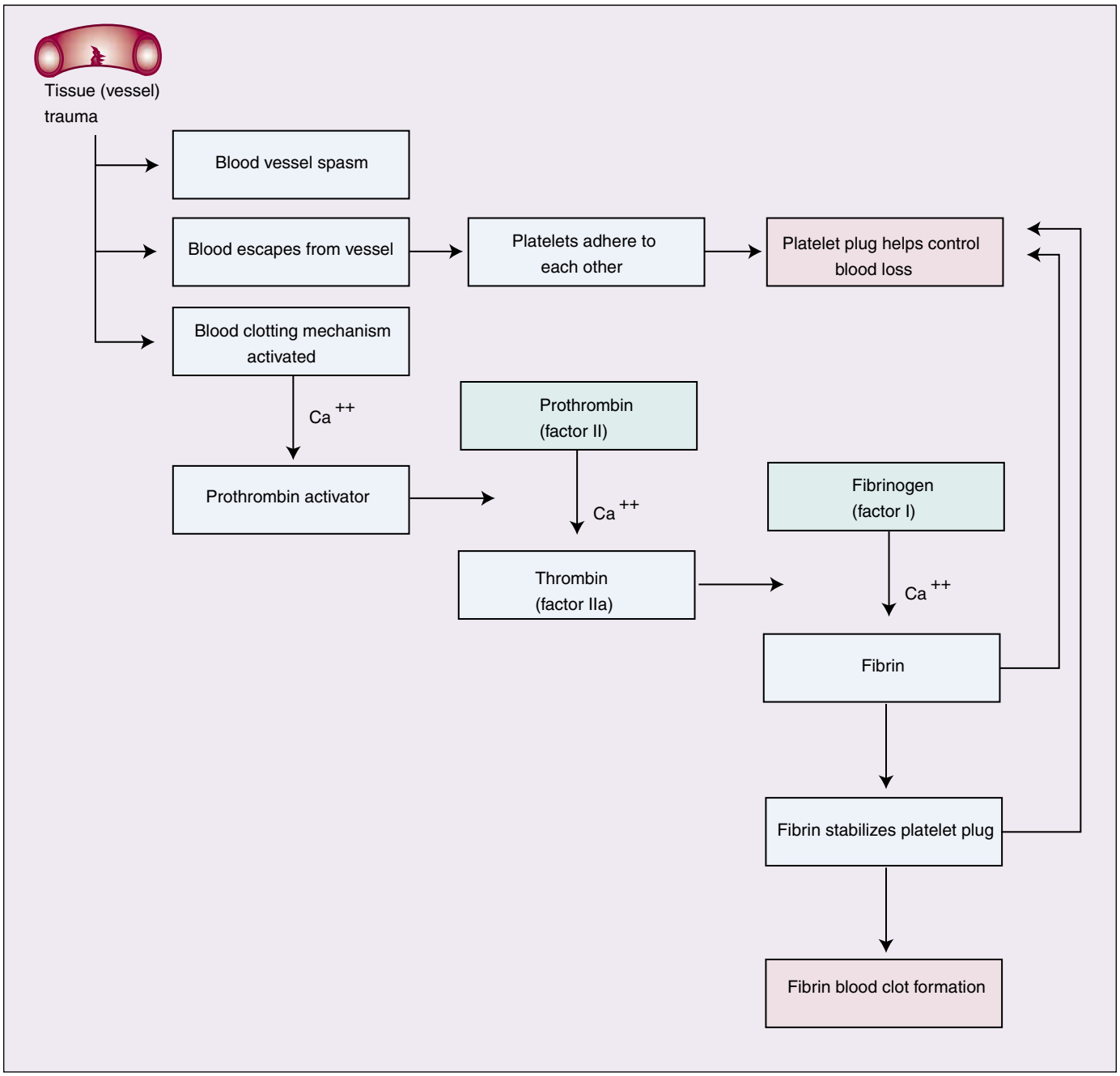


Figure 30–1 Flow chart illustrates the series of events that is triggered when there is an injury to the blood vessel wall.

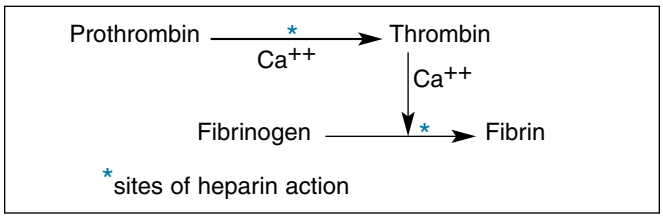


Figure 30–2 Final stages of the blood clotting process. Heparin exerts its anticoagulant activity by interfering with the conversion of prothrombin to thrombin.

(e.g., subcutaneous bleeding, blood in the stool, bleeding gums).

Overdosage with heparin can be treated by the administration of a slow infusion of 1% **protamine sulfate** solution. The strongly basic protamine combines with the strongly acidic heparin to form a stable complex with no anticoagulant activity. A dose of about 0.5–1 mg of protamine is required to antagonize the action of each 100 USP units of heparin.

TABLE 30–2

Dosage Guidelines for Administering Heparin

METHOD OF ADMINISTRATION	DOSAGE FREQUENCY	RECOMMENDED DOSE (150 LB ADULT) IN USP UNITS
deep subcutaneous injection (intrafat)	initial dose	10,000–20,000 units immediately preceded by an initial IV loading dose of 5,000 units
	every 8 hours	8,000–10,000 units
	every 12 hours	15,000–20,000 units
intermittent intravenous therapy	initial dose	10,000 units
	every 4–6 hours	5,000–10,000 units
continuous intravenous infusion	continuous	20,000–40,000 units/day in 1,000 mL of isotonic sodium chloride solution immediately preceded by an initial IV loading dose of 5,000 units

BOX 30–1
Some Drugs That May Induce Bleeding or Delay Coagulation Time

salicylates (aspirin, etc.)
abciximab (ReoPro)
bromelain
cephalosporins
dipyridamole (Persantine)
eptifibatide (integrilin)
hydroxychloroquine
NSAIDS (ibuprofen, etc.)
indomethacin (Indocin)
penicillins
phenylbutazone (Butazolidin)
ticlopidine (Ticlid)
tirofiban (Aggrastat)

BOX 30–2
Some Drugs/Herbals That May Decrease Effect of Heparin

antihistamines
digitalis
nicotine
nitroglycerin
tetracyclines

Certain herbs:
- cinchona bark
- gingko biloba
- goldenseal

Enoxaparin (Lovenox) and Dalteparin (Fragmin)

Enoxaparin is an anticoagulant drug related to heparin. Currently it is approved only to be used subcutaneously. It is used for prophylaxis of deep vein thrombosis (DVT) in clients undergoing hip or knee replacement and abdominal surgery. It is also indicated for the treatment of existing DVT/pulmonary embolus for both inpatient and outpatient clients. For joint replacement, an initial dose of 30 mg of the drug is administered within 12–24 hours following surgery, if hemostasis has been established. This is continued for 7 to 10 days at 30 mg twice a day. For abdominal surgery, prophylaxic 40 mg is given 2 hours before surgery and then daily for 7 to 12 days postoperatively. For treatment of existing DVT or pulmonary embolus, enoxaparin 1 mg/kg every 12 hours is administered.

Dalteparin is also a heparin derivative and is used to prevent DVT, particularly for clients undergoing abdominal surgery. The drug is administered subcutaneously starting 1–2 hours before surgery and is continued once daily for 5 to 10 days after surgery. It is given in single doses of 2,500 IU each day.

Ardeparin sodium (**Normiflo**) is the third low-molecular heparin to be marketed and, along with **danaparoid sodium** (**Orgaran**), represents the newest of the antithrombolytics to be approved in late 1997. Both are indicated in the prevention of DVT and act by inhibiting reactions that lead to clotting and the formation of fibrin clots. Both focus on blocking coagulation Factor Xa. Their action against thrombin is so limited that routine coagulation studies of prothrombin and partial

TABLE 30–3

Oral Anticoagulants

Note: These agents should be used with caution in clients with trauma, infection, hypertension, diabetes, or major surgery. Prothrombin times should be taken every 4 to 6 weeks once the client has been stabilized. Monitor the client for the development of drug interactions.

DRUG	INITIAL DOSE	DAILY MAINTENANCE DOSE	DURATION OF ACTION
anisindione *(**an**-is-in-**DYE**-ohn)* (Miradon)	300 mg on first day, 200 mg on second day, 100 mg on third day	25–250 mg	1–3 days
dicumarol, bishydroxy coumarin *(dye-**KOO**-mah-rohl, **bis**-hy-**drock**-see-**KOO**-mah-rin)*	200–300 mg	25–200 mg	2–10 days
warfarin sodium *(**WAR**-fah-rin **SOH**-dee-um)* (Coumadin Sodium, Panwarfin, Warfilone ✱)	10–15 mg	2–15 mg	2–5 days

thromboplastin times are not indicated. Ardeparin sodium is administered subcutaneously 50 units/kg every 12 hours. Denaparoid sodium is also administered subcutaneously using a dose of 750 units every 12 hours. As with heparin, both carry the primary adverse effect of bleeding. Because they are as effective as heparin and appear to be as safe, their greater bioavailability and longer duration of action provide for more predictable results.

Oral Anticoagulants

In the early 1920s, it was reported that cattle fed improperly cured sweet clover hay developed severe, but reversible bleeding tendencies. On further investigation it was found that the hay contained dicumarol, an agent that could inhibit normal blood-clotting mechanisms and is still used today for its anticoagulant properties. Although many agents chemically related to dicumarol have been studied, only a few are currently being employed in therapy.

The oral anticoagulants inhibit blood clotting by interfering with the synthesis of vitamin K-dependent clotting factors (II, VII, IX, and X) in the liver. Synthesis of these factors in the body is dependent upon a sufficient supply of this vitamin. If dietary intake of vitamin K is reduced or if the action of vitamin K-synthesizing bacteria in the gut is inhibited by broad-spectrum antibiotics, depression of blood clotting mechanisms in the body is observed.

Unlike heparin, the action of oral anticoagulants is not evident for at least 12–24 hours after the first dose has been administered. This delay is due to the time required for the normal removal of circulating clotting factors to take place. As prothrombin (Factor II) is depressed by the oral anticoagulants, the determination of "prothrombin time" is an accurate means of monitoring client therapy.

The oral anticoagulants now in use differ in pharmacological activity only by their different onset and duration of activity. Table 30–3 compares these and other properties of the oral anticoagulants. Although all of these agents have adequate anticoagulant activity, warfarin is generally considered to be the agent of choice, because it has a more predictable action and a lower incidence of side effects.

Therapy with oral anticoagulants requires extreme care and close client monitoring. Dosage must be individually determined for each client and controlled by periodic determination of prothrombin time. Such determinations should be made each day during the initiation of therapy and whenever the client begins or discontinues therapy with a drug that may affect anticoagulant blood levels. Once stabilized, INR (International Normalized Ratio) prothrombin times should be

monitored every 2 weeks. Although high initial loading doses of oral anticoagulants have been and may still be employed, these agents are probably best started at anticipated maintenance dosage levels. Subsequently, daily dosages may be adjusted based on the results of prothrombin time determinations. Dosage should be adjusted to achieve and maintain a prothrombin time from 1.5 to 2.5 times the control value with a level of 2 times the control value being desirable for most clients.

As a group, the oral anticoagulants have a greater potential for clinically significant drug interactions than any other pharmacological class of drugs. As warfarin and other oral anticoagulants are highly protein bound, the administration of drugs that may displace anticoagulants from these binding sites will raise the concentration of free anticoagulant and increase anticoagulant activity (Figure 30–3). Likewise, if the client's maintenance dose of anticoagulant has been established while the client was on one of the drugs listed in Box 30–3, discontinuation of the drug could increase the amount of anticoagulant in the bound state and diminish anticoagulant activity. Drugs such as the salicylates (e.g., aspirin), nonsteroidal anti-inflammatory drugs (e.g., ibuprofen, naproxen, **ketoprofen**), and penicillins may increase anticoagulant effects by affecting platelet function or by causing GI irritation.

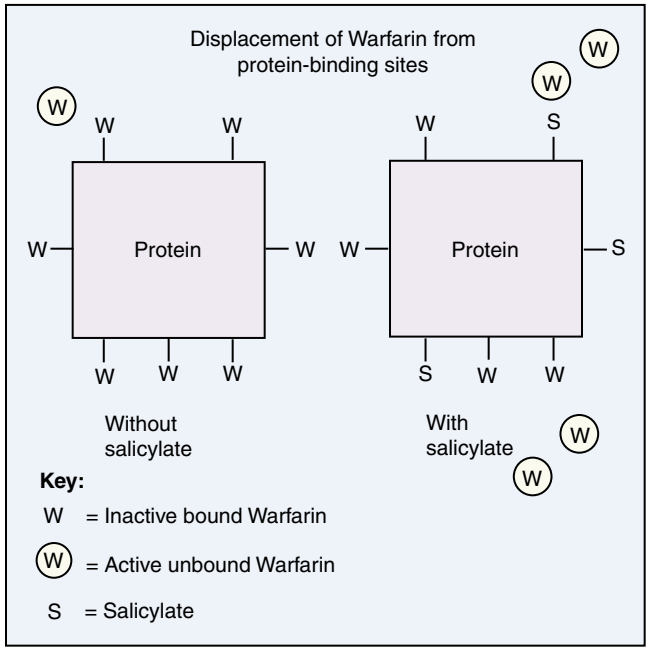


Figure 30–3 Some drugs (e.g., the salicylates) are able to displace oral anticoagulants from their binding sites. This increases the concentration of unbound anticoagulants in the blood and results in an increase in anticoagulant activity.

Oral anticoagulants are primarily metabolized in the liver by microsomal enzymes. The addition to a client's therapy of a drug that could increase microsomal enzyme production (Box 30–4) could result in a more rapid metabolism of the anticoagulant and in a diminished anticoagulant effect. Likewise, removal of such a drug from the client's regimen could reduce the rate of metabolism of the anticoagulant and increase its inhibition of the clotting process. It should be evident that close control of all drug therapy in a client on oral anticoagulants is extremely important.

Overdosage of anticoagulants, which may be evidenced by bleeding and/or excessive *hypoprothrombinemia*, can be treated by omitting one or more anticoagulant doses until the client stops bleeding or until the prothrombin time is again within normal limits. If these measures are not effective, **vitamin K_1** (phytonadione) may be

BOX 30–3
Some Commonly Used Drugs That Increase Oral Anticoagulant Activity

acetominophen
aminoglycosides
amiodarone
androgens
beta-adrenergic blocking agents
cephalosporins
chloral hydrate
cimetidine
cyclophosphamide
diflunisal
fluconozole
glucagon
hydantoins
ifosfamide
indomethacin
isoniazid
intraconozole
ketoconazole
loop diuretics
metronidazole
miconazole
NSAIDS
omeprazole
penicillins
quinolones
salicylates
sulfinpyrazone
sulfonamides
tomoxifen
tetracyclines
thioamines
thiopurines
urokinase
vitamin E

Note: Barbiturates, phenytoin (in chronic therapy), and rifampin DECREASE warfarin activity.

BOX 30–4
Some Drugs/Herbals That Increase the Metabolism of Oral Anticoagulant by Altering Liver Breakdown

- alcohol
- aminoglutethimide
- aminiodarone
- barbiturates
- carbamazepine
- chloramphenicol
- cimetidine
- charithromycin
- erythromycin
- etretinate
- glutethimide
- lovastatin
- metronidazole
- omeprazole
- propafenome
- quinidine
- rifampin
- St. John's Wort
- sulfamethoxazole and trimethoprim

administered in normal doses of 1 to 10 mg. In more serious cases the use of parenteral doses of 20 to 40 mg of vitamin K_1 may be justified. The use of high doses of vitamin K_1 has recently been discouraged, because of its capability to exert prolonged and undesirable effects on future anticoagulation. The use of blood transfusions and/or close client monitoring may be an appropriate alternative to high-dose **vitamin K_1** therapy. The vitamins are discussed in more detail in Chapter 33.

ANTIPLATELET AGENTS

A number of agents are used to inhibit the aggregation of platelets. Such drugs are useful in treating clients who have experienced CVAs or myocardial infarctions. Evidence seems to indicate that these agents may help to prevent recurrence of such disorders. Some drugs commonly used for this purpose are aspirin, dipyridamole (**Persantine**), and sulfinpyrazone (**Anturane**), as covered in Chapters 10, 29, and 13, respectively.

Glycoprotein IIb/IIIa Inhibitors

Eptifibatide (Integrilin) and tirofiban (Aggrastat) are two of the newest agents to receive FDA approval to delay clotting by altering platelet aggregation. They act by blocking the enzyme glycoprotein IIb/IIIa, which is essential for platelet aggregation.

Eptifibatide is a cyclic heptapeptide fashioned after the protein found in the venom of rattlesnakes native to the U.S. It is usually used in conjunction with aspirin and heparin to treat unstable angina and AMI. It is initially administered by IV bolus with the dose of 180 mcg/kg IV pushed over 1 to 2 minutes. This is followed by a continuous infusion of 2 mcg/kg/min. For clients undergoing percutaneous coronary procedures, the dosage is decreased. As with many agents, eptifibatide should not be given to clients with creatinine levels above 2.0 mg/dL. Vials of this drug should be refrigerated and protected from light until used. Any unused portion left in the vial should be discarded.

Tirofiban is a nonpeptide synthetic molecule and has fewer range of uses. At present, it is officially indicated for use in treating unstable angina and AMI in conjunction with heparin. Like eptifibatide, tirofiban is administered intravenously with an initial rate of 0.4 mcg/kg/min. for 30 minutes then infused continuously at 0.1 mcg/kg/min during angiographic procedures and for 12 to 24 hours after an angioplasty. It is available as a concentrated solution and is reconstituted in 0.9% normal saline or 5% dextrose in water solution. The contraindications for tirofiban are the same of other drugs in this class; however, tirofiban should not be used in the presence of acute pericarditis.

Ticlopidine (Ticlid)

Ticlopidine is an inhibitor of platelet aggregation also used to prevent recurrence of stroke or in clients who are susceptible to stroke. A small proportion of clients using this drug may develop neutropenia 3 weeks to 3 months after starting therapy. Complete blood counts (CBCs) and white cell differentials should, therefore, be performed every 2 weeks starting on the second week and continuing to the third month of therapy. If neutropenia develops, the drug should be discontinued.

Abciximab (ReoPro)

Abciximab is an injectable antiplatelet drug used with aspirin and heparin to prevent coronary vessel occlusion in clients undergoing percutaneous transluminal coronary angioplasty or atherectomy (PCTA). Intravenous administration of a single bolus dose of 0.25 mg/kg followed by a

continuous 10 mcg/minute infusion for 12 hours is generally used. Because of the potential for increased episodes of serious bleeding, the nurse should use caution in performing arterial or venous punctures, IM injections, or insertion of catheters or nasogastric tubes.

THROMBOLYTIC AGENTS

Thrombolytic enzymes act to convert the substance known as plasminogen to the enzyme fibrinolysin. This enzyme dissolves fibrin clots, as well as other plasma proteins. These substances are present in thrombi and emboli. Thrombolytic enzymes will therefore permit the dissolution of such potentially fatal vascular obstructions. Two thrombolytic enzymes are currently available in the United States, **urokinase** (**Abbokinase**) and **streptokinase** (**Streptase**, **Kabikinase**). Although each of these enzymes works by a slightly different mechanism of action, each is effective. They are indicated for the lysis of acute massive pulmonary emboli and for treatment of central venous line sepsis caused by fibrin formation. Urokinase is becoming the drug of choice for clearing fibrin from the catheters of central venous accesses, which are the most common cause of line sepsis in these clients. The first line of treatment is intravenous antimicrobial therapy followed by instillation and dwelling of 1 to 1.8 ml urokinase (which contains 5,000 u/ml) in the central venous catheter and clamp catheter for 1 hour. After this time, withdraw the urokinase and flush with 10 ml of 0.9% normal saline. They are also employed for the lysis of acute extensive thrombi of the deep veins, as well as acute arterial thrombi and emboli. Administration of these thrombolytic enzyme products is generally accomplished by intravenous infusion. All intramuscular injections must be avoided, because of the high risk of hematoma formation. Clients should also be monitored for the development of spontaneous bleeding while on thrombolytic therapy.

Tenecteplase Recombinant (TNKase)

This thrombolytic is produced by recombinant DNA technology. It dissolves thrombi by breaking down the fibrin clot. **Tenecteplase recombinant** is similar in action to alteplase, anistreplase, reteplase, and streptokinase and is indicated in the treatment of acute myocardial infarction. Currently it isn't labeled for the treatment of pulmonary emboli or acute strokes.

The significant advantage of tenecteplase recombinant over the other agents is the simplicity and convenience of its administration. Tenecteplase recombinant is administered in a single intravenous bolus dose, rather that the multiple doses or continuous infusion required with the other agents.

The same contraindications and precautions are necessary for tenecteplase recombinant as with other thrombolytic agents, including for clients with active bleeds, severe uncontrolled hypertension, history of CVA, arteriovenous malformation (AVM), intracranial neoplasm or trauma, and those with aneurysm. Adverse effects, the most noted and serious being bleeding, are similar to other thrombolytic agents as well.

Nursing implications regarding the administration of tenecteplase recombinant include: (1) reconstitute as directed, (2) flush line well before and after administration with normal saline because dextrose-containing fluids may cause precipitate, (3) avoid intramuscular injections, (4) monitor potential bleeding sites (arterial puncture sites, venipuncture sites), and (5) monitor client for arrhythmias. Tenecteplase recombinant does not contain bacteriostatic preservatives, so reconstitute immediately before administration. The standard thrombolytic dose is 30 mg IV bolus over 5 seconds.

Anistreplase (Eminase)

Anistreplase is a chemical derivative of the complex formed when streptokinase reacts with plasminogen in the body. The resulting compound causes the formation of plasmin from plasminogen, either within a thrombus or in the bloodstream. The production of plasmin exerts a thrombolytic effect that can benefit clients with acute myocardial infarction. As with other agents that promote plasmin formation, anistreplase may increase the risk of internal and superficial bleeding from disturbed sites (e.g., arterial punctures, venous cutdowns, or sites of recent surgery).

Thirty units of anistreplase should be administered by IV injection into an IV line or vein over a 2- to 3-minute period as soon as possible after the onset of symptoms. Solutions of the drug must be freshly prepared by reconstituting the powder with sterile water for injection. The powder should be stored in a refrigerator. Solutions of anistreplase should be discarded if not used within 30 minutes of reconstitution.

TISSUE PLASMINOGEN ACTIVATOR (t-PA)

Alteplase-recombinant (Activase) is a tissue plasminogen activator (t-PA) produced by recombinant DNA technology. It is used in the management of acute myocardial infarction. When this enzyme is introduced into the systemic circulation, it binds to fibrin in a thrombus and converts plasminogen in the thrombus to plasmin resulting in a local fibrinolysis and disintegration of the clot.

The effectiveness of treatment with alteplase is related to how soon it is administered after the onset of symptoms of acute myocardial infarction. Lysis of coronary artery thrombi has been documented in 71% of clients treated within six hours of the onset of symptoms. Improvement of ventricular function and reduction in the incidence of congestive heart failure have been reported in clients treated within four hours of the onset of symptoms.

The recommended dose of alteplase is 100 mg, of which 60 mg is administered during the first hour (6–10 mg by IV bolus during the first 1–2 minutes, the rest by IV infusion). This is followed by an additional 20 mg over the second hour and another 30 mg over the third hour. Doses in excess of 150 mg are not recommended because this may increase the likelihood of intracranial bleeding.

The most common complication of alteplase therapy is internal bleeding that may involve the GI tract, genitourinary tract, retroperitoneal or intracranial sites. Superficial bleeding may be evident at needle insertion sites or areas recently involved in surgery. The use of aspirin, dipyridamole (Persantine) or other agents that alter platelet function prior, during, or after alteplase therapy may increase the risk of bleeding.

Because of the considerable expense of alteplase therapy, there is controversy as to the relative merits of using alteplase, anistreplase, or streptokinase in treating clients with acute myocardial infarction.

HEMORHEOLOGIC AGENTS

A hemorheologic agent is one that improves blood flow by decreasing blood viscosity. Such an agent is useful in the treatment of intermittent claudication, a chronic condition characterized by occlusion of the arteries of the limbs.

Pentoxifylline (Trental)

Pentoxifylline is a hemorheologic agent that increases the flexibility of red blood cells and reduces their aggregation. It also reduces the concentration of fibrinogen (Factor I), thereby reducing the likelihood of blood clotting. Pentoxifylline is administered orally in a dose of 400 mg three times daily with meals. Therapy is generally continued for at least eight weeks.

HEMOSTATIC AGENTS

Hemostatic agents are used to stop the flow of blood in excessive bleeding (for example, during surgery). Some hemostatic agents (**aminocaproic acid**, **tranexamic acid**, **aprotinin**, and **desmopressin**) are administered systemically with others (**thrombin**, **microfibrillar collagen**, gelatin, and **oxidized cellulose**) applied topically directly to the bleeding site.

Aminocaproic Acid (Amicar)

Aminocaproic acid is a systemic hemostatic agent. It acts by inhibiting the action of substances that activate *plasminogen* and by inhibiting plasmin (fibrinolysin) activity. Aminocaproic acid is used in the treatment of excessive bleeding resulting from systemic *hyperfibrinolysis* and urinary fibrinolysis. The drug may be administered orally in an initial dose of 5 g followed by hourly doses of 1–1.25 g. This therapy is continued for about 8 hours or until bleeding has been controlled. However, the administration of more than 30 g of aminocaproic acid in a 24-hour period is not recommended.

The drug may also be administered by IV infusion beginning with an initial dose of 4–5 g during the first hour of administration followed by a continuous infusion of about 1 g per hour. Throughout therapy the client must be closely monitored for the development of blood clots, thrombophlebitis, or other adverse effects. Aminocaproic acid is contraindicated in disseminated intravascular coagulation (DIC).

Tranexamic acid (Cyklokapron)

This is a competitive inhibitor of plasminogen activation. Although its action is similar to that of aminocaproic acid, tranexamic acid is 10 times more potent. It is indicated for short-term use

(2–8 days) in clients with hemophilia to prevent hemorrhage during and after tooth extraction. The drug may be administered as a 10 mg/kg dose IV just before surgery. Following surgery 25 mg/kg is administered orally 3–4 times daily for 2–8 days. Alternatively, the drug may be given 25 mg/kg orally, 3–4 times daily beginning one day before surgery.

Aprotinin (Trasylol)

This is a natural protease inhibitor that inhibits plasmin and kallikrein, thereby limiting fibrinolysis. It is administered intravenously for prophylactic use in preventing blood loss in clients undergoing coronary artery bypass surgery. Because it is obtained from bovine lung tissue, aprotinin administration may result in the development of hypersensitivity reaction. Clients receiving the drug, especially those with a history of allergic reactions, should be given a small test dose first and monitored throughout treatment.

Thrombin (Thrombinar, Thrombogen, Thrombostat)

This topical agent acts to directly promote the conversion of fibrinogen to fibrin (see Figure 30–2). Topical thrombin is derived from animal sources and is available as a sterile powder usually reconstituted with sterile distilled water or isotonic saline. The speed with which the drug solution promotes the clotting of blood is proportional to its concentration, and solutions ranging in concentration from 100 units/mL to 2,000 units/mL may be used. The drug solution can be used in conjunction with other topical hemostatic agents to control surgical bleeding.

Desmopressin Acetate (DDAVP)

Desmopressin acetate (DDAVP) is a posterior pituitary hormone shown to increase factor VIII levels within 30 minutes after administration by the IV route. It is employed in treating clients with hemophilia A during surgery and other bleeding episodes. It is also used in the treatment of diabetes insipidus caused by a deficiency in vasopressin.

Microfibrillar Collagen Hemostat (Avitene)

This substance derived from animal collagen is also used as a topical hemostat. It acts by attracting platelets and then providing a surface upon which the platelets can aggregate to form thrombi. It is usually applied as a dry sterile powder onto bleeding sites. Once bleeding has stopped, the excess powder is carefully removed. The powder that remains is gradually absorbed as the wound heals.

Gelatin Products

Several gelatin products are used to provide a hemostatic effect in various surgical procedures. **Absorbable gelatin sponge** (**Gelfoam**), for example, is available in a variety of sizes and shapes. It is applied onto bleeding tissue and quickly stops the flow of blood; the gelatin material is gradually absorbed by the body without inducing excessive scar formation or an inflammatory response.

Absorbable gelatin film (**Gelfilm**) is similar to the gelatin sponge, but has a cellophane-like appearance in the dry state and a soft, elastic consistency when moistened. It is used in neurosurgery, thoracic surgery and ophthalmic surgery to cover tissue defects and to prevent excessive bleeding. As with the sponge product, gelatin film is also gradually absorbed by tissue after it has been implanted. It is unlikely to produce an inflammatory response.

Oxidized Cellulose (Oxycel, Surgicel)

Oxidized cellulose is a hemostatic agent prepared from cellulose. It is also used as a sterile packing material at surgical sites to control bleeding. It acts by absorbing blood and, in the process, forms an adhesive mass which stops bleeding. If left in the wound site, it is gradually absorbed by the body.

APPLYING THE NURSING PROCESS

NURSING CLIENTS RECEIVING ANTICOAGULANTS

Assessment

Nursing assessment plays an important role in the health and well-being of clients receiving anticoagulants. In particular, it is important to observe the client carefully for signs and symptoms of bleeding. The nurse closely monitors the client for the development of:

- hematuria
- tarry stools
- excessive vaginal bleeding
- abdominal, flank, or joint pain
- headaches
- changes in neurological status
- hematomas or *ecchymotic* areas
- vomiting blood (often called "coffee grounds," if it is dark blood)
- bleeding from the nose or gums

Vital signs are routinely checked on all clients receiving anticoagulants. A weak, rapid pulse rate and restlessness may be the first signs of bleeding.

Nursing Diagnoses

Including but not limited to:

- Risk for injury, bleeding related to anticoagulant therapy
- Deficient knowledge related to health alteration and medication regimen

Planning/Goals

- Client will not experience injury due to bleeding related to anticoagulant therapy.
- Client will verbalize understanding of appropriate use of anticoagulants, including signs and symptoms to report to physician.

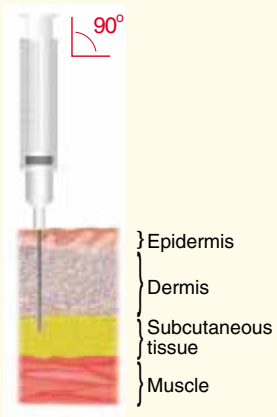
Implementation

The nursing focus in caring for clients receiving anticoagulant therapy involves: (1) assisting in the provision of effective therapy, (2) ensuring comfortable and safe administration of these drugs, and (3) minimizing the adverse effects of therapy. To assist in the provision of effective therapy, it is essential for the nurse to be familiar with the drugs being used and to have some knowledge of the treatment goal established by the physician. Periodic blood tests will be ordered to determine the progress made toward accomplishing this goal. For example, when heparin is used, the goal is often to keep the partial thromboplastin time (PTT) at 1½ to 2½ times its normal value. This will be assessed through use of the activated partial thromboplastin time or, alternatively, by use of a Lee-White clotting time.

Providing safe administration of anticoagulants requires knowledge of agents administered parenterally and those given orally. In addition, the nurse must be familiar with the proper techniques for the administration of heparin. Care must be taken when administering heparin subcutaneously to be certain that it is not given intramuscularly by mistake. To avoid intramuscular injection, the nurse selects a short needle (⅝ inch) and chooses a site with substantial subcutaneous but little muscle tissue (e.g., the iliac crest). Figure 30–4 outlines the subcutaneous injection technique used to administer heparin. The fatty layer of the abdomen 2 inches away from the umbilicus and the area near the iliac crest may also be used.

If rapid anticoagulation is desired, heparin is usually administered intravenously, either by continuous infusion or intermittently through a heparin lock. When given as a continuous infusion, a constant blood level of heparin can be maintained. Also, if necessary, the effects of heparin can be easily reversed through the use of protamine sulfate given intravenously. When heparin has been administered subcutaneously, it is also possible to reverse its effects by use of protamine sulfate, but the protamine must be given several times because of the variable absorption rate of the heparin.

When heparin is administered by continuous intravenous infusion, care must be taken to ensure a steady rate of administration. Often an electronic infusion control device is used to ensure a precise rate of infusion. As a safety measure, only a portion of the day's dosage, for example a 6-hour supply, is prepared for administration at any one time. Because of the possibility



1. Wash your hands.
2. Draw up the appropriate dose of heparin. Use a tuberculin syringe to accurately measure small doses.
3. Replace with a new sterile needle (⅝ inch, 26, or 27 gauge).
4. Identify the client.
5. Put on disposable gloves.
6. Select an injection site on the abdomen outside a 2-inch radius around the umbilicus to avoid the umbilical veins. Remember to rotate sites in the fatty layer of the abdomen or near the iliac crest. Although the abdomen is the preferred site, other subcutaneous sites may be used.
7. Apply ice in a plastic bag or rubber glove to the injection site if client experiences discomfort. Application should last several minutes to decrease discomfort.
8. Cleanse, but do not rub, the desired site with antiseptic. Allow the antiseptic to dry on the skin.
9. Firmly grasp the skin to form a fat pad, being careful not to pinch the tissues.
10. Insert the needle like a dart at a 90° angle. DO NOT ASPIRATE. Release your fingers holding the skin and slowly inject the heparin.
11. Withdraw the needle without changing the angle.
12. Press a sterile sponge over the area. Maintain pressure for 10 seconds or more. DO NOT RUB OR MASSAGE THE SITE.
13. Apply the ice to the injection site for 1–2 minutes.
14. Remove gloves and wash hands.
15. Record the procedure, including time, dosage, location of the injection site and relevant observations.

Figure 30–4 Procedure for the subcutaneous administration of heparin. Heparin is administered at a 90° angle as a subcutaneous (intrafat) injection.

of drug incompatibilities, no other medication is administered through the heparin line.

In recent years, intermittent intravenous infusion of heparin through a special scalp vein needle with a rubber diaphragm has become popular. This administration set is called a saline lock (Figure 30–5). Intermittent infusion is usually preferred by clients, as it does not restrict mobility and is more comfortable. It also avoids the risks of circulatory overload and electrolyte imbalance that may be associated with continuous intravenous infusion. The procedure for administering heparin through a saline lock (IVAD, Chapter 3) varies and the nurse must become familiar with the institution's procedure. General guidelines for drug administration through a saline lock include checking the placement by aspirating before injection, cleaning the diaphragm with 70% alcohol and using a small-gauge needle, preferably 25G, which permits the diaphragm to reseal itself after repeated injections. Also, heparin is injected slowly, and the nurse watches for signs of infiltration. If this occurs, the lock is removed and replaced at the next scheduled time for heparin administration.

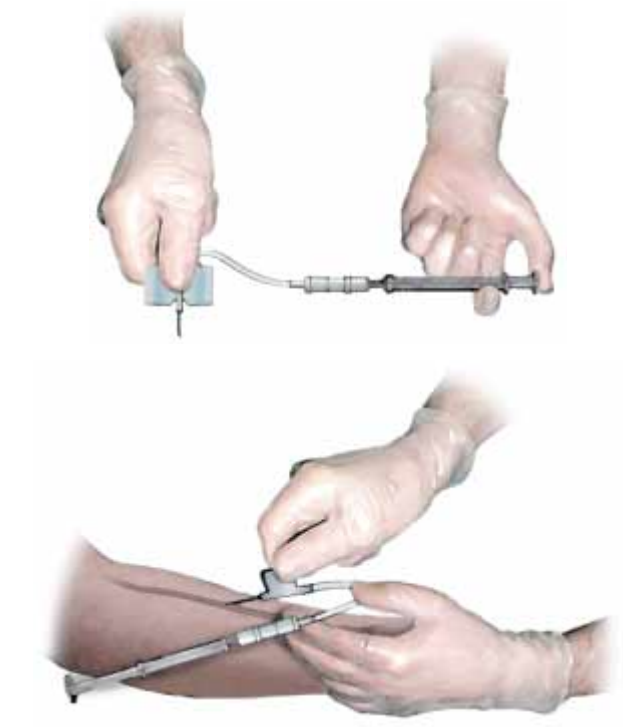


Figure 30–5 The nurse is holding a saline lock or intermittent intravenous administration set. Note placement of the needle for administration of a dose of heparin.

Saline locks are occasionally used for the administration of other drugs, especially corticosteroids and drugs used in the treatment of blood-clotting disorders, e.g., Antihemophilic Factor (Factor VII). To prevent clot formation on the needle tip, the needle is flushed following drug administration with a saline lock flush solution containing 10–100 USP units of heparin/mL. Saline locks should not be used for the intravenous administration of drugs, such as antibiotics, which irritate the veins, unless these drugs are well diluted in other solutions.

Intermittent administration is usually ordered every 4–6 hours because of heparin's short duration of action in the body. The drug solution should be injected slowly. As was the case with continuous infusion, intermittent administration has the advantages of immediate effect and reversibility. However, the interpretation of blood coagulation tests may be more difficult, as coagulation characteristics will vary depending upon when the last administration of heparin took place.

Oral anticoagulant administration is most often employed in long-term anticoagulant therapy. Most of these agents are administered orally, aimed at keeping the prothrombin time at or about 25–30 seconds. If the prothrombin time is 30 seconds or greater, the nurse must contact the physician before administering the next dose. Oral anticoagulants are frequently begun while the client is receiving heparin therapy because it takes some time before their therapeutic effects are evident. Heparin administration is usually discontinued when the prothrombin time reaches 1½–2½ times normal.

Comfort and Safety

Client safety becomes an especially important consideration. During treatment with anticoagulants, painful hematomas may develop at the site of any intramuscular injection. Therefore, such injections are best avoided. If intramuscular injection must be given, pressure must be maintained on the site for several minutes following injection. If possible, arterial and femoral vein punctures are avoided, to prevent hematoma formation.

As an additional safety measure the client should be alerted to the possibility of bleeding and the development of hematomas. Clients are cautioned to be particularly careful to avoid trauma. For shaving, the use of electric razors is preferred to blades. A soft bristle toothbrush is recommended for brushing. Bedrails and assistance with ambulation are provided as needed to avoid falls and unnecessary injury.

If uncontrolled bleeding occurs, the nurse must take emergency measures to stabilize the client. The client's physician is notified and the most recent laboratory report is obtained for inspection. Drugs employed in reversing the effects of the anticoagulant are prepared for administration. As noted previously, protamine sulfate reverses the effects of heparin. Vitamin K_1, or phytonadione, is used as an antidote for oral

KEY NURSING IMPLICATIONS 30–1

Anticoagulants

1. Report abnormal bleeding or indications of internal bleeding, such as headache, tarry stools, and changes in neurological status.
2. To avoid intramuscular injection of heparin, select a short needle and choose a site with adequate subcutaneous tissue.
3. The effects of heparin can be reversed through the intravenous use of protamine sulfate.
4. When heparin is administered by continuous intravenous infusion, an infusion pump is generally used to ensure a precise rate of infusion.
5. When administering heparin through a saline lock, disinfect the diaphragm, use a small-gauge needle and watch for signs of infiltration.
6. Contact the prescriber before administering the next dose of an oral anticoagulant if the prothrombin time is 30 seconds or greater.
7. Review the procedure for safe administration of heparin.
8. Monitor partial thromboplastin time (PTT) when administering heparin and contact the prescriber if PTT is not within prescribed parameters (usually 1.5–2.5 times normal [30–40 seconds]).

KEY NURSING IMPLICATIONS 30–2

Comfort and Safety During Anticoagulant Therapy

1. Avoid intramuscular injections in clients on anticoagulants. If such injections are necessary, maintain pressure on the site for several minutes after injection.
2. Vitamin K_1 (phytonadione) is used as an antidote for oral anticoagulants.
3. Avoid the use of aspirin and aspirin-containing products.

anticoagulants. This drug may be administered intramuscularly, intravenously or orally, depending on the severity of the client's condition. The use of Vitamin K_1 is influenced by the fact that its administration may make the client resistant to future treatment with anticoagulants for some time.

Clients taking heparin and those taking oral anticoagulants are cautioned against the use of aspirin and aspirin-containing products, as these drugs can interfere with blood clotting. A sign may be placed above the bed of clients receiving anticoagulants to indicate that the client should not receive intramuscular injections, aspirin-containing products, or other drugs that could interfere with anticoagulant therapy.

A number of guidelines regarding drug administration are followed in the section on caring for clients receiving anticoagulant therapy. If a dose of anticoagulant is given later than ordered, the time of administration of the next dose needs to be altered accordingly. Care must be taken not to administer intravenous infusions too rapidly to catch up to an established schedule. When approaching discharge, the hospitalized client must be instructed about maintaining a regular schedule of administration at home. Also, the nurse suggests methods to enable the client to adhere to the prescribed regimen.

Client Education

Client education is an important part of the nursing care plan. It is vital that the client understands why anticoagulants are used and why frequent blood tests are necessary. Because the dosage of oral anticoagulants is based on the results of blood studies, clients should be instructed in preparing the correct dosage for administration. The nurse may ask them to work dosage problems such as, "If the physician wants you to take 7.5 mg of warfarin and you have 5 mg tablets, what would you do?" Instruction and supervised practice in the administration of phytonadione may also be part of the client education program.

In addition to encouraging client compliance, it must be stressed that no drug, including alcohol, should be taken, nor should any drug be discontinued without consulting the physician. Clients are instructed not to radically alter their diet for that too much or too little vitamin K in green leafy vegetables to be consumed. Client instruction includes that laxatives and mineral oil may decrease the absorption of vitamin K and should, therefore, be avoided. This is particularly emphasized in education of older persons.

Newly discharged clients are instructed to notify all health personnel with whom they may have contact that they are taking anticoagulants. This is especially true if dental work and/or any type of surgical procedure is anticipated. Carrying information about therapy and the name and phone number of the supervising physician is advisable and may prove helpful in emergency situations. A family member is instructed, whenever possible, in the treatment plan and associated precautions, both for client safety and compliance.

Some clients taking anticoagulants are women of childbearing age. These women should be advised that oral anticoagulants may cross the placental barrier and may also appear in breast milk. Women who have reason to believe they are pregnant, who wish to become pregnant, or who plan to breastfeed a child are urged to maintain close contact with an obstetrician if they are on oral anticoagulant therapy.

Other precautions impressed on clients include the avoidance of dangerous activities or hobbies, such as the use of power tools and engaging in contact sports. The importance of reporting febrile and gastrointestinal illnesses to the physician is stressed, as such illnesses may affect the absorption and/or metabolism of oral anticoagulants. Finally, clients must understand the importance of keeping appointments for

KEY NURSING IMPLICATIONS 30–3

Anticoagulants

1. Clients are advised to avoid situations that could lead to trauma.
2. Clients are instructed to talk with the primary care provider before adding or subtracting any drug from their treatment program.
3. Drastic changes in diet, laxatives and mineral oil should be avoided.
4. Identification and information about treatment should always be carried or a Medic-Alert tag worn.
5. Women on anticoagulants who are considering pregnancy must be referred to an obstetrician.

laboratory studies and follow-up visits. Written guidelines may be useful in helping clients remember key points.

As a general guide, the client is instructed to call the physician if any of the following occur:

- red or dark brown urine
- red or black stools
- excessive bleeding following cuts
- evidence of unusual bleeding from anywhere on the body
- severe headache or stomach pain
- dizziness, nausea, or fever
- bruising, swelling, or pain from a minor bump
- skin rash
- unusually heavy menstrual bleeding
- pregnancy

Overall, nursing actions are oriented toward client comfort and safety. This is true whether the nurse is responsible for administration of anticoagulants or the client is responsible for their administration. In the latter situation, especially, client education plays a critical role.

Evaluation

- Client does not experience injury due to bleeding related to anticoagulant therapy.
- Client verbalizes understanding of appropriate use of anticoagulants, including precautions to take regarding avoiding trauma and signs and symptoms to report to physician.

NURSING CLIENTS AFTER INTRACORONARY THROMBOLYSIS

Assessment

Initial nursing assessment can contribute to the medical diagnosis and appropriate treatment of the client and to the development of a nursing care plan. The person who has experienced an acute myocardial infarction may be in severe pain and have high levels of anxiety. It is important to determine the location, nature, and duration of pain. The nurse checks the client's vital signs and begins electronic monitoring of cardiac functioning. Observations are made about the client's color, respiratory functioning, and evidence of shock, such as cold, clammy skin. Continued assessment is necessary for clients receiving intracoronary thrombolysis treatment.

The nurse observes the client for bleeding, including cerebral, gastrointestinal, and *pericardial* bleeding. Vital signs and neurological status are monitored carefully. Bleeding at the site of intravenous infusion(s) is treated by local pressure. If bleeding is severe or unresponsive to pressure, additional treatment will be required. Clients receive intravenous heparin for several days after the procedure. In addition to fever, hives, itching, flushing, and nausea that clients may experience from the use of streptokinase, they may develop problems related to heparin therapy. Clients are monitored for dysrhythmias and chest pain. The nurse must report any evidence of these problems to the physician immediately.

Although currently expensive, alteplase (a tissue plasminogen activator) is replacing streptokinase as the major thrombolytic treatment of acute myocardial infarction. An advantage of alteplase is that it seldom causes allergic reactions. The nursing care for clients receiving alteplase is very similar to that for clients receiving streptokinase. In the emergency setting, rapid client assessment must be made to determine if a myocardial infarction has occurred and when it occurred. The nurse assesses the client, including assessment of pain, vital signs, and neurologic status. An ECG is taken and baseline blood values are obtained.

During the infusion of alteplase, the nurse monitors the client for clinical indications that the therapy has been successful. These indications

include sudden or dramatic decrease in chest pain, a decrease in the ST segment elevation as indicated on the ECG, and reperfusion-related dysrhythmias. It is believed that the rapid reperfusion of the heart causes electrical instability and the development of dysrhythmias. The development of such dysrhythmias is treated by the administration of drugs such as lidocaine. All clients receiving alteplase are placed on cardiac monitors to easily assess the development of arrhythmias. Some clients develop bradycardia, which is treated with atropine.

During and following alteplase administration, the nurse assesses the client for fluid volume deficit related to intravascular blood loss. Vital signs are routinely checked, as are neurological signs with the skin checked for bruising. The urine and stool are screened for blood, puncture sites are checked, and clients are assessed for bleeding into the abdomen and joints.

Nursing Diagnoses

Including but not limited to:

- Ineffective tissue perfusion, cardiopulmonary related to heart or pulmonary ischemia secondary to acute myocardial infarction or pulmonary embolus
- Risk for injury, bleeding related to thrombolytic therapy
- Deficient knowledge related to pathophysiologic process and thrombolytic therapy

Planning/Goals

- Client's thrombolytic therapy will be successful in dissolving clot as evidenced by improving signs of tissue perfusion including decreasing chest pain, dyspnea, anxiety, vital signs WNL.
- Client will not experience injury due to bleeding related to anticoagulant therapy.
- Client will verbalize understanding of myocardial infarction/pulmonary embolus; appropriate use of thrombolytics, including precautions the client must take to avoid injury; and potential for bleeding related to the thrombolytics.

Implementation

Some clients who have experienced coronary thrombosis receive streptokinase or urokinase therapy to dissolve the thrombus occluding the blood flow in the coronary vessel. This may limit the extent of myocardial damage. This therapy is only used for clients who have experienced thrombosis within the previous 4 to 6 hours and who meet other specific criteria. The administration of streptokinase or urokinase originally was cardiac catheterization, but now intravenous administration is often used. The drug is prepared for intravenous administration by the addition of 5 mL Sodium Chloride Injection, USP or Dextrose (5%) Injection, USP. The vial is rolled and tilted gently to reconstitute. Do not shake the vial as this could cause foaming and flocculation. Additional diluent is then added to the vial to provide the desired dose per milliliter. Solutions containing large amounts of flocculation should be discarded. Reconstituted drug solutions are discarded if not used within 24 hours.

If the client is a candidate for alteplase treatment (i.e., not at unusual risk for bleeding based on past history of bleeding disorder, recent surgery, or other risk factors and has had an acute myocardial infarction within the previous 4 to 6 hours), the nurse assists with the administration of alteplase. Nursing functions may include drawing blood for baseline values and initiating or assisting with initiation of several intravenous lines. Often three intravenous lines are initiated: one for the alteplase, one for a continuous infusion of heparin, and one for lidocaine sometimes given to prevent the development of life-threatening arrhythmias. The physician may insert an arterial line or a saline lock (or a heparin lock if using a CVAD) that can be used to draw blood for analysis during the course of treatment. Whenever possible, all arterial and venous lines are established before alteplase treatment is initiated, to decrease the likelihood of bleeding from puncture sites. Sites selected for intravenous lines are in areas accessible to compression, if this should be needed to stop bleeding. Also, the client is not given intramuscular or subcutaneous injections during treatment and for at least 24 hours after treatment with alteplase, to decrease the probability of bleeding. Manual pressure is applied to puncture sites for 20 to 30 minutes, followed by application of a pressure dressing and careful assessment of all puncture sites. If bleeding from a puncture site

KEY NURSING IMPLICATIONS 30–4

Thrombolytic Agents

1. Observe the client receiving streptokinase for allergic reactions. Observe all clients receiving thrombolytic agents for bleeding, changes in vital signs, and chest pain.
2. Reconstitute streptokinase with Sodium Chloride Injection or Dextrose (5%) Injection. Do not shake the vial to mix it.
3. Many clients develop reperfusion arrhythmias that require prompt identification and treatment following alteplase use.
4. To minimize bleeding, intravenous lines are established prior to initiating therapy with thrombolytic agents.
5. Apply manual pressure for 20 to 30 minutes, followed by application of a pressure dressing on all puncture sites during and following thrombolytic therapy.
6. Use preservative-free sterile water for injection to reconstitute alteplase.
7. Following the infusion of alteplase, the line is flushed with 5% Dextrose in water (D5W) or normal saline, to ensure administration of the entire dose.
8. Institute safety measures (e.g., padded siderails, routine vital signs, assessment of skin) to prevent unnecessary blood loss.
9. Monitor the client for the development of reocclusion of the coronary arteries.
10. Client and family education regarding drug therapy and lifestyle changes is an important nursing function.

cannot be controlled in this way, a gauze pad soaked in aminocaproic acid (**Amicar**) can be placed on the site.

The nurse may be responsible for preparing the alteplase for administration. The drug is reconstituted using preservative-free sterile water for injection, as preservatives inactivate alteplase. The vial is gently rotated to mix, but is not shaken. The first dose administered is a bolus, with a subsequent dose infused continuously over approximately 2 hours. The reconstituted drug must be used within 8 hours.

Monitoring the alteplase infusion is another nursing function. This drug is infused through a line without other medications. No filter is used, but an electronic infusion device controls the infusion. Following the infusion of alteplase, the line is flushed with 5% dextrose in water (D5W) or normal saline to ensure complete dose administration. The amount of fluid used for flushing the line depends on the capacity of the setup.

When intravenous lines are no longer needed, they are generally clamped off, but left in place until 24 hours following the infusion, when the client is less likely to bleed on removal of the line. A sign is placed on the client's bed indicating that bleeding precautions are in effect. In addition to safety measures already discussed, the client should be handled carefully, and siderails are padded to prevent bruising. The client and family are informed that bleeding is common. They are reassured that precautions will be taken to minimize blood loss.

Finally, the nurse monitors the client for the development of reocclusion of the coronary arteries. Usually, the client is scheduled for cardiac catheterization several days following alteplase therapy to assess whether the coronary arteries are narrowed. If they are, the client may undergo *percutaneous transluminal coronary angioplasty* (balloon angioplasty) or coronary artery bypass grafting (CABG) to prevent reocclusion.

As with all clients receiving drug therapy, the nurse is responsible for alleviating the client's deficient knowledge regarding the treatment and life-style changes that may be indicated. Many clients will be taking anticoagulants for several months and will benefit from personalized instruction and from written materials regarding this therapy.

Evaluation

- Client's thrombolytic therapy is successful in dissolving clot as evidenced by improving signs of tissue perfusion, including decreasing chest pain, dyspnea, and anxiety, with vital signs WNL.
- Client does not experience injury due to bleeding related to anticoagulant therapy.
- Client verbalizes understanding of myocardial infarction/pulmonary embolus, appropriate use of thrombolytics including precautions the client must take to avoid injury, and potential for bleeding related to the thrombolytics.

NURSING CARE PLAN

A Client with Acute Myocardial Infarction Receiving Alteplase (Activase), A Tissue Plasminogen Activator

Edward Carter is a 50-year-old office supervisor who had chest pain around 9:30 AM. An ambulance was called and he was given nitroglycerin spray en route to the hospital. On arrival in the emergency room at 10:30 AM, he had continuing chest pain which was relieved with morphine sulfate 2 mg IV. His initial EKG showed ST depression but no Q waves. As he had no previous medical problems and no cardiac history, the physician decided to use alteplase (Activase), a tissue plasminogen activator. Mr. Carter smokes 1–2 packs of cigarettes daily and frequently has cocktails before dinner. He states he is prone to weight gain. Admission height and weight were 5'10" and 200 pounds. Family history indicates that his father died of a heart attack at age 55.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Chest pain, nature and duration of pain.	Acute pain related to myocardial ischemia.	Client will have relief of pain within 20 minutes after pain intervention.	Medicate client with morphine sulfate as necessary for pain. Keep head elevated to promote oxygenation.	Client verbalizes pain relief after initial dose of morphine sulfate. Client appears comfortable.
Vital signs. Short of breath.	Impaired gas exchange related to altered oxygen supply secondary to decreased cardiac output.	Client maintains optimal gas exchange as evidenced by normal arterial blood gases and alert mentation.	Administer oxygen via nasal cannula. Check arterial blood gases as ordered. Frequently check vital signs and level of consciousness. Assess for adequate tissue perfusion.	Client maintains blood gases and vital signs within normal limits. Client remains alert and responsive.
Anxiety. Upset about diagnosis and need for alteplase.	Deficient knowledge related to unfamiliarity with disease process, treatment, and recovery.	Client will demonstrate understanding of alteplase and its usefulness in treating acute myocardial infarction.	Explain alteplase routine. Triple lumen central venous catheter may be inserted prior to giving alteplase. Draw blood for baseline laboratory work (prothrombin time, partial thromboplastin time, complete blood count, fibrinogen and crossmatch for 2 units of blood). Heparin drip after blood work obtained. Premedicate with diphenhydramine (Benadryl). First dose of alteplase 6–10 mg is given IV over 2 minutes. Remainder of drug in IV piggybacks over next three hours. Provide support and maintain supportive environment.	Client is able to verbalize the alteplase routine and the reasons for various activities.
Cardiac monitor, vital signs.	Risk for decreased cardiac output related to cardiac arrhythmias secondary to altephase administration.	Client will have prompt treatment for cardiac arrhythmias.	Observe for bradycardia or ventricular tachycardia which may occur during reperfusion. Administer atropine or lidocaine as ordered.	Client maintains adequate cardiac rate and rhythm (NSR) during reperfusion.

Dietary practices.	Imbalanced nutrition: less than body requirements related to need to decrease oxygen consumption.	Client will understand need for limited food in first 24 hours.	Explain to client that not eating solid food will help reduce oxygen demands.	Client maintains liquid diet for 24 hours.
Alteplase precautions, evidence of bleeding.	Risk for injury related to adverse effects of alteplase administration.	Client will demonstrate understanding of factors that might cause bleeding and the need to restrict activity for 24 to 48 hours.	Explain to client that he needs to be on strict bedrest to prevent bleeding. Assess client for signs of internal or intracerebral bleeding. Observe for large hematomas or bleeding from puncture sites. Blood for laboratory work taken from central line to avoid venipunctures until coagulation times are normal. Pad siderails to prevent bruising. Place sign on client's bed that bleeding precautions are in effect.	Client demonstrates understanding of factors that could potentiate bleeding and avoids them until coagulation time returns to normal. Client maintains strict bedrest for 24 to 48 hours.

HOME CARE / CLIENT TEACHING

1. In patients taking anticoagulants, reinforce such teaching as avoidance of trauma risk, talking with the primary care provider before adding or subtracting any drug from the treatment program, avoidance of changes in diet, and avoidance of laxatives or mineral oil.
2. Be certain that clients taking anticoagulants wear or carry identification and information about their treatment.
3. Reinforce the caution that anticoagulants must not be shared with anyone.
4. Clients receiving anticoagulant therapy should be instructed on why anticoagulants are being used for their therapy and the importance of:
   a. Follow-up blood tests
   b. Avoidance of injury
   c. Compliance with therapy
   d. Seeking medical guidance before taking any drug, including alcohol
   e. Avoiding laxatives and antacids, as they can decrease the absorption of anticoagulants
   f. Communicating to any health professional, including dentists that they are taking anticoagulants
   g. Reporting febrile and gastrointestinal illnesses, as these can effect the absorption/metabolism of anticoagulants
   h. Reporting signs and symptoms of bleeding, including red or black stools, red or brown urine, bleeding gums, nosebleeds (epistaxis), severe headaches, stomach pains, bruising, excessive bleeding from cuts
5. Female clients should be instructed to report unusually heavy menstrual bleeding.
6. Female clients of childbearing age should be advised that anticoagulants can cross the placental barrier and can be secreted in breast milk.
7. Clients receiving thrombolytic therapy need to be advised of same bleeding precautions as those on anticoagulants.
8. Clients having experienced an acute myocardial infarction or pulmonary embolus receiving thrombolytics need to be instructed to inform health care personnel of improvements they note in their condition—decreasing chest pain, improved breathing.

CASE STUDY

Mrs. Ruth George, age 56, is recovering satisfactorily from gallbladder surgery. She develops tenderness, pain, and warmth in her right calf. Her physician determines that she has developed phlebitis and orders:

- Bedrest
- Continuous heat application to the right calf
- Insert saline lock and give heparin 10,000 USP units by IV stat; then 5000 USP units q6h
- PTT before first dose of heparin and daily thereafter

This therapy is continued for 4 days after which the client is started on the following medication schedule:

- **Warfarin sodium** (**Coumadin Sodium**) 10 mg daily
- Heparin 5000 USP units q6h on 3/18; 2500 USP units q6h on 3/19
- Discontinue (D/C) heparin 3/20 after 12 AM dose

Prothrombin times are done daily. The results are called to Mrs. George's physician who adjusts the dosage of warfarin sodium accordingly. Mrs. George responds well to therapy and is discharged on March 26 with a prescription for warfarin sodium 5 mg p.o. once daily.

continues

Questions for Discussion

1. What are the advantages and disadvantages of using a heparin lock for intermittent administration of heparin?
2. What nursing observations should be made while Mrs. George is receiving heparin?
3. What general guidelines should be followed when administering heparin through a saline lock?
4. Why is the client receiving both heparin and an oral anticoagulant for several days?
5. What instructions would you provide for Mrs. George regarding the oral anticoagulant she will be taking at home?

CRITICAL THINKING EXERCISES

1. Prepare a guide to be used in the instruction of a client taking oral anticoagulants.
2. Make a poster outlining the steps in the blood-clotting process. Indicate the steps where heparin and oral anticoagulants exert their therapeutic effects.
3. Review a hospital's procedure for use of saline locks. Obtain a saline lock and examine it. Compare the advantages and disadvantages of using a saline lock with those of using continuous intravenous infusion.
4. Identify the laboratory studies needed and the reasons they are ordered for clients receiving thrombolytic agents.

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31 Diuretics and Antihypertensives

OBJECTIVES

After studying this chapter, the student will be able to:

- List the major health problems for which treatment with diuretic drugs is used
- List the major classes of diuretics, their mechanism of action and their side effects
- Identify the mechanism of action and major adverse effects for each of the commonly used antihypertensive drugs
- List major nursing diagnoses and goals in caring for hypertensive clients
- Distinguish among mild, moderate, and severe dietary sodium restriction
- Describe two ways in which the nurse can increase client cooperation with a hypertension treatment plan
- List specific ways in which the nurse can minimize the side effects of antihypertensive drug therapy
- Discuss the long-term management of hypertensive clients
- Apply the nursing process when caring for clients experiencing a hypertensive emergency

DIURETICS

Diuretics are drugs used to remove sodium and water from the body. They are clinically employed in clients with *edema* or *ascites*, both of which are pathological increases in extracellular fluid volume. Diuretics are also used in the treatment of hypertension, as they can promote blood pressure reduction while reducing the adverse effects of other antihypertensive drugs.

A typical 70 kg individual has a body sodium content of about 3000 milliequivalents (mEq). Most of this is confined to the extracellular fluid, which makes up about 20% of body weight and about one-third of the water in the body. In a normal adult client about 180 liters of fluid are filtered by the kidneys each day. This fluid contains about 25,000 mEq of sodium. For an individual who ingests a normal diet containing approximately 100 mEq of sodium per day, an equal amount must be excreted to maintain the body's sodium balance. This means that more than 99% of the sodium passing through the kidneys in a given day must be reabsorbed by the kidney tubules to maintain sodium balance.

Such a balance is maintained by the reabsorption of sodium along the entire length of the *nephron* (Figure 31–1). In the proximal tubule, about 70%–80% of the filtered sodium is actively reabsorbed into the bloodstream. In the ascending loop of Henle, an additional 10%–20% of the filtered sodium is absorbed. Finally, in the distal tubule, the remaining 5% of the sodium is reabsorbed or exchanged for potassium. The rate at which sodium is reabsorbed in the distal tubule is dependent

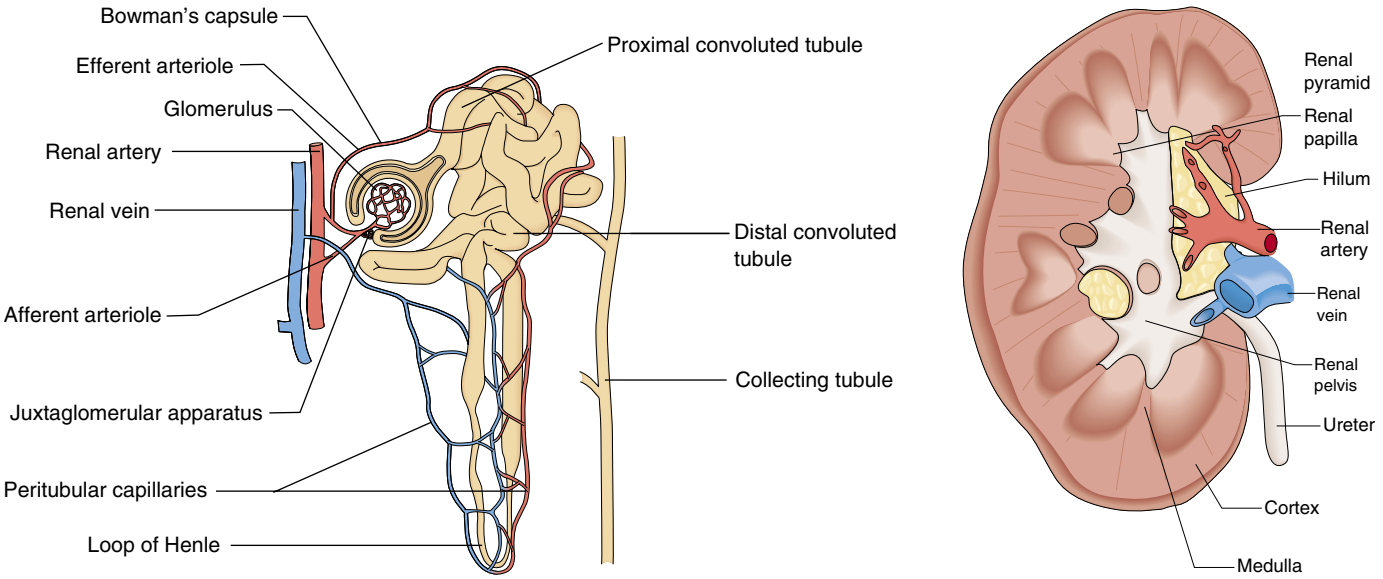

Figure 31–1 Parts of the nephron and the process of urine formation from the initial filtering of the blood through the collection of urine by the renal pelvis.

on the concentration of the hormone, *aldosterone*. The regulation of sodium balance by the kidney is therefore determined by:

- glomerular filtration rate (i.e., the rate at which fluid is filtered by the kidney glomeruli)
- concentration of aldosterone, a hormone secreted by the adrenal cortex
- baroreceptors of the body

In certain illnesses the excretion of sodium may be impaired, thus leading to the accumulation of fluid and sodium within the body. Diuretics are designed to correct this situation by promoting the excretion of sodium by inhibiting its reabsorption.

Thiazide Diuretics

The thiazide diuretics were developed in the 1950s and have evolved to be the safest diuretic agents in current use. They appear to act by inhibiting sodium and chloride reabsorption in the early portion of the distal tubule, although they may also block chloride reabsorption in the ascending hoop of Henle. As the concentration of sodium reaching the distal tubule is higher in clients using thiazide diuretics, a greater than normal sodium-potassium exchange takes place, thereby possibly leading to potassium depletion and hypokalemia. Because of the neurotransmission importance of potassium, its depletion can have serious, even life-threatening, consequences. Neurotransmitters conduct impulses to muscles of the body including and most particularly the heart. Thus, with insufficient potassium, clients may experience cardiac arrhythmias, as well as muscle weakness in skeletal and smooth muscles of the body. In addition, an excessive amount of chloride is also sometimes excreted by such clients, thereby leading to chloride depletion and *metabolic alkalosis*.

When thiazide diuretics are used for prolonged periods, it is often necessary to provide potassium and chloride supplementation (e.g., in the form of potassium chloride) to avoid electrolyte depletion. This may be administered as tablets, capsules, liquids, or effervescent solutions. The liquid supplements are generally preferred to solid dosage forms, because of an irritating property of potassium salts. Exceptions may be the use of potassium chloride tablets, with the potassium salt embedded in a wax matrix, or microencapsulated products, which reduce its irritating effect on the gastrointestinal tract (e.g., Slow-K, Micro-K). For further information on potassium supplements, see Chapter 33. Other adverse effects that may occur with the use of diuretics include elevation of blood glucose concentration (hyperglycemia), elevation of blood uric acid levels (hyperuricemia), and sensitivity reactions often manifested as skin rashes.

Although many different thiazide derivatives have been marketed, differences among them are minor; selection of the agent to be used is often based on the duration of action desired and the cost. Table 31–1 lists the thiazide diuretics in use in the United States.

TABLE 31–1

Thiazide Diuretics

Note: These drugs may cause hyperuricemia and hyperglycemia. Carefully monitor clients with gout or diabetes mellitus.
Monitor potassium level and assess client for hypokalemia, including symptoms of muscle cramps and weakness.
Encourage intake of potassium-rich foods, including citrus fruits, bananas, and apricots.
Give drug early in the day to prevent nocturia.
Record intake and output on hospitalized clients.
Monitor blood pressure and weight.
Observe clients taking thiazide diuretics with cardiac glycosides for the development of cardiac glycoside toxicity (visual disorders, bradycardia, bigeminy, nausea, vomiting, and anorexia).
Use of alcohol, barbiturates or narcotics may aggravate postural hypotension.
Discontinue drug use before parathyroid function tests are performed.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
bendroflumethiazide *(**ben**-droh-**floo**-meh-**THIGH**-ah-zyd)* (Naturetin)	oral	2.5–20 mg/day *Children:* 50–100 mcg/kg once daily	See note above.
chlorothiazide *(**kloh**-roh-**THIGH**-ah-zyd)* (Diuril, etc.)	oral, IV	0.5–2 g/day	Do not administer SC or IM. Unused parenteral solutions may be stored at room temperature for 24 hours after which they should be discarded.
chlorthalidone *(klor-**THAL**-ih-dohn)* (Hygroton, Uridon ✤, etc.)	oral	50–100 mg/day	See note above. Although not truly a thiazide it is quite similar in action.
hydrochlorothiazide *(**hy**-droh-**kloh**-roh-**THIGH**-ah-zyd)* (Esidrix, Oretic, HydroDIURIL, Urozide ✤)	oral	*Adults:* 25–200 mg/day as single or divided dose *Children:* 2mg/kg/day in 2 doses	—
hydroflumethiazide *(**hy**-droh-**floo**-meh-**THIGH**-ah-zyd)* (Saluron, Diucardin)	oral	25–200 mg/day	—
indapamide *(in-**DAP**-ah-myd)* (Lozol)	oral	2.5 mg/day	See chlorthalidone.
methyclothiazide *(**meth**-ih-kloh-**THIGH**-ah-zyd)* (Aquatensen, Duretic ✤, Enduron)	oral	2.5–10 mg/day	—
metolazone *(meh-**TOHL**-ah-zohn)* (Diulo, Zaroxolyn, Mykrox)	oral	2.5–20 mg/day	See chlorthalidone.

continues

TABLE 31–1 *continued*

See **Note** at beginning of Table 31–1, page 600.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
polythiazide *(**pol**-ee-**THIGH**-ah-zyd)* (Renese)	oral	1–4 mg/day	See note above.
quinethazone *(kwin-**ETH**-ah-zohn)* (Hydromox)	oral	50–200 mg/day	—
trichlormethiazide *(try-**klor**-meh-**THIGH**-ah-zyd)* (Naqua, etc.)	oral	1–4 mg/day	—

Loop Diuretics

Loop diuretics, **furosemide** (Lasix), **ethacrynic acid** (**Edecrin**), **bumetanide** (**Bumex**), and **torsemide** (**Demadex**) are widely used. These agents act by inhibiting the reabsorption of sodium and chloride in the ascending loop of Henle, thereby reducing the ability of the kidneys to concentrate urine. The loop diuretics are considerably more potent than the thiazides in promoting sodium and fluid excretion. Unlike the thiazides, they remain effective, even in clients with seriously impaired glomerular filtration rates. This has made them popular agents in treating elderly clients, who may not adequately respond to thiazides.

Because of the relatively high concentration of sodium that enters the distal tubule, considerable sodium-potassium exchange occurs in clients using loop diuretics, thereby promoting the development of hypokalemia. The use of these agents has also been associated with hearing loss, particularly when administered parenterally in high doses.

Potassium-Sparing Diuretics

Several agents having diuretic activity, but different modes of action, exert their action in the distal tubule. **Spironolactone** (**Aldactone**) imparts its diuretic activity by inhibiting the action of the hormone aldosterone. **Triamterene** (**Dyrenium**) and **amiloride HCl** (**Midamor**) directly block sodium reabsorption in the distal tubule independently of aldosterone. None of these agents is a potent diuretic. They are, therefore, often used in combination with a thiazide or loop diuretic to obtain enhanced diuretic activity. As these agents inhibit potassium excretion, they are generally employed in combination with potassium-depleting diuretics to decrease the incidence of hypokalemia. Some clients receiving such a potassium-sparing agent develop hyperkalemia, particularly if they are also using potassium supplements. Because of the neurotransmission importance of potassium, its overabundance could have similar serious, even life-threatening, consequences to the depletion associated with thiazide diuretics. Elevated potassium levels can also lead to cardiac arrhythmias, as well as muscle spasms in skeletal and smooth muscles of the body.

Although the incidence of side effects in the use of distal tubule blocking agents is low, an appreciable number of male clients using spironolactone for prolonged periods experience the development of enlarged breasts (gynecomastia).

Osmotic Diuretics

Osmotic diuretics are agents capable of being filtered by the glomerulus, but have a limited capability of being reabsorbed into the bloodstream. This results in a high concentration of osmotic agent in the kidney tubule, which leads to large amounts of fluid and produces a profound diuretic effect.

Agents such as glycerin and **isosorbide** are used orally. **Urea** and **mannitol** are administered intravenously as osmotic diuretics. They are employed primarily in the treatment of increased intracranial pressure, but is also used to treat acute renal

failure as well as in conditions where rapid reduction of the pressure and volume of intraocular and/or intraspinal fluid is required.

Carbonic Anhydrase Inhibitors

Carbonic anhydrase is an enzyme found in a number of organs of the body, including kidneys and eyes. In kidneys, the enzyme acts to promote the reabsorption of sodium and bicarbonate from the proximal tubule, thereby maintaining the alkalinity of the blood. The administration of drugs such as acetazolamide (Diamox), **dichlorphenamide** (**Daranide**), and **methazolamide** (**Neptazane**) that inhibit carbonic anhydrase activity, promotes the excretion of bicarbonate, sodium and water, and results in a mild diuretic effect. The use of carbonic anhydrase inhibitors as diuretics has diminished greatly with the development of more effective diuretic drugs. These agents are used widely, however, for the reduction of intraocular pressure in glaucoma clients (review Chapter 26). This application is based upon the observation that inhibition of carbonic anhydrase activity reduces the rate of production of aqueous humor in the eye.

Table 31–2 summarizes the properties of nonthiazide diuretics currently in use in the United States.

Combination Potassium-Sparing and Hydrochlorothiazide Diuretics

To decrease the adverse effects associated with thiazide diurectics (hypokalemia) and those of the potassium-sparing diuretics (hyperkalemia), the three potassium-sparing diuretics mentioned are all available in combination with hydrochlorothiazide. This also increases the drug's action as an antihypertensive.

Aldactazide is a combination of spirolactone and hydrochlorothiazide (HCTZ) and comes in two strengths, the same strength for each drug—25 mg/25 mg and 50 mg/50mg. The usual dose is 1 to 4 tablets a day.

Dyazide and **Maxide** are trade names for the drugs combining triamterene and HCTZ. Dyazide is made up of 37.5 mg of triamterene and 25 mg of HCTZ. Maxide is 75 mg of triamterene ant 50 mg of HCTZ. These are usually dosed at 1 to 2 capsules or 1 to 4 tablets per day.

Finally, **Moduretic** is a combination of amiloride and HCTZ. The usual dosage is 1 to 2 tablets per day.

ANTIHYPERTENSIVE AGENTS

Hypertension is defined as an abnormal increase in arterial blood pressure. It is a complex state that may be caused by renal disease, disease of the adrenal gland and/or other disorders. In the vast majority of cases, however, no underlying disease is evident and the condition is referred to as essential or primary hypertension. If left untreated, elevated blood pressure may lead to progressive deterioration of cardiac, renal, and ocular function, as well as stroke (cerebral vascular accident). One out of every four Americans experiences elevated blood pressure and 2 million new cases are diagnosed with hypertension each year.

Blood pressure is generally considered to be dependent on two factors: cardiac output and peripheral resistance. Cardiac output is controlled by the capacitance vessels, that is, the kidney and the heart. Peripheral resistance is mediated by the resistance vessels, such as the arterioles. Virtually all forms of drug therapy for hypertension affect one or both of these systems either directly or indirectly.

During the past decade a stepped-care approach to treating hypertension has become popular. On November 6, 1997, the Joint National Committee for the Prevention, Detection, Evaluation and Treatment of Hypertension established new guidelines based on a person's cardiovascular risk for hypertension that match treatment recommendations according to each stage of hypertension and the risk group. Risks factors are listed in Box 31–1. People are then grouped according to these risks (Box 31–2). Box 31–3 illustrates the stepped-care guidelines based on the stage of hypertension and the risk group. In using this approach, a client with hypertension is placed on a lifestyle modification program that often includes weight reduction, regular physical exercise, smoking cessation, reduction of sodium intake, and moderation of alcohol intake. If lifestyle changes don't produce the desired reduction in blood pressure in people in Risk Group A with either high normal blood pressure or those in Stage 1, drug therapy is initiated. The dose of the agent is increased slowly until the therapeutic goal has been achieved, adverse side effects are no longer tolerable, or the maximum dose of the drug has been reached. If the drug does not adequately reduce the client's blood pressure, other drugs may be added to therapy to reduce the client's blood pressure to normal

TABLE 31–2

Nonthiazide Diuretics

Note: Give early in the day to prevent nocturia.

Record intake and output in hospitalized clients.

Monitor fluid and electrolyte balance, especially potassium.

Observe clients taking cardiac glycosides and diuretics, other than potassium-sparing diuretics, for the development of cardiac glycoside toxicity (visual disturbances, bradycardia, bigeminy, nausea, vomiting, and anorexia).

Monitor blood pressure and weight.

DRUG	DIURETIC CLASS	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
acetazolamide *(**as**-et-ah-**ZOL**-ah-myd)* (Diamox, Novo-Zolamide ✱)	carbonic anhydrase inhibitor	oral, IV	5 mg/kg/day	May cause false-positive urine protein tests due to alkalinization of the urine. Encourage potassium-rich diet if serum potassium level is low. Take with meals to avoid GI upset.
amiloride HCl *(ah-**MILL**-oh-ryd **hy**-droh-**KLOR**-eyed)* (Midamor)	potassium-sparing	oral	5–10 mg/day	Should be taken with food to minimize GI upset. Avoid large quantities of potassium-rich foods.
bumetanide *(byou-**MET**-ah-nyd)* (Bumex)	loop	oral, IM, IV	0.5–2 mg/day maximum 10 mg/day	Parenteral solutions should be freshly prepared and used within 24 hours. Report hearing loss or dizziness.
dichlorphenamide *(**dye**-klor-**FEN**-ah-myd)* (Daranide)	carbonic anhydrase inhibitor	oral	100–200 mg initially, followed by 25–100 mg every 12 hours	Encourage consumption of a potassium-rich diet if serum potassium level is low.
ethacrynic acid *(**eth**-ah-**KRIN**-ick **AH**-sid)* (Edecrin, Sodium Edecrin)	loop	oral, IV	*Adults:* 50–200 mg/day *Children:* 25 mg orally per dose	Monitor client for excessive fluid and electrolyte loss. Use with cephalosporin or aminoglycoside antibiotics will increase the potential for ototoxicity and nephrotoxicity. Do not administer by SC or IM route. Encourage consumption of a potassium-rich diet if serum potassium level is low. If severe diarrhea develops, drug may have to be discontinued. This drug may enhance the effects of oral anticoagulants.
furosemide *fyou-**ROH**-seh-myd)* (Lasix, Novo-Semide ✱)	loop	oral, IM, IV	*Adults:* 20–80 mg/day *Infants and Children:* 2 mg/kg per dose	Monitor client for excessive fluid and electrolyte loss. Drug may raise blood glucose levels. Clients who are sensitive to sulfa drugs may also be sensitive to furosemide. Encourage consumption of a potassium-rich diet if serum potassium level is low. Store oral solution in the refrigerator to ensure stability and potency. Orthostatic hypotension may be aggravated by alcohol. Advise client to report sore throat, fever, or severe abdominal pain.

continues

TABLE 31–2 *continued*

See **Note** at beginning of Table 31–2, page 603.

DRUG	DIURETIC CLASS	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
glycerin *(**GLIS**-er-in)* (Osmoglyn)	osmotic	oral	1–1.5 g/kg	Administer 1–1½ hours prior to ocular surgery.
mannitol *(**MAN**-ih-tol)* (Osmitrol, etc.)	osmotic	IV	20–200 g/day	When exposed to low temperature, crystals may develop in solutions. If this occurs, warm solution in hot water and then cool to body temperature (about 37°C) before administering. IV administration set should include a filter. Infiltration of IV may result in tissue necrosis.
methazolamide *(**meth**-ah-**ZOH**-lah-myd)* (Neptazane)	carbonic anhydrase inhibitor	oral	50–100 mg 2–3 times daily	Encourage consumption of a potassium-rich diet if serum potassium level is low.
spironolactone *(**speer**-on-oh-**LACK**-tohn)* (Aldactone, Novospiroton ✤)	potassium-sparing	oral	25–200 mg/day *Children:* 1–3.3 mg/kg/day	Excessive potassium intake may cause hyperkalemia. Drug may cause drowsiness and mental confusion. Advise client to use caution while driving or performing other tasks that require alertness.
torsemide *(**TOHR**-seh-myd)* (Demadex)	loop	oral, IV	5–10 mg/day	Administer dose early in the day. Monitor client for excessive fluid and electrolyte loss. Oral and IV doses are equivalent, so dosage need not be changed when using different dosage form. Administer IV injection slowly over 2 minutes.
triamterene *(try-**AM**-ter-een)* (Apo-Triazide ✤, Dyrenium)	potassium-sparing	oral	100 mg twice daily after meals maximum 300 mg/day	Excessive potassium intake may cause hyperkalemia.

BOX 31–1 Cardiovascular Risk Factors

Risk Factors	Conditions	Risk Factors	Conditions
Smoking	Left ventricular hypertrophy	Postmenopausal women	Heart failure
High serum cholesterol	Angina or prior myocardial infarctions	Family history of heart disease	Stroke or transcient ischemic attack
Age older than 60 years	Diabetes		Nephropathy
Men	Prior cardiac revascularization		Peripheral vascular disease
			Retinopathy (eye damage)

BOX 31–2 Hypertension Risk Groups

Risk Groups	Number of Risk Factors
Risk Group A	No cardiovascular risk factors or conditions
Risk Group B	One cardiovascular risk factor but no diabetes or other risk conditions
Risk Group C	Diabetes and/or any of the other risk conditions

levels. Within each stage, the drug is chosen on the basis of client factors, such as age, other underlying conditions, cost, and the client's reaction to the medication.

Diuretics

Oral diuretics have long been considered to be the cornerstone of antihypertensive drug therapy and are often used as the initial form of treatment. Most of these agents have been shown to be capable of lowering both systolic and diastolic blood pressure in virtually all clients treated for essential hypertension. They will also potentiate the action

BOX 31–3 Joint National Committee for Prevention, Detection, Evaluation and Treatment of Hypertension Guidelines

Stage of hypertension (Systolic/diastolic mm Hg)	Risk Group A	Risk Group B	Risk Group C
High normal (130-139/85-89)	Lifestyle modifications	Lifestyle modifications	Drug therapy (for those with heart failure, renal insufficiency, or diabetes Lifestyle modifications
Stage 1 (140-159/90-99)	Lifestyle modifications Drug therapy to begin within 1 year, if BP remains uncontrolled.	Lifestyle modifications Drug therapy to begin within 6 months, if BP remains uncontrolled; drug therapy may be more prompt if multiple risk factors	Drug therapy Lifestyle modifications
Stage 2 (160-179/100-109)	Lifestyle modification + Drug therapy	Lifestyle modification + Drug therapy	Lifestyle modification + Drug therapy
Stage 3 (180/110 or higher)	Lifestyle modification + drug therapy	Lifestyle modification + drug therapy	Lifestyle modification + drug therapy

of most other oral, nondiuretic, antihypertensive agents.

Although early reports attributed the antihypertensive effects of the oral diuretics to their ability to reduce plasma volume, it has been observed that reductions in blood pressure tend to persist after months of diuretic therapy, even though plasma volume has returned to normal levels. There is considerable evidence to support the theory that diuretics cause a redistribution of sodium out of the arteriolar wall, thereby producing a reduction of vascular resistance and a lowering of arterial blood pressure.

The oral thiazide diuretics are generally considered to be interchangeable in regard to their diuretic and antihypertensive effects. They differ primarily in the dosage required and the duration of action produced. The most popular of these, hydrochlorothiazide (HydroDIURIL, Esidrix, etc.), is most commonly prescribed in doses of 50 mg twice daily. The use of doses in excess of 100 mg in 24 hours does not appear to enhance the antihypertensive effect of this drug, but does increase its electrolyte-depleting and diuretic effects.

So-called "loop" diuretics, such as furosemide (Lasix), ethacrynic acid (Edecrin), bumetanide (Bumex), and torsemide (Demadex), are considerably more potent than the thiazide agents. They do not, however, have any advantage over thiazides in the treatment of hypertension in a client with normal renal function, as they exert no greater antihypertensive effect, but do cause appreciably greater electrolyte depletion. In clients with renal insufficiency, loop diuretics have been proven to be more effective antihypertensive agents than the thiazides.

Potassium-sparing diuretics, such as spironolactone (Aldactone), triamterene (Dyrenium) and amiloride HCl (Midamor), are not usually considered to be drugs of first choice in the treatment of essential hypertension. However, they may be used either alone or in combination with a thiazide when potassium depletion is to be avoided (e.g., in a client using a cardiac glycoside, see Chapter 28).

A nondiuretic antihypertensive agent, such as a beta-adrenergic blocking agent, a calcium channel blocker, or an angiotensin-converting enzyme (ACE) inhibitor may be indicated as a Step I drug if adequate reduction of blood pressure has not occurred within 3–6 weeks after initiation of diuretic therapy. The drugs now discussed are often used in conjunction with diuretic therapy.

Centrally Acting Antiadrenergic Agents

Centrally acting antiadrenergic agents are generally potent antihypertensive agents that frequently cause sedation as a major adverse effect.

Methyldopa (Aldomet). Although its mechanism of action is not entirely clear, methyldopa appears to act by being metabolized to alpha-methylnorepinephrine. This metabolite is believed to replace norepinephrine in adrenergic storage sites, so that on stimulation of the adrenergic neuron, this false neurotransmitter is released. Methyldopa may also act by directly stimulating alpha-adrenergic receptors in the central nervous system (CNS), thereby resulting in dilation of peripheral blood vessels and reduction of blood pressure.

The use of methyldopa is limited because it may produce considerable sedation and must be administered 2–4 times daily. As tolerance often develops to the sedative effects of this drug, dosage increases are generally best initiated in evening doses, rather than morning or afternoon doses. Other less frequent adverse effects reported with the use of methyldopa include *Coomb's-positive* hemolytic anemia and hepatic dysfunction.

Clonidine (Catapres). **Clonidine** appears to act by stimulating alpha-adrenergic receptors in the CNS, resulting in a decrease in sympathetic outflow from the brain. Its action is apparent within 30–60 minutes after administration of an oral dose. Its maximum antihypertensive effect occurs within 3–5 hours. As the action of clonidine is relatively transient, clients should be advised not to miss doses or to discontinue therapy without consulting their physician; rapid elevation of blood pressure may occur. Clonidine is also available as a transdermal patch (**Clonidine-TTS**), which releases the drug slowly over 7 days and reduces the variation in action observed when the tablets are used. In discontinuing clonidine therapy, the dose of the drug should be decreased gradually over a period of 2 to 4 days to avoid hypertensive rebound.

Guanfacine HCl (Tenex). **Guanfacine HCl** is a centrally acting agent that appears to stimulate alpha-adrenergic receptors. This results in a reduction of sympathetic nerve impulses from the vasomotor center to the heart and blood vessels, thereby producing vasodilation and reduction of heart rate.

Because of its effect on the CNS, guanfacine may cause sedation or drowsiness, especially during

the initial stages of therapy. Abrupt discontinuation of the drug may result in rapid blood pressure elevation, nervousness, and anxiety.

Guanabenz Acetate (Wytensin). **Guanabenz acetate** is a centrally acting alpha$_2$-adrenergic agonist (review Chapter 15). Its antihypertensive action appears to result in reduced sympathetic outflow from the brain. Because of its central action, most clients receiving this drug will experience sedation and drowsiness. Many also experience dry mouth and dizziness. Guanabenz may be used alone, but is generally administered in combination with a thiazide diuretic.

Peripherally Acting Antiadrenergic Agents

Rauwolfia Derivatives. Agents derived from the *Rauwolfia serpentina* plant, such as reserpine, **rescinnamine**, **deserpidine**, and **rauwolfia serpentina**, appear to reduce blood pressure by depleting the neurotransmitter norepinephrine from peripheral sympathetic nerve junctions. When used in doses ranging from 0.1 to 0.5 mg once daily, reserpine's onset of action may be very slow, taking from several days to several weeks. Likewise, when discontinuing therapy, drug-induced effects may be evident for 1 to 6 weeks. The major advantage in the use of reserpine is its low daily dose and its once-daily administration. The major disadvantage lies in its ability to cause depression, particularly in clients who have had prior depressive episodes. This is believed to be due to reserpine's ability to deplete norepinephrine from the CNS. In addition, reserpine may stimulate gastric secretion and may, thereby, exacerbate peptic ulcer disease. It may also cause nasal congestion during the early weeks of therapy.

Guanethidine Monosulfate (Ismelin Sulfate). **Guanethidine** is one of the most potent antihypertensive agents currently in clinical use. It is believed to act by depleting peripheral adrenergic neurons of catecholamines and then blocking their re-uptake and storage. The consequence of this action is partial or complete sympathetic blockade and reduction of blood pressure.

Virtually all clients receiving therapeutic doses of guanethidine experience side effects, most of which tend to be dose-related. The most common of these effects are postural hypotension, impairment of sexual function in males, and diarrhea. Postural hypotension is generally exhibited as dizziness, weakness, or syncope that is most prominent upon arising from bed in the morning and can often be controlled by dosage reduction. Because of the frequency and severity of side effects, guanethidine is generally recommended only for clients in whom less potent agents have not been completely successful or in cases where urgent reduction of blood pressure is required.

Guanadrel Sulfate (Hylorel). **Guanadrel** is chemically and pharmacologically similar to guanethidine. It acts by inhibiting norepinephrine release from peripheral nerve storage sites in response to nerve stimulation. It accomplishes this by being taken up by these nerve terminals and displacing norepinephrine.

Guanadrel exhibits many of the same adverse effects associated with the use of guanethidine. Of particular importance is the common development of orthostatic hypotension and its effects (dizziness, weakness, etc.). The use of tricyclic antidepressants (see Chapter 18) and indirect-acting sympathomimetic agents, such as phenylpropanolamine, may block the antihypertensive action of this drug, as they do the action of guanethidine. As sodium retention may occur in clients using this drug, thiazide diuretics are frequently used in combination with it.

Prazocin (Minipress), Terazosin (Hytrin), and Doxazosin (Cardura). These related agents exert their antihypertensive effect by selectively blocking postsynaptic alpha-adrenergic receptors. This results in the dilation of both arterioles and veins and a lowering of blood pressure. Clinical experience with these drugs has revealed the possibility of a "first-dose" effect when these agents are used. This is characterized by the development of significant hypotension and syncope with sudden loss of consciousness with the first few doses or if dosage is increased rapidly. The first-dose effect may be minimized by limiting the initial dose of these drugs to 1 mg given at bedtime. Subsequent dosage is increased slowly with adequate precautions taken to prevent client injury, i.e., avoiding driving and other potentially hazardous tasks during the early days of therapy.

Terazosin and **doxazosin** are also used to treat symptomatic benign prostatic hyperplasia (BPH). These drugs act to reduce symptoms and increase urine flow rates by blocking alpha$_1$-adrenergic receptors in the bladder, thereby reducing bladder obstruction without affecting bladder contractility.

Beta-Adrenergic Blocking Agents

A number of beta-adrenergic blocking agents are employed in the treatment of hypertension. Their mechanism of antihypertensive action is not yet clear, but is believed to be partially due to their ability to reduce cardiac output by producing beta-adrenergic blockade. These agents appear to be of greatest value when used in conjunction with a diuretic agent. They exhibit relatively few serious side effects.

Propranolol, nadolol, **penbutolol**, **timolol**, **pindolol**, **carteolol**, and **labetalol** inhibit both the $beta_1$-adrenergic receptors (located primarily in cardiac muscle) and the $beta_2$-adrenergic receptors (located primarily in bronchial and vascular musculature). They are capable, therefore, of reducing heart rate and force of contraction, as well as potentially causing bronchoconstriction. Metoprolol, **betaxolol**, **bisoprolol**, atenolol, and acebutolol are said to be cardioselective, as they tend to preferentially block $beta_1$-adrenergic receptors. Pindolol, acebutolol, and penbutolol are said to have intrinsic sympathomimetic activity (ISA). This action reduces the likelihood of drug-induced reduction of heart rate, an effect commonly seen in clients using beta blockers without ISA. Unlike other currently available beta blockers, labetalol exerts $alpha_1$-adrenergic blocking action in addition to its nonselective beta blocking action. This may enhance its activity as an antihypertensive drug.

The use of beta-adrenergic blocking agents is contraindicated in clients with heart disease that is dependent upon beta-adrenergic stimulation for control (e.g., congestive heart failure). Beta blockers are also not to be used in clients who are prone to nonallergic bronchospasm (e.g., chronic bronchitis, emphysema), as beta-adrenergic blockade would intensify bronchoconstriction while also compromising the effectiveness of bronchodilator drugs that act by beta-adrenergic stimulation (e.g, isoproterenol).

Vasodilators

Hydralazine (Apresoline). **Hydralazine** acts to lower blood pressure by directly dilating peripheral arterioles. As a consequence of this action a compensatory stimulation of the heart may occur which results in *palpitations*, *tachycardia*, and increased cardiac oxygen consumption. In clients with *ischemic* heart disease (e.g., angina pectoris), attacks may be precipitated as a consequence of the increased oxygen requirements of coronary blood vessels. It is advisable to administer hydralazine with a beta-adrenergic blocking agent to minimize this reflex cardiac stimulation.

Minoxidil (Loniten). **Minoxidil** is another agent which is believed to act by directly dilating peripheral arterioles. It is also capable of causing reflex cardiac stimulation. Its most serious drawback is its ability to cause considerable sodium and fluid retention in some clients. Such an effect can often be managed successfully by using a diuretic agent at the same time, but this approach is not always effective. Minoxidil is only indicated for the treatment of severe hypertension which has not responded to safer drugs. It should generally be used with a beta-adrenergic blocking agent to minimize reflex cardiac stimulation.

An unusual adverse effect related to minoxidil use is the growth and thickening of fine body hair which occurs within 3–6 weeks of starting therapy. Various studies have shown that hair growth may be stimulated in some clients by topically applying a minoxidil solution to the skin. A topical dosage form of minoxidil solution (**Rogaine**) has been marketed specifically for the treatment of male pattern baldness.

Nitroglycerin Intravenous. When administered intravenously, nitroglycerin relaxes smooth muscle of blood vessels throughout the body, thereby reducing both systolic and diastolic blood pressure. By this route it is used primarily in controlling blood pressure during surgical procedures, particularly those involving the cardiovascular system.

Angiotensin-Converting Enzyme (ACE) Inhibitors

Benazepril (Lotensin), Captopril (Capoten), Enalapril (Vasotec), Fosinopril (Monopril), Lisinopril (Prinivil, Zestril), Quinapril (Accupril), Ramipril (Altace). Unlike other antihypertensive agents, these drugs act as antagonists of the *renin-angiotensin system* (Figure 31–2). The drugs interfere with the conversion of angiotensin I to angiotensin II by inhibiting the action of ACE, the enzyme that permits that conversion. This action results in the dilation of peripheral blood vessels and a reduction in blood pressure. Clients receiving ACE inhibitors should be monitored for the

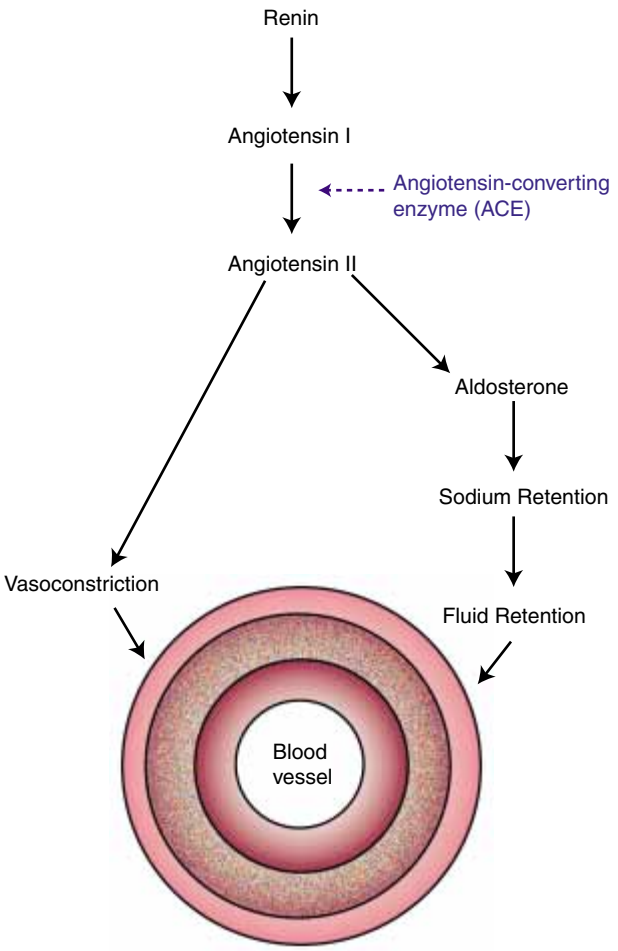

Figure 31–2 Renin-angiotensin system. ACE inhibitors act as antagonists of the renin-angiotensin system by interfering with the conversion of angiotensin I to angiotensin II. This ultimately results in vasodilation.

development of renal and hematologic changes that may be caused by these drugs.

Angiotensin II Antagonists

Losartan (**Cozaar**) was the first angiotensin II antagonist to be marketed. It blocks the binding of angiotensin II on its receptors, thereby resulting in reduced aldosterone concentrations in the blood and reduced blood pressure.

Valsartan (**Diovan**) was the second of this class to be developed. It reduces both blood pressure and left ventricular hypertrophy and has been targeted for use with clients whose hypertension is accompanied by congestive heart failure. As with most of the antihypertensive agents, most of its adverse effects are experienced in the respiratory system with cough and the CNS with headache, dizziness, fatigue, and insomnia.

Irbesartan (**Avapro**) is the newest of the angiotension II receptor antagonists to be marketed in the United States. Its adverse effects include diarrhea, fatigue, and upper respiratory infection. Irbesartan's advantage is that, unlike the other angiotension II receptor antagonists, it does not usually cause coughing.

Calcium Channel Blocking Agents

Calcium channel blocking agents reduce arterial blood pressure at rest and during exercise by dilating peripheral arterioles and reducing peripheral resistance. **Amlodipine**, felodipine, isradipine, **mibefradil dihydrochloride** (Posicor), nicardipine, verapamil, and sustained-release forms of **diltiazem** and **nifedipine** have been approved for the treatment of essential hypertension. Chapter 28 reviews the use of calcium channel blockers for the treatment of other cardiovascular disorders.

Miscellaneous Antihypertensive Agents

Mecamylamine HCl (Inversine). **Mecamylamine** is a potent ganglionic blocking agent employed in treating moderately severe to severe hypertension, as well as uncomplicated malignant hypertension. Its use is commonly accompanied by adverse effects that include orthostatic hypotension, dizziness, syncope, anorexia, *ileus*, dry mouth, and constipation. In rare cases, the use of the drug may produce tremors, mental aberrations, and convulsions. When therapy with mecamylamine is abruptly discontinued, blood pressure elevation rapidly returns. Because of the many adverse effects associated with its use, mecamylamine is rarely used.

Combination Products. A number of products that contain two or more antihypertensive drugs are currently available for the treatment of hypertension. Each component drug exerts a different action in lowering blood pressure. Such products are best used only in clinical situations in which the client's therapy has included the rational introduction of single antihypertensive agents and in which a specific dosage of each agent appears to be of greatest benefit to the client. In such cases, the use of two or more drugs in a single dosage form would tend to increase the likelihood that clients will be compliant with their antihypertensive therapy.

Agents Used to Treat Hypertensive Emergencies

A hypertensive emergency exists when a client's blood pressure reaches a level at which it may produce permanent bodily damage or death. In such cases it is necessary to use antihypertensive drugs by a parenteral route.

Diazoxide (Hyperstat IV). **Diazoxide** is chemically and pharmacologically related to the thiazide diuretics. Its actions are, however, much more rapid and potent. In the treatment of hypertension, diazoxide is given by rapid intravenous administration (the dose is given within 30 seconds). Diazoxide is used primarily in the treatment of hypertensive emergencies. It acts to relax the walls of peripheral arterioles and thereby effectively lowers blood pressure. Because diazoxide administration frequently causes the retention of sodium and water, it is often administered with a diuretic.

Sodium Nitroprusside (Nitropress, Nipride). This agent is also used primarily in the treatment of hypertensive emergencies. Unlike diazoxide, **sodium nitroprusside** relaxes both arteriolar and venous smooth muscle, thereby increasing the likelihood of *venous pooling* when the client is in an upright position. Sodium nitroprusside is only administered by intravenous infusion. Its onset of action is apparent shortly after an infusion is started and the drug's activity ends rapidly after the infusion is stopped. By carefully controlling the rate of infusion, therefore, the client's blood pressure can be precisely maintained. Because one of the byproducts of nitroprusside metabolism is cyanide (then thiocyanate), the nurse needs to monitor client for cyanide toxicity.

Solutions of sodium nitroprusside are somewhat unstable in the presence of light. Prepared parenteral dosage forms must therefore be protected from light and discarded if they discolor.

Trimethaphan Camsylate (Arfonad). An agent which reduces blood pressure by blocking nerve transmission in *autonomic ganglia*, resulting in a direct vasodilating effect, **trimethaphan** camsylate is employed in the control of blood pressure during surgery and/or in hypertensive emergencies.

Table 31–3 summarizes the properties of the nondiuretic antihypertensive agents. Nursing implications provide guidelines for the care of clients receiving these products.

APPLYING THE NURSING PROCESS

Nurses have been actively involved in formulating and disseminating goals for the care of hypertensive clients. The Task Force on the Role of Nursing in High Blood Pressure Control has identified six goals for nurses:

- understanding of the disease and the prescribed treatment by clients and their families
- successful adjustment of clients and families to the diagnosis and therapy
- assumption of responsibility by clients for their own care
- achievement of a stable blood pressure in accordance with the goal set by the physician
- limitation of side effects from drugs
- limitation of damage to internal organs due to therapy or the disease itself

These goals provide important guides for the nurse in working with clients receiving antihypertensive agents. Unlike many clients for whom drug therapy means cure of their illness, hypertensive clients may not feel the same commitment to taking their medications as ordered. This is because hypertension is often asymptomatic and because the client fails to understand that the goal of drug therapy is control, not cure. For these reasons, the nurse must be instrumental in teaching the client and family about hypertension, its symptoms, consequences, and treatment.

Successful adjustment to diagnosis and therapy involves supportive care, counseling, and suggestion of measures to minimize the interference of the treatment plan with the daily activities of the client. For example, the nurse can suggest that clients receiving diuretics take their medication early in the day, so that their sleep is not interrupted by several trips to the bathroom.

ASSESSMENT

Nurses are often responsible for blood pressure measurements as part of screening programs or routine physical examinations. It is important that these readings be determined using a cuff of

TABLE 31–3

Nondiuretic Antihypertensive Agents

Note: Client education program should stress the importance of compliance.

Monitor blood pressure. If postural hypotension occurs, teach client to change position slowly, especially on first rising in the morning. Elastic stockings or ingesting a high-protein snack at bedtime may also be helpful.

Clients on sodium-restricted diets require special instruction and follow-up.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
Centrally Acting Adrenergic Agents			
clonidine HCl *(**KLOH**-nih-deen **hy**-droh-**KLOR**-eyed)* (Catapres, Catapres-TTS, Dixarit)	oral, transdermal	Oral: 0.2–0.6 mg/day in divided doses Transdermal: 1 transdermal system applied every 7 days 0.1 mg	When discontinuing clonidine therapy, reduce dose gradually over 2–4 days. Monitor client for development of skin reaction when transdermal product is used.
guanabenz acetate *(**GWAHN**-ah-benz **AH**-sih-tayt)* (Wytensin)	oral	4–8 mg twice daily maximum dose 32 mg twice daily	Caution client about possible sedation and/or dizziness that may occur during therapy.
guanfacine HCl *(**GWAHN**-fah-seen **hy**-droh-**KLOR**-eyed)* (Tenex)	oral	1–3 mg/day	Administer medication at bedtime. Medication should not be abruptly discontinued.
methyldopa, methyldopate HCl *(**meth**-ill-**DOH**-pah, **meth**-ill-**DOH**-payt **hy**-droh-**KLOR**-eyed)* (Aldomet, Dopamet ✱, etc.)	oral, IV	Oral: 0.5–3 g/day divided into 2–4 doses IV: 0.25–0.5 g every 6 hours	Use with caution in clients with liver disease. Observe client for signs of anemia and liver dysfunction. May cause drowsiness early in therapy. Administration of daily dose at bedtime may alleviate this problem.
Peripherally Acting Antiadrenergic Agents			
deserpidine *(dee-**SER**-pih-deen)* (Harmonyl)	oral	250–500 mcg/daily	See rauwolfia serpentina.
doxazosin mesylate *(dox-**AY**-zoh-sin **MEH**-sih-layt)* (Cardura)	oral	1–2 mg daily maximum 16 mg/day	Higher doses may be used, but are likely to produce postural hypotension.
guanadrel sulfate *(**GWAHN**-ah-drel **SUL**-fayt)* (Hylorel)	oral	20–75 mg daily in 2–4 divided doses	See guanethidine.
guanethidine monosulfate *(gwahn-**ETH**-ih-deen **mon**-oh-**SUL**-fayt)* (Ismelin Sulfate)	oral	10–50 mg/day	Monitor client for development of postural hypotension and bradycardia. Males may temporarily lose the ability to ejaculate.

continues

TABLE 31–3 *continued*

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
prazosin HCl *(**PRAY**-zoh-sin **hy**-droh-**KLOR**-eyed)* (Apo-Prazo, Minipress)	oral	Initially 1 mg 2–3 times/day followed by gradual increase to 3–20 mg/day given in 3 divided doses	Monitor client for development of syncope during early portion of therapy. When increasing dose, give first dose at bedtime to reduce the likelihood of syncope.
rauwolfia serpentina *(rah-**WOOL**-fee-ah sir-pen-**TEEN**-ah)* (Raudixin, etc.)	oral	50–200 mg/day given as a single dose or in 2 divided doses	Use with extreme caution in clients with a history of mental depression. Report indications of depression, including appetite and sleep disturbances, withdrawal from social contact, and comments relating to suicide. May cause nasal stuffiness; avoid the use of systemic or local nasal decongestants. Stuffiness improves as therapy continues. May cause drowsiness; avoid activities requiring mental alertness.
reserpine *(reh-**SER**-pin)* (Serpasil, etc.)	oral	0.1–0.25 mg/day	See rauwolfia serpentina.
terazosin *(ter-**AY**-zoh-sin)* (Hytrin)	oral	1–5 mg daily	See prazosin HCl. Also used to treat symptomatic benign prostatic hyperplasia (BPH).
Beta-Adrenergic Blocking Agents			
acebutolol HCl *(**ah**-see-**BYOU**-toh-lohl **hy**-droh-**KLOR**-eyed)* (Monitan, Sectral)	oral	200–1200 mg daily given as 1–2 doses	Daily dose should be reduced by 50% if client's creatinine clearance is less than 50 mL/min and by 75% if it is less than 25 mL/min. See propranolol.
atenolol *(ah-**TEN**-oh-lohl)* (Novo-Atenol, Tenormin)	oral	50–100 mg/day	See propranolol.
betaxolol HCl *(beh-**TAX**-oh-lohl **hy**-droh-**KLOR**-eyed)* (Kerlone)	oral	Initially 10 mg once daily; dosage may be increased to 20 mg if necessary *Older adults:* 5 mg/day	Initial dose of 5 mg should be used in elderly clients. Discontinue drug gradually over a 2-week period.
bisoprolol fumarate *(bih-**SOH**-proh-lohl **FYOU**-mah-rayt)* (Zebeta)	oral	5–20 mg/day	See propranolol.
carteolol HCl *(kar-**TEE**-oh-lohl **hy**-droh-**KLOR**-eyed)* (Cartrol)	oral	2.5–10 mg once daily	Dosage interval should be extended in clients with renal impairment.

continues

TABLE 31–3 ***continued***

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
labetalol HCl *(lah-**BET**-ah-lohl **hy**-droh-**KLOR**-eyed)* (Normodyne, Trandate)	oral, IV	Oral: Initially, 100 mg twice daily; dose may be increased in 100 mg/day increments every 2–3 days; maintenance dose is 200–400 mg twice daily IV: 50–300 mg	See propranolol.
metoprolol tartrate *(meh-**TOH**-proh-lohl **TAR**-trayt)* (Betaloc ✱, Lopressor)	oral	100–450 mg/day as a single or divided dose	See propranolol.
nadolol *(nay-**DOH**-lohl)* (Apo-Nadol ✱, Corgard)	oral	40–320 mg/day	See propranolol.
penbutolol sulfate *(pen-**BYOU**-toh-lohl **SUL**-fayt)* (Levatol)	oral	20 mg/day	See propranolol.
pindolol *(**PIN**-doh-lohl)* (Apo-Pindol ✱, Visken)	oral	Initially 5 mg twice daily; dosage may be gradually increased to a maximum of 60 mg daily	See propranolol.
propranolol HCl *(proh-**PRAN**-oh-lohl **hy**-droh-**KLOR**-eyed)* (Detensol ✱, Inderal, Inderal LA)	oral	40 mg twice daily or 80 mg once daily [with sustained-release (LA) product]	Monitor client for breathing difficulty and bradycardia. Abrupt discontinuation of drug can precipitate severe angina. Monitor apical pulse for a full minute before administration. Withhold drug if pulse is below 60 or in excess of 100 beats per minute. Drug masks indications of hypoglycemia; carefully monitor diabetics receiving insulin or oral hypoglycemics. Advise clients to protect distal extremities with clothing during cold weather.
timolol maleate *(**TIM**-oh-lohl **MAL**-ee-ayt)* (Apo-Timol ✱, Blocadren)	oral	10–40 mg/day; usually divided into 2 doses	Seven days should elapse between increases in dosage. See propranolol.
Vasodilators hydralazine HCl *(hy-**DRAL**-ah-zeen **hy**-droh-**KLOR**-eyed)* (Apresoline, Novo-Hylazin ✱, etc.)	oral, IM, IV	Oral: 10–50 mg 4 times/day IM, IV: 20–40 mg as required	May cause headache or palpitations during first few days of therapy. Initiate therapy at low dose and gradually increase to control the disorder. Parenteral route should only be used when the drug cannot be given orally. Report any indication of a lupus erythematosus-like syndrome (fever, sore throat, skin rash, or joint and muscle aches). Periodic blood counts are suggested during long-term therapy.

continues

TABLE 31–3 *continued*

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
minoxidil *(mih-**NOX**-ih-dill)* (Loniten)	oral	Initially 5–10 mg/day; increased gradually to 40 mg/day in single or divided doses *Children under 12:* 0.2–1 mg/kg daily	Monitor client for the development of fluid retention. Weigh client at least weekly. The majority of clients develop excessive growth of body hair during therapy. This extra hair generally disappears within 6 months of stopping the drug. Drug is usually given with a beta-adrenergic blocking agent to control tachycardia.
nitroglycerin intravenous *(**nigh**-troh-**GLIS**-er-in)* (Nitrosat IV, etc.)	IV	Initially 5 mcg/minute; this may be increased at 3–5-minute intervals until a response is noted	Product should only be used with glass IV containers and administration sets provided by the manufacturer.
Calcium Channel Blockers			
amlodipine *(ahm-**LAHD**-ih-peen)* (Norvasc)	oral	5–10 mg once daily	May be taken with or without meals.
diltiazem *(dill-**TYE**-ah-zem)* (Cardizem SR, Apo-Diltiaz 🍁)	oral	Initially 60–120 mg twice daily; increase to 240–360 mg daily if required in 2 divided doses	Only sustained-release diltiazem capsules are approved for the treatment of hypertension.
felodipine *(feh-**LOH**-dih-peen)* (Plendil)	oral	Initially 5 mg once daily; increase to 10 mg once daily if needed	Tablets should be swallowed whole and not crushed or chewed. Reduced dosage should be used in clients with impaired liver function. Monitor clients for the development of edema.
isradipine *(is-**RAD**-ih-peen)* (DynaCirc)	oral	Initially 2.5 mg twice daily; increase gradually to as much as 10 mg twice daily if needed	Adverse effects to the drug increase significantly in daily doses greater than 10 mg. If dosage increases are required, they should be made in 5 mg/day increments every 2–4 weeks.
mibefradil dihydrochloride *(mi-**BEH**-fra-dil dy-**HY**-dro-klo-ride)* (Posicar)	oral	50–100 mg	Full antihypertensive effect occurs in 1–2 weeks. Can take without regard to meals. Client should swallow tablet not chew or crush it. Not approved for use in children.
nicardipine *(ny-**KAR**-dih-peen)* (Cardene)	oral	Initially 20 mg 3 times daily; increase to 40 mg 3 times daily if needed	Client's blood pressure should be monitored 1–2 hours and 8 hours after dosing to determine maximal and minimal response respectively.

continues

TABLE 31–3 ***continued***

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
nifedipine *(ny-**FED**-ih-peen)* (Apo-Nifed, Procardia XL)	oral	Initially 30–60 mg once daily; increase gradually to 120 mg daily if needed	Only sustained-release form of drug should be used to treat hypertension. Tablets should not be chewed or divided.
verapamil *(ver-**AP**-ih-mill)* (Apo-Verap, Calan, Isoptin, Verelan)	oral	Initially 80 mg 3 times daily with short-acting product or 240 mg once daily with sustained-release product; increase to 360 mg daily if required	Sustained-release products should be administered with food.
Angiotensin-Converting Enzyme (ACE) Inhibitors			
benazepril HCl *(beh-**NAY**-zeh-prill **hy**-droh-**KLOR**-eyed)* (Lotensin)	oral	Initially 10 mg once daily; increase to 20–40 mg daily if needed	Drug is metabolized to benazeprilat, the active form of the drug.
captopril *(**KAP**-toh-prill)* (Capoten)	oral	25–150 mg 3 times daily	When possible, discontinue previous antihypertensive drug regimen for 1 week prior to starting captopril therapy. Should be administered 1 hour before meals. Administer at the same time each day. Monitor client for development of sore throat, fever, swelling of hands or feet, irregular heart beat, or chest pains. Instruct client to report sore throat, fever, chest pain or edema. Taste sensation may be impaired. May potentiate hypoglycemia in insulin-dependent clients. Monitor renal function. Assess for dry cough.
enalapril maleate *(eh-**NAL**-ah-prill **MAL**-ee-ayt)* (Vasotec)	oral	2.5–40 mg daily as a single or divided dose IV: 1.25 mg over 5 min	See captopril. May cause decreased libido.
fosinopril sodium *(foh-**SIN**-oh-prill **SOH**-dee-um)* (Monopril)	oral	See benazepril	Dosage does not need to be changed in clients with renal impairment.
lisinopril *(lice-**IN**-oh-prill)* (Prinivil, Zestril)	oral	10–40 mg/day as a single daily dose	See captopril.
quinapril *(**KWIN**-ah-prill)* (Accupril)	oral	Initially 10 mg once daily; increase gradually at 2-week intervals to 20–80 mg daily	See captopril.

continues

TABLE 31–3 *continued*

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
ramipril *(**RAM**-ih-prill)* (Altace)	oral	Initially 2.5 mg once daily; may gradually be increased to as high as 20 mg daily if needed	Monitor client for development of cough.
Angiotension II receptor antagonists			
irbesartan *(ihr-beh-**SAR**-tan)* (Avapro)	oral	100–300 mg daily	May cause fetal or neonatal injury if taken during second or third trimester. Can take without regard for meals. Not approved for use in children.
losartan *(low-**SAR**-tan)* (Cozaar)	oral	25–100 mg daily	Monitor for URI. See irbesartan.
valsartan *(vahl-**SAR**-tan)* (Diovan)	oral	80–320 mg daily	See irbesartan.
Miscellaneous Antihypertensive Agents			
mecamylamine HCl *(**meck**-ah-**MILL**-ah-meen **hy**-droh-**KLOR**-eyed)* (Inversine)	oral	Initially 2.5 mg twice daily; may be gradually raised by 2.5 mg increments at intervals of not less than 2 days; usual maintenance dose is 25 mg/day administered in 3 divided doses	Monitor client for development of postural hypotension, tremor, seizures, or ileus. Administer drug after meals. Measure blood pressure while in the erect position.
Agents Used to Treat Hypertensive Emergencies			
diazoxide *(**dye**-az-**OX**-eyed)* (Hyperstat IV)	IV	1–3 mg/kg administered by IV push in 30 seconds or less; do not exceed 150 mg in a single injection *Children:* 1–3 mg/kg	Monitor client for sodium and fluid retention as well as signs of hyperglycemia. To avoid orthostatic hypotension, advise client to remain supine for 30 minutes after the injection.
nitroglycerin *(**nigh**-troh-**GLIS**-er-in)* (Nitrostat IV, Tridil, etc.)	IV	Initially 5 mcg/minute administered through an infusion pump; dose may be raised by 5 mcg/minute intervals until response is noted	Protect solution from light. Use only with glass IV bottles and administration set provided.

continues

TABLE 31–3 *continued*

See **Note** at beginning of Table 31–3, page 611.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
nitroprusside sodium *(**nigh**-troh-**PRUS**-eyed **SOH**-dee-um)* (Nipride, Nitropress)	IV	0.3–10 mcg/kg/min	Should be administered only by continuous IV infusion. Drug should only be dissolved in D5W. Prepared drug solutions should be wrapped in aluminum foil or other opaque material to protect from light. Do not use drug solutions more than 4 hours after they have been prepared. Infuse with automatic infusion pump. Check blood pressure every 5 minutes initially, then every 15 minutes. Stop infusion and advise physician if severe hypotension occurs. Infiltration can result in tissue damage. Monitor for cyanide toxicity that may occur if more than 500 mcg/kg is given faster than 2 mcg/kg/minute; toxicity may be preceded by metabolic acidosis. Monitor thiocyanate levels every 24–48 hours; results should be less than 100 mcg thiocyante/ml or 3 umol cyanide/ml.
trimethaphan camsylate *(try-**METH**-ah-fan **KAM**-sih-layt)* (Arfonad)	IV	Administer a solution containing 1 mg/mL of drug in 5% Dextrose Injection at a rate of 0.1–1 mg/min as needed	Used for rapid, short-term control of blood pressure during surgery and/or hypertensive emergencies. Use infusion pump to administer drug. Monitor blood pressure frequently during administration.

appropriate size for the client's extremity. If an elevated reading is obtained (140/90 or higher), another reading should be taken using the other arm. The observation of an elevated reading should be followed by initial questions regarding whether the client or family members have a history of hypertension, and the client's recent activities (for example, smoking, ingestion of caffeine, or physical exercise), plus an observation of the client's level of anxiety. A medication history is taken to determine if the client is taking any medications known to increase blood pressure. Examples of such medications include corticosteroids, oral contraceptives, and some nonprescription cold preparations. Clients with elevated readings should be monitored over time and those with three elevated readings 1 week apart are referred to a physician for a diagnostic workup for hypertension.

Often nurses have the primary responsibility for providing the health care received by hypertensive clients. In such situations, an initial assessment is made of the relevant medical history, current physical condition, reaction to stress, understanding of their health problem and treatment, and problems such as low income that might relate to adherence to the treatment program. Subsequent visits will include weight and blood pressure determinations and inquiries about diet, alcohol intake, exercise, and smoking, plus problems encountered with medication. Much of the time spent with clients is centered on education and counseling. One of the purposes of this activity is to encourage and support client efforts to assume responsibility for self-care. In selected cases, the nurse is responsible for instructing the client and family in measurement of blood pressure.

NURSING DIAGNOSES

Including but not limited to:

- Risk for injury, hypertensive crisis related to elevated blood pressure
- Risk for deficient fluid volume related to diuretic therapy
- Risk for injury related to adverse effects of antihypertensive therapy
- Noncompliance related to sexual dysfunction secondary to antihypertensive therapy
- Deficient knowledge related to hypertension and medication regimen

PLANNING/GOALS

- Client will not experience hypertensive crisis.
- Client will maintain fluid and electrolyte balance within normal limits.
- Client will not experience adverse effects associated with antihypertensive therapy.
- Client will demonstrate compliance with antihypertensive therapy.
- Client will demonstrate/verbalize understanding of hypertension and medication regimen.

IMPLEMENTATION

Meeting Sodium and Potassium Needs

Clients who are hypertensive and those who may be receiving diuretic therapy for other reasons are frequently on sodium-restricted diets. The level of sodium restriction is determined by the physician. Restriction of sodium can decrease the amount of fluid retained by the body. Most people do not realize the amount of sodium they consume every day or the sources of dietary sodium. Americans daily consume on the average of twenty times the sodium necessary for the body's needs. Much of this is in the form of leavening agents, preservatives, and artificial sweeteners. Some of the sodium is contained in antacids and in other drugs that may be purchased without a prescription.

The level of sodium restriction prescribed by the physician governs the instructions given to the client. Mild restriction (1,500 mg) means that the client should avoid adding salt during cooking and avoid very salty foods, such as potato chips and pickles. Moderate restriction (1,000 mg) involves avoidance of salty foods, table salt, and salt while cooking. Severe restriction (500 mg) requires the avoidance of foods high in sodium, including bread and milk, except for specially prepared low-sodium products. It also includes the restrictions required in the moderate restriction diet. Clients on severe sodium restriction and those receiving diuretics are cautioned about the possibility of sodium deficit, particularly during hot weather. Common signs and symptoms of sodium deficit include weakness, confusion, abdominal cramps, and muscle twitching. If sufficiently severe, convulsions can occur. Cases of suspected deficient sodium are reported to the physician for assessment. A temporary increase in sodium intake will frequently be recommended.

Many clients taking diuretics may lose potassium. Muscle cramps are often an indication of low potassium. Muscle weakness and changes in the pulse are other indications of low potassium. Generally, potassium loss is not too severe and can be replaced through dietary sources. Many foods low in sodium—such as fresh vegetables, fruits, and fruit juices—are high in potassium. Recommending an increase in intake of these high-potassium foods is often sufficient to return the serum potassium level to normal. When potassium loss is severe or life-threatening, potassium supplements may be ordered or potassium-sparing diuretics may be used. Because of the danger of hyperkalemia, potassium supplements and potassium-rich diets are contraindicated when potassium-sparing

KEY NURSING IMPLICATIONS 31–1

Assessment

1. In measuring blood pressure, use an appropriate size cuff.
2. If a reading of 140/90 or higher is obtained, check the blood pressure in the other arm, take a personal, family, and medication history and observe the client's level of anxiety.
3. Refer clients to the physician if they have three elevated readings 1 week apart.
4. Ongoing assessment includes blood pressure readings, weight, inquiries about diet, alcohol intake, exercise, smoking, and problems related to medication.

diuretics are used. Instructions about the medication given to the client include the name of the medication and the associated advice regarding potassium intake.

Two nursing actions are particularly helpful to the client on a special diet. The first is teaching the client to read labels on food products, beverages, and over-the-counter (OTC) medications. They are instructed to look for any ingredient containing the word "sodium" as well as salt, baking soda, or baking powder. The second action is to work with the client and the person responsible for food preparation to adapt the diet as nearly as possible to the client's daily schedule and food preferences. This often results in improved cooperation.

Limiting Adverse Effects

Nursing intervention can also help the client achieve a stable blood pressure at the level deemed desirable for the client. The measures previously mentioned, such as promoting adherence to the suggested sodium restriction, contribute toward this goal. One of the most important factors, however, is encouraging client cooperation with the medication schedule. Clients who experience or who believe they experience unpleasant side effects from their medications are less likely to adhere to the drug treatment program. The nurse can assist in minimizing adverse reactions in several ways. The first way is careful monitoring of the progress of treatment. Routine blood pressure determinations are made employing principles of accurate measurement. The nurse makes observations of the fluid and electrolyte balance, especially if the client is taking diuretics. These observations include weight, tissue turgor and signs and symptoms of low serum potassium, such as pulse irregularities, leg cramps, and general muscle weakness. Low serum potassium can enhance the likelihood of cardiac glycoside-induced toxicity.

In addition to these routine observations, accurate intake and output records are maintained for hospitalized clients newly placed on diuretic therapy. They are also kept for clients with severe fluid volume excess (e.g., those with congestive heart disease) who are on diuretic therapy for extended periods. Commonly used diuretics frequently affect the treatment of other health problems the client may have. For example, thiazide diuretics like **chlorothiazide**, **hydrochlorothiazide**, **triamterene**, and ethacrynic acid may cause hyperglycemia (an increase in blood sugar level) resulting in the necessity to adjust insulin or oral hypoglycemic drug dosage in diabetics. The thiazide diuretics and ethacrynic acid may increase serum uric acid levels, requiring an adjustment of medication in clients who have gout.

The nurse must be aware of several drug interactions which can occur when diuretics are used. For example, when alcohol, narcotics or barbiturates are taken with a thiazide diuretic, hypotension on first rising from a sitting or lying position may be aggravated. Another example is the interaction of salicylates, such as aspirin, with spironolactone (Aldactone), which may lead to a possible decrease in sodium and chloride excretion. A third example is the enhanced tendency to develop ototoxicity (e.g., hearing loss) when ethacrynic acid (Edecrin) and aminoglycoside antibiotics (see Chapter 7) are used. This effect is usually reversible when drug therapy is discontinued. Another loop diuretic, furosemide (Lasix), may be less effective in its diuretic action if clients are taking anticonvulsants. Finally, clients taking a thiazide diuretic and lithium (see Chapter 18) must be observed very carefully for lithium toxicity, as a decrease

KEY NURSING IMPLICATIONS 31–2

Sodium and Potassium Needs

1. Some clients with hypertension benefit from a sodium restricted diet, either mild (1,500–2,000 mg), moderate (1,000 mg) or severe (500 mg).
2. Clients on sodium-restricted diets may experience sodium deficit, particularly during hot weather. A temporary increase in sodium is recommended.
3. Muscle cramps, muscle weakness, and change in the pulse may indicate potassium deficit. Potassium is replaced by intake of foods such as fruits and fruit juices.
4. Clients on sodium-restricted diets must be taught to read the labels on foods and medications to identify sources of sodium.
5. Clients taking potassium-sparing diuretics are instructed to avoid salt substitutes containing potassium.

in lithium excretion may result in excessively high lithium blood levels.

Each antihypertensive agent has its own side effects, and the nurse must remain alert for these. For example, rauwolfia derivatives (e.g., reserpine) may produce nasal congestion, which could prompt the client to purchase a nasal spray or decongestant to try to counteract this effect. Clients are instructed that nasal decongestants contain agents that may cause vasoconstriction and are contraindicated in hypertensive clients. Rauwolfia derivatives often produce mental depression, which may, on occasion, be serious enough to lead to suicide attempts. The nurse must be alert to early signs of depression, such as nightmares, poor appetite, and insomnia. Such observations are reported to the physician.

Other drugs, such as methyldopa (Aldomet) and guanethidine (**Ismelin**) may produce orthostatic hypotension or a rapid decrease in blood pressure on rising from a sitting or lying position. This may be most severe in the morning and may lead to dizziness or fainting. Clients are instructed not to rise too rapidly to a standing position, but to proceed from a supine to a sitting position and then to rise slowly. They are cautioned particularly about rising rapidly to answer the doorbell or phone. Clients experiencing postural hypotension can also be instructed to flex calf muscles to increase the blood return to the heart. Straining at stool and using alcohol are to be avoided. When clients rise from a sitting position, they are instructed to hold onto a stationary object. Those with early morning orthostatic hypotension are advised to eat a snack high in protein before retiring. Some clients may benefit from the use of elastic stockings or a counterpressure support garment that begins at the metatarsals and continues to above the waist. Stockings or garments are pulled on while the client is still in bed. In addition to orthostatic hypotension, methyldopa may also cause drowsiness, particularly when treatment is first begun. Because of this, the client may want to terminate its use. If treatment is continued, this drowsiness usually decreases and no longer interferes with ability to concentrate. All clients taking methyldopa are observed for signs and symptoms of anemia (e.g., pale mucous membranes and easy fatigability) and liver dysfunction, which may appear as jaundice, poor appetite, and fatigue.

One of the more troublesome consequences of guanethidine (Ismelin) use in male clients is possible loss of the ability to ejaculate. Because some male sexual difficulties seem to have a psychological rather than a physiological cause, some physicians, however, prefer not to tell clients about this possible problem before therapy is initiated. Some clients who develop this problem, however, identify the relationship between guanethidine therapy and sexual dysfunction and will stop taking their medication. Consequently, the nurse needs to address this possible adverse effect with the client during client teaching and instruct the client to notify the physician if impotence occurs. The nurse must stress that the client should **not** stop taking the medication until he is seen by the physician. Assist the client to understand that in the event that sexual dysfunction does occur, other antihypertensive agents or combinations of agents may need to be prescribed. Combination therapy allows for lower doses of the agents to be used. This provides for hypertension control without the sexual adverse effect.

In limiting the adverse effects of therapy in clients taking beta-adrenergic blocking agents, the nurse monitors the client for the development of respiratory difficulties and bradycardia. The apical pulse should be checked before administering the medication, and the dose is withheld if the pulse is less than 60 or greater than 100. The prescriber should be notified about the dose withheld. Diabetic clients taking insulin or oral hypoglycemic agents are carefully monitored, as this class of drugs may mask hypoglycemic symptoms. Clients need to learn alternative indications of hypoglycemia. For example, instead of tremor they should be aware of fatigue or headache as indicators of hypoglycemia. Finally, clients are instructed to protect their hands and feet with warm clothes in cold weather.

Another way in which the nurse can help to minimize adverse reactions is by instructing all clients who are scheduled for surgery to tell the surgeon, anesthesiologist, and admitting nurse about their antihypertensive medication. Many times, the client will be instructed to stop taking the antihypertensive agent(s) several days before admission for elective surgery. The interaction of antihypertensive medication and anesthesia may cause serious hypotension during or immediately following surgery. If the client undergoes emergency surgery without the opportunity for

the drug holiday, the nurse must observe the client very carefully for hypotension immediately following surgery. Another frequent drug interaction is that which may occur between antihypertensive agents and alcohol. This interaction enhances the effect of the antihypertensive drug and hypotension can occur.

When assessing the effectiveness of antihypertensive agents through blood pressure readings, it is important for the nurse to remember that decreasing blood pressure in the elderly can be associated with more drastic effects than occur in younger persons. Older clients are more likely to develop dizziness and fainting than younger persons, and they may develop these problems after relatively minor decreases in blood pressure. For this reason older clients are questioned carefully about dizziness and observed for unsteadiness on rising. They are advised to rise slowly, and precautions must be taken to protect them from falling.

LONG-TERM CLIENT MANAGEMENT

The final goal for nursing identified by the Task Force on the Role of Nursing in High Blood Pressure Control is to limit the damage to internal organs due to therapy or to the disease, itself. The drug-monitoring function previously discussed assists in the prevention of organ damage due to therapy. There are several other activities the nurse can implement or suggest. The client is instructed to limit activities, that place stress on the cardiovascular system. Rest periods should be spaced throughout periods of demanding activities such as shoveling snow, lifting and moving furniture, and similar tasks. Such tasks must not be done immediately following a heavy meal. In fact, it is best to avoid heavy meals whenever possible, particularly when the client is severely hypertensive. Straining at stool is also contraindicated. The nurse is prepared to discuss ways to avoid this, for example, by adequate fluid and roughage intake.

If the client is overweight, weight loss may be recommended as one way to decrease the burden on the cardiovascular system and to reduce blood pressure without the use of drugs. The nurse is a key person in discussing nutrition and in helping the client to establish realistic weight reduction goals. Nursing support and verbal reward for progress may make the difference in the outcome of the weight control effort.

KEY NURSING IMPLICATIONS 31–3

Limiting Adverse Effects

1. Cooperation may be enhanced when the unpleasant side effects of therapy are controlled.
2. Assess blood pressure, weight, tissue turgor, and indications of low serum potassium such as muscle weakness, leg cramps and pulse irregularities.
3. Maintain intake and output records for all hospitalized clients taking diuretics.
4. Use of thiazide diuretics may result in hyperglycemia, with both thiazides and ethacrynic acid possibly increasing serum uric acid levels. Diabetics and those with gout must be monitored carefully.
5. Rauwolfia derivatives may produce nasal stuffiness and mental depression. Clients are advised to avoid the use of over-the-counter decongestants containing pressor agents. Therapy may be discontinued if the client becomes depressed.
6. Postural hypotension is alleviated by changing positions slowly, eating a high-protein snack at night, flexing the calf muscles to increase blood return to the heart and wearing elastic stockings or a counter-pressure garment. Clients are cautioned to avoid alcohol and straining at stool and to hold onto a stationary object when rising.
7. Observe clients taking beta-adrenergic blocking agents for respiratory difficulties and bradycardia. Diabetics are monitored for hypoglycemia. All clients are instructed to protect the extremities from cold.
8. Clients taking antihypertensives should tell other health care personnel that they are taking these drugs.
9. Observe the elderly for orthostatic hypotension and protect them from falls.

Clients who smoke should be encouraged to stop. The vasoconstriction and tachycardia that result from smoking interfere with attaining the goals of therapy. The nurse can serve as a source of information about community resources to assist the client in this effort. In addition, the nurse provides continuing support during this often difficult period of smoking cessation.

Recent research on hypertension has produced some other information about lifestyle that the nurse can share with the client. Aerobic exercise may be helpful in producing fitness and decreasing stress. Isometric exercises, however, may increase blood pressure readings. With guidance from the physician and nurse, a client can begin an exercise program with walking and advance to other aerobic exercises, if appropriate, while avoiding exercises such as weightlifting. Also, alcohol has been found to increase blood pressure, and hypertensive clients are usually limited in the amount of alcohol they should consume each day. In addition, alcohol can interact with the medications the client is taking to intensify hypotension. Finally, diets rich in potassium and calcium may be helpful in lowering blood pressure. Changes in diet, however, must be carefully undertaken with full knowledge of the person's illnesses and medical treatment.

The precise relationship between stress and hypertension is unknown. It has been suggested that hypertension may be a disease of adaptation or that results from the body's reaction to stress. At this time, even though there is no irrefutable evidence concerning the relationship between stress and hypertension, it does seem advisable for the nurse to make the client aware of this possible relationship. Clients should be made aware of their response to stress and assisted in learning positive coping mechanisms.

Because the client may feel well, there is a tendency to discontinue medications and to fail to keep clinic or physician appointments. The nurse, by providing information, support, and follow-up encourages the client to continue therapy. Television public service announcements advise hypertensive people to continue medications, if not for themselves, then for the loved ones in their lives. Such an appeal may be helpful in encouraging some clients to continue therapy.

The nurse has an opportunity to make the community more aware of the problem of hypertension and to engage in casefinding through participation in local screening programs. Such programs, whether conducted in public places or in work settings, have the potential for detecting hypertension in the early stages, when treatment may prevent renal, ophthalmic, and cardiovascular damage. To assist the nurse in preparing public education programs, materials are available through local chapters of the American Heart Association and state and county health departments.

KEY NURSING IMPLICATIONS 31–4

Long-Term Client Management

1. Clients are advised to avoid heavy meals and exercise after meals.
2. Straining at stool is contraindicated, and measures should be taken to prevent constipation.
3. Weight loss is recommended, and clients who smoke should be encouraged to quit.
4. Aerobic exercise, avoidance of alcohol, and a diet rich in potassium and calcium may all be important in controlling blood pressure.
5. Clients should learn coping measures to deal with stress.
6. Clients are instructed to read the labels of over-the-counter (OTC) drugs since many of them contain pressor substances contraindicated in hypertension.

MANAGEMENT OF HYPERTENSIVE EMERGENCIES

A hypertensive emergency exists when the diastolic blood pressure is above 120 mm Hg and there is evidence of cardiac, renal, or CNS damage. If the diastolic pressure is above 120, but there is no evidence of end organ damage, a state of hypertensive urgency exists. In either case, the client requires prompt medical attention and nursing care. In emergency situations, the client will probably be connected to a cardiac monitor and have lines inserted to monitor central venous and arterial pressures. Intravenous medications such as sodium **nitroprusside** (**Nipride**, **Nitropress**), diazoxide (**Hyperstat IV**), nitroglycerin (Nitrostat IV), **hydralazine hydrochloride** (**Apresoline**), or trimethaphan camsylate (**Arfonad**) will be administered to decrease the blood pressure. The nurse must carefully monitor the client, because a sudden decrease in pressure may result in decreased cerebral blood flow causing cerebral ischemia and possibly stroke. The nurse monitors vital and neurologic signs and promptly reports significant changes. Drugs are administered by IV bolus injection or by intravenous infusion using an electronic infusion device to ensure precise flow regulation.

NURSING CARE PLAN

A Client with Hypertension Taking Enalapril Maleate (Vasotec) Hydrochlorothiazide

Angelo Angeroni is a 45-year-old contractor who has been having severe headaches. He makes an appointment with the ophthalmologist to have his glasses changed. When the physician performs the eye examination, he discovers swelling of the optic disk, which is usually symptomatic of elevated blood pressure. He takes Mr. Angeroni's blood pressure in the office and finds a reading of 260/120. He refers Mr. Angeroni to the nearest hospital where he is admitted to intensive care for IV administration of nitroprusside sodium (Nipride). The client has no previous history of hypertension. He is, however, overweight at 280 pounds and 5'11" tall. He is kept in intensive care for 48 hours and then transferred to a regular room and started on enalpril 20 mg BID (a beta-blocking agent) and hydrochlorothiazide 50 mg BID (a diuretic). He is also placed on an 1,800-calorie diet and instructed to increase intake of foods containing potassium. He is told to stay home from work for at least 1 week and is cautioned to avoid heights and stay off ladders until he is acclimated to his new medications. He is scheduled for a follow-up office visit in 10 days.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Headache.	Acute pain related to severe hypertension.	Client will obtain relief of headache within 1 hour of pain relief measures.	Client should be instructed to stay calm and take prescribed analgesic; lie down in a darkened room and to maintain antihypertensive medication schedule.	Client is having fewer headaches and is able to obtain prompt relief of headaches when they occur.
Visual changes.	Disturbed sensory perception: visual related to effect of hypertension on retina.	Client will not experience further visual changes.	Monitor client for blurred vision, diplopia, or impaired visual acuity. Teach client to have routine eye examinations when blood pressure is controlled.	Client has a return of normal vision after blood pressure is controlled. Client schedules annual eye exam.
Anxiousness, nervousness.	Anxiety related to acute illness and intensive care.	Client verbalizes a reduction in anxiety.	Provide explanations for drugs and procedures. Assess client for signs and symptoms of anxiety. Encourage client to verbalize fears and concerns. Identify methods of coping.	Client verbalizes relief of anxiety. Client has a relaxed appearance.
Blood pressure, pulse, and respirations.	Ineffective tissue perfusion: systemic related to increased peripheral resistance.	Client will maintain adequate systemic tissue perfusion as evidenced by normal vital signs and pedal pulses.	Frequent checks of blood pressure, pulse, and respirations (initially every hour moving to 4 times a day when stable). Assess skin color, warmth. Check for palpable pedal pulses. Client should monitor urine output for effectiveness of diuretic therapy. Avoid caffeine, nicotine, and stress-producing situations.	Client demonstrates adequate tissue perfusion as seen by warm and dry skin, good color, palpable pulses, and vital signs within normal limits.
Dietary habits, nutritional likes and dislikes, weight, physical activity.	Imbalanced nutrition: more than body requirements related to intake greater than metabolic needs.	Client will lose 1–2 pounds per week until reaching normal limits for his height.	Encourage client to maintain 1,800-calorie diet, to avoid caffeine, reduce salt, and increase foods containing potassium. Instruct about limiting alcohol intake. Remind client to keep follow-up physician's visits for medication adjustment, as blood pressure may drop as weight drops. Encourage client to discuss an exercise program with the physician.	Client follows dietary restrictions and shows a consistent weight-loss pattern. Client verbalizes the importance of follow-up visits and knows the date of his next appointment.

continues

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Knowledge of drug therapy.	Deficient knowledge related to illness and prescribed diuretic and antihypertensive medications, desired effects and potential side effects.	Client will demonstrate understanding of drug therapy and recognize importance of compliance.	Teach client about the effect of hypertension on the body and the importance of strict cooperation. Caution client not to skip doses or alter schedule. Teach client to take diuretics early in the day to avoid sleep interruption. Possible side effects of drug therapy include dizziness, impotence, bradycardia, and mood changes. Advise client to protect extremities from cold.	Client establishes a schedule and follows it. Client verbalizes side effects and when to report them.

Specific nursing implications for each of these drugs are discussed in Table 31–3.

EVALUATION

- Client does not experience hypertensive crisis and blood pressure readings return to WNL.
- Client maintains fluid and electrolyte balance as evidenced by intake and output balance, potassium level 3.5–5.0 mEq/L, and sodium level of 135–145 mEq/L.
- Client does not experience adverse effects associated with antihypertensive therapy.
- Client demonstrates compliance with antihypertensive therapy.
- Client demonstrates/verbalizes understanding of hypertension and medication regimen.

KEY NURSING IMPLICATIONS 31–5

Hypertensive Emergencies

1. A hypertensive emergency exists when the diastolic blood pressure exceeds 120 mm Hg and there is evidence of end organ damage.
2. Medications, such as sodium nitroprusside or diazoxide, will be administered intravenously.
3. Monitor the vital and neurologic signs and report significant changes.

HOME CARE / CLIENT TEACHING

1. Nurses involved in screening for hypertension have an opportunity to provide information about this health problem and to counsel persons regarding lifestyle modifications intended to reduce cardiovascular risk.
2. Because treatment is often life-long, nurses working in community settings should take the opportunity to routinely measure blood pressure and question persons about medication compliance and about problems they may be experiencing while taking antihypertensive medication.
3. Clients taking thiazide and potassium-sparing diuretics need to be instructed to followup with physician and have periodic potassium and sodium blood levels monitored.
4. Clients who smoke and experience hypertension should be provided with materials about smoking cessation programs and given information about the cause and effect of smoking and hypertension.
5. Clients taking diuretics and antihypertensives should be informed about dietary modifications, how to read food labels, and general nutrition guidelines.
6. Clients with hypertension should have at least one family member who can regularly check client blood pressures.
7. Clients taking diuretics and antihypertensives need in-depth instructions regarding the actions, dosing schedules, and adverse effects of these medications.
8. Clients taking antihypertensives should be instructed on the importance of maintaining compliance with therapy. If the client experiences adverse effects, such as decreased libido or impotence, he/she should be instructed not to discontinue the medication, but to inform physician of these side effects so that alterations in the dosing or medication regimen can be made.
9. Clients taking diuretics should be informed of signs and symptoms of sodium and potassium depletion and potassium excess and importance of notifying physician if any of the signs and symptoms occur.
10. Clients taking thiazide diuretics should be monitored for hyperglycemia.
11. Clients taking ethacrynic acid should be monitored for hyperuricemia.
12. Clients taking antihypertensives should be encouraged to rise slowly from lying to or sitting positions to lessen the risk of orthostatic hypotension.
13. Clients taking antihypertensive medications should have a thorough assessment of the medications they are currently taking and should be informed about numerous drug interactions associated with these drugs.
14. Clients on sodium-restricted diets and taking potassium-sparing diuretics should be informed that salt substitutes contain potassium and may contribute to hyperkalemia.
15. Clients scheduled for surgery should be instructed to inform the surgeon, anesthesiologist, and admitting nurse that they are taking antihypertensive medication.

CASE STUDY

Sylvia Krasnowski, 30 years old, first learned that she had hypertension when she was 23. Although it was discovered in the course of a general check-up, Sylvia was not surprised, as her sister, mother and an aunt were also hypertensive. No recommendations for treatment or follow-up were made at the time.

One month ago Sylvia went to a community blood pressure screening program and was again found to be hypertensive (150/96). The nurse advised her not to worry about it, but to visit her physician. Upon being examined by her physician her blood pressure was measured to be 150/100. Sylvia was begun on hydrochlorothiazide (**Esidrix**) qd in the morning, and advised to avoid the use of table salt. After 2 weeks, her blood pressure has dropped to 145/94. After taking her medication for 2 more weeks, Sylvia decides to stop using it, because she thinks it is making her feel tired and depressed.

On her next monthly visit Sylvia informs her physician that because of the side effects she experienced, she is no longer taking the hydrochlorothiazide. The physician advises Sylvia to take the hydrochlorothiazide as ordered and also prescribes methyldopa (Aldomet) 500 mg bid. One month after starting this therapy Sylvia reports feeling tired and occasionally dizzy. The dizziness is particularly noticeable on first rising in the morning and on getting out of the bathtub.

In talking to the office nurse Sylvia indicates that no one has discussed with her the nature of her illness and the consequences of not taking the medication.

Questions for Discussion

1. Is Sylvia's treatment plan (beginning with a diuretic and restricting table salt, then moving to a more potent antihypertensive) a typical treatment plan? Support your answer.
2. If you were the nurse at the community screening program, what would you have done when you found Sylvia's elevated reading?
3. What should Sylvia know about methyldopa?
4. If you were the office nurse in whom Sylvia confided that she did not understand her illness and its treatment, what would you have done?

CRITICAL THINKING EXERCISES

1. Obtain instructional materials on blood pressure control and discuss the value and use of these materials in client education.
2. Participate in a blood pressure screening program.
3. Identify local community groups that could benefit from a blood pressure screening program.
4. If you are caring for a hypertensive client over a period, keep a graph of the client's blood pressure to record changes in the therapeutic regimen and significant life events experienced by the client. Is there any relationship between these factors and blood pressure readings?
5. Prepare a 1-week menu for a client on a moderate sodium-restricted diet.
6. Present an educational program on blood pressure control to your peers.
7. Determine the sodium content of a typical meal in a fast food restaurant.
8. Determine the sodium content of two meals you have consumed during a week.

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SECTION 9

Agents Affecting Nutrition

MAJOR NURSING DIAGNOSES

- Imbalanced Nutrition: Less than Body Requirements
- Ineffective Health Maintenance
- Deficient Fluid Volume
- Deficient Knowledge (Illness and Its Treatment)
- Impaired Skin Integrity
- Risk for Infection
- Low Self-Esteem
- Ineffective Tissue Perfusion
- Risk for Injury

32 Agents Used to Treat Anemias

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the symptoms of anemia
- List five groups at high risk for the development of iron deficiency anemia
- List three foods that are good sources of iron
- List the advantages and/or disadvantages of oral, intramuscular, and intravenous iron therapy
- List three causes of vitamin B_{12} deficiency
- List three foods that are good sources of vitamin B_{12}
- List three foods that are good sources of folic acid
- Describe the treatment of iron overdose
- Differentiate among normocytic, microcytic, hypochromic and megaloblastic red blood cells
- List three drugs that can cause blood loss
- Apply the nursing process related to the administration of agents used in the treatment of nutritional anemias

Anemia is defined as a decrease in circulating red blood cells (RBC) that is associated with a decrease in hemoglobin concentration. It is generally not considered to be a disease, but rather a symptom complex caused by one or more underlying disorders (Box 32–1). Because of the many possible causes of anemia, it represents one of the most common clinical problems. Although the precise incidence of anemia is unknown, it has been estimated that it affects approximately 4 million people in the United States and in people younger than 65 years old, six times as many women as men have anemia. After the age of 65, however, this gap shrinks to 2 to 1. Although this is a common health alteration, if left untreated, the disorder can result in serious illnesses.

Typically, the absence of adequate hemoglobin in an anemic client interferes with the oxygen-carrying capacity of the blood. This results in tissue *hypoxia*, which, if left untreated, could result in *angina pectoris*, muscle cramps, faintness, headache, and abdominal pain. Generally, however, the body attempts to compensate for the effects of impaired oxygenation of tissue by increasing blood flow to the brain, heart, and kidneys by diverting blood from nonvital organs, such as the skin. In addition, the respiratory rate may increase and the kidneys may begin secreting an agent known as *erythropoietin*, which acts to stimulate red blood cell production.

BOX 32–1
Some Causes of Anemia

I. Anemias Caused by Excessive Red Blood Cell Destruction
- A. drug hypersensitivity
- B. transfusion reactions
- C. autoimmune reactions
- D. certain enzyme deficiencies (e.g., glucose-6-phosphate dehydrogenase deficiency)

II. Anemias Caused by Inadequate Red Blood Cell Production
- A. endocrine dysfunction (e.g., hypopituitarism, hypothyroidism)
- B. bone marrow failure (e.g., aplastic anemia caused by radiation therapy or some drugs)
- C. nutrient deficiency (e.g., iron, B_{12}, folic acid deficiency)
- D. renal failure

III. Anemias Caused by Both Increased Destruction and Decreased Production of Red Blood Cells
- A. hemoglobinopathy (e.g., sickle cell disease)
- B. malignancies
- C. infection
- D. antineoplastic therapy

Anemias are often classified by their cause or by the appearance of the client's red blood cells. In this latter classification, the following terms are often used to describe the red blood cells:

- microcytic, hypochromic—small, pale red blood cells often associated with iron deficiency
- normocytic—red blood cells with normal appearance
- macrocytic—enlarged red blood cells often caused by a deficiency of vitamin B_{12} or folic acid

Anemic clients often have similar symptoms, no matter what the cause of the anemia. These include pallor, malaise and lethargy.

Although anemias may be caused by many different factors, this chapter considers the most common—that is, nutritional deficit.

IRON DEFICIENCY ANEMIA

The most common form of anemia is iron deficiency anemia, a condition which affects at least 10% of the United States population. The most common cause of this anemia is blood loss although it may be caused by only a dietary deficiency of iron. Those at greatest risk of developing iron deficiency anemia are:

- clients with chronic bleeding disorders such as peptic ulcer, hemorrhoids, and diverticulitis
- menstruating females (approximately 15–30 mg of elemental iron are lost per menstrual cycle)
- frequent blood donors (approximately 250 mg of elemental iron are lost per unit of blood)
- those using drugs that cause blood loss (Box 32–2)
- pregnant women (total iron loss during pregnancy is approximately 600–1,300 mg)
- infants (particularly premature) to age 1 year
- lactating females (loss of iron is about 2 mg/day)

The iron-deficient red blood cell is hypochromic and microcytic. Treatment of the client with iron-deficiency anemia usually involves an attempt to correct the cause of the underlying blood loss, if any. This is generally supplemented by iron therapy that is intended to raise the iron content of hemoglobin and to replenish iron stores. Iron supplements are generally administered orally, as this route is safe, less costly, and more convenient than parenteral therapy.

The major site of gastrointestinal absorption of iron is the proximal portion of the small intestine. Normally, about 5%–10% of ingested iron is absorbed. This may increase to as much as 20%–30% in a client with serious iron deficiency. The form of iron administered is important, as the ferrous form is absorbed three times more readily

BOX 32–2
Some Drugs Which May Cause Blood Loss

alcohol

indomethacin (Indocin)

oxyphenbutazone

phenylbutazone (Butazolidin, etc.)

salicylates (e.g., aspirin)

steroids (anti-inflammatory)

than the ferric form. Three iron salts are commonly used for replacement therapy:

- **ferrous sulfate**
- **ferrous fumarate**
- **ferrous gluconate**

Although these salts contain different proportions of *elemental* iron, effective iron therapy can be accomplished by using appropriate doses of each.

Optimally, a client should receive approximately 200 mg of elemental iron per day. This usually means that the client must take 3 tablets of ferrous sulfate (325 mg each), or ferrous fumarate (200 mg each), or 6 tablets of ferrous gluconate (325 mg each) or its equivalent every day. Such therapy must often continue for about 6 months to ensure adequate replenishment of iron stores. Iron tablets should be taken on an empty stomach, because food and antacids can decrease absorption by as much as 40%–50%. The administration of iron with ascorbic acid (vitamin C) may increase the absorption of iron. The percentage of iron absorbed diminishes with increasing dose, so iron should be given in divided doses rather than as a large single dose. Such doses should be spaced at least 4 hours apart to maximize iron absorption.

A wide variety of iron-containing products is available. Enteric-coated products, although possibly reducing the potential for GI upset, may not properly release iron at the ideal absorptive portion of the small intestine. This may, therefore, reduce the amount of iron absorbed. Sustained-release iron products, although reducing the number of doses that need be taken each day, have not been shown to be superior to conventional oral dosage forms in providing iron therapy. Also, they are often considerably more expensive. Other ingredients, such as stool softeners (to prevent iron-induced constipation), antacids (to reduce iron-induced GI upset), trace metals, liver, and vitamins are often combined with iron to reduce the incidence of adverse effects and/or to improve iron absorption. However, these combinations have not been found to significantly alter therapy and usually add to its cost.

Adverse effects occur in about 10% of clients receiving oral iron therapy. The most common are gastrointestinal effects such as nausea, anorexia, and constipation and/or diarrhea. The incidence and severity of these effects are generally proportional to the amount of elemental iron ingested. Consequently, other iron salts given at equivalent dosages can be expected to produce equivalent adverse reactions.

Parenteral iron therapy may be indicated for clients unable to absorb sufficient iron from the GI tract because of ulcerative or regional enteritis, malabsorption syndromes (e.g., sprue), or surgical removal of a portion of the small intestine. Such therapy may also be used when a client's hemorrhagic condition cannot be adequately controlled or in situations in which the client is not compliant with oral therapy.

Virtually all parenteral iron preparations currently available contain **iron-dextran** as their active component. Iron is released from this chemical complex at a slow rate. It is, therefore, less likely to cause serious adverse effects than in an uncomplexed form. Intramuscular iron therapy is commonly associated with pain at the injection site, slow absorption from the muscle, and formation of sterile abscesses and hematomas. To minimize the likelihood of these adverse effects, not more than 2 mL of iron-dextran solution should be administered into a single IM site.

Intravenous iron therapy avoids many of the problems associated with intramuscular administration but may cause fever, skin rash, local phlebitis, and anaphylaxis. The primary advantage of its use is that, unlike IM iron injections, administration of an IV dose can be discontinued rapidly if adverse effects begin to occur.

Clients with kidney failure from a variety of causes frequently undergo dialysis (the process of removing toxic substances and maintaining fluid and electrolyte balance by diffusing blood across a semipermeable membrane), which does the work of the failed kidneys. Iron deficiency anemia can be a complication of chronic dialysis. If iron supplements do not resolve the anemia adequately, parenteral administration of iron may be required. The newest parenteral drug for this is **sodium ferric gluconate complex in sucrose injection**, which is administered intravenously. Sodium ferric gluconate joins iron dextran to be one of only two parenteral iron preparations currently approved for use by the FDA. Unlike iron dextran, which has a number of indications, sodium ferric gluconate is to be used only to treat iron-deficiency anemia in clients undergoing chronic dialysis. The same risk of hypersensitivity is present with sodium ferric gluconate as exists with iron dextran, and the same assessments and precautions apply.

Epoetin alfa recombiant (**Procrit**) is also indicated in the treatment of anemia associated with chronic renal failure. It is used in both adults and

children, whether on dialysis or not. Epoetin alfa recombiant has the same biologic effects as endogenous erythropoitin (normally synthesized by the kidney and stimulates red blood cell production). It has demonstrated the ability to elevate and maintain red blood cell levels, thus decreasing the need for blood transfusions in clients with renal failure.

Although iron may appear to be a benign substance, accidental pediatric overdosage is a major problem. Since the minimum lethal dose of ferrous sulfate in children is quite low (about 3 g), clients should be cautioned to store iron-containing products out of reach of children. Table 32–1 compares some of the properties of iron supplements.

MEGALOBLASTIC ANEMIAS

The megaloblastic anemias are characterized by the presence of larger than normal red blood cells (macrocytes) in the circulating blood as well as characteristic changes in the neutrophils and *platelets*. The most common causes of megaloblastic anemia are vitamin B_{12} (cyanocobalamin) and/or folic acid deficiency.

Vitamin B_{12} Deficiency

An adequate diet provides about 25 mcg of vitamin B_{12} daily. Normally, dietary B_{12} is chemically combined with intrinsic factor, a complex protein formed by the parietal cells in the stomach. This B_{12}-intrinsic factor combination is then absorbed into the bloodstream at the terminal *ileum*. Vitamin B_{12} deficiency is commonly caused by:

- gastrectomy (which may remove the site of intrinsic factor production)
- pernicious anemia (a relatively uncommon genetic disease in which antibodies are formed against intrinsic factor)
- chronic use of drugs that decrease B_{12} absorption (e.g., slow-release potassium chloride tablets and colchicine)

Anemia does not generally develop until the total B_{12} content of the body falls below 200 mcg. Since the normal body content of B_{12} is about 500 mcg and since the body loses only about 2–5 mcg daily, macrocytic anemia caused by a dietary B_{12} deficiency or by surgical or disease-induced malabsorption of B_{12} may take years to develop.

When symptoms of anemia caused by B_{12} deficiency develop, they are usually characterized by weakness, sore tongue and numbing or tingling of the extremities. Anorexia, shortness of breath and a yellowed complexion may also be present. The neurological symptoms of this disease are the result of a gradual degeneration of the white matter in the spinal cord and the brain. If left untreated, the disorder may lead to *spasticity* and emotional disturbances.

Treatment of anemia caused by B_{12} deficiency is accomplished by administering adequate B_{12} doses not only to provide the client's daily requirements of the vitamin, but also to replenish liver stores of B_{12}. Since impaired B_{12} absorption is often the cause of the client's anemia, oral supplementation is generally of little value. Parenteral therapy is generally begun by administering an intramuscular loading dose of 1,000 mcg of either cyanocobalamin (B_{12}) or **hydroxycobalamin** (B_{12A}) daily for 4 consecutive days. This is followed by the administration of 100 mcg of cyanocobalamin or hydroxycobalamin daily, weekly, biweekly or monthly until the client's symptoms begin to subside. Clients who do not properly absorb vitamin B_{12} must generally receive intramuscular maintenance therapy of 100 mcg per month for life. Although hydroxycobalamin produces higher and more sustained blood levels than cyanocobalamin, either can be used successfully in the treatment of B_{12} deficiency.

Folic Acid Deficiency

The average diet provides up to 200 mcg of folic acid daily. Dietary folic acid must be acted upon by enzymes in the gastrointestinal tract before it can be absorbed as the pharmacologically inactive substance dihydrofolate (Figure 32–1). Once

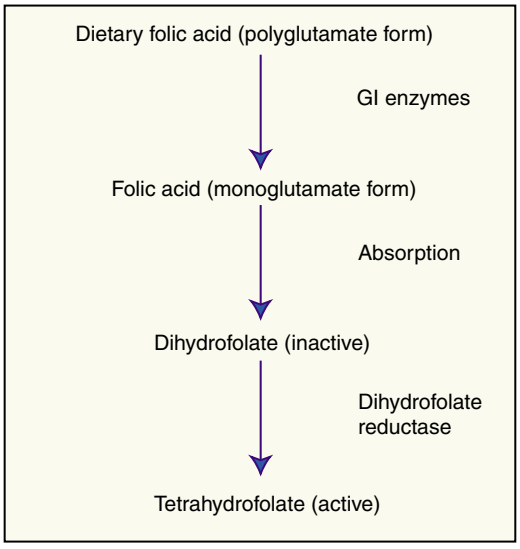


Figure 32–1 Pathway of folic acid utilization

TABLE 32–1

Iron Preparations

Note: Administer on empty stomach with water. If GI upset occurs, give after meals or with food.
May cause darkening of stools, diarrhea, or constipation.
Avoid administration with antacids or tetracyclines.
Liquid product may be given with water or fruit juice to mask taste.
Vitamin C in an oral dose of 200 mg/30 mg of iron may enhance iron absorption.

DRUG	ROUTE(S)	USUAL DOSE	ELEMENTAL IRON CONTENT*	NURSING IMPLICATIONS
ferrous fumarate *(**FAIR**-us **FYOU**-mah-rayt)* (Femiron, Feostat, etc.)	oral	200–800 mg daily	33 mg	See above note.
ferrous gluconate *(**FAIR**-us **GLOO**-koh-nayt)* (Fergon,Fertinic ✱, Simron, etc.)	oral	325–650 mg 4 times daily	11.6 mg	—
ferrous sulfate *(**FAIR**-us **SUL**-fayt)* (Mol-Iron, etc.)	oral	300 mg 2–4 times daily	20 mg	—
ferrous sulfate, exsiccated *(**FAIR**-us **SUL**-fayt, **ECK**-sih-**kay**-ted)* (Feosol, etc.)	oral	300–1000 mg daily	31.6 mg	—
iron dextran *(**EYE**-ern **DECKS**-tran)* (InFeD)	IM, IV	Based upon need; IM: Daily dose should not exceed: 25 mg in infants under 5 kg, 50 mg in children under 10 kg, 100 mg for others IV: up to 2 mL daily of a solution containing 50 mg of iron per milliliter	—	Observe for signs of anaphylaxis. Test dose of 0.5 mL is given on first day of therapy, followed by close observation for 1 hour; then remainder of dose may be given slowly (1 mL or less per minute). Monitor blood pressure and pulse. Use Z-track method for IM injection.
sodium ferric gluconate complex in sucrose injection *(so-dee-um **FARE**-ic **GLU**-co-nate)* (Ferrlecit)	IV	First give 25 mg test dose of elemental iron diluted in 50 ml of 0.9% normal saline and administer over 1 hour. If test dose tolerated, administer 125 mg of elemental iron in 100 ml of 0.9% normal saline over 1 hour. Most clients require a minimum cumulative dose of 1 gram.	—	Monitor closely during test dose for hypersensitivity reaction, including pharyngeal edema, dyspnea, bronchospasms, urticaria, or pruritis. Administer immediately after dilution. Use only 0.9% normal saline as dilutent.

*in each 100 mg of product

absorbed, dihydrofolate must be converted to the biologically active tetrahydrofolate form by the enzyme dihydrofolate reductase.

Deficiency of folic acid is most likely in:

- pregnant women
- alcoholics
- nutritionally deprived clients
- clients using drugs that may increase the need for folic acid (Box 32–3)

In 1996, the FDA required U. S. food manufacturers of flours, enriched breads, cornmeals, pastas, rice, and other grain products to add folic acid to their products. This was in response to the increasing evidence that tied folic acid deficiencies with neural tube defects, spina bifida, during pregnancy. Under the new FDA guidelines, specified grain products are required to add from 0.43 milligrams to 1.4 milligrams of folic acid per pound of product.

Except in the acute treatment of a client who is severely folate deficient (e.g., a chronic alcoholic), doses of folic acid greater than 1 mg daily are rarely justified. Such doses may be given orally, intramuscularly, subcutaneously or intravenously. They need only be administered for about 2–3 weeks in most clients to replenish folic acid stores.

BOX 32–3
Drugs That May Increase the Need for Folic Acid

alcohol	pyrimethamine (Daraprim)
oral contraceptives	triamterene (Dyrenium)
phenytoin (Dilantin)	trimethoprim (Proloprim, Trimpex)

Folic acid is a relatively safe drug which only rarely produces adverse effects. The greatest hazard in its use is in the treatment of undiagnosed anemia. This is because folic acid can reverse the megaloblastic anemia in a B_{12}-deficient person but will allow the neurological degeneration caused by B_{12} deficiency to continue. Because of this effect of folic acid, OTC vitamin preparations for general adult use are not permitted to contain more than 0.4 mg of folic acid per dose. Vitamin products specifically intended for pregnant or lactating women can contain as much as 0.8 mg per dose and still maintain their nonprescription status.

APPLYING THE NURSING PROCESS

ASSESSMENT

Nurses have many opportunities to function as nutrition counselors for the general public and persons being treated for health problems. Appropriate counseling by nurses or referral to a dietician can help to prevent many cases of anemia. The nurse should be aware of the type of person who is likely to develop anemia and should discuss proper nutrition with these individuals. Persons who could benefit from special attention to nutritional counseling are:

- pregnant women
- nursing mothers and mothers of young infants
- adolescents
- the elderly
- lower income families
- parents wishing to raise their children as vegetarians

Casefinding is an important role of the nurse in relationship to anemias. The nurse should be able to recognize individuals likely to develop nutritional anemias and the signs and symptoms of anemia. The types of clients likely to develop anemia include, in addition to those listed above, alcoholics, persons with chronic diseases, children in periods of rapid growth, persons with chronic renal failure, and persons on fad diets. Infants are at particular risk of developing iron-deficiency anemia, especially around the time that their birth weight doubles. Both iron and vitamin E have been used to treat this anemia. Vitamin E stabilizes the membrane of the red blood cell, helping to protect it from destruction. When both vitamin E and iron are ordered, they must be administered at different times, as iron may interfere with the absorption of vitamin E. Nursing assessment of height (in children), weight, and nutritional status is important. When indications of nutritional anemia, such as fatigue, lack of energy, and tachycardia or pallor, occur in high-risk individuals, referral to a physician is made.

NURSING DIAGNOSES

Including but not limited to:

- Ineffective tissue perfusion related to insufficient circulating red blood cells
- Imbalanced nutrition, less than body requirements related to nutritional deficiencies
- Ineffective health maintenance related to knowledge deficit of basic nutritional needs
- Risk for injury, fetal, related to folic acid deficiency
- Risk for constipation related to iron replacements

PLANNING/GOALS

- Client will experience increase in circulating red blood cells to WNL as a result of iron replacement or vitamin B_{12} therapy.
- Client will maintain adequate nutrition as evidenced by lack of iron, vitamin B_{12}, and folic acid deficiencies.
- Client will demonstrate understanding of basic nutritional needs.
- No fetal injuries will occur as a result of folic acid deficiency.
- Client will not experience constipation.

IMPLEMENTATION

Many individuals with whom the nurse has contact will evidence deficient knowledge about the nutritional needs of the body and how to meet them. Nutritional instruction for healthy persons and those with illnesses is an important role of the nurse. The selection and preparation of foods rich in various nutrients and the serving size necessary for various family members can be discussed. Audiovisual materials, food models, and printed information are helpful in enhancing understanding and retention.

Some individuals with whom the nurse has contact will be taking iron preparations prescribed by a physician or that are included in nutritional supplements purchased without prescription. In individuals taking oral iron products therapeutically, the nurse stresses the importance of taking the medication in divided doses and between meals, to promote absorption. Because iron therapy may be associated with gastrointestinal upset, some clients are advised to take the iron preparation at the beginning of a meal. Instruction is given to avoid the simultaneous use of milk or antacids and iron, as this decreases the iron absorption.

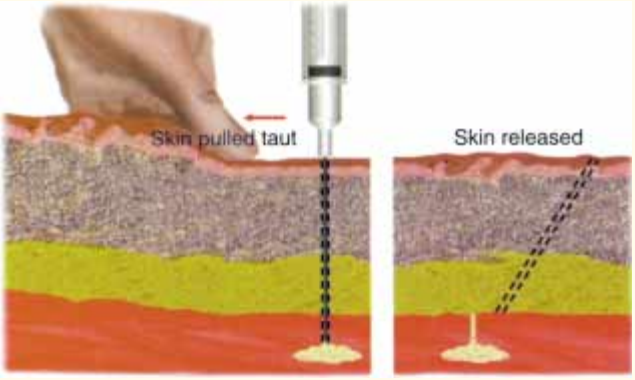
If side effects become a problem, the client is referred to the physician who may switch to another iron preparation. Clients who develop constipation are encouraged to increase the amount of fluid and bulk in their diet. When iron therapy is initiated, clients are informed that the color of their stool will become darker (tarry stool). The appearance of the tarry stool indicates compliance with the treatment.

If the person is unable to swallow the iron in tablet form, liquid or chewable preparations may be used. Liquid preparations should be diluted in water or fruit juice and should be taken through a straw placed well into the mouth to prevent staining of the teeth.

Clients who are beginning iron therapy should know that periodic blood studies will be done to check the therapeutic effectiveness of the treatment. They are told that treatment will generally continue for 3 to 6 months after the hemoglobin values return to normal. This allows clients to replenish their iron stores. Meanwhile, dietary instruction is given. The rich dietary sources of iron are meats (including organ meats), eggs, poultry, and leafy green vegetables.

Some clients, usually those who are hospitalized, will require parenteral administration of iron preparations. The intramuscular route is usually preferred over intravenous administration. Iron is irritating to the tissues and can stain the skin, so special attention to administration is required. The Z-track technique is preferred for intramuscular injection. Figure 32–2 describes the intramuscular administration of iron preparations using the Z-track method.

Individuals taking iron in the form of vitamin preparations that do not require a prescription must know that they should not exceed the dosage recommended on the label. Toxic levels of iron can accumulate in the body. Some of the causes of excess iron are purposeful or accidental ingestion of iron preparations (especially by children), and multiple blood transfusions required in the treatment of some diseases. If too much iron does accumulate in the body, a *chelating agent*, **desferoxamine mesylate** (**Desferal Mesylate**) may be used to remove the excess amount through the kidneys. This agent may be given intramuscularly, intravenously, or



1. Wash your hands, put on disposable gloves, and assemble the necessary equipment.
2. Withdraw the preparation with a needle and syringe using aseptic technique.
3. Replace the original needle with a sterile 2–3 inch, 19–20 gauge needle. **Note:** The length of the needle depends on the size of the client's muscle mass.
4. Identify the client and ask him/her to lie prone or in a lateral position on the bed.
5. Select an administration site in the upper outer quadrant (dorsogluteal site) of the buttocks. **Note:** Never use the deltoid injection site for iron or Z-track.
6. Cleanse the site. Remove the needle guard and draw 0.5 mL of air into the syringe. (This air will follow the medication into the muscle and clear the needle of medication. This step helps to prevent leakage along the track when the needle is withdrawn.)
7. If you are right-handed, use the left hand to retract the skin about 1 inch to either side of the injection site and hold it there.
8. With the right hand, dart the needle into the injection site.
9. Aspirate and observe carefully for evidence of blood. As the medication is dark, it may be difficult to see evidence of blood. Special care must be taken, however, since intravascular injection must be avoided.
10. Slowly inject the medication and wait 10 seconds before withdrawing the needle.
11. Immediately after withdrawing the needle release the tension on the skin and apply light steady pressure to the site with a sterile sponge. DO NOT MASSAGE.
12. Instruct the client not to wear restrictive clothing or to engage in strenuous physical exercise for about an hour following the injection. Walking will help to increase absorption of the medication.
13. Remove gloves, wash hands, and chart the procedure including medication, dosage, location of injection site, and time of administration.

Figure 32–2 Intramuscular administration of iron preparations

by slow subcutaneous injection (using special equipment). The urine of a client receiving desferoxamine mesylate develops a characteristic reddish color.

Another nutritional anemia is caused by deficiency of vitamin B_{12}. When this is due to a simple lack of the vitamin in the diet, a brief course of treatment may be used and the client is instructed in dietary sources of this nutrient. Vitamin B_{12} is found in animal sources such as lean meats, organ meats, milk, oysters, and saltwater fish. Strict vegetarians, those refusing all animal proteins, may develop this type of deficiency anemia. Most people with this type of anemia, however, lack intrinsic factor and will require lifelong treatment with vitamin B_{12}. Many of these individuals are instructed in self-injection. Clients receiving long-term B_{12} treatment must understand that damage to the nervous system may occur if they discontinue treatment.

Side effects from B_{12} therapy are rare; however, clients who are allergic to cobalt must not receive preparations containing this substance. It is important to remember to rotate injection sites, because injections are required over a long period of time.

KEY NURSING IMPLICATIONS 32–1

Clients Taking Drugs Used to Treat Anemias

1. Assessment includes the identification of signs and symptoms of nutritional anemia, such as fatigue, lack of energy, tachycardia, dizziness, or pallor.
2. Important nursing functions in working with clients with nutritional anemias include casefinding, nutritional instruction, medication administration, and instruction about medication.
3. The Z-track technique is used in administering intramuscular iron preparations to avoid staining of the tissues.
4. Desferoxamine mesylate, a chelating agent, is used to remove excess iron from the body when an overdose has been taken.
5. Clients receiving long-term vitamin B_{12} therapy for the treatment of pernicious anemia must understand that damage to the nervous system may occur if they discontinue treatment.
6. Clients on long-term anticonvulsant therapy may require folic acid supplementation.

NURSING CARE PLAN

A Client with Crohn's Disease Taking Vitamin B_{12}

Bobby Joe Hegeman, age 28, was on vacation in Florida with his wife and two small children when he became ill. He returned home and was diagnosed as having Crohn's disease. He asked for an explanation of the disease and was told that it is a chronic type of inflammatory bowel disease that leads to malabsorption and inflammation within the bowel. Bobby was admitted to a hospital and treated with corticosteroids. Surgery was performed to remove the damaged portion of his small intestine. He had developed a fistula, in addition to a bacterial infection in his bloodstream. He was given antibiotics to control the bacterial infection and was told he would need follow-up treatment of vitamin B_{12} injections monthly. He was also told to monitor his diet, to get plenty of rest, and avoid stressful situations.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Abdominal pain.	Acute pain related to bowel inflammation and recent surgery.	Client will verbalize relief of pain following pain relief interventions.	Encourage client to follow physician's instructions. Steroids ordered to reduce inflammation. Take antacid with steroid to lower stomach irritation. Avoid aspirin to minimize GI upset and bleeding and avoid contact with infected persons to minimize infections.	Client has healing of bowel and no further abdominal pain.
Tolerance for physical activity.	Activity intolerance related to generalized weakness and pain.	Client utilizes energy conservation techniques.	Encourage client to plan for extra rest following surgery. The client should be taught to slow down and increase periods of rest and sleep consistently.	Client maintains activity level within capabilities as evidenced by normal heart rate.
Dietary habits. Food preferences.	Imbalanced nutrition: less than body requirements related to malabsorption.	Client plans a high-protein, high-calorie diet, low in residue and fat prior to discharge.	Teach client to avoid spices, chocolate, pork, caffeine, alcohol, fresh fruit, and carbonated drinks. Instruct on high-protein, high-calorie, low-fat, low-residue diet.	Client's nutritional status improves as evidenced by weight gain, controlled diarrhea, and normal serum electrolyte balance.
Dietary supplements, vitamin B_{12}.	Deficient knowledge related to surgical procedure and need for consistent replacement of vitamin B_{12}).	Client verbalizes understanding of disease process and long-term management.	Teach client that the removal of the distal ileum means that he will need lifelong B_{12} injections. Rare side effects include diarrhea, edema, congestive heart failure, anaphylaxis, and hypokalemia. Remind client that additional B_{12} may be needed during injections. Signs of B_{12} deficiency include fatigue, anorexia, pallor, dyspnea on exertion, and visual disturbances.	Client can list the signs of vitamin B_{12} deficiency. He has a nurse give him his monthly injections and has no adverse side effects.
Lifestyle patterns. Stress.	Deficient knowledge related to stress management and follow-up care.	Client will identify stress management techniques and will follow schedule for yearly physical examination and colonoscopy.	Client is encouraged to verbalize feelings of increased stress, need to escape personal problems, and frustration. Teach client to deal with the problem and feelings, and reduce the physiologic responses by staying calm and using available support from family, friends, or professional sources.	Client identifies stresses in life and ways to reduce them. Maintains regular schedule of follow-up appointments with physician.

The treatment of folic acid deficiency is relatively uncomplicated, as this medication may be given by mouth. It is rarely associated with adverse side effects, other than occasional hypersensitivity. Treatment is often of short duration. The nurse discusses dietary sources of folic acid with the client. These include meats, eggs, leafy green vegetables, and yeast products. Clients should also know that cooking will dramatically decrease folic acid content and those foods that can be eaten raw, e.g., vegetables, are best eaten that way.

The nurse should be aware that women taking oral contraceptives may have increased need for folic acid and vitamins B_6 and C. Adolescents, especially those who are taking these contraceptives, may require a multiple-vitamin supplement if their diets are deficient in these nutrients. Clients on long-term anticonvulsant therapy, particularly phenytoin (Dilantin) may require folic acid supplementation. Recent studies have shown that smokers may require additional vitamin C.

EVALUATION

- Client experiences increase in circulating red blood cells to WNL as a result of iron replacement or vitamin B_{12} therapy.
- Client maintains adequate nutrition as evidenced by lack of iron, vitamin B_{12}, and folic acid deficiencies.
- Client demonstrates understanding of basic nutritional needs through healthy eating habits and nutrition diary.
- No fetal injuries occur as a result of folic acid deficiency.
- Client does not experience constipation.

HOME CARE / CLIENT TEACHING

1. Clients experiencing anemia secondary to inadequate nutritional intake need to be instructed concerning the appropriate intake of mineral in the diet, such as iron, vitamin B_{12}, and folic acid.
2. Female clients of childbearing age who are or plan to become pregnant need to be informed of the need to have an adequate intake of folic acid and the relationship between certain birth defects (spina bifida) and folic acid deficiency.
3. Clients receiving cobalamine injections need to be instructed about foods rich in vitamin B_{12}.
4. All clients need basic nutritional teaching regarding proteins, fats, carbohydrates, vitamins, minerals, and fluids and the relationship between adequate nutrition and good health.
5. Clients taking oral iron preparations should be informed:
   a. taking milk or antacids with oral iron preparations may decrease the absorption of iron;
   b. oral iron preparations should be taken in divided doses and between meals to improve absorption;
   c. if gastric upset occurs from iron medications, they may be taken before meals rather than between meals;
   d. iron therapy may cause stools to become darker in color; and
   e. liquid preparations should be taken with a straw placed well into the mouth to avoid staining the teeth.
6. Persons may not comply with iron therapy, because they become constipated. Before therapy is initiated and periodically during treatment, clients should be instructed in measures to control this problem.
7. The regular schedule for administration of vitamin B_{12} and sometimes injectable iron products provides the nurse with an excellent opportunity for assessment and health teaching.

CASE STUDY

Marla Washburn is a 67-year-old widow who has been using 6 g (18 tablets) of aspirin daily for the past 2 years for the treatment of rheumatoid arthritis. During the last 3 weeks she has gradually become more lethargic. Friends have indicated that she does not appear well.

Diagnostic testing reveals the presence of microcytic, hypochromic red blood cells accompanied by a hemoglobin level of 8 g/dL (normal is 14.8 ± 2 g/dL). The physician prescribes:

Ferrous sulfate tablets 300 mg, 1 tablet 3 times daily

Several weeks later Mrs. Washburn complains of constipation and darkened stools.

Questions for Discussion

1. What circumstances may have contributed to the development of Mrs. Washburn's anemia?
2. What is the probable cause of the lethargy?
3. How long must her iron therapy be continued?
4. How could the client's most recent symptoms be explained?
5. What nursing interventions would be appropriate in caring for this client?

CRITICAL THINKING EXERCISES

1. Prepare a visual aid that would be helpful in instructing clients with iron-deficiency anemia about dietary sources of iron.
2. Prepare a teaching plan for a client with a newly diagnosed case of pernicious anemia who will be self-administering vitamin B_{12}.
3. Describe the laboratory tests done to diagnose the different types of nutritional anemias.
4. Visit a local pharmacy and examine the various vitamin and mineral preparations available. Note the amounts of iron and folic acid in these products.

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Vitamins, Minerals, and Other Nutritional Agents

33

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify the roles of protein, fat, and carbohydrate in human nutrition
- List the major vitamins and minerals required for health
- Identify common misconceptions about the purpose of and requirements for vitamins and minerals
- Identify several common causes of hypokalemia
- List the fat-soluble and water-soluble vitamins and indicate the common circumstances in which a deficiency of each could occur
- Apply the nursing process associated with the administration of vitamin and mineral preparations
- Briefly describe the function of the nurse in providing nutritional education
- Apply the nursing process for clients receiving total parenteral nutrition (TPN)

During the last half-century, Americans have become among the best fed people of the world. At the same time, however, good nutrition has declined, because of the overconsumption of high-calorie foods often rich in refined sugars and fats but low in *vitamins*, minerals, and fiber. It has been estimated that the average American consumes about 55 kg (120 lb) of sugar and 57 kg (125 lb) of fat each year. This has been linked with an increasing incidence of obesity, diabetes, cardiovascular disorders, and breast and colon cancer. An understanding of the fundamental nutrients required to maintain good health is, therefore, essential for all health practitioners.

It has been well established that about 50 nutrients are required by the human body. Of these, 10 are considered "leader nutrients"—protein, carbohydrate, fat, vitamin A, vitamin C, thiamine, riboflavin, niacin, calcium, and iron. If proper amounts of these nutrients are supplied in the diet, the other 40 will probably be consumed in amounts sufficient for the body's needs. The level of these "leader nutrients" is usually listed on the information panels of food labels, thereby permitting the consumer and health professional to compare the nutritional content of various food products.

Estimates of daily requirements of most of the 50 required nutrients, known as Recommended Daily Allowances (RDA), have been established and published periodically by the National Research Council (NRC). The RDA of a nutrient is the level of intake considered by the NRC Food and Nutrition Board to be adequate, on the basis of available scientific knowledge, to meet the known nutritional needs of practically all healthy persons. In using the RDA levels one should remember that they are:

- recommendations for the total amount of nutrient that should be consumed each day. Allowances must be made for nutrient losses possible in food processing and preparation
- recommendations meant to maintain health and may not cover special nutritional needs that arise during illness
- estimates of the needs of most members of large population groups and may not be appropriate for each member of the group

As new research findings evolve, changes in the published RDA levels are made. Table 33–1 lists the most recent RDA levels published by the NRC.

Nutrients may be classified into several categories, including proteins, fats, carbohydrates, vitamins, and minerals. Each of these categories is considered briefly.

PROTEIN

Protein is essential for the synthesis, maintenance, and repair of body tissues; for energy production; for the continuation of enzymatic and immunological processes; and the maintenance of osmotic pressure in the vasculature. Protein is made up of component parts known as amino acids. Of the 22 amino acids, 8 are considered essential, or indispensable, for human nutrition; the body cannot synthesize them at levels sufficient to meet its needs. During digestion, dietary protein is broken down into its amino acid components. The body then reassembles the amino acids into many different proteins, each serving a specialized function.

Different foods supply protein of differing value to the human body, depending upon the nature of the amino acids in the protein source. High-quality protein (e.g., protein derived from meat, fish, poultry, eggs, and milk) supplies the 8 indispensable amino acids in usable proportions. Protein derived from vegetables and grains is often lower in nutritional quality, because certain essential amino acids may be missing or in insufficient quantity. By carefully combining protein from varying sources, adequate amino acid intake can be assured.

Protein generally supplies about 4 large calories (kcal) of energy per gram. Clients who cannot digest dietary protein properly may use products containing the essential amino acids in their pure form. These may be supplied orally in the form of an elemental diet or parenterally as part of a *total parenteral nutrition* (TPN) regimen.

FAT

Fat is a very concentrated dietary source of energy that supplies about 9 kcal/g of energy. Fat provides the body with essential fatty acids and, along with carbohydrates, helps to spare protein for its tissue-building and repairing functions. Fat is also a carrier of fat-soluble vitamins (A, D, E, and K), hormones, and components of human cell membranes. Fat deposits in the body also help to support vital organs and provide insulation.

During digestion, dietary fats are broken down to fatty acids. One of these, linoleic acid, is essential for life and must be supplied by the diet, as the body cannot manufacture its own supply. A deficiency of fatty acids rarely occurs, because the body's daily need for fat can be met with only 15–25 g of dietary fats. At greatest risk for development of essential fatty acid deficiency are clients receiving special nutritional therapy utilizing elemental oral feedings or TPN as the sole nutritional source. Such clients may benefit by the regular addition of safflower oil to the elemental diet formula or by the administration of intravenous fat emulsion (e.g., **Intralipid** or **Liposyn** products).

CARBOHYDRATE

Sugars and starches are the principal kinds of carbohydrate. Starches are complex forms of sugar. Most sugars and starches are eventually converted by biochemical reactions of the body to glucose (one of the body's most important fuels). It is either readily utilized by the cells and tissues of the body or it is stored by the liver and muscles as glycogen. The availability of carbohydrates as an energy source spares protein from being used for energy, thereby allowing it to be used for tissue growth and repair. Carbohydrates also aid in fat utilization and prevent the breakdown of fat in the body. When utilized by the body, carbohydrates contain about 4 kcal/g of energy.

Americans obtain about one-half their calories from carbohydrate. Although no specific requirements have been established for carbohydrate in the diet, consumption of starches and unrefined sugars making up approximately 55% of the diet (fats contributing 20%–30% and protein rounding off the other 10%) has long been believed to be desirable. This theory has been challenged lately by the belief that this intake of carbohydrates actually contributes to the rising problem of obesity in the United States. Many eating plans have come to the forefront

TABLE 33-1

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Elements

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	CALCIUM (mg/d)	CHROMIUM (µg/d)	COPPER (µg/d)	FLUORIDE (mg/d)	IODINE (µg/d)	IRON (mg/d)	MAGNESIUM (mg/d)	MANGANESE (mg/d)	MOLYBDENUM (µg/d)	PHOSPHORUS (mg/d)	SELENIUM (µg/d)	ZINC (mg/d)
Infants												
0–6 mo	210*	0.2*	200*	0.01*	110*	0.27*	30*	0.003*	2*	100*	15*	2*
7–12 mo	270*	5.5*	220*	0.5*	130*	11*	75*	0.6*	3*	275*	20*	**3**
Children												
1–3 y	500*	11*	**340**	0.7*	**90**	*7*	**80**	1.2*	**17**	**460**	**20**	**3**
4–8 y	800*	15*	**440**	1*	**90**	**10**	**130**	1.5*	**22**	**500**	**30**	**5**
Males												
9–13 y	1,300*	25*	**700**	2*	**120**	**8**	**240**	1.9*	**34**	**1,250**	**40**	**8**
14–18 y	1,300*	35*	**890**	3*	**150**	**11**	**410**	2.2*	**43**	**1,250**	**55**	**11**
19–30 y	1,000*	35*	**900**	4*	**150**	**8**	**400**	2.3*	**45**	**700**	**55**	**11**
31–50 y	1,000*	35*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**
51–70 y	1,200*	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**
>70 y	1,200*	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**
Females												
9–13 y	1,300*	21*	**700**	2*	**120**	**8**	**240**	1.6*	**34**	**1,250**	**40**	**8**
14–18 y	1,300*	24*	**890**	3*	**150**	**15**	**360**	1.6*	**43**	**1,250**	**55**	**9**
19–30 y	1,000*	25*	**900**	3*	**150**	**18**	**310**	1.8*	**45**	**700**	**55**	**8**
31–50 y	1,000*	25*	**900**	3*	**150**	**18**	**320**	1.8*	**45**	**700**	**55**	**8**
51–70 y	1,200*	20*	**900**	3*	**150**	**8**	**320**	1.8*	**45**	**700**	**55**	**8**
>70 y	1,200*	20*	**900**	3*	**150**	**8**	**320**	1.8*	**45**	**700**	**55**	**8**
Pregnancy												
≤18 y	1,300*	29*	**1,000**	3*	**220**	**27**	**400**	2.0*	**50**	**1,250**	**60**	**13**
19–30 y	1,000*	30*	**1,000**	3*	**220**	**27**	**350**	2.0*	**50**	**700**	**60**	**11**
31–50 y	1,000*	30*	**1,000**	3*	**220**	**27**	**360**	2.0*	**50**	**700**	**60**	**11**
Lactation												
≤18 y	1,300*	44*	**1,300**	3*	**290**	**10**	**360**	2.6*	**50**	**1,250**	**70**	**14**
19–30 y	1,000*	45*	**1,300**	3*	**290**	**9**	**310**	2.6*	**50**	**700**	**70**	**12**
31–50 y	1,000*	45*	**1,300**	3	**290**	**9**	**320**	2.6*	**50**	**700**	**70**	**12**

NOTE: This table presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Panthothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); and *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001). These reports may be accessed via www.nap.edu. Reprinted with permission from *RDAs from Recommended Dietary Allowance: 10th Edition*. 1989. National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

during the late 1990s, including the Atkin's Revolutionary diet, "Sugar Busters," Mayo Clinic diet, and the "30-30-30" diet, that have presented evidence that carbohydrates in the diet are responsible for increasing fat stores. This occurs because insulin is secreted when carbohydrates are metabolized. The glucose that is not readily used or stored as glycogen is stored as fat. For this reason, both the medical and nutrition communities are looking more critically at the "low-fat" diet theory and considering more alternatives in dietary planning.

VITAMINS

Vitamins are chemical substances that regulate and/or participate in chemical reactions within the body. They are generally not synthesized in sufficient quantities by the body to supply its needs. This category of nutrients is, perhaps, the most controversial. Although most people believe that vitamins are important and essential for good health, some believe that if a little is good, more is better. This fallacy can be dangerous when applied to vitamin supplementation. Although the consumption of a well-balanced diet would seem to minimize the likelihood of vitamin deficiencies, the definition of a well-balanced diet may not be clear. The role of food processing and cooking as well as the widespread consumption of "fast food" and highly processed, multicomponent convenience foods makes the evaluation of adequate vitamin consumption even more difficult.

Considerable variation exists in the vitamin needs of different segments of the population. The following groups may have an appreciably greater need for vitamin supplementation:

- pregnant and lactating women
- those who are consuming very low-calorie reducing diets
- the elderly
- clients with chronic illnesses
- clients who have surgery involving the absorptive parts of the bowel
- chronic alcoholics
- persons experiencing great physical stress (e.g., surgery)
- persons with *malabsorption syndrome*

Vitamins are often classified by their solubility in fat or water.

Fat-Soluble Vitamins

Vitamins A, D, E, and K are fat-soluble vitamins. These vitamins are, to a great extent, stored by the body.

Vitamin A. **Retinol** or vitamin A is a chemical substance only found in foods of animal origin, such as liver, milk fat, and egg yolk. Other compounds, such as carotene, are known as provitamin A, as they may be converted, in part, to vitamin A in the body. Carotenes are orange pigments found in foods of both plant and animal origin.

Vitamin A has a number of functions in the human body. It is essential for the proper growth and development of children and infants, even before birth. It is responsible for maintaining the normal structure of mucous membranes and epithelial cells of the body. Retinal is a substance formed from retinol in the body, which permits the eye to function normally. With a deficiency of vitamin A, the ability to see in dim light is reduced and the skin may become dry and thickened. There may also be a greater susceptibility to infections of the mucous membranes, particularly in the eyes, nose, and throat.

When excessive amounts of vitamin A are consumed for long periods, a condition known as hypervitaminosis A may develop. Symptoms related to this condition include irritability, vomiting, loss of appetite, and loss of body hair. Additional changes affect the liver, brain, skin, and many other structures of the body. Most of these symptoms usually disappear when vitamin A consumption is reduced.

Vitamin D. In conjunction with parathyroid hormone and *calcitonin*, **vitamin D** serves to regulate calcium metabolism within the body. It also promotes the absorption of calcium and phosphorus by the intestinal mucosa of the gastrointestinal tract. The RDA is 5 to 15 mcg/d depending on the sex and age of the person.

Vitamin D is a term used to describe two chemical compounds having equivalent activity, **ergocalciferol** (**vitamin D_2**) and **cholecalciferol** (**vitamin D_3**). These agents each have the ability to prevent or cure *rickets* in children and *osteomalacia* in adults, conditions characterized by impaired calcium absorption and deposition into bone and cartilage, as well as loss of calcium and phosphate from existing bone.

Ergocalciferol is formed when various chemical agents known as ergosterols, found in yeasts and fungi, are exposed to ultraviolet light. Cholecalciferol is formed in the human body by exposure of certain chemical agents in the skin to sunlight. With regular exposure to sunlight, supplementation with additional vitamin D is not usually required. The richest dietary source of vitamin D is fish, particularly fish liver oils such as cod liver oil.

Dietary deficiency of vitamin D is rare in the United States, as many commercial food products contain supplemental vitamin D (e.g., milk and cereals). Secondary vitamin D deficiency is, however, seen more frequently. This may be caused by renal disease, gastrointestinal malabsorption, *hypoparathyroidism*, and long-term use of certain anticonvulsant drugs.

As with vitamin A, the acute or chronic administration of high doses of vitamin D may cause a hypervitaminosis condition. Hypervitaminosis D is characterized by hypercalcemia caused by dramatically increased levels of calcium absorption from the gut. If not appropriately managed, development of calcium deposits in soft tissues and within the kidney may occur. Other symptoms may include weakness, lethargy, nausea, and vomiting, as well as behavioral changes. Treatment of hypervitaminosis D usually includes the withdrawal of vitamin D from the diet, dietary calcium restriction, increased fluid consumption and the administration of corticosteroids.

Vitamin E. This is a term used to describe several compounds that occur naturally in vegetable oils and green leafy vegetables. These compounds are known as the tocopherols. Of these compounds, alpha tocopherol exerts the greatest vitamin E activity. Although vitamin E has been shown to take part in a number of different biochemical reactions in the body, no appreciable symptoms have been linked to a deficiency of this vitamin.

During the past decade, many claims have been made about the usefulness of vitamin E in the prevention and/or treatment of muscular dystrophy, cancer, infertility, and other disorders. Increasing evidence has emerged to support these claims. Vitamin E has been shown to be useful in preventing and treating some forms of hemolytic anemia in premature infants. It also has been used successfully in premature infants to reduce the toxic effects of oxygen therapy on the lung and retina. Vitamin E has also been shown to promote healthy cardiac function and in recent studies has shown promise in preventing prostate cancer. Although vitamin E is a fat-soluble vitamin and does accumulate in the body when large doses are administered, few if any toxic symptoms have been reported with such use.

Vitamin K. This vitamin is a factor which is essential for the normal biosynthesis of various blood-clotting factors, see Chapter 30. Its activity is shared by two naturally occurring substances and one which is prepared synthetically. Vitamin K_1 or phytonadione is available naturally in green, leafy vegetables. **Vitamin K_2** includes a series of compounds known as menaquinones. It is derived from bacteria and is normally synthesized by the intestinal *flora*. **Vitamin K_3**, or **menadione**, is a synthetically derived agent with vitamin K activity. Although all three of the vitamin K forms are fat-soluble, vitamins K_1 and K_2 require the presence of bile salts to be absorbed from the GI tract. Vitamin K_3 is absorbed even in the absence of bile salts and is useful, therefore, in the treatment of vitamin K deficiencies caused by malabsorption syndromes.

Vitamin K is most commonly used for the treatment of *hypoprothrombinemia* in newborn children. This condition, which may be even more severe in premature infants, is caused by the inadequate dietary intake of the vitamin and the temporary absence of normal intestinal flora. This clotting factor deficiency results in the development of a hemorrhagic state. The administration of vitamin K to the newborn infant prevents hypoprothrombinemia and is considered a routine part of neonatal care. The agent of choice for such therapy is vitamin K_1, because it appears to be associated with the lowest level of toxicity. A single parenteral dose of 0.5–1 mg of this compound is usually administered to an infant immediately after delivery.

Agents with vitamin K activity may also be used to reverse hypoprothrombinemia caused by the excessive use of oral anticoagulants and long-term use of broad-spectrum antibiotics, which may impair the production of vitamin K by intestinal bacteria. Vitamin K_1 is the preferred form for this use, as well.

Water-Soluble Vitamins

Most water-soluble vitamins are not stored to any extent in the body. Vitamin B complex, folic acid, and vitamin C are water-soluble.

Thiamine. **Vitamin B_1**, or **thiamine**, is abundantly found in whole grain and enriched breads and cereals and in pork, as well as in organ meats and in a variety of nuts and legumes. It plays a key role in a variety of chemical reactions in the body, particularly those involving carbohydrate metabolism. The requirement for this vitamin usually increases in direct proportion to the amount of carbohydrate utilized for energy production. The RDA is 0.9–1.2 mg/d, depending on the sex and age of the person.

A deficiency of thiamine causes a disorder known as beriberi. Although quite rare in the United States, beriberi is not uncommon in areas of the world plagued by malnutrition. Its symptoms are most commonly neurological and may range from sensory loss in the extremities to personality changes. Alcoholism is the most common cause of thiamine deficiency in the United States. The combination of poor diet and high alcohol intake seems to predispose to the development of deficiency symptoms.

Thiamine is responsible for the "vitamin odor" often associated with multivitamin products. Thiamine is easily destroyed by heat, so appreciable losses of the vitamin can occur during the cooking process. Since thiamine is a water soluble vitamin, it is not stored in the body to any great extent. It must therefore be replenished daily in the diet or by use of vitamin supplements.

Riboflavin. **Vitamin B_2**, or **riboflavin**, is a component of several enzymes important in carbohydrate, fat and protein metabolism. It also helps the body utilize oxygen. This vitamin is supplied by a number of foods. Rich sources of riboflavin include organ meats, dairy products, yeast, enriched bread and cereal, eggs, and green leafy vegetables. The RDA for riboflavin is 0.9–1.3 mg/d, depending on the sex and age of the person. Dietary deficiency of riboflavin is associated with skin disorders, inflammation of the mouth and lips, and ocular changes. Such a deficiency is almost always accompanied by a deficiency of other B-complex vitamins.

Riboflavin has a deep orange color. It may impart a greenish-yellow fluorescence to the urine. Although it is quite resistant to heat, prolonged exposure to light may result in some chemical decomposition. Because of its solubility in water, care must be taken to avoid its loss during the cooking process.

Niacin. **Nicotinic acid**, or **niacin**, is a constituent of two important *coenzymes* that assist in the breakdown of sugars, synthesis of fat, and tissue respiration. The RDA for niacin is 12–16 mg/d, depending on the sex and age of the person. A deficiency of this vitamin results in a condition known as pellagra, a disease characterized by inflammation of the mouth and tongue, diarrhea, and mental abnormalities.

In the human body, niacin is converted to niacinamide (nicotinamide). Both niacin and niacinamide can be used to fulfill the dietary requirements for this vitamin. Preformed niacin is supplied by liver, lean meats, fish, poultry and by enriched flour and cereals. A portion of the niacin used by the body is formed when the amino acid tryptophan is converted to niacin within the body. Some foods (e.g., corn) contain relatively low levels of tryptophan. Other foods (e.g., milk and eggs) are rich in this amino acid and further contribute to an adequate supply of niacin in the diet.

Niacin has been used as a peripheral vasodilator and for the treatment of certain forms of hyperlipoproteinemia (discussed in Chapter 34). Niacinamide, however, does not appear to be useful for these purposes. Extremely high doses (megadoses) of both niacin and niacinamide have been used experimentally for the treatment of schizophrenia. The usefulness of this vitamin for this disorder remains questionable, and it has been associated with considerable toxicity, ranging from GI distress and cutaneous vasodilation (flushing) to hepatotoxicity.

Pyridoxine. One of three naturally occurring substances claimed to have vitamin B_6 activity is pyridoxine; the others are **pyridoxal** and **pyridoxamine**. They are abundantly found in whole grain cereals, beef, liver, pork, and ham. Alhough pyridoxine is the most common form of vitamin B_6 in the diet and in vitamin supplement products, this agent is converted in the body to the pyridoxal and pyridoxamine forms, which are biologically active. The RDA for pyridoxine is 1.0–1.7 mg/d, depending on the sex and age of the person.

In humans, the need for vitamin B_6 increases in proportion to the amount of protein in the diet, as vitamin B_6 plays several important roles in the chemical manipulation of the body's amino acids. A deficiency of vitamin B_6 has been associated with a variety of dermatological and neurological disorders.

The prolonged use of the antitubercular drug isoniazid (INH) or oral contraceptives has been associated with the development of vitamin B_6 deficiency. Pyridoxine supplements are, therefore, routinely employed whenever these drugs are used for long periods.

Pyridoxine use has also been associated with reduced action of levodopa in the treatment of Parkinson's disease. Clients using this drug should, therefore, not receive supplemental doses of pyridoxine. A vitamin B_6-free multivitamin product, Larobec, has been specifically formulated for clients using levodopa.

Vitamin B_{12}. Cyanocobalamin is a complex chemical compound with vitamin B_{12} activity. It is

abundantly found in foods such as meat, fish, and dairy products and is used by the body to form the nuclear material of red blood cells. The RDA for cyanocobalamin is 2.4 mcg/d for both men and women from 19 years old to 71+ years of age. As with all other nutrients, the RDA for cyanocobalamin is different for infants and children.

Vitamin B_{12} deficiency is most common in clients with pernicious anemia, a condition characterized by deficiency or absence of *intrinsic factor*, which is normally produced by the stomach. The vitamin deficiency may occur in clients who are chronic alcohol abusers. It also appears in those who have had a portion of the stomach or small bowel surgically removed and who are no longer capable of absorbing sufficient amounts of the vitamin from dietary sources. Frequently B_{12}-deficient clients will develop *megaloblastic anemia*. When not promptly and effectively treated, such clients may develop irreversible damage to the nervous system because of cell death of nerves within the spinal column and cerebral cortex.

Replacement therapy for clients who are deficient in vitamin B_{12} is often performed by administering the drug parenterally over a long period. Oral administration alone is usually unsuccessful, because of the client's inability to properly absorb the vitamin from the gastrointestinal tract without intrinsic factor. The student is referred to Chapter 32 for a discussion of the role of vitamin B_{12} in the treatment of nutritional anemias.

Folic Acid. This nutrient and similar chemical compounds (folates) are substances that act with vitamin B_{12} to assure the proper formation and functioning of red blood cells. Almost all food groups are rich in folates; fresh green vegetables, liver, and yeast are particularly valuable sources. The RDA for folic acid is 300–400 mcg/d, depending on the sex and age of the person. This increases to 600 mcg/d in pregnant women to help prevent deficiencies that can lead to neural tube anomalies in the unborn child.

Folate deficiency is often caused by malabsorption of the vitamin from the GI tract. Alcoholics are among the most common clients to have folate deficiency. The use of certain drugs (e.g., oral contraceptives, methotrexate, and certain anticonvulsants) may also result in a folate deficiency. Although folate-deficient clients will also often exhibit *megaloblastic anemia*, neurological abnormalities rarely occur. The student is referred to Chapter 32 for a review of the role of folates in the treatment and prevention of nutritional anemias.

Pantothenic Acid. **Vitamin B_5**, or **pantothenic acid**, is a water-soluble vitamin for which the RDA is 4–5 mg/d, depending on the sex and age of the person. Pantothenic acid appears to be utilized in the body to facilitate the metabolism of carbohydrates, fats, and proteins. As it is abundantly found in many different food groups, deficiency symptoms related to pantothenic acid have not yet been described.

Biotin. **Biotin** is a substance found in many foods and which is synthesized by microorganisms in the GI tract. The RDA is 20–30 mcg/d, depending on the sex and age of the person. Biotin deficiency only appears when excessive quantities of raw egg white are consumed. Apparently a component of egg white forms an unabsorbable complex with biotin, thereby eventually leading to deficiency symptoms. Biotin deficiency is associated with dermatitis, anorexia, muscle pain, and other minor symptoms, which rapidly respond to even small doses of this substance.

Ascorbic Acid. **Vitamin C**, or **ascorbic acid**, is an essential vitamin found in citrus fruits, green leafy vegetables, tomatoes, and many other foods. It plays an important role in the formation and maintenance of collagen, a substance binding body cells together and that is necessary for the normal growth and repair of many cells. Ascorbic acid is also involved in the formation of teeth and bone and in the synthesis of a number of hormones. The classical deficiency state of ascorbic acid, scurvy, is rarely seen in the United States. However, a deficiency of ascorbic acid may result in hemorrhage, impaired wound healing, and dental disorders.

During the last two decades, there has been a controversy on the appropriate intake of ascorbic acid required for the maintenance of optimal health. Some have claimed that high doses of ascorbic acid are useful in preventing and reducing the severity of the common cold. Others have suggested that high doses of this vitamin may protect against certain forms of cardiovascular disease and cancer. Further study is required to clarify the precise role of vitamin C in the treatment or prevention of these disorders as well as in defining its toxicity to humans when used in high doses. Although ascorbic acid has been used for many years as a urinary acidifier, recent evidence has revealed that it is not significantly effective for this purpose.

MINERALS

Minerals are found in water and in natural foods. They may be divided into two groups: major elements and micronutrients. The major elements are calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulfur. The micronutrients are iron, copper, iodine, manganese, zinc, fluorine, cobalt, chromium, molybdenum, and selenium.

Sodium and Potassium

Sodium is the predominant positively charged ion in the extracellular fluid of the body. **Potassium** is the predominant intracellular positively charged ion. Together, they control the electrical potential across cell membranes and assist in the regulation of the body's fluid volume. Levels of sodium and potassium normally remain within a narrow range, because of the regulatory action of the kidney and other systems.

When a disturbance of the sodium and/or potassium balance occurs (e.g., due to diarrhea and/or diuretic use) a wide range of symptoms may develop. Some of these may threaten the life of the client. Rapid correction of any imbalance of these two important elements is required to prevent dramatic adverse effects.

Hyponatremia. When the concentration of sodium in the extracellular fluid falls below 135 mEq/liter *hyponatremia* exists. Such a condition may be the result of either an overexpansion of extracellular fluid volume or an excessive loss of sodium from the body. Overexpansion of extracellular fluid volume may occur when:

- excessive amounts of fluid are consumed with an inadequate amount of salt
- cardiac, liver, or renal failure exists
- excessive amounts of antidiuretic hormone (ADH) are secreted by the posterior pituitary gland

Excessive loss of sodium from the body is most commonly caused by adrenal insufficiency, diabetic *ketoacidosis*, or prolonged, severe diarrhea and/or vomiting (e.g., in a client undergoing cancer chemotherapy). Hyponatremia may cause a wide array of effects, including confusion, agitation, weakness, or cramping of muscles. Convulsions and coma may also develop from hyponatremia.

When treating hyponatremia caused by overexpansion of extracellular fluid volume, it is desirable to restore normal sodium concentration to the extracellular fluid without further overloading the fluid volume. This may be accomplished by restricting the intake of fluids so as to permit the gradual increase of extracellular sodium concentration. When more rapid correction is desired, small amounts of hypertonic saline solution (3%–5%) may be administered intravenously. The administration of potent diuretics e.g., furosemide (Lasix), may also help to rapidly reduce extracellular fluid volume. As such agents also remove sodium from the body, adequate sodium administration must accompany their use.

When hyponatremia is the result of excessive fluid and sodium loss (e.g., due to severe diarrhea), the administration of normal saline solution (0.9%) may be effective in restoring normal sodium and fluid levels.

Hypernatremia. *Hypernatremia* is present when the serum sodium concentration exceeds 145 mEq/liter. In most cases, the disorder is caused by excessive loss of water from the body without an accompanying loss of sodium or by inadequate fluid intake. Excessive fluid loss may occur in clients with diabetes mellitus or diabetes insipidus, those receiving osmotic diuretics, and clients with a number of other conditions. As the thirst mechanism normally protects the body from inadequate fluid intake, any disruption of a client's ability to obtain or request fluid could result in dehydration and hypernatremia.

The primary symptom of hypernatremia is thirst, although increased body temperature, flushed skin, and dry mucous membranes may also be evident. As hypernatremia is almost always the result of inadequate fluid content in the body rather than excessive total salt levels, treatment of this condition is usually best accomplished by the administration of sodium-free fluids. These may be given either orally (as plain water) or intravenously (as a 5% dextrose solution).

Hypokalemia. When the serum potassium concentration falls below 3.5 mEq/liter, hypokalemia results. It occurs when the excretion of potassium by the kidneys and/or its loss from the gastrointestinal tract exceeds its intake. A potassium deficit may be the result of a variety of causes, some of which are listed in Box 33–1.

The most serious manifestation of hypokalemia is the development of cardiac arrhythmias. Such rhythm defects of the heart are the result of increased automaticity and spontaneous myocardial contractions associated with low levels of potassium. Hypokalemia may also sensitize the heart muscle to the action of digitalis-like drugs,

BOX 33–1
Some Causes of Hypokalemia

metabolic acidosis or alkalosis

hyperaldosteronism

chronic diarrhea (e.g., that may accompany the use of potent laxatives or cancer chemotherapy)

prolonged vomiting (e.g., that may accompany cancer chemotherapy)

long-term use of potassium-depleting diuretics (e.g., thiazides or furosemide)

thereby increasing the likelihood of the development of cardiotoxicity when such drugs are employed. Low levels of serum potassium also interfere with skeletal muscle function. The magnitude of such effects is related to the degree of potassium deficit and may range from mild weakness to generalized muscle paralysis.

The treatment of hypokalemia varies according to the severity of the potassium deficit. In mild cases of hypokalemia, an increased dietary intake of potassium-rich foods may be effective in returning serum potassium levels to within normal limits (Table 33–2). In moderate to severe hypokalemia, the administration of commercial potassium supplements (either parenterally or orally) may be required.

Parenteral potassium supplements are generally used only when oral replacement is not feasible or when rapid potassium supplementation is required (e.g., in treating arrhythmias caused by hypokalemia). In most cases, when parenteral potassium supplementation is indicated, the use of the chloride salt of potassium is desirable, as most clients with hypokalemia will also have a chloride deficit, i.e., they will be hypochloremic. When *hypochloremia* is not present, other salts of potassium (e.g., **potassium citrate**, **potassium bicarbonate**, **potassium acetate** or **potassium gluconate**) may be administered.

Parenteral administration of potassium is always performed by slow intravenous infusion of a potassium salt that has been diluted in a large volume of parenteral fluid (usually 5% dextrose solution). Although, in most cases, a dilution of 40 mEq of potassium per liter of IV fluid is desirable; in some cases, concentrations as high as 80 mEq/liter may be used. At high concentrations, however, venous irritation and/or the development of cardiac arrhythmias become more likely. An administration rate of 10 to 40 mEq of potassium per hour is generally advisable, with the higher rate being reserved for treatment of clients with severe hypokalemia.

Oral potassium supplementation is usually performed by administering one of many different potassium chloride preparations. Such preparations include liquids, soluble or effervescent crystals or powders, and slow-release capsules or tablets.

TABLE 33–2

Some Potassium-Rich Foods

FOOD	POTASSIUM CONTENT in mg per 100 g
Fruits	
apricots	440
bananas	420
raisins (dried)	735
Vegetables	
artichokes	430
kidney beans	1,310
lentils, dried	810
mushrooms	520
potatoes, raw	410
spinach	662
sweet potatoes	530
Swiss chard	680
Other Foods	
almonds, dried	690
peanut butter	670
peanuts, roasted	740
molasses	1,500
pistachio nuts	972
wheat germ	780

Products administered as a solution are least likely to cause gastrointestinal bleeding or ulceration and are preferred for oral administration. They should always be administered with a full glass of water to minimize gastric upset. When the client cannot tolerate a liquid potassium supplement or refuses to use them because of their unpleasant taste, a slow-release wax matrix tablet (e.g., **Slow-K**) may be advisable. Such tablets contain small potassium chloride crystals embedded in a wax matrix, or core. When such tablets enter the gastrointestinal tract, fluids penetrate the matrix and gradually permit the slow dissolution and release of the salt from the tablet.

Hyperkalemia. When serum potassium concentration exceeds 5 mEq/liter, hyperkalemia is said to exist. Although such a condition may occur for a variety of reasons, it is often caused by: (1) the excessive use of potassium supplements (including commercial "salt substitutes" that contain potassium salts) and/or (2) the use of potassium-sparing diuretics, such as spironolactone (Aldactone), triamterene (Dyrenium), or amiloride (**Midamor**). Hyperkalemia may also result in clients with adrenal insufficiency and/or acute renal failure. It also appears in clients who have experienced severe tissue trauma (e.g., burns) in which substantial quantities of potassium have been released from damaged cells and have entered the extracellular fluid. When hyperkalemia occurs, it may produce muscular weakness, cardiac arrhythmias, paresthesias of the extremities, or, in extreme cases, complete neuromuscular paralysis or cardiac arrest.

Treatment of acute hyperkalemia is usually directed at reversing any adverse cardiac effects and at rapidly reducing serum potassium levels. Three measures may be useful in such treatment: (1) the parenteral administration of calcium, sodium bicarbonate, and/or a solution containing dextrose and insulin, (2) the intravenous administration of **calcium gluconate** (generally as 10% solution) to aid in antagonizing the cardiac depression caused by the hyperkalemic state, and (3) the administration of sodium bicarbonate or solutions containing a combination of dextrose and insulin to facilitate the movement of potassium into the cells from the extracellular fluid.

In treating nonacute hyperkalemia, the use of a cationic exchange resin, such as **sodium polystyrene sulfonate** (**Kayexalate**), may be beneficial. When administered orally or as a retention enema suspended in water or syrup (e.g., 70% sorbitol solution), the resin acts to bind potassium and remove it from the body. By either route, administrations are repeated up to 4 times daily until serum potassium levels return to within a normal range. In cases in which hyperkalemia is to be treated in a client who cannot be given an orally or rectally administered exchange resin (e.g., after gastrointestinal surgery), the use of hemodialysis or peritoneal dialysis may be considered.

Calcium

Calcium is one of the most abundant chemical elements found in the body. It is mostly concentrated within the skeletal system (99%), although a small amount is distributed throughout the cells and plasma. Calcium takes part in many processes, including blood coagulation, muscle contraction, and nerve excitation. The RDA for calcium is 1,000 mg/d for both men and women ages 19–50 years and then increases to 1,200 mg/d for both after the age of 50 years.

Although calcium intake is essential for all humans to replace losses that normally occur each day, adequate calcium intake is particularly important during periods of bone growth in childhood and adolescence, as well as during pregnancy and lactation. An appropriate supply of calcium is also necessary in adults, particularly those over 40 years of age, to prevent calcium loss that may contribute to the development of osteoporosis.

Calcium deficiency is associated with a number of physiological disorders:

- *tetany* in newborn infants
- hypoparathyroidism
- osteoporosis
- rickets
- osteomalacia

Dairy foods are a particularly rich source of calcium and should be a regular part of the daily diet. These are generally good sources of vitamin D, a nutrient promoting calcium absorption from the gastrointestinal tract. A variety of oral calcium supplements are available commercially. As each calcium compound may contain varying levels of elemental calcium, the dose of each product to be used should be based on its elemental calcium content.

Clients receiving calcium supplements in therapeutic doses over long periods may develop *hypercalcemia* and *hypercalciuria*. As this may result in the formation of kidney stones, as well as other disorders, clients on such therapy should have urine and serum calcium levels periodically monitored.

Parenteral calcium salts may be administered to treat hypocalcemia in conditions requiring a prompt increase in calcium levels (e.g., neonatal tetany) or in cardiac resuscitation, with calcium can increase the strength of myocardial contraction. Calcium gluconate is generally preferred over other parenteral calcium sources because it is less irritating to tissue.

Iron

The body normally contains about 3 to 5 g of iron, mostly in the blood. When iron is absorbed from the GI tract, it is transported to the bone marrow, where it combines with protein to form hemoglobin, the red substance in red blood cells. As blood is carried through the lungs, hemoglobin combines with oxygen and carries it to tissues throughout the body. Hemoglobin then combines with carbon dioxide and carries it to the lungs, where CO_2 can be exhaled. Iron is, therefore, essential for maintaining the oxygen-carrying function of the blood. It is also utilized by the body to form certain enzymes and to prevent certain types of anemia (discussed in Chapter 32).

Iron is normally conserved and recycled by the body. A red blood cell, when formed with iron in the bone marrow, lives for about 120 days. It then dies and breaks down in the spleen, thereby releasing iron and permitting it to be reused by the body. Iron deficiency is most likely to occur in women of child-bearing age, pregnant women, and growing children. When a deficiency of iron is identified, the possibility of blood loss—due to GI bleeding, menstruation, or other causes—must be considered.

As only about 10% of iron consumed in the diet is absorbed into the bloodstream, regular and appropriate sources of iron must be supplied in the diet. Organ and other meats, as well as fortified cereals, are rich sources of iron in the diet. Ascorbic acid may slightly increase the absorption of iron from the GI tract and is included in some iron supplement products. A wide variety of commercial preparations are available for use in both oral and parenteral iron supplementation. The student is referred to Chapter 32 for a discussion of these iron supplement products and their use in treating iron deficiency.

Phosphorus

This element, in the form of phosphate, is a major component of bone. It is also involved in the release of energy in the body and is part of many enzymes and other biochemical agents of the body. The RDA for phosphorus is 700 mg/d for both men and women ages 19–71+ years of age. Phosphate deficiency rarely occurs, because of the many different dietary sources of this element (e.g., dairy products, nuts, and grains). *Hypophosphatemia* may occur, however, in clients who are not receiving adequate levels of vitamin D and in those who receive aluminum antacids for long periods of time (see Chapter 14). In this latter group, phosphate deficiency may occur because of the binding of phosphate by aluminum, thereby impeding its ability to be absorbed.

Magnesium

Magnesium has many functions and is present in all body cells. It is the major cation in intracellular fluid. An adult body contains about 25 g of magnesium and about 70% of this is combined with calcium and phosphorus in the bone. It is also an essential element in enzyme systems associated with energy metabolism and in protein metabolism. The RDA for magnesium is 320–420 mg/d, depending on age and sex, with men requiring more than women. Large concentrations of magnesium are found in unmilled grains, but more than 80% is located in the germ and outer layers, which are removed when the grain is processed. The main food sources for magnesium are nuts, soybeans, cocoa, seafood, whole grains, dried peas and beans, and green vegetables.

A deficiency is usually caused by malnutrition, especially in conjunction with high calcium levels, because of the inverse relationship between calcium and magnesium levels in the body. Other causes include alcoholism, long-term IV feedings, diuretics, diabetic ketoacidosis, and *hyperthyroidism*. Symptoms include cardiovascular, neuromuscular, and mental disturbances.

Because magnesium is excreted in the urine, clients with renal failure who require dialysis are prone to developing hypermagnesia. This is treated with calcium supplements.

Fluoride

Fluoride compounds, such as **sodium fluoride** and **stannous fluoride**, are employed primarily to prevent dental caries. Fluoride has been added to the drinking water of about 50% of the population of the United States. This has resulted in a 50%–60% reduction in caries in those so treated.

The RDA for flouride is 3 mg/d for women ages 19–71+ years of age and 4 mg/d for men in the same age group.

Fluoride is believed to exert its protective effect on the teeth by chemically bonding to the enamel structure. This bonding makes the tooth less porous and less soluble than untreated enamel and, therefore, more resistant to acids in the mouth that promote decay. There is also evidence indicating that fluoride compounds inhibit the growth of bacteria indirectly responsible for the development of dental caries.

Fluoride preparations may be used either topically or systemically. Topically, they are applied as rinses, gels, or pastes by a dentist or as part of regular home dental hygiene. Systemic fluoride products are administered orally in the form of tablets or liquids. These have both a topical action on enamel and a systemic benefit to unerupted teeth. When a tooth erupts in the mouth of a child under the age of 6, the enamel surface of the tooth is relatively immature and susceptible to erosion and decay. As the enamel matures it becomes less porous and more resistant to the development of caries. Young children, therefore, benefit most from topical and systemic therapy with fluorides. To provide greatest protection to both deciduous and permanent teeth, the child should receive fluorides daily from infancy to about the age of 13. The use of commercial fluoride supplements is based on the level of fluoride in the child's drinking water. Usually supplementation is indicated when the fluoride content of drinking water is below 0.7 parts per million (ppm).

Fluoride compounds (particularly sodium fluoride) have also been used for the treatment of osteoporosis. Doses as high as 50 mg daily are employed in conjunction with calcium and vitamin D. The usefulness and safety of this therapy remains to be determined.

Micronutrients (Trace Elements)

Many chemical elements play an important role in the functioning of the human body even though their concentration may be quite low. Among these trace elements are copper, chromium, and selenium. Copper is associated with iron in enzyme systems and hemoglobin synthesis. Chromium is associated with glucose metabolism and lowers serum cholesterol (LDL— low-density lipoproteins) and increases HDL—high-density lipoprotein commonly known as "good cholesterol." No RDA standards have been established for copper or chromium. Selenium is a structural component of teeth and is a synergistic antioxidant with vitamin E. Recent studies have shown it to be useful in both preventing and treating prostate cancer. The RDA of selenium is 55 mcg/d. Deficiencies of these substances are rare since they are often present in minute amounts in many dietary sources. Deficiencies of micronutrients may occur when a client is exclusively consuming a carefully controlled synthetic diet, as in the use of infant formulas by neonates and in TPN.

APPLYING THE NURSING PROCESS

Nurses are actively involved in ensuring the adequate nutritional status of clients. In addition, they are frequently consulted by the public on matters relating to nutrition, including vitamin and mineral supplementation. Nurses are often looked to as nutritional role models.

As indicated previously, there are legitimate uses for supplemental vitamins and minerals. In these circumstances, nurses should provide dietary guidance, or arrange for more intensive guidance from a dietitian and should encourage the client to take the supplements as professionally ordered. However, in many cases the nurse will be in the position of discouraging individuals from purchasing and consuming unnecessary, costly, and sometimes dangerous amounts of these products.

The public should have a basic understanding of the body's need for various nutrients and the dietary sources of these nutrients. People should know what constitutes an adequate diet and that such a diet supplies sufficient amounts of vitamins and minerals for most persons. Those who feel they need additional supplementation and those who may be at risk of poor nutritional status despite dietary counseling, should be referred to a physician. It is true that the public generally does not consider vitamins and minerals to be drugs. They may, therefore overdose themselves without being aware that adverse side effects are possible with vitamins. People should know that unpleasant and sometimes life-threatening side effects can occur, especially as a result of toxic levels of fat-soluble vitamins (A, D, E, and K).

ASSESSMENT

Because of the public's view of vitamins and minerals as not being drugs, many people admitted to hospitals or clinics will neglect to mention nutritional supplements, as well as other over-the-counter drugs, they may be using. If none are mentioned in response to the history-taking question about medication or drugs being taken, the nurse should ask specifically about such products. If vitamins or minerals are taken, the dosage and frequency of administration are obtained and noted.

In some cases, a nutritional deficiency may be present, particularly with a history of poor dietary intake. The nurse must be aware of individuals at risk of such deficiencies. These individuals include:

- pregnant women
- infants and children
- persons on fad diets
- those with chronic GI disorders, such as peptic ulcers and colitis
- alcoholics and other drug-dependent persons
- the elderly, particularly those who live alone

Nursing assessment includes evaluation of a client's nutritional status. Information on nutritional status is obtained from dietary history, health history, physical examination, and laboratory studies. The nurse observes the client for pale mucous membranes, edema, dry skin, brittle hair and nails, abnormalities of the tongue and oral mucous membranes, muscle weakness and tenderness, and tachycardia on minimal exercise. Accurate body weight is obtained. The laboratory tests of a client with deficient nutrition may show decreased serum albumin, decreased lymphocyte count, decreased iron binding capacity, and low hemoglobin and hemocrit.

The nurse takes a careful medication history to determine if medications are interfering with a person's ability to absorb or use nutrients. If nutritional problems are identified, the client may be referred to a dietitian for a more detailed history and workup.

The need for specific nutrients may be increased in certain individuals such as smokers (vitamin C), those taking oral contraceptives (vitamin C and B_6), those with little exposure to sunlight (vitamin D), premature infants with hemolytic anemia resulting from limited transfer of vitamin E from the mother, and those on prolonged antibiotic treatment (vitamin K).

NURSING DIAGNOSES

Including but not limited to:

- Risk for impaired skin integrity related to inadequate protein intake or edema associated with hypernatremia
- Risk for deficient fluid volume related to inadequate sodium intake
- Risk for infection related to decreased immune status secondary to inadequate nutritional intake or central venous access and TPN
- Imbalanced nutrition, more than body requirements related to dietary intake
- Deficient knowledge related to nutritional standards and individual nutritional needs

PLANNING/GOALS

- Client will not experience skin breakdown.
- Client will maintain fluid and electrolyte balance within normal limits.
- Client will not experience infection.
- Client will demonstrate nutritional intake within prescribed guidelines.
- Client will demonstrate/verbalize understanding of nutritional standards; function of nutrients, vitamins, and minerals; and individual nutritional needs.

IMPLEMENTATION

In many cases, slight modification of diet may correct low levels of nutrients; in others, some dietary supplement may be required. If a supplement is suggested, clients can be helped to understand how to meet the need for the nutrient(s) in view of the RDA. They are also helped to evaluate various products to resolve such questions as whether "natural" source vitamins are superior and whether they should order from a specialty mail order firm or purchase supplements at their local pharmacy.

The nurse must be aware that the absorption of fat soluble vitamins may be reduced in persons using mineral oil or **cholestyramine** resin. Aged persons with poor nutritional habits and those who regularly use mineral oil are especially at risk. If mineral oil is required, it is to be taken at bedtime and not in conjunction with meals or with vitamin supplements.

One of the hazards of the common public view about the safety of vitamins and minerals is that containers of these substances are left around the house where children may be able to

obtain them. Also, many products do not come in child-resistant containers, and children can overdose themselves with these preparations. In addition, many nutritional supplements are available in flavored, chewable forms. Young children especially, must never be told these are candy, and their access to these preparations must be controlled for their safety.

The administration of potassium supplements is associated with the use of special nursing interventions. As oral administration of potassium supplements frequently causes GI upset, they are given after meals or with food and with a full glass of water. Tablets containing potassium supplements must not be chewed or crushed, but rather swallowed whole. An exception is the microencapsulated form of oral potassium (Micro-K), for example, which can be crushed and mixed with food. Clients using chewable potassium supplements are advised to chew them slowly and follow the dose with a large glass of water. Those using effervescent products are instructed to wait until the fizzing has stopped to avoid excess bicarbonate intake. Clients using a liquid or powder supplement are instructed to dilute the product in at least 120 mL of water or low-potassium juice and follow the dose with a glass of liquid. The client is encouraged to slowly sip the dose over 5 to 10 minutes to avoid a bolus effect. Those clients who object to the taste can be advised to ice the supplement-fluid combination and sip it through a straw. Sucking on ice chips for several minutes before consuming the dose or adding the liquid or powder to gelatin desserts also may increase compliance. Caution clients taking potassium supplements not to use salt substitutes containing potassium, unless they have been advised to do so by their primary care provider.

Clients taking potassium supplements are closely monitored for the development of gastrointestinal distress or darkened stool, which may indicate the presence of GI bleeding. Clients taking drugs that slow the GI tract (e.g., antispasmodics) are at particular risk of developing potassium-induced lesions. Finally, inform clients using extended-release, wax-matrix formulations that after the matrix releases its contents, it is excreted and can appear intact in the stool.

Parenteral potassium supplementation is always performed by the administration of slow intravenous infusion containing the potassium supplement diluted in a large volume of parenteral solution. Generally a concentration of 40 mEq/liter of IV fluid is desirable, although concentrations as high as 80 mEq/liter may be employed. A central venous line is preferred if the client will be receiving continuous replacement of potassium over a period of days and is required for administration of doses of more than 10 mEq/hour. Infusion control devices should be used whenever concentrations of more than 40 mEq/liter are administered. **Note:** When adding potassium chloride to a plastic parenteral fluid container, inject the drug into the port in an upright position (facing the ceiling), so the potassium adequately mixes with the solution, rather than concentrating at the bottom of the container. Potassium-containing solutions are very irritating to tissues. Care is exercised to avoid infiltration, as tissue necrosis may result if extravasation occurs. Phlebitis and/or venospasm may also occur at the site of injection. To reduce burning at the site of injection, lidocaine may be ordered as an addition to the infusion. If severe extravasation occurs, the tissues may be infiltrated with a combination of **procaine HCl** and **hyaluronidase** to reduce vasospasm and dilute the KCl in the tissues. Priority is placed on careful monitoring of the injection site, preventing infiltration, and changing the site if redness, heat, swelling, or pain are noted.

In clients with impaired renal function, the administration of potassium salts may produce hyperkalemia and cardiac arrest. This may develop rapidly. Careful monitoring of the client, particularly of the cardiac rhythm, is essential.

Nurses may be responsible for the administration of an ion exchange resin e.g., sodium polystyrene sulfonate (Kayexalate) used in the treatment of hyperkalemia. The administration of this resin is accomplished orally or as a retention enema. Oral administration generally involves the use of 15–60 g of drug dispersed in 150–200 mL of tap water. It may be administered 1–4 times a day. If a client cannot tolerate oral administration, the agent is administered as a retention enema. Such enemas must be retained for 30 to 45 minutes in order for adequate potassium binding to occur.

Increasing attention is being focused on the prevention of osteoporosis, especially in post-

menopausal women. Nurses must be aware of persons at risk, including those with low calcium intake, those on prolonged bedrest, and postmenopausal women, especially white or oriental women who have experienced early menopause. Measures to prevent osteoporosis include ensuring a diet with adequate calcium intake, encouraging weight-bearing exercise, and encouraging compliance with medication. For example, replacement estrogens are often prescribed for menopausal women to prevent loss of bone mass. Additional advice includes restricting the intake of caffeine, **nicotine** and alcohol. Some clients are advised to take calcium supplements in divided doses to facilitate absorption. Also, they should be taken approximately 1 hour following meals to avoid interference with calcium absorption by fats and fibers. If the client has low gastric acid production, however, calcium should be given with meals. Advice also is given to avoid simultaneous administration of zinc and calcium supplements, as zinc can inhibit calcium absorption. Some clients use dolomite or bone meal acquired in health food stores to provide a source of calcium. These products may be contaminated with lead and are not recommended as sources of daily calcium. Finally, the nurse should provide for the safety of clients with loss of bone mass by identifying persons at high risk and using interventions to prevent falls and by encouraging exposure to sunlight. This will aid in ensuring that individuals have an adequate supply of vitamin D to facilitate absorption of calcium.

In clients taking fluoride supplementation, the nurse provides instructions about the method of administration. To maximize the benefit achieved from these products the client is advised to chew and retain the product in the mouth prior to swallowing it and to administer the agent after thorough brushing and just prior to bedtime.

An extreme form of need for nutritional supplements is the client receiving parenteral nutrition, either to supplement oral nutritional intake or to meet total nutritional needs. TPN may provide calories, proteins, fat, water, electrolytes, vitamins, and minerals. The preparation is administered into a large blood vessel, such as the subclavian vein. The nurse observes the client receiving TPN to be sure the diet meets the nutritional needs of the body. This includes keeping records of weight, blood pressure, intake and output, and fractional urine determinations for sugar. In addition, periodic blood studies, such as blood glucose, *hematocrit*, and electrolytes, will be ordered. TPN mixtures generally do not contain:

- folic acid, which must be administered daily
- vitamin K, which can be given daily or weekly, depending on the preparation
- vitamin B_{12}, which may be given intramuscularly once a month

The nurse assesses the TPN recipient for electrolyte and/or glucose imbalance and vitamin and mineral excess, including such indications of hypervitaminosis as pancreatitis and soft tissue calcification. Observations about the client's status and tolerance of TPN are reported to the primary physician or to an interdisciplinary nutrition support team.

A number of complications are possible in persons receiving TPN. One of these is infection, because of contamination of the central line used for the feeding or inappropriate handling of the feeding solution. The nurse examines the catheter site daily for redness or swelling and uses aseptic technique when changing the central line dressing and when hanging a new bottle of feeding solution. The feeding solution should be stored as directed by the manufacturer or as directed by additional labeling. Additional nursing interventions are required for clients receiving TPN, and the student is referred to the recommended readings at the end of this chapter for more information. Finally, the nurse is advised not to add any drug to the TPN line without prior consultation with the pharmacist to determine possible incompatibilities.

EVALUATION

- Client does not experience skin breakdown.
- Client maintains fluid and electrolyte balance within normal limits.
- Client does not experience infection.
- Client demonstrates nutritional intake within prescribed guidelines.
- Client demonstrates/verbalizes understanding of nutritional standards; function of nutrients, vitamins, and minerals; and individual nutritional needs.

NURSING CARE PLAN

A Client with Congestive Heart Failure Receiving a Diuretic with a Potassium Supplement

Anna Shah, age 62, arrives at the hospital at 4 PM after having been seen in her doctor's office this morning. On admission, she has jugular venous distension (JVD), 4 plus pedal edema, and an enlarged abdomen with distant bowel sounds. Her breathing is labored and lung sounds reveal rales bilaterally. She is admitted to a monitored unit for observation. The initial monitor reading reveals atrial fibrillation that was not present on her last admission. The physician orders immediate blood work for electrolytes, blood urea nitrogen, blood sugar, and digoxin level. Shortly after admission, her monitor pattern shows rapid atrial fibrillation with a rate of 160 beats per minute. The physician orders digoxin 0.25 mg IV stat along with furosemide (Lasix) 40 mg IV. She has a Foley catheter inserted and almost immediately her urine output becomes clear white in color and increases to 200 mL per hour. When the initial laboratory results are called to the unit, the potassium is low at 3.5 mEq/L. The nurse recognizes that with Mrs. Shah's diuresis, the potassium level will drop further. She notifies the physician of the present potassium level and receives orders for potassium chloride (Slow-K) 16 mEq BID and repeat electrolytes at 8 PM. By 9 PM Mrs. Shah has had urine output of 1400 mL. The 8 pm electrolytes show a potassium level of 3.2 mEq/L. Her breathing has improved tremendously and breath sounds are now clear.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Breathing patterns, breath sounds.	Impaired gas exchange related to excessive fluid and retained secretions.	Client will have adequate oxygenation and breathing within normal limits as evidenced by arterial blood gases within normal limits.	Promote optimum lung expansion by encouraging client to maintain high Fowler's position. Oxygen by cannula or mask prn. Limit activities which increase oxygen demand.	Client's breathing pattern shows normal rate, rhythm, and depth within 24 hours of admission. Arterial blood gases adequate. Breath sounds clear.
Jugular venous distension (JVD), pedal edema, rales, blood pressure.	Fluid volume excess related to decreased cardiac output.	Client will have reduction of fluid volume as evidenced by weight loss, decrease in edema, and clear breath sounds.	Weigh daily. Diuretic as ordered. Monitor intake and output. Foley catheter for hourly output. Restrict sodium intake. Elevate edematous legs. Check blood pressure frequently. Observe for electrolyte loss or blood sugar elevation that may occur with furosemide use.	Client no longer has JVD or pedal edema. She has had weight loss of 4 lbs in 24 hours. Blood pressure within normal limits. Breath sounds clear.
Fatigue, activity, dyspnea on exertion.	Activity intolerance related to insufficient oxygen to meet metabolic demands.	Client will maintain adequate oxygen levels for activities of daily living as evidenced by vital signs within normal limits.	Assess client's response to activity. Plan care with rest periods to reduce fatigue. Identify stress factors that may increase oxygen demands.	Client maintains vital signs within normal limits during activity.
Heart rate, and rhythm. Monitor pattern. Hemodynamic parameters.	Decreased cardiac output related to left sided failure and loss of stroke volume.	Client will maintain adequate cardiac output to provide tissue oxygenation as evidenced by normal vital signs, strong peripheral pulses, urine output 30 mL/hr.	Limit self-care activity. Monitor Swan-Ganz, wedge readings, and cardiac output until client is stable. Monitor EKG for arrhythmia. Be sure hourly output is greater than intake and is more than 30 mL per hour.	Client has been treated successfully for arrhythmias. Blood pressure within normal limits. Urine output indicates diuresis greater than 100 mL per hour in first 24 hours.

Dietary habits, food preferences.	Imbalanced nutrition: less than body requirements related to anorexia and fatigue.	Before discharge, client will plan a well balanced diet prescribed by physician with sodium and fluid restrictions and increased amounts of potassium.	Teach client diet plan. Restrict sodium and fluid and increase potassium. Teach client that foods high in potassium are nuts, broccoli, carrots, potatoes, peanut butter, bananas, oranges, melons, and whole grain cereal and bread. Provide a list of foods high in potassium for reference at home.	Client adheres to sodium-restricted and potassium-rich diet.
Laboratory results, rapid fluid loss.	Risk for deficient fluid volume related to diuretic therapy.	Client maintains fluid and electrolytes within normal range as evidenced by normal skin turgor, vital signs, mentation, and EKG. Variations in fluid and electrolyte balance are recognized and treated early.	Monitor electrolytes and fluid balance. Report signs and symptoms of fluid deficit/electrolyte imbalance promptly to health care provider.	Client has balanced intake and output and electrolytes are within normal range.
Knowledge of drug therapy.	Deficient knowledge related to potassium therapy.	Client will be able to identify appropriate method for administering drug and will list side effects and when to report them.	Teach client not to crush potassium chloride (Slow-K) tablets, as this causes gastric irritation. Teach client to report symptoms of hypokalemia, weakness, fatigue, disturbances in cardiac rhythm, polyuria, and polydipsia. Because of possible GI upset, potassium should be taken with food or following meals. Also teach client to avoid use of potassium-containing salt substitutes. Instruct client about the importance of follow-up care including laboratory studies.	Client takes potassium regularly and correctly and recognizes and reports signs and symptoms of hyperkalemia or hypokalemia.

KEY NURSING IMPLICATIONS 33–1

Clients Taking Vitamin and Mineral Supplements

1. Nurses can be instrumental in educating the public about an adequate diet and the benefits and hazards of vitamin therapy.
2. Individuals at risk of nutritional deficiencies include pregnant women, infants and children, individuals with eating disorders, persons on fad diets, persons with chronic GI disorders, alcoholics, drug-dependent persons, and the elderly.
3. Nursing assessment includes evaluation of the client's nutritional status using information from a dietary history, health history, physical examination, and laboratory studies.
4. The absorption of fat-soluble vitamins may be reduced in persons using mineral oil or cholestyramine resin. Mineral oil should not be taken with meals or vitamin supplements.
5. Oral potassium supplements should be taken after meals or with food and with a full glass of water to decrease GI upset.
6. Tablets containing potassium supplements must not be chewed or crushed.
7. Clients taking potassium supplements are monitored for the development of gastrointestinal distress or GI bleeding.
8. Parenteral potassium is infused slowly. Infiltration may be associated with tissue necrosis.
9. Ion exchange resins, such as polystyrene sulfonate (Kayexalate), may be given orally or rectally as a retention enema.
10. Calcium supplements should be taken in divided doses approximately 1 hour after meals. Encourage exposure to sunlight, weight-bearing exercise, and compliance with other medications intended to prevent osteoporosis.
11. Maximum benefit from fluoride supplementation is achieved by chewing and retaining the product in the mouth before swallowing it.
12. Assess the weight, blood pressure, and intake and output of clients receiving TPN. Monitor for the development of complications, such as infection.
13. No drugs are added to the TPN line without prior consultation with the pharmacist to determine possible incompatibilities.

CASE STUDY

Emilio Marcuse, who has just turned 3 years of age, has been going through a picky-eater stage. On his last visit to the pediatrician, the physician suggested that Mrs. Marcuse obtain a pediatric chewable vitamin preparation from her local pharmacy. As Mrs. Marcuse is a friend of yours, she asks you to provide her with help in selecting and using such a preparation for Emilio.

Questions for Discussion

1. Why might a vitamin supplement be indicated in Emilio's case?
2. Under what circumstances would fluoride supplementation be indicated?
3. As a nurse, what advice would you give Mrs. Marcuse about the selection and use of a preparation for Emilio?

HOME CARE/CLIENT TEACHING

1. Clients should be instructed about nutrients, their functions, sources, and recommended daily requirements.
2. Clients receiving vitamin and mineral supplements should be informed of any adverse effects associated with these supplements.
3. All clients should be instructed concerning how to read nutritional labels on all foods they purchase.
4. Clients should be informed about the most appropriate times for taking vitamins and mineral supplements to achieve best absorption of these nutrients.
5. Client receiving potassium and/or sodium supplements should be advised to follow up with physician to have periodic serum blood levels drawn to evaluate the effectiveness of treatment and to detect possible hyperstates of these electrolytes.
6. Clients requiring calcium supplements should be encouraged to remain compliant with this therapy and to avoid caffeine, nicotine, and alcohol.
7. Clients receiving fluoride supplements should be advised to chew and retain the product in their mouth before swallowing to maximize the benefits of these supplements.
8. Persons receiving TPN at home and their caregivers must receive thorough instruction in storage and administration of solutions and in maintaining the central line. The catheter site should be checked daily for redness or swelling. Aseptic technique must be used when hanging a new bottle of TPN solution and changing dressings.

CRITICAL THINKING EXERCISES

1. Visit a local pharmacy and examine the selection of vitamin and mineral products available. Make a comparison of the range of costs for a particular dosage of a nutrient—for example, what is the cost of various preparations of vitamin C 100 mg?
2. From newspapers and magazines obtain advertisements for nutritional supplements. Determine what information the public should have to evaluate the claims made in the advertisements.
3. Prepare a brief report on megavitamin therapy for the treatment of schizophrenia.
4. Prepare a visual for use in the instruction of the public regarding a balanced diet. You may want to prepare this aid for a special group, such as elementary school children or pregnant women.
5. Prepare a nursing care plan for a client receiving TPN.

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34 Agents Used in the Treatment of Hyperlipidemia

OBJECTIVES

After studying this chapter, the student will be able to:

- List the major risk factors associated with the development of atherosclerosis
- Identify the mechanism of action of each class of agents used in the treatment of hyperlipidemia
- Identify the role of diet and drug therapies in the control of hyperlipidemia
- Identify the common side effects of agents used to treat hyperlipidemia
- Select the proper method of administering agents commonly used for the treatment of hyperlipidemia
- Identify significant drug interactions associated with drugs employed in the treatment of hyperlipidemia
- Apply the nursing process related to the administration of agents used to treat hyperlipidemia
- List common factors to be included in a comprehensive nursing assessment of the client with hyperlipidemia

Atherosclerosis is a disease characterized by the accumulation of fatty substances on the inner wall of large and medium-sized arteries. These include the aorta and coronary, cerebral, and renal arteries. If allowed to progress, atherosclerosis may eventually lead to coronary heart disease, cerebral vascular disease, or peripheral vascular disease, as well as renal disease or failure. These disorders are collectively responsible for more deaths in the United States than any other cause.

HYPERLIPIDEMIA

Although many factors, including cigarette smoking, hypertension, and family history, appear to determine the risk of developing coronary heart disease, there is considerable clinical evidence indicating that high levels of fatty substances (lipids) in the circulating blood promote the development of atherosclerosis. This factor thereby contributes to the development of many cardiovascular disorders.

Most lipids entering the body are chemically bound to a plasma protein called albumin. They form chemical compounds known as lipoproteins. As each lipoprotein contains a different ratio of lipid to protein, each has a different density. Therefore, the lipoproteins found in the blood are often classified into four major groups based on their relative density. The greater the proportion of lipid in the lipoprotein, the lower the density will be (Table 34–1).

TABLE 34–1

Classes of Lipoproteins

CLASS	DENSITY
chylomicrons	0.95
very low density (VLDL)	0.95–1.006
low density (LDL)	1.006–1.063
high density (HDL)	1.063–1.21

The largest lipoprotein particles are the chylomicrons, substances secreted by the intestinal mucosa into the *portal circulation* when lipids are absorbed from a fat-containing meal. As the chylomicrons contain the highest proportion of lipid, they tend to be the least dense of the lipoprotein particles.

Very low-density lipoproteins (VLDL) also contain a relatively high proportion of lipid. They are secreted in the liver. Their *triglyceride* component is partially derived from dietary carbohydrate intake. Because of the high triglyceride content of the chylomicrons and VLDL particles, an increase in their concentration in the blood results in an increase in plasma triglyceride levels.

Low-density lipoproteins (LDL) contain the greatest proportion of cholesterol of all the lipoproteins. When their level in the blood is increased, therefore, plasma cholesterol levels usually also increase.

High-density lipoproteins (HDL) are the smallest lipoproteins and contain the greatest proportion of protein. Although their role in the development of atherosclerosis is still controversial, there is evidence that abnormally low serum levels of HDL tend to promote coronary artery disease. Evidence to support the concept of raising the dietary intake of HDL as a means of preventing coronary artery disease is lacking and further investigation is needed.

Based on this classification of lipoprotein particles, it has been determined that VLDL and LDL play the most important roles in promoting atherosclerosis. When measurements of plasma cholesterol and triglycerides reveal high concentrations of these substances as compared to the "normal" population, some form of treatment is usually indicated. Such treatment often includes dietary management and may include drug therapy, if dietary control alone is not adequate.

Several drugs have been shown to reduce the plasma levels of various lipoproteins, particularly cholesterol. Little evidence has been produced to demonstrate that these drugs can reverse existing atherosclerosis. It is still unclear whether or not drug-induced reduction of cholesterol or triglyceride levels increases, decreases, or has no effect on morbidity or mortality. In addition, the necessity of using these drugs for long periods often subjects a client to a wide array of adverse effects.

Clofibrate (Atromid-S, Claripex)

In the early 1960s, it was demonstrated that a number of chemically related compounds could reduce plasma lipid and cholesterol concentrations. Many of these compounds were later proven to be clinically ineffective or sufficiently toxic to prohibit their use. **Clofibrate** evolved as the member of this group that provided the greatest effectiveness with the least toxicity.

Although the exact mode of action of clofibrate is still unclear, it is believed to inhibit the synthesis of blood lipids (particularly cholesterol) while also increasing their excretion. The drug is currently indicated for use as an adjunct to diet in reducing elevated serum cholesterol levels. Clofibrate is usually administered orally in a 500 mg dose, 4 times daily. Such therapy must generally be continued for several weeks or months before serum lipid levels are adequately reduced. During this time, the client's serum lipid levels must be carefully monitored. These levels are compared to baseline lipid levels established prior to initiating therapy. The drug is generally withdrawn after 3 months of continuous therapy if the client does not respond favorably. As clofibrate tends to enhance the action of oral anticoagulants, the dose of such agents must often be reduced by one-half when the client is begun on clofibrate (see Chapter 30 for information on anticoagulants).

Gemfibrozil (Lopid) and Fenofibrate (Tricor)

Gemfibrozil (**Lopid**) and **fenofibrate** (**Tricor**) are both fibrinic acid derivatives or fibrates and have pharmacological actions similar to clofibrate. They are most effectively used when it is necessary to lower triglyceride levels and raise HDL levels,

when niacin has proven ineffective or when other drugs have not brought about the needed changes. Although the precise mechanism of action has not been established, it is believed that these agents reduce the synthesis of triglycerides in the liver, thereby resulting in a reduction of VLDL and LDL concentrations, and increased HDL levels. They are employed primarily for the treatment of adults with very high triglyceride levels who do not respond adequately to diet therapy.

The use of these agents has been associated with the development of gastrointestinal disturbances, as well as a variety of other effects. In addition to having serum lipid levels monitored, clients receiving these agents should be observed for hematological and liver function changes.

Dosage for gemfibrozil is usually 1,200 mg/day administered in 2 divided doses 30 minutes before the morning and evening meals, although some clients may respond to a dosage as low as 900 mg/day. The dosage for fenofibrate is 67 mg/day given with meals.

Probucol (Lorelco)

Probucol is a drug considered as an adjunct to diet for reducing elevated serum cholesterol levels. Its mechanism of action has not been determined, although some evidence seems to indicate that probucol, unlike clofibrate, does not affect the synthesis of cholesterol in the body. But it does appear to increase the rate of LDL breakdown in the body, however, it also lowers HDL levels by 20% to 30%. Probucol is usually administered in 500 mg doses with the morning and evening meals. As with clofibrate, therapy should be evaluated regularly to determine if an adequate clinical response is being achieved. Unlike clofibrate, probucol does not appear to alter the serum levels of oral anticoagulants.

HMG-CoA Reductase Inhibitors (Statins)

The newest class of antihyperlipidemic drugs is the HMG-CoA reductase inhibitors. The class includes **atorvastatin** (**Lipitor**), **cerivastatin** (**Baycor**), **fluvastatin** (**Lescol**), **lovastatin** (**Mevacor**), **pravastatin** (**Pravachol**), and **simvastatin** (**Zocor**).

HMG-CoA reductase is an enzyme required for the production of cholesterol in the body. This class of drugs inhibits the action of this enzyme, thereby resulting in an increase in HDL cholesterol and a reduction in LDL and VLDL cholesterol, as well as a reduction of triglyceride levels. These changes are generally evident within 1–2 weeks after starting therapy with one of these drugs and maximal effect is usually seen within 4–6 weeks. The beneficial response is believed to continue as long as the client continues use of the medication. In some studies, these medications have proven to reduce the rates of coronary heart disease, first and second heart attacks, and death related to coronary events. Atorvastatin is the most effective of these agents for reducing both triglyceride and LDL cholesterol. This is perhaps because atorvastatin has been approved for administration at higher doses.

The HMG-CoA reductase inhibitors are usually administered once a day in the evening (except atorvastatin), because most cholesterol is synthesized between midnight and 3:00 AM. If more intensive therapy is required, a second dose taken in the morning may be added to the medication regimen. The agents are generally used when the response to dietary measures alone has been insufficient to meet the client's needs.

These agents must be used with great caution in clients who have a history of liver disorders or who consume substantial quantities of alcohol. Liver function tests should be performed on clients about to begin therapy with these agents and repeated every 4–6 weeks during the first 3 months of therapy, every 6–12 weeks during the next 12 months, and at approximately 6-month intervals thereafter. Particular attention should be given to clients who develop elevated serum transaminase levels. If transaminase levels rise to 3 times the upper limit of normal and persist, the drug should be discontinued. All of the drugs in this class are contraindicated in pregnancy and are rated in Pregnancy Category X, because they are capable of damaging the fetus. Other adverse effects associated with the use of these agents include GI upset and constipation or diarrhea. Headache may also occur in clients using these drugs.

Clients using the HMG-CoA inhibitors should be advised that photosensitivity may occur with their use and that sunscreens and protective clothing should be worn during exposure to sunlight and other ultraviolet light. They should also be advised that diet must be carefully followed and that lovastatin should be taken with meals,

whereas fluvastatin, pravastatin, atorvastatin, and simvastatin may be taken without regard to meals. Clients should be advised to report any unexplained muscle pain, weakness, or malaise.

Nicotinic Acid (Niacin)

Niacin is vitamin B_3. When used in high doses, it is extremely effective in decreasing triglyceride levels, raising HDL levels higher than other anticholesterol medications. It is also the least expensive of this classification of drug. In addition, it lowers LDL and lipoprotein levels; however, adverse effects make this an undesirable choice. The necessity of using large oral doses generally results in a high incidence of gastrointestinal irritation and pruritus. In addition, nicotinic acid may cause flushing because of its peripheral vasodilating action. It may, therefore, cause hypotension when used with certain antihypertensive agents. It is administered in doses of 1–2 grams 3 times daily with or following meals. This dose may be increased slowly to as much as 8 g daily if needed and tolerated by the client.

Dextrothyroxine Sodium (Choloxin)

Clients with hypothyroidism have long been known to have elevated concentrations of plasma lipids. When treated with thyroid hormone, their plasma lipid concentration usually decreases. Likewise, clients with hyperthyroidism tend to have low plasma cholesterol levels—probably because thyroid hormone increases the elimination of cholesterol in the feces, as well as promoting the conversion of cholesterol to bile acids. These findings have resulted in the study of a number of compounds derived from thyroid hormones in an attempt to find agents to reduce serum lipid levels without producing increases in metabolism usually associated with thyroid hormone administration.

Dextrothyroxine sodium is a thyroid hormone derivative that reduces serum levels of cholesterol and LDL. Unfortunately, it often increases the frequency and severity of anginal attacks in clients with coronary heart disease and produces other *hypermetabolic* effects, such as arrhythmias, nervousness, sweating, and insomnia, in direct proportion to the dose administered. These findings, as well as the realization that dextrothyroxine may actually increase the mortality rate in clients with coronary heart disease, have led to recommendations that the drug be used only in clients who are free from coronary heart disease.

The use of dextrothyroxine may enhance the action of cardiac glycosides, as well as oral anticoagulants such as warfarin. This may require the use of reduced doses of these drugs when dextrothyroxine is used. Because dextrothyroxine may also increase blood sugar levels, diabetic clients using this agent may require higher doses of insulin or oral hypoglycemic agents (see Chapter 36 for a discussion of hyperglycemic and hypoglycemic drugs).

Dosage in clients who are euthyroid (have normal thyroid function) is initially started at 1 to 2 mg daily. If necessary, this dose is increased by 1 to 2 mg increments at monthly intervals until a maximum daily level of 4 to 8 mg is reached.

Cholestyramine (Questran, Cholybar) and Colestipol HCl (Colestid)

Cholesterol is the major precursor of bile acids. Bile acids are normally secreted into the intestines via the liver and gallbladder and promote absorption of lipids from ingested food. Most bile acids secreted into the intestine are reabsorbed and return to the liver by way of the enterohepatic circulation.

Several compounds, including cholestyramine and **colestipol HCl**, chemically combine with bile acids in the intestine to form an insoluble complex eliminated in the feces. This results in the partial removal of bile acids from the enterohepatic circulation; a proportional increase in the amount of cholesterol is broken down to bile acids and serum cholesterol levels are reduced.

Each of these binding agents is available as a dry powder or granular form that must be mixed with a liquid (water, milk, juice, etc.) or soft food (cereal, fruit, etc.) prior to administration. They should never be administered in dry form. The most common adverse reactions associated with the use of these agents involve the gastrointestinal tract and may include constipation, abdominal discomfort, nausea and vomiting, and diarrhea. Because of their ability to bind many drugs in addition to bile acids, cholestyramine and colestipol HCl must not be administered within 1 hour after or 4 hours before any other orally administered drug.

Table 34–2 lists the effects of antihyperlipidemic drugs on serum lipids and lipoproteins. Note that, in some cases, a drug may increase lipoprotein levels.

TABLE 34–2

Effects of Antihyperlipidemic Drugs on Serum Lipids and Lipoproteins

DRUG	USUAL DOSE	CHOLESTEROL (LIPID)	TRIGLYCERIDE (LIPID)	VLDL (LIPOPROTEIN)	LDL (LIPOPROTEIN)	HDL (LIPOPROTEIN)
atorvastatin *(a-tore-**VAS**-tah-tin)* (Lipitor)	10–80 mg/day	decrease	decrease	—	decrease	increase
cerivastatin *(sere-**VAS**-tah-tin)* (Baycor)	0.4 mg daily	decrease	decrease	—	decrease	increase
cholestyramine *(koh-less-**TEER**-ah-meen)* (Questran)	4 g 1–6 times daily	decrease	increase or unchanged	increase or unchanged	decrease	increase or unchanged
clofibrate *(kloh-**FYE**-brayt)* (Atromid-S)	2 g daily in divided doses	decrease	decrease	decrease	decrease or no change	increase or unchanged
colestipol *(koh-**LESS**-tih-pohl)* (Colestid)	2–16 g daily of tablets or 5–30 g daily of granules given once or in divided doses	decrease	increase or unchanged	increase	decrease	increase or unchanged
dextrothyroxine *(**decks**-troh-thigh-**ROCK**-sin)* (Choloxin)	*Adults:* 1–8 mg daily *Children:* 0.05–0.4 mg/kg/day	decrease	unchanged	unchanged	decrease	unchanged
fluvastatin *(**floo**-vah-**STAT**-in)* (Lescol)	20–40 mg daily as a single dose in the evening	decrease	decrease	decrease	decrease	increase
lovastatin *(**low**-vah-**STAT**-in)* (Mevacor)	10–80 mg daily in single or divided doses	decrease	decrease	decrease	decrease	increase
nicotinic acid *(**nick**-oh-**TIN**-ick **AH**-sid)*	1–2 g 3 times daily with or following meals	decrease	decrease	decrease	decrease	increase
pravastatin *(prah-vah-**STAT**-in)* (Pravachol)	10–20 mg once daily at bedtime	decrease	decrease	decrease	decrease	increase
probucol *(proh-**BYOU**-kohl)* (Lorelco)	500 mg twice daily with AM and PM meal	decrease	unchanged	decrease	decrease	decrease
simvastatin *(**sihm**-vah-**STAT**-in)* (Zocor)	5–40 mg daily as a single dose in the evening	decrease	decrease	decrease	decrease	increase

APPLYING THE NURSING PROCESS

ASSESSMENT

Assessment includes taking a health history, conducting a physical examination, obtaining blood studies to determine baseline values, and identifying the particular lipoprotein excess. The nurse should obtain information on the client's exercise patterns, dietary patterns, weight, use of alcohol and tobacco, and family history. Examination of the skin may result in identification of yellow nodules, or papules, called xanthomas, containing cholesterol.

Common nursing diagnoses for clients with hyperlipidemia include alteration in nutrition, more nutrient intake than body requirements, deficient knowledge about the health condition and lifestyle modifications used in treatment, and potential for nonadherence to the therapeutic regimen related to the side effects of drugs or to dietary restrictions.

NURSING DIAGNOSES

Including but not limited to:

- Ineffective health maintenance related to elevated cholesterol levels
- Risk for injury, stroke, or heart attack related to elevated cholesterol levels
- Deficient knowledge related to dietary needs and health requirements
- Risk for noncompliance related to adverse effects of medications and lack of symptoms of elevated LDL levels

PLANNING/GOALS

- Client will experience decreased cholesterol levels (<200 gm/dl), decreased triglyceride levels (35–160 mg/dl), and increased HDL (>45 mg/dl).
- Client will not experience injury due to elevated cholesterol levels.
- Client will demonstrate/verbalize understanding of appropriate behaviors to decrease cholesterol levels.
- Client will demonstrate compliance with hyperlipidemia therapy.

IMPLEMENTATION

Treatment of hyperlipidemia involves several measures in addition to drug therapy. Dietary treatment is usually initiated to encourage weight loss, if necessary, and to decrease the specific lipoproteins that may be excessive. Other health conditions associated with high lipoprotein levels (for example, diabetes mellitus and hypothyroidism) are treated at this time.

The treatment of hyperlipidemia is often long term. Client cooperation with the treatment plan may be difficult to obtain. The client and other family members must understand the purposes of dietary and drug treatment. Dietary instruction is provided to the client and the family member most responsible for meal preparation. The nurse develops a supportive relationship with the client and encourages follow-up visits to the physician.

In addition to these general nursing actions, specific measures are associated with the various drugs used to treat this health problem. For example, the use of clofibrate (**Atromid-S**) often results in constipation. This is particularly a problem in elderly persons and in those with cardiac diseases. Clients who develop this problem are encouraged to take plenty of fluids and to increase the amount of bulk in their diet.

If the client is taking probucol (**Lorelco**), the nurse must be aware that gastrointestinal side effects, particularly diarrhea, are common. These side effects are usually transient. Providing this information to the client may help to foster compliance.

Several problems can occur with use of nicotinic acid. Pruritus and flushing may diminish if small doses are taken initially and the dose increased gradually. If not contraindicated by the client's health condition or treatment plan, taking one adult aspirin tablet 30 minutes before the dose of nicotinic acid may decrease flushing and pruritus. Aspirin's antiprostaglandin activity may explain its effectiveness. Gastrointestinal symptoms, such as nausea, may be decreased by giving the medication with or following meals. Clients who are on long-term treatment may develop liver disease. The nurse reports any suspicion of jaundice to the physician.

NURSING CARE PLAN

A Client with Hyperlipidemia Receiving Lovastatin (Mevacor)

Louis Taylor, age 40, has accepted a position driving a tractor-trailer for a major trucking company. When he reports for a physical examination his height is 6'2" and weight is 232 pounds. His EKG is normal. Blood studies reveal elevated cholesterol count at 265 mg/dL and elevated triglycerides at 300 mg/dL. These elevations cause the physician to question Louis about other illnesses. He states he has never been sick. He smokes three packs of cigarettes a day and drinks an occasional beer. Family history reveals a father who died of heart attack at age 55, a mother with Type 2 diabetes mellitus still living at age 62, and a grandfather who had a stroke at age 60. The physician explains to Louis that he is prone to atherosclerosis, which could lead to coronary artery disease or stroke. He also needs to be checked for diabetes mellitus, hypothyroidism, nephrotic syndrome, and liver disease. In the meantime, Louis is given dietary instructions, including a weight reduction program, along with daily exercise. Four weeks later, cholesterol levels remain high, although the other examinations are negative. The physician at that time starts Louis on lovastatin (Mevacor) 20 mg daily to be taken with the evening meal. He is permitted to start his new job, with the provision that he must report to the company physician for laboratory tests and follow-up every month.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Dietary habits, food likes and dislikes.	Imbalanced nutrition: more than body requirements related to intake of foods high in fat and cholesterol.	Client identifies foods low in fat and cholesterol.	Teach client to eat less animal fat and meats. Polyunsaturated fatty acids, such as corn and soybean oil, lower serum cholesterol levels. Increase fiber, which increases fecal excretion of cholesterol.	Client adheres to a low-cholesterol, low-fat diet.
Dietary habits, body weight.	Imbalanced nutrition: more than body requirements related to intake greater than metabolic needs.	Client will begin and maintain a weight reduction program.	Teach client that weight control is based on eating less and exercising more. Plan for daily exercise. Avoid fat and fried foods. Use herbs and spices rather than gravies for flavor. Set a short-term goal of 1 to 2 lbs loss a week. Plan long-term goal of ideal body weight for next year.	Client loses 12 pounds in the first month and starts daily walks.
Smoking, alcohol consumption.	Risk for ineffective health maintenance related to risk of atherosclerosis secondary to unhealthy behaviors.	Client will identify and reduce risks by eliminating alcohol and smoking.	Encourage client to begin a smoking cessation program and make other changes in lifestyle to reduce cardiac risk.	Client cuts down to one pack of cigarettes a day or less.
Stress, coping mechanisms.	Risk for ineffective individual coping related to lifestyle changes to reduce risks.	Client will be able to identify positive approach to lifestyle changes.	Encourage client to modify Type-A behavior. Attempt to find ways to reduce competitiveness, time urgency, hostility, and aggressiveness. Encourage client to adopt relaxation techniques to reduce stress.	Client is able to identify behavior patterns and works toward a more relaxed lifestyle.

Knowledge of drug therapy.	Deficient knowledge related to the use of lovastatin to lower serum cholesterol levels.	Client will describe treatment regimen with lovastatin, including adverse reactions and what to report.	Teach client that drug works best when taken with food. It usually works better with the evening meal, as that is usually the heaviest of the day. Cholesterol levels are controlled with diet, exercise, and weight reduction at same time as medication. Client needs follow-up liver function tests every 4–6 weeks. He is instructed to report evidence of jaundice or malaise. He should also be taught to report vision changes, as opacity of lens may develop from lovastatin.	Client maintains daily dosage of 20 mg with the evening meal. Client keeps follow-up visits.

Clients taking dextrothyroxine sodium (**Choloxin**) are observed carefully for metabolic effects such as increase in blood sugar levels, cardiac arrhythmias and angina. A reduction in dosage or discontinuance of dextrothyroxine may be necessary if these problems occur.

Several nursing measures are important in caring for clients taking the exchange resins cholestyramine (**Questran**) and colestipol HCl (**Colestid**). The first measure concerns the proper method of administration. The powder must not be administered in a dry form, but rather be mixed with a noncarbonated beverage, high-fluid-content soup or pureed fruit such as applesauce. The nurse must also teach the client to take other drugs 1 hour before—or 4–6 hours after—these drugs. Another nursing consideration is the prevention or early detection of adverse side effects. Constipation may worsen existing hemorrhoids. This side effect occurs in many clients and may be minimized through the use of a diet high in bulk and fluids and by stool softeners. Long-term use of these exchange resins is sometimes associated with the development of electrolyte and/or metabolic disturbances. These include elevated chloride levels and deficiencies of fat-soluble vitamins, particularly vitamins A, D, and K. The most serious of these is probably the development of bleeding tendencies because of hypoprothrombinemia as a result of low vitamin K levels. Such clients may require the parenteral administration of the deficient vitamins.

Several nursing considerations apply to clients taking HMG-CoA reductase inhibitors, such as atorvastatin, cerivastatin, fluvastatin, lovastatin , pravastatin , or simvastatin. The first, as with the other agents discussed, is to continue the prescribed diet throughout treatment with these drugs. The second is to report evidence of visual problems, jaundice, or other indications of liver problems, such as malaise, or unexplained muscle pain. Clients are encouraged to keep all appointments for eye examinations and blood testing for liver function. Instruct the client to take lovastatin with meals to increase its absorption. If a once daily dose is prescribed, the drug should be taken with the evening meal.

EVALUATION

- Client experiences cholesterol levels of 170 to 180 mg/dl, triglyceride levels of 90 to 110 mg/dl, and HDL of 60 mg/dl.
- Client does not experience injury due to elevated cholesterol levels.
- Client demonstrates/verbalizes understanding of appropriate behaviors to decrease cholesterol levels.
- Client demonstrates compliance with diet, weight loss, nonsmoking behaviors, and with antihyperlipidemia drug therapy.

KEY NURSING IMPLICATIONS 34–1

Clients Receiving Treatment for Hyperlipidemia

1. Assessment includes taking a personal and family health history, conducting a physical examination and obtaining laboratory studies. Ask about exercise, diet, and use of alcohol and tobacco. Measure body weight.
2. The treatment of hyperlipidemia is long term. Client compliance is important but may be difficult to obtain.
3. Gastrointestinal symptoms, such as nausea, may be decreased by giving nicotinic acid with or following meals.
4. Clients taking dextrothyroxine sodium are observed for an increase in blood sugar level, cardiac arrhythmias, and angina.
5. Administer exchange resins mixed with a noncarbonated beverage, high-fluid-content soup or pureed fruit, such as applesauce.
6. Other drugs must be taken 1 hour before or 4–6 hours after exchange resins.
7. Exchange resins and clofibrate may produce constipation. This is minimized by diets high in bulk and fluid and by the use of stool softeners.
8. Exchange resins may produce a deficiency of fat-soluble vitamins. Monitor the client for the development of bleeding tendencies.

HOME CARE / CLIENT TEACHING

1. Treatment for hyperlipidemia is long-term, and clients may become discouraged or experience troublesome side effects and may stop taking their medication regularly. It is useful to reinforce the importance of regular use of the medication and adherence to special diets. It may be helpful to assist clients in tracking the relationship between dietary and drug compliance and the results of blood studies.
2. Clients with elevated LDL cholesterol levels need to be instructed concerning appropriate dietary limitations, including decreasing saturated fats and carbohydrates.
3. Clients with hyperlipidemia should be encouraged to remain or become smoke-free.
4. Clients taking antihyperlipidemia medications should be instructed to drink plenty of fluids (2–3 liters or 2,000–3,000 ml/day unless contraindicated) and to increase the amount of bulk in their diet.
5. Clients should be informed of adverse effects associated with antihyperlipidemia medications and how to decrease these symptoms.
6. Clients taking cholestyramine and colestipol HCl should be informed that the powder form of these medications come in should not be administered in the dry form, but should be mixed with a noncarbonated beverage, high-fluid-content soup, or pureed fruit, such as applesauce.
7. Clients taking antihyperlipidemia medications should be encouraged to keep all follow-up appointments for eye examinations and blood tests.
8. Clients taking lovastatin should be instructed to take medication with meals and to report any visual changes, jaundice, malaise, and unexplained muscle pain.
9. Clients taking antihyperlipidemia drugs should be informed that lowering their cholesterol and triglyceride levels is a long-term process and that compliance with therapy is critical to success.

CASE STUDY

George Sepick, age 59, has a strong family history of heart disease and atherosclerosis. Laboratory tests indicate that Mr. Sepick has a blood cholesterol level of 300 mg/dL (normal 150–240 mg/dL), so Dr. Rapp orders:

- Cholestyramine (Questran) powder 1 packet bid
- Referral to a dietician for instruction regarding a low-cholesterol diet

The client is instructed to begin therapy and to call the office nurse in 3 days to report his progress. When he calls, Mr. Sepick tells the nurse that he is doing fine, except for an upper respiratory infection he has developed. He indicated that he is taking a cold remedy for it.

Questions for Discussion

1. Before beginning therapy with cholestyramine, what instructions should Mr. Sepick be given about its administration?
2. What side effects of cholestyramine therapy should the nurse know about to respond appropriately to Mr. Sepick's report?
3. What advice should the nurse give Mr. Sepick about the timing of the cold remedy he is taking?

CRITICAL THINKING EXERCISES

1. Prepare a visual aid showing the pathway for synthesis of lipoproteins.
2. Prepare a chart comparing the different forms of hyperlipidemia.
3. Obtain copies of the five therapeutic diets suggested by the National Heart, Lung, and Blood Institute for the treatment of the five types of hyperlipidemia. Compare the foods permitted on these diets. Explain the similarities and differences.
4. Prepare a brief paper on the risk factors associated with coronary heart disease. Why are diseases associated with atherosclerosis more common in industrially developed than in undeveloped countries?
5. Prepare a visual aid showing the difference between arteriosclerosis and atherosclerosis.

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SECTION 10

Agents Used to Correct Hormonal Imbalance

MAJOR NURSING DIAGNOSES

- Deficient Fluid Volume
- Excess Fluid Volume
- Disturbed Sleep Pattern
- Disturbed Body Image
- Ineffective Health Maintenance
- Imbalanced Nutrition: Less Than Body Requirements
- Imbalanced Nutrition: More Than Body Requirements
- Risk for Impaired Skin Integrity
- Deficient Knowledge (Illness and Its Treatment)
- Low Self-Esteem

35 Agents Affecting Thyroid, Parathyroid, and Pituitary Function

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the mechanism by which thyroid hormones are synthesized in the body
- Identify symptoms that may accompany hyperthyroidism and hypothyroidism
- Describe the mechanism by which each of the following forms of therapy relieves symptoms of hyperthyroidism:
  - antithyroid drugs
  - iodides
  - radioactive iodine (I 131)
  - potassium perchlorate
  - beta-adrenergic blocking agents
  - surgery
- Compare the difference in cause of primary, secondary and tertiary hypothyroidism
- Compare the derivation and action of each of the following thyroid hormone sources:
  - desiccated thyroid
  - thyroglobulin
  - levothyroxine sodium
  - liothyronine sodium
  - liotrix
- Discuss the normal function of the parathyroid glands
- Compare the causes, symptoms, and treatment of hypoparathyroidism and hyperparathyroidism
- List the hormones secreted by the anterior pituitary and the posterior pituitary glands
- Compare the causes, symptoms, and therapy of hypopituitarism, hyperpituitarism, and diabetes insipidus
- List the factors that should be included in the teaching plan for clients undergoing drug therapy for diseases of the thyroid, parathyroid, and pituitary glands
- Identify the precautions to be taken when administering thyroid preparations
- List the radiological safety precautions related to the treatment of hyperthyroidism with I 131
- Identify agents used to treat thyroid, parathyroid, or pituitary disorders that should be avoided by pregnant women and nursing mothers
- Define thyroid storm and distinguish its treatment from that of other thyroid conditions

- Identify the appropriate routes of administration for human growth hormone, corticotropin, and vasopressin
- Outline appropriate nursing assessment of persons taking drugs affecting thyroid, parathyroid, or pituitary function
- Apply the nursing process related to caring for clients receiving therapy for diseases of the thyroid, parathyroid, or pituitary gland

The thyroid gland lies on either side of the neck in the region of the larynx. Its chief function is to maintain the metabolic rate of the body in order to meet the body's needs. This is accomplished by the secretion of two thyroid hormones, triiodothyronine (T_3) and thyroxine (T_4). T_3 has about four times the biologic potency as T_4. The synthesis of these hormones takes place in a series of chemical steps. Iodides consumed in food and water are absorbed and enter the bloodstream. When blood passes through the thyroid gland, iodide is trapped and converted to iodine. This iodine is then combined with the amino acid tyrosine to form iodotyrosine. Finally, iodotyrosine molecules are combined to form T_3 and T_4 which are then stored in the gland until they are released (Figure 35–1). When T_4 is released into the bloodstream, a portion of it is converted to T_3.

The synthesis of thyroid hormones is dependent on the anterior pituitary hormone thyrotropin (thyroid-stimulating hormone, TSH). The release of this hormone is in turn controlled by a *negative feedback mechanism*, which results in a suppression of TSH release when levels of thyroid hormone in the blood increase.

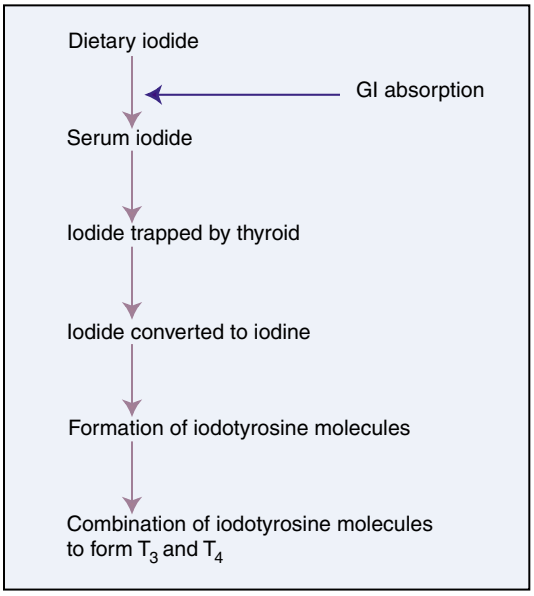

Figure 35–1 Summary of steps in the biosynthesis of the thyroid hormones T_3 and T_4

Thirteen million people in the United States have some type of thyroid dysfunction, and 8 million are not even aware of their conditions. Twenty-five of every 10,000 Americans have Graves' disease (hyperthyroidism).

THYROID DISORDERS

Thyroid hormones play many important roles in the human body. They aid in the regulation of lipid and carbohydrate metabolism and are essential for normal growth and development. In addition, thyroid hormones affect heat production within the body. When a hyperthyroid state exists, body temperature often increases. A decrease in body temperature is often evident when a hypothyroid state is present. Thyroid hormones also exert complex metabolic effects on the body. They appear to promote the metabolic breakdown of cholesterol to bile acids and they tend to accelerate the utilization of carbohydrates in the body. Because of these wide-ranging effects, dysfunction of the thyroid gland may have many serious consequences.

Hyperthyroidism

Excessive secretion of thyroid hormone by the thyroid gland results in increased levels of metabolism in virtually all physiological systems within the body. Most of the symptoms observed in clients with hyperthyroidism stem from the excessive production of heat, motor activity and excessive activity of the sympathetic nervous system (see Chapter 15). Typical clinical symptoms of hyperthyroidism include weight loss frequently accompanied by increased appetite, muscle weakness, fatigue, palpitations, irritability, nervousness, sleep

TABLE 35–1

Classification of Hyperthyroidism

TYPE	DESCRIPTION
Graves' disease	Most common form of hyperthyroidism. Occurs five times more frequently in women than in men. Most common onset is between 30 and 40 years of age. Strong familial association in its development. Symptoms include thyroid gland enlargement and ophthalmopathy.
toxic nodular disease (Plummer's disease)	Least common form of hyperthyroidism. Usual onset is between 40 and 50 years of age. A single nodule, usually 3–5 cm in diameter, produces excessive amounts of thyroid hormone. This results in a suppression of activity in other parts of the gland.
multinodular disease	Several nodules may be present on the gland. Client may remain asymptomatic until spontaneous hyperactivity of one or more nodules takes place. Cardiovascular symptoms often develop.
drug-induced hyperthyroidism	May be caused by iodide supplementation in clients who have been iodide deficient. May also be caused by excessive doses of thyroid hormones.
thyroid storm	An acute overproduction of thyroid hormone which may be precipitated by increased stress or infection. May cause death if not promptly treated.

disorders, flushing, heat intolerance, tremors, altered menstrual flow, diarrhea, and exophthalmos.

Hyperthyroidism may result from a variety of different disease states, even though the ultimate symptoms observed are often quite similar. Table 35–1 summarizes these disorders and their characteristics. Treatment of hyperthyroidism may involve the administration of antithyroid drugs, iodides, ionic inhibitors, beta-adrenergic blocking agents, and/or radioactive isotopes of iodine. In some clients surgery may be a viable form of therapy.

Antithyroid Drugs. Two chemically related antithyroid drugs, **propylthiouracil** (PTU) and **methimazole** (**Tapazole**), have emerged as effective means of controlling hyperthyroidism. They act by inhibiting the coupling of iodine to tyrosine and thereby prevent the formation of thyroid hormones in the gland. PTU also has the added effect of interfering with the conversion of T_4 to T_3 in the peripheral circulation. It may therefore be the preferable agent to use in acute cases of hyperthyroidism.

Adverse effects observed in clients using these drugs are not common. Some clients develop a mild skin rash that often subsides spontaneously or on changing drugs. The development of agranulocytosis has been reported in a small number of clients. This condition develops rapidly, so clients should be instructed to report any signs of sore throat or fever immediately, as they often precede this adverse effect.

Iodides. These drugs have been shown to be useful in treating mild cases of hyperthyroidism, particularly in young clients. When administered in appropriate doses, iodides inhibit the production of thyroid hormones by antagonizing the ability of thyrotropin to stimulate thyroid hormone secretion. Such therapy may relieve symptoms of hyperthyroidism within 24 hours. Iodides exert their maximal suppressive effect within 10–15 days of continuous therapy. A limitation in the use of these agents for this purpose is the phenomenon in which the thyroid gland "escapes" from iodide inhibition of hormone production. This may occur after only a week or two of therapy.

Iodides may be administered in several different forms. The most popular are Lugol's solution (Strong Iodine Solution)—which contains 5% iodine and 10% potassium iodide—and Saturated Solution of Potassium Iodide (SSKI).

Sodium Iodide I 131. Radioactive isotopes of iodine, particularly **sodium iodide I 131** are commonly used for the diagnosis and treatment of hyperthyroidism. When administered orally or intravenously, I 131 is rapidly taken up and stored by the thyroid gland. Destructive radiation (beta rays) is emitted by the trapped isotope, which effectively destroys thyroid cells without appreciably damaging surrounding tissue. The extent of thyroid damage can be predetermined by carefully selecting the proper dose of isotope. Low doses are used diagnostically and pose a minimal risk to thyroid tissue, although high doses can effectively destroy all thyroid function. As the I 131 isotope has a *half-life* of only 8 days, more than 99% of the radiant energy emitted by a given dose will be dissipated within about 56 days. Appropriate administration of this isotope will cause a reduction in thyroid hormone production. Therefore, clients undergoing this therapy must be continually monitored for the development of hypothyroidism.

Ionic Inhibitors. The perchlorates are ionic inhibitors that closely resemble the iodide ion and are concentrated by the thyroid gland in a similar fashion. This diminishes the ability of the gland to trap iodide and, therefore, to form thyroid hormone. **Potassium perchlorate** has been employed in this manner with some success, but its use has virtually disappeared because of its association with the development of aplastic anemia in some clients.

Beta-Adrenergic Blocking Agents. Propranolol (Inderal) and other beta-adrenergic blocking agents have been used successfully in suppressing some of the signs and symptoms of hyperthyroidism. Although these agents do not inhibit the functioning of the thyroid gland, their ability to block the tachycardia, tremor, and anxiety often associated with hyperthyroidism makes them useful adjuncts to other forms of therapy, particularly before the other measures have begun exerting their effect.

Table 35–2 lists the properties of drugs used to treat hyperthyroidism.

Surgery. Surgical removal of part of the thyroid gland (subtotal thyroidectomy) is an effective means of treating hyperthyroidism, particularly when other forms of therapy might be contraindicated (e.g., in pregnancy and in young children). Prior to surgery, the client is brought to a *euthyroid* state with the use of agents that suppress thyroid function. A beta-adrenergic blocking agent may be given to control symptoms.

Hypothyroidism

Thyroid hormone deficiency may be caused by a number of different disease states. The deficiency may result in primary, secondary, or tertiary hypothyroidism. Primary hypothyroidism is the consequence of an abnormality of the thyroid gland, itself. The condition may be the result of a disorder of the iodide trapping mechanism, the conversion of iodide to iodine, the coupling of iodine with tyrosine, and/or the release of thyroid hormone from its storage sites in the body.

Secondary hypothyroidism is the result of a disorder of the anterior pituitary gland in which inadequate concentration of thyroid-stimulating hormone (TSH) is released. This, in turn, diminishes the production of thyroid hormone and results in the development of hypothyroidism.

Tertiary hypothyroidism may stem from a reduction in the secretion of thyrotropin-releasing hormone by the hypothalamus. As this hormone is believed to stimulate the release of TSH from the pituitary gland, it may also eventually result in a reduced output of thyroid hormone.

Hypothyroidism may be further classified as being nongoitrous or goitrous. Goiters are thyroid glands that have enlarged as a result of excessive stimulation by TSH. Such elevated TSH levels are caused by low levels of circulating thyroid hormone.

Although each of the forms of hypothyroidism may be caused by a number of possible factors (e.g., surgery or radiation), primary hypothyroidism is the most common. Table 35–3 lists some common forms of hypothyroidism. Whatever its form, hypothyroidism results in the development of many symptoms, including thickened skin, hair loss, lethargy, constipation and anorexia. Cretinism in an infant results from absence or atrophy of the thyroid gland during fetal life.

The primary objective in treating the hypothyroid client is to achieve a euthyroid state by supplying the body with appropriate concentrations of T_3 and/or T_4. Consideration must also be given to preventing adverse effects possible when thyroid hormone levels are increased, particularly in clients with preexistent cardiovascular and/or central nervous system (CNS) disorders.

Thyroid hormone is available for oral administration in a variety of different products. Some contain extracts of the thyroid glands of slaughterhouse animals such as cattle or hogs. Others may contain pure forms of T_3 and/or T_4 that have been synthetically derived. Although all of these

TABLE 35–2

Drugs Used to Treat Hyperthyroidism

Note: Assess clients for the development of hypothyroidism, including intolerance to cold, depression, edema, and fatigue.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
Antithyroid Drugs			
methimazole *(meth-**IM**-ah-zohl)* (Tapazole)	oral	*Adults:* 5-20 mg every 8 hours initially, then 5–15 mg daily *Children:* Initially, 0.4 mg/kg/day administered in 3 doses at 8-hour intervals; then 0.2 mg/kg/day	Observe for signs of agranulocytosis (e.g., sore throat, fever, headache, malaise). Report immediately. Caution client not to exceed recommended dose. Pregnant clients should discuss continued treatment with the physician. Periodic blood counts should be done. Drug is usually discontinued if severe rash, agranulocytosis or enlarged cervical lymph nodes develop.
propylthiouracil, PTU *(**proh**-pill-**thigh**-oh-**YOU**-rah-sill)* (Propyl-Thyracil ✱)	oral	*Adults:* Initially, 300–900 mg daily divided into 3 doses given at 8-hour intervals; then maintain at 100–150 mg daily *Children (6–10 years):* Initially 50–150 mg/day; then dose according to response *Children (10 years and over):* Initially 150–300 mg/day; then dose according to response	See methimazole. Monitor prothrombin time, as drug may cause hypoprothrombinemia. Use carefully in clients taking anticoagulants.
Iodides			
potassium iodide, sodium iodide *(pot-**TASS**-ee-um **EYE**-oh-dyd, **SOH**-dee-um **EYE**-oh-dyd)*	oral	as required 250 mg 3 times a day	Monitor for symptoms of iodism, including metallic taste, fever, skin rash, and/or mucous membrane lesions. May be diluted with water, fruit juice, or milk to improve taste. Liquid preparations may be given through a straw to minimize unpleasant taste. Contraindicated in iodine sensitivity.
strong iodine solution (Lugol's solution)	oral	0.3 mL 3 times daily	See potassium iodide.
Radioactive Iodine (RAI)			
sodium iodide I 131 *(**SOH**-dee-um **EYE**-oh-dyd eye-131)* (Iodotope, etc.)	oral	Dose depends on use	Not generally administered to clients under 30 years of age or to pregnant or lactating women.

continues

TABLE 35–2 *continued*

See **Note** at beginning of Table 35–2, page 676.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
sodium iodide I 131 *continued*			The recent use of radiographic contrast media, thyroid, or antithyroid medications or iodine-containing products may affect the uptake of this agent by the thyroid gland. Such drugs are usually discontinued for a week before I 131 treatment is begun. Use precautions for 6–8 hours when handling vomitus and urine. Additional precautions depend upon dose used.
Beta-Adrenergic Blocking Agents			
propranolol *(proh-**PRAN**-oh-lohl)* (Detensol ✤, Inderal)	oral	10–30 mg 3–4 times daily	Monitor for development of bradycardia, cardiac failure, hypotension and/or bronchospasm. Do not administer if apical pulse rate is below 60. Monitor diabetics carefully as this drug masks signs and symptoms of hypoglycemia.

products may be effective in the treatment of hypothyroidism, selection of the most appropriate agent is based on the relative proportion of T_3 and T_4 in each dose, the cost of the preparation, and the duration of action desired.

Thyroid USP. This preparation contains desiccated or dried thyroid obtained from animal thyroid glands. It is standardized according to its iodine content and may have a variable ratio of T_4 to T_3 depending on its animal source. This may cause some variability of response when different sources of the product are used. Because this form of thyroid supplement contains animal protein and other impurities, decomposition and hypersensitivity reactions may be evident. **Thyroid USP** remains quite popular, however, because it is the least costly source of thyroid hormone. It is particularly useful in controlling stabilized euthyroid clients who require long-term thyroid hormone supplementation.

Thyroglobulin (Proloid). This is a purified extract of hog thyroid that has been biologically standardized to produce a T_4:T_3 ratio of 2.5:1. It is somewhat more expensive than desiccated thyroid and offers no appreciable advantage over it.

Levothyroxine Sodium (Synthroid, etc.). The most widely prescribed synthetic thyroid hormone preparation is **levothyroxine sodium**, or T_4. It offers the advantage of chemical purity, moderate cost, and a relatively long (7-day) half-life. This half-life permits T_4 to be administered in a once-daily dosage regimen, possibly increasing client compliance with long-term therapy.

Liothyronine Sodium (Cytomel, Triostat). The agent **liothyronine sodium** or T_3 is also a pure synthetically derived thyroid hormone. It is not usually considered the ideal drug for long-term supplemental therapy as it is relatively expensive and has a much shorter half-life (1½ days) than levothyroxine sodium. Because it tends to produce a clinical response about four times as rapidly as T_4, the use of T_3 has been associated with the development of a greater magnitude of adverse cardiac effects.

TABLE 35–3

Classification of Hypothyroidism

TYPE	DESCRIPTION
Nongoitrous (No Gland Enlargement)	
idiopathic atrophy	Atrophy of the gland, usually the result of another disease process.
iatrogenic hypothyroidism	Treatment-induced destruction of the gland that may be caused by surgery, radioactive iodine therapy, or X-ray therapy.
cretinism (congenital hypothyroidism)	May result from a deficiency of thyroid hormone in the fetus. This may be caused by inadequate thyroid hormone synthesis, pituitary or hypothalamic dysfunction, or incomplete growth of the gland. If untreated, this condition results in neurological damage and impaired growth and development. Condition may be goitrous if induced by maternal thyroid deficiency.
secondary hypothyroidism	Thyroid dysfunction caused by pituitary dysfunction.
tertiary hypothyroidism	Thyroid dysfunction caused by hypothalamic dysfunction.
Goitrous (Gland Enlargement)	
dyshormonogenesis	Refers to a disorder in which the synthesis, transport, or action of thyroid hormone is impaired.
Hashimoto's thyroiditis	Immunological disturbance resulting in the inability of the thyroid gland to bind iodides effectively.
drug-induced hypothyroidism	Some drugs that may interfere with thyroid activity include iodides, lithium, phenylbutazone, and some oral antidiabetic agents used to treat diabetes mellitus.
iodide deficiency	Caused by prolonged dietary deficiency of iodide. If the population of an entire geographical area is involved it is called endemic hypothyroidism.
diet-induced hypothyroidism	Consumption of large amounts of goitrogenic foods (e.g., cabbage, rutabagas, and turnips) may produce hypothyroidism. It is believed that these foods contain thiocyanate, a substance that may inhibit iodine trapping by the thyroid gland.

Liotrix (Euthroid, Thyrolar). Several commercial products contain **liotrix**, a combination of T_4 and T_3 in a ratio of 4:1. This fixed ratio was chosen because it mimics the composition of normal thyroid secretions. Although such products are effective, they are relatively expensive and offer no significant advantage over less expensive thyroid hormone products, as much of the T_4 component of these products is converted to T_3 within the body.

Table 35–4 lists the thyroid hormone products currently in use.

PARATHYROID DISORDERS

The parathyroid glands are pinhead-sized structures located on either side of the thyroid gland. Their primary function is the secretion of parathyroid hormone (PTH, parathormone), a substance secreted in response to a reduction of the serum calcium level. Parathyroid hormone appears to increase the serum calcium level by three different mechanisms: (1) it promotes bone *resorption*, (2) it increases the absorption of calcium from the intestine, and (3) it may increase the reabsorption of

TABLE 35–4

Thyroid Preparations

Note: Thyroid drugs must be used carefully in clients with cardiovascular disorders.

Report chest pains immediately.

Check apical pulse before administering.

Withhold if pulse rate is above 100 beats per minute in adults or in excess of the normal range in children.

Report changes of heart rhythm to prescriber.

Administer early in the day to avoid insomnia.

Thyroid preparations are generally discontinued from one to several weeks before thyroid function tests are scheduled.

The dosage of oral anticoagulants may have to be decreased, with dosages of insulin and oral hypoglycemics possibly needing to be increased.

Report signs of hyperthyroidism, including loss of weight, palpitations, excessive perspiration, insomnia and rapid pulse.

DRUG	COMPOSITION	USUAL DOSE	NURSING IMPLICATIONS
thyroid, desiccated *(**THIGH**-royd, **DESS**-ih-kay-ted)* (Thyroid USP)	defatted, desiccated hog, beef or sheep thyroid gland	16–195 mg daily	May deteriorate on prolonged storage.
thyroglobulin *(thigh-roh-**GLOB**-you-lin)* (Proloid, etc.)	partially purified pig thyroglobulin	16–160 mg daily	Each grain of thyroglobulin is equivalent to one grain of thyroid USP.
levothyroxine sodium (T_4) *(**lee**-voh-thigh-**ROCK**-sin **SOH**-dee-um)* (Synthroid, Levothroid, etc.)	synthetic, pure T_4	0.0125–0.2 mg daily	0.1 mg (100 mcg) of T_4 is approximately equivalent to 65 mg (1 grain) of thyroid USP. May also be given IM or IV. The IV dose must be prepared immediately before use.
liothyronine sodium (T_3) *(**ly**-oh-**THIGH**-roh-neen **SOH**-dee-um)* (Cytomel, etc.)	synthetic, pure T_3	5–100 mcg daily	25 mcg of T_3 is approximately equivalent to 65 mg (1 grain) of thyroid USP.
liotrix *(**LY**-oh-tricks)* (Euthroid, Thyrolar)	T_4:T_3 in 4:1 ratio by weight	Based upon need for T_4 and T_3	See T_4 and T_3. Client should not change from one brand to the other unless instructed to do so by the prescriber.

calcium by the renal tubules. Parathormone also tends to decrease the renal tubular absorption of phosphate.

When calcium levels of the blood increase, there is a reduction of PTH secretion and a second hormone, **calcitonin**, is released by specialized cells of the thyroid gland in humans. Calcitonin tends to reduce the serum calcium level by inhibiting bone resorption and, with PTH, helps to finely regulate the serum calcium level.

Hypoparathyroidism

A deficiency of parathormone may occur in some individuals for a variety of reasons ranging from a congenital absence of the parathyroid glands to surgery involving the thyroid gland. Such a deficit results in a reduction of serum calcium levels, elevated phosphate level and a wide array of symptoms, including increased neuromuscular irritability and psychiatric disorders.

The treatment of hypoparathyroidism focuses on the replenishment of calcium stores to reverse the client's hypocalcemia. This can be accomplished in acute cases by the intravenous administration of calcium salts, particularly **calcium chloride** and calcium gluconate. Once the acute phase of hypocalcemia has subsided, oral therapy with calcium supplements can be administered. See Chapter 33 for a discussion of calcium supplement products.

Vitamin D is also frequently administered to clients with hypoparathyroidism to promote calcium absorption from the GI tract and to further stabilize a client's condition. See Chapter 33 for a discussion of vitamin D action.

Hyperparathyroidism

Hypersecretion of parathormone is generally the result of either an *adenoma* or *carcinoma* of the parathyroid gland. Clinically, this condition results in elevated serum calcium levels due to stimulation of bone resorption by PTH and a reduction of serum phosphate levels. When the blood calcium level reaches an appropriate threshold concentration, calcium concentration in the urine begins to increase and calcification of the renal tubules may occur.

Therapy of hyperparathyroidism often includes surgery. However, phosphate supplementation and/or potent diuretics, such as furosemide (Lasix), may be administered to promote an increase in the excretion of excess calcium. Within the last several years, the use of calcitonin (particularly salmon calcitonin) has emerged as a means of treating hypercalcemia caused by hyperparathyroidism. Salmon calcitonin is considerably more potent and has a longer duration of action than human calcitonin. It is available commercially by the brand names **Calcimar** and **Miacalcin**. These agents are usually administered subcutaneously or intramuscularly at a dose of 50–100 International Units (IU) per day.

Calcitonin-human (**Cibacalcin**) is a synthetic hormone that has the same chemical structure as naturally occurring human calcitonin. Although it is less potent than salmon calcitonin, calcitonin-human may be useful for clients who have developed resistance to nonhuman calcitonin or in clients who have hypersensitivity to the nonhuman hormone. Calcitonin-human is usually administered subcutaneously at a dose of 0.25 to 0.5 mg daily.

Etidronate disodium (**Didronel**) and **pamidronate disodium** (**Aredia**) are synthetic agents that reduce normal and abnormal bone resorption and thereby reduce calcium levels in the blood. These drugs do not appear to alter renal tubular reabsorption of calcium, but appear to inhibit the dissolution of hydroxyapatite crystals in bone tissue. Etidronate and pamidronate are employed in treating hypercalcemia associated with malignancy. Etidronate is also used to prevent ossification of surrounding tissue after total hip replacement or spinal injury and in treating *Paget's disease* of bone.

When given orally, etidronate disodium is administered in a dose of 5–10 mg/kg/day for up to 3 months. Additional courses of therapy may be provided after the client has been free of the drug for at least 90 days. When administered intravenously, etidronate disodium is given in a dose of 7.5 mg/kg/day for 3 successive days. Generally, the oral form then is employed for maintenance therapy.

Pamidronate is usually administered by IV infusion in a dose of 60–90 mg given over a 24-hour period. Retreatment may occur after a minimum of 7 days has elapsed since the last treatment.

PITUITARY DISORDERS

The pituitary gland is perhaps the most remarkable organ in the human body. Although it is quite small in size, it is considered to be the master gland, as it regulates and coordinates the action of other endocrine glands and influences the growth and development of the body.

The gland consists of two parts, which may be regarded as two separate organs, the anterior pituitary and the posterior pituitary. The anterior lobe secretes a variety of different hormones (Figure 35–2). These include:

- adrenocorticotropic hormone (ACTH)
- human growth hormone (HGH)
- prolactin
- follicle-stimulating hormone (FSH)
- luteinizing hormone, interstitial cell-stimulating hormone (LH, ICSH)
- thyroid-stimulating hormone (TSH, **thyrotropin**)
- melanocyte-stimulating hormone (MSH)

The posterior lobe of the pituitary secretes two additional hormones:

- posterior pituitary hormone (**vasopressin**)
- **oxytocin**

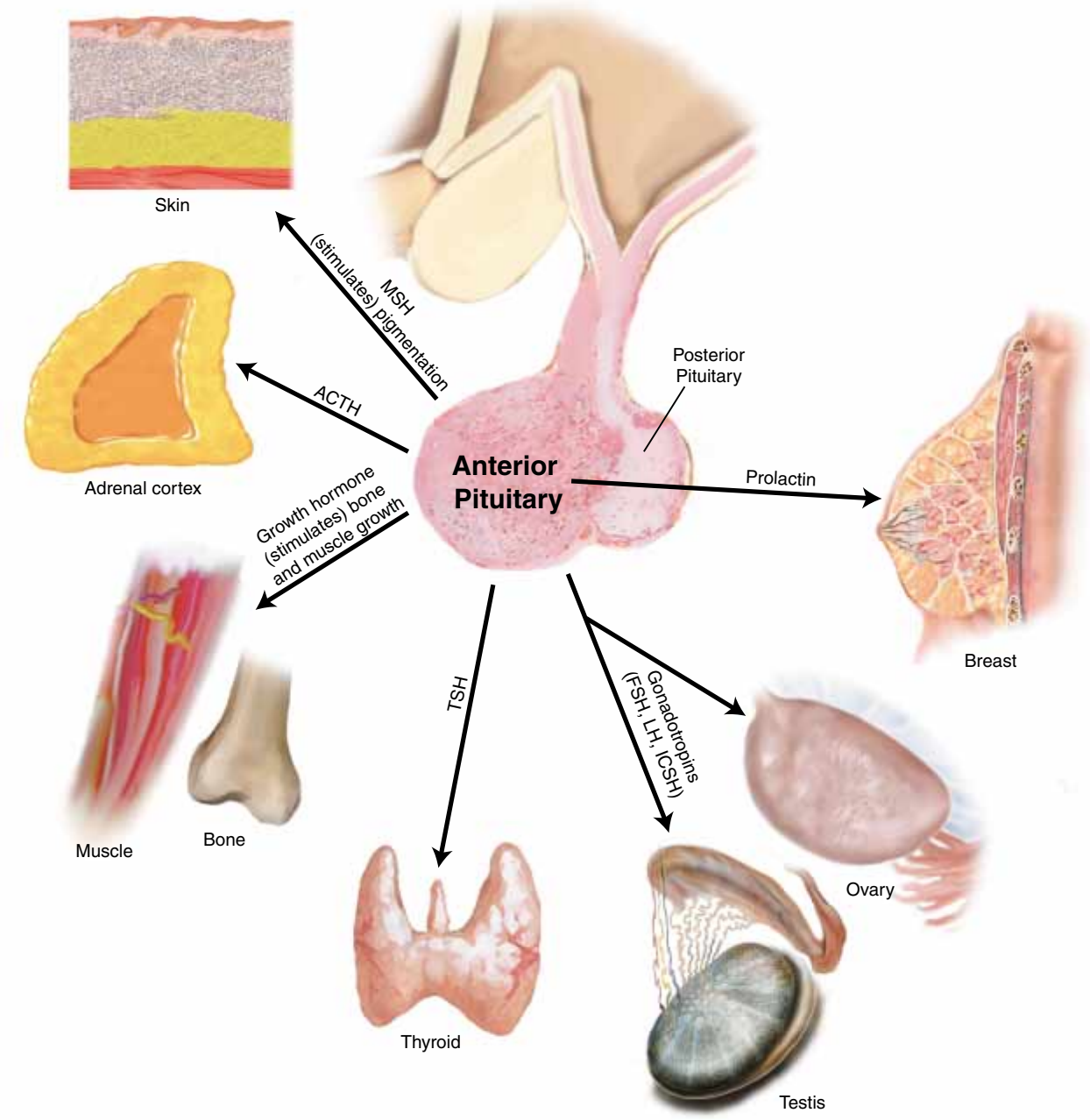

Figure 35–2 Hormones secreted by the anterior pituitary.

Hypopituitarism

The underproduction of pituitary hormones may be a congenital dysfunction or it may be the result of pituitary damage caused by surgery, radiation, tumors, or other conditions. Therapy is generally focused on the replacement of corticosteroids, thyroid and sex hormones that may not be secreted in adequate concentrations in the affected client.

In the young, hypopituitarism may be the cause of dwarfism, a condition manifested by slow growth and development. Therapy for such clients may include the administration of **somatropin** (**Humatrope**, **Nutropin**) or **somatrem** (**Protropin**) to prevent serious growth impairment. These human growth hormone products are prepared by recombinant DNA technology. Before reconstitution, they should be kept refrigerated. After reconstitution, somatropin solutions are stable for 14 days and somatrem solutions for 7 days, if kept under refrigeration. Somatropin is dosed based on weight initially 6 mcg/kg with children's doses 0.16–0.3 mg/kg per week. Somatrem is usually ordered at 0.3 mg/kg per week.

Hyperpituitarism

Overproduction of pituitary hormones is generally caused by a functioning benign tumor, or adenoma. This condition may affect the secretion of one or more pituitary hormones and may result in a variety of clinical symptoms. The most dramatic of these are gigantism and *acromegaly*. Gigantism results when a hypersecretion of growth hormone occurs prior to the closure of the *epiphyses* of the long bones. As a result, body growth is accelerated, with some clients growing to a height of 8 feet. Hypersecretion of growth hormone in adults produces normal stature, but enlarged hands, feet, and facial features. The disorder is called acromegaly.

Treatment of hyperpituitarism usually involves the use of chemotherapy, radiation, or surgery to inactivate or remove the gland.

Diabetes Insipidus

Diabetes insipidus (not to be confused with diabetes mellitus) is a condition caused by a deficiency or total absence of vasopressin secretion by the posterior pituitary. It may be the result of a congenital deficiency of hormone secretion or it may be induced by damage to the posterior lobe due to surgery, tumor or other trauma.

The major symptom of diabetes insipidus is the inability to concentrate urine. This results in the production of large volumes of urine (polyuria), excessive thirst (polydipsia) and the ultimate development of dehydration and hypernatremia. The most effective therapy for this disorder is the administration of substances having antidiuretic hormone (ADH) activity. **Posterior pituitary injection** is an extract having *oxytocic*, *vasopressor*, and ADH activity. Its use in the treatment of diabetes insipidus is limited because of the unwanted effects which it produces and because of its association with hypersensitivity reactions in some clients.

Vasopressin is a purified form of posterior pituitary hormone which exerts only pressor and ADH activity. It is available from both natural and synthetic sources and may be administered intramuscularly, subcutaneously and intranasally.

Lypressin is a synthetic form of vasopressin. It has a short duration of action (3–4 hours) and potent antidiuretic effect but little vasopressor or oxytocic effect. Lypressin is administered intranasally as a spray whenever urination frequency increases or significant thirst develops. Desmopressin acetate is quite similar to lypressin. It is a synthetic form of vasopressin which is administered nasally as a spray or solution (administered by nasal tube). It may also be administered parenterally by the SC or IV route. Its specific advantage over lypressin is its longer duration of action (8–20 hours). In addition to its use in treating diabetes insipidus, desmopressin acetate also is used intranasally for the treatment of *enuresis* and certain cases of hemophilia (where it can raise levels of factor VIII).

Table 35–5 lists the properties of drugs used to treat diabetes insipidus.

APPLYING THE NURSING PROCESS

Endocrine glands produce and secrete hormones discharged in the bloodstream that circulate throughout the body. These hormones affect various body tissues. Endocrine dysfunction leads to many pathological disorders requiring medical treatment, nursing care and pharmacotherapy.

CLIENTS TAKING THYROID MEDICATION

Assessment

Assessment includes taking a nursing history, doing a physical assessment, and consulting laboratory results. The nursing history should include information about past and present health conditions, family history, and current use of medications. The nurse should obtain information about the person's activity tolerance, food intake, changes in body weight and sleep patterns. Physical assessment includes measurement of body weight, blood pressure, pulse, respirations, and temperature. Note enlargement of the thyroid gland, the appearance and temperature of the client's skin, appearance and texture of hair, appearance of the eyes for exophthalmos, and evidence of edema, especially over the tibial area. Record observations about the client's general appearance and responsiveness to the assessment process.

TABLE 35–5

Drugs Used in the Treatment of Diabetes Insipidus

Note: Record body weight and fluid intake and output.
Vasopressin toxicity is indicated by water intoxication, low serum sodium levels, and constriction of smooth muscles, producing intestinal or uterine cramping.
Record daily blood pressure.
Monitor drug use carefully in the elderly and in persons with coronary artery disease.
May produce chest pain.
Provide instruction in administration technique.

DRUG	DOSAGE FORMS AVAILABLE	USUAL DOSE	NURSING IMPLICATIONS
desmopressin acetate *(**des**-moh-**PRESS**-in **AH**-sih-tayt)* (DDAVP, Stimate)	nasal solution, SC, IV	Intranasal *Adults:* 0.1–0.4 mL = 10–40 mcg daily administered in 1–3 doses *Children 3 mo.–1 year:* 0.05–0.3 mL daily in 1–2 doses SC or IV: 0.5–1 mL daily in 2 divided doses—adults 0.025 mcg/kg—children	Monitor for local congestion, headache, shortness of breath, abdominal cramps, etc. Client may adjust dosage, depending on frequency of urination and thirst. A dose may be taken at bedtime to prevent nocturia. To assure uniform dosing, the spray should be held upright and the client should be in a vertical position with the head upright.
lypressin *(ly-**PRESS**-in)* (Diapid)	nasal spray	1–2 sprays in each nostril 4 times daily	See desmopressin acetate. Advise client to carry medication because of its short duration of action.
vasopressin *(**vas**-oh-**PRESS**-in)* (Pitressin Synthetic)	SC, IM, intranasal	SC or IM: 5–10 units 2–3 times daily *Children:* 2.5–10 units 3–4 times daily Intranasal: Adjust according to response	Intranasal application may be accomplished as a spray or drop or absorbed onto cotton pledgets inserted into nose.

Nursing Diagnoses

Including but not limited to:

- Ineffective health maintenance related to thyroid dysfunction
- Disturbed sleep pattern related to thyroid dysfunction and thyroid medication
- Disturbed body image related to exophthalmus.
- Imbalanced nutrition, less than body requirements related to hyperthyroidism
- Risk for injury related to side effects of thyroid medications
- Deficient knowledge related to disease process and medication regimen

Planning/Goals

- Client will demonstrate ability to manage thyroid dysfunction through appropriate self-administration of thyroid medication.
- Client will demonstrate normal sleeping pattern of 6 to 8 hours of undisturbed sleep per night.
- Client will verbalize understanding of exophthalmus and express positive self-image.
- Client will establish weight WNL for height according to standardized chart.
- Client will not experience injury related to adverse effects of thyroid medication regimen.
- Client will verbalize understanding of disease process, self-medication, and signs and symptoms to report to physician, plus importance of follow-up visits and blood levels.

Implementation

The treatment of hypothyroidism is relatively uncomplicated, as a number of easily

administered oral preparations are available for use. The nurse can play an important role in medication counseling for these clients, who usually require lifelong treatment. Clients on long-term therapy receive instruction regarding the name of the medication they take, the dosage and administration schedule, the most common side effects, and the actions which should be taken when side effects occur. In addition, someone close to the client should be familiar with the treatment and know who is to be contacted if problems develop. All clients must understand the importance of long-term treatment and the role of thyroid hormones in preventing premature *atherosclerosis* and cardiac disease. Women who become pregnant are instructed to continue their medication for the treatment of hypothyroidism during pregnancy.

Clients taking thyroid USP are informed that it may be several weeks before they become euthyroid. Treatment is begun with low dosages to prevent cardiac problems. Also, the effects of these preparations may last for several weeks after treatment is stopped.

In general, the nurse should check the apical pulse rate for a full minute before administering thyroid preparations. The physician must be contacted and thyroid medications withheld if adult clients have a pulse rate in excess of 100 beats per minute. Children with pulse rates in excess of the normal for their age should not be given the thyroid medication without contacting the prescriber. Medical attention is also needed before administering thyroid preparations when there has been a change in cardiac rhythm. The ideal time for administration of thyroid preparations is in the early morning before breakfast.

Several other precautions are taken when administering thyroid preparations. If the client has adrenal insufficiency or has recently had the anterior pituitary removed, thyroid preparations are not administered until the insufficiency of adrenal hormones has been corrected. Also, the dosage of oral anticoagulants is generally decreased, while the dosages of insulin and oral hypoglycemic agents may need to be increased in clients taking thyroid preparations. The nurse must be careful in administering narcotics, barbiturates or other CNS depressants to hypothyroid clients. Before becoming euthyroid, these clients are very sensitive to CNS depressants. They may need to receive lower dosages of these drugs than those given to other clients of the same age and body weight. When CNS depressant drugs are used, clients are observed carefully for respiratory depression. Cardiac clients are sensitive to the effects of thyroid preparations and must be observed for signs of angina or other indications that myocardial oxygen consumption is being increased too dramatically.

Nurses and clients observe and report clinical progress and toxic effects of the medication to the physician. Movement toward a euthyroid state is indicated by improved strength and endurance, loss of weight, stabilization of body weight, and disappearance of signs of hypothyroidism, such as edema, dry coarse hair, and slow pulse rate. Toxic signs and symptoms associated with hyperthyroidism include:

- restlessness
- insomnia
- loss of weight
- tachycardia
- palpitations
- nervousness
- hyperglycemia
- excessive perspiration
- rapid pulse rate

The development of such signs and symptoms is generally cause for decreasing the maintenance dose of the thyroid preparation.

Evaluation

- Client demonstrates ability to manage thyroid dysfunction through appropriate self-administration of thyroid medication.
- Client demonstrates normal sleeping pattern of 6–8 hours of undisturbed sleep per night.
- Client verbalizes understanding of exophthalmus and express positive self-image.
- Client establishes weight WNL for height according to standardized chart.
- Client does not experience injury related to adverse effects (hypothyroidism) of thyroid medication regimen.
- Client verbalizes understanding of disease process, self-medication, signs and symptoms of hypothyroidism to report to physician, and importance of follow-up visits and blood levels.

KEY NURSING IMPLICATIONS 35–1

Thyroid Medication

1. Assess activity tolerance, food intake, changes in body weight, and sleep patterns. Measure body weight and vital signs.
2. The apical pulse rate is checked for a full minute before administering thyroid medication. Medication is withheld for adults with a rate in excess of 100 beats per minute and for children with rates in excess of the normal for their age.
3. Thyroid preparations are best administered in the early morning before breakfast.
4. Observe and report clinical improvement as indicated by improved strength and endurance, loss of weight and disappearance of signs of hypothyroidism.
5. Observe and report toxic signs and symptoms such as restlessness, insomnia, loss of weight, tachycardia, palpitations, nervousness, hyperglycemia, excessive perspiration and rapid pulse rate.

CLIENTS TAKING ANTITHYROID MEDICATION

Assessment

Because the thyroid gland regulates body metabolism, nursing assessment is focused on obtaining information about metabolic functioning. A nursing history includes information about past and present health conditions, family history, and current use of medications. Obtain information about the person's activity level, food intake, and sleep pattern disturbances. Physical assessment includes body weight, and measurement of blood pressure, pulse, respirations, and temperature, which may be elevated in clients with a hyperactive thyroid gland. Note both the pulse rate and rhythm. Note also any enlargement of the thyroid gland and the appearance and temperature of the client's skin and appearance and feel of the hair. Record observations about fine muscle tremors and nervousness. Observe the eyes for the presence of exophthalmos.

Nursing Diagnoses

Including but not limited to:

- Ineffective health maintenance related to fatigue
- Imbalanced nutrition, more than body requirements related to hypothyroidism
- Risk for injury related to side effects of thyroid medications
- Deficient knowledge related to disease process and medication regimen

Planning/Goals

- Client will demonstrate ability to manage thyroid dysfunction through appropriate self-administration of thyroid medication.
- Client will establish weight WNL for height according to standardized chart.
- Client will not experience injury related to adverse effects of thyroid medication regimen.
- Client will verbalize understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits and blood levels.

Implementation

Treatment of hyperthyroidism is often more complex than the treatment of hypothyroidism and may require the use of several drugs, surgery, and/or sodium iodide I 131. Iodine is one of the drugs often used in conjunction with other forms of therapy. It may be used before surgery to decrease the size and vascularity of the thyroid gland. When given in the form of Lugol's solution, or a **saturated potassium** or **sodium iodide solution**, the preparation is diluted in a small amount of liquid such as milk or juice to mask its unpleasant taste. The unpleasant taste may also be minimized by administering the preparation through a straw. The nurse is alert for signs of iodism, which include gum soreness, excessive salivation, nausea, fever, parotitis (inflammation of the salivary glands), and metallic taste in the mouth. When the physician is notified about these signs, iodine therapy will probably be discontinued.

Some hyperthyroid clients will receive sodium iodide I 131. Generally the nurse does not administer this drug. The nurse must know about this treatment, however, to provide information and support. Clients are reassured that

they will not become radioactive or a hazard to others.

The I 131 solution is a colorless, tasteless liquid. Following its administration, no special safety precautions need to be taken unless the client's clothing or environment becomes contaminated with excretions, such as vomitus or urine. Nurses must be familiar with the general safety procedures to be used in such cases. Generally, these involve wearing rubber gloves for cleanup and disposal of the excreta and properly disposing of the contaminated items. The institution's radiation safety officer is the primary source of information in such cases. Several days following administration of the I 131, the client may experience swelling and soreness of the thyroid gland. This is temporary. A more long-term consequence is the eventual development of hypothyroidism, which can occur up to 10 years following treatment. For this reason, clients are informed about the signs of hypothyroidism and advised to remain under the care of their physician.

Propylthiouracil and related drugs are often used in the treatment of hyperthyroidism. Clients need to know that these drugs must be taken over a period of time, as they will not create a euthyroid state within several days. Clients are also instructed to take the drugs daily at the hours prescribed and to avoid doubling and/or skipping doses. Most side effects are dose-related. The development of sore throat, fever, or malaise, however, must be reported immediately to the physician. These may be symptomatic of agranulocytosis, a life-threatening condition; the physician will probably examine the client and order some laboratory work. Generally, white blood cell and differential counts are ordered periodically during long-term treatment to monitor the effects of these drugs on blood and blood-forming organs. Although not as serious, clients are made aware of other possible side effects such as skin rash, gastrointestinal upset, joint pain, swelling of cervical lymph nodes, and headache. Finally, propylthiouracil can increase the effects of oral anticoagulants; a reduction in the dosage of the anticoagulant will probably be ordered.

Many of the clients who take antithyroid medication are of childbearing age. Generally, treatment with I 131 is avoided in this age group, although other drugs are used. The female client should know that drugs such as propylthiouracil cross the placenta and may cause damage to the fetus. They also appear in breast milk and should not be used by nursing mothers. Women taking

KEY NURSING IMPLICATIONS 35–2

Antithyroid Medication

1. Assess activity level, food intake, and sleep pattern disturbances. Measure body weight, blood pressure, pulse, respirations, and temperature.
2. Liquid iodine preparations are diluted in a small amount of liquid before administration.
3. The unpleasant taste of liquid iodine products can be decreased by administering the diluted medication through a straw.
4. Clients taking iodine preparations are observed for iodism, including gum soreness, excessive salivation, nausea, fever, inflammation of the salivary glands, and metallic taste in the mouth.
5. No special safety precautions need to be taken for clients who have received I 131, unless the client's clothing or environment becomes contaminated by excretions.
6. Several days following I 131 administration, the client may experience a temporary swelling and tenderness of the thyroid gland.
7. Some clients who have received I 131 later develop hypothyroidism.
8. Clients taking propylthiouracil and related antithyroid drugs must immediately report sore throat, fever, or malaise, as these may indicate agranulocytosis.
9. Women of childbearing age who are taking antithyroid drugs should contact their physician for advice before becoming pregnant or as soon as pregnancy is suspected.
10. Thyroid storm, an extreme hyperthyroid state, may follow stress, surgery, or withdrawal of antithyroid drugs. It is characterized by fever, tachycardia, congestive heart failure and CNS disturbances. Immediately notify the physician of its development.

antithyroid medications of any type are instructed to contact their physician for advice before becoming pregnant or, if pregnancy has occurred, as soon as it is suspected.

An extreme hyperthyroid state called thyroid storm requires the use of several types of drugs, as well as supportive nursing actions. This state—characterized by fever, tachycardia, congestive heart failure and CNS disturbances—may follow stress, surgery, or withdrawal of antithyroid hormones. Its treatment may require the use of oxygen, *hypothermia*, digitalis preparations, diuretics, acetaminophen (Tylenol), antithyroid drugs, and a beta-adrenergic blocking agent, such as propranolol (Inderal) or esmolol (Brevibloc). Initially the beta-blocking agent is given intravenously. Its purpose is to alleviate adrenergic problems such as tachycardia, sweating, and tremor. Antithyroid drugs, such as propylthiouracil or methimazole, are given to control thyroid secretion.

Client instruction plays an important part in nursing clients with thyroid problems. After the diagnosis has been made and appropriate treatment begun, the client may have limited contact with health care personnel. Problems, such as adverse effects of the medication and/or a temporary increase in symptoms, and questions about treatment may not arise until the client has been home for some time. Also, many clients require treatment over a long period. For these reasons, clients need to receive information about their thyroid condition and its treatment geared to their level of understanding and interest. Clients are also encouraged to keep follow-up visits, even though they are feeling well. Occasional contact with the client improves the probability of detecting adverse drug reactions and the need to discontinue medication because a euthyroid state is reached. Such concern for the client's health and well-being may improve cooperation with the treatment plan.

Evaluation

- Client demonstrates ability to manage thyroid dysfunction through appropriate self-administration of thyroid medication.
- Client establishes weight WNL for height according to standardized chart.
- Client does not experience injury related to adverse effects of thyroid medication regimen.
- Client verbalizes understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits and blood level checks.

CLIENTS TAKING MEDICATION FOR PARATHYROID DISORDERS

Assessment

The nursing history includes questioning the client about family and personal health history, medication use, and recent changes in body functioning. Clients should be questioned specifically about fatigue, muscle weakness, constipation, paresthesias, painful contraction of muscles, nausea, and vomiting. Physical assessment includes observation of skin, hair, muscle strength, and tremor or spasm. Serum calcium determinations are made, and, if the nurse draws blood for this study, care must be taken not to apply the tourniquet too tightly or to occlude the vessel for longer than necessary, as this could result in an erroneously high result. Serum parathyroid hormone assay also may be obtained.

Nursing Diagnoses

Including but not limited to:

- Risk for injury related to altered calcium and phosphorous levels
- Risk for injury related to side effects of parathyroid medications
- Deficient knowledge related to disease process and medication regimen

Planning/Goals

- Client will not experience injury related to altered calcium and phosphorous levels.
- Client will experience calcium and phosphorous levels WNL.
- Client will not experience injury related to adverse effects of parathyroid medication regimen.
- Client will verbalize understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits and blood level checks.

Implementation

Once hypoparathyroidism is diagnosed, its treatment with calcium preparations is fairly

straightforward. Initial treatment often involves intravenous administration of calcium. Before injection, the solution should be warmed to body temperature. Calcium solutions are injected slowly into a large vein to minimize the tingling sensation, calcium taste, "heat waves," and/or syncope that can occur with rapid injection. Also, attention must be paid to the client's cardiac function, as rapid injection can cause bradycardia, arrhythmias, and cardiac arrest. Extreme care must be used if the client is taking any digitalis preparation, as these drugs may interact, producing digitalis toxicity. During intravenous administration, the heart rate and rhythm should be monitored using ECG, especially in known cardiac clients and elderly persons. Clients are advised to remain in bed for a short time after administration to prevent syncope. If the calcium preparation is administered by intravenous infusion rather than by IV push, the nurse must monitor the administration carefully, because necrosis and sloughing of tissues may follow extravasation of these preparations. Periodic serum calcium determinations are ordered for clients receiving parenteral therapy. The nurse notifies the physician if the calcium level deviates significantly from 8.5–10.5 mg/dL in adults and slightly higher than this level in children.

Periodic monitoring of serum calcium levels continues during oral administration of calcium. To enhance the effectiveness of therapy, oral calcium products are generally given 1–1½ hours after meals. Some foods may interfere with calcium absorption. This is particularly true of those containing high levels of oxalic acid (e.g., spinach and rhubarb), bran and whole grain cereals, and foods high in phosphorus (e.g., dairy products). This information is included in a client education program, which also includes an explanation of why this therapy is being used and why vitamin D may also be ordered as part of the treatment plan.

The treatment of hyperparathyroidism is more varied. If diuretics are used with or without normal saline infusions, the nurse monitors the client's intake and output, weight, vital signs, and serum electrolyte levels. Special efforts must be made to be sure that clients confined to bed have a bedpan or urinal conveniently available, as urinary output may be considerable.

Phosphate therapy may be administered orally, rectally as a retention enema, or

KEY NURSING IMPLICATIONS 35–3

Medication for Parathyroid Disorders

1. Assess the client for fatigue, muscle weakness, tremor or spasm, numbness, tingling, constipation, paresthesias, nausea, and vomiting.
2. Hypoparathyroidism is treated with calcium preparations. The initial calcium may be given intravenously. The solution should be warmed to body temperature and injected slowly into a large vein.
3. During intravenous injection of calcium, the heart rate and rhythm should be monitored by ECG in known cardiac clients and elderly persons.
4. Following the intravenous injection of calcium, clients are advised to remain in bed for a short period to avoid syncope.
5. Extravasation of intravenously infused calcium may result in tissue necrosis and sloughing.
6. Calcium should not be added to an IV line containing bicarbonate or phosphate, as a precipitate may form in the IV line.
7. Oral calcium products should be given 1–1½ hours after meals or at bedtime. For maximum effectiveness the client's diet should not be high in oxalic acid (spinach and rhubarb), bran and whole grain cereals, or phosphorus.
8. Clients receiving drug therapy for the treatment of hyperparathyroidism are observed for hypocalcemia as indicated by spasms of the hands and feet, along with cardiac irregularities.
9. Clients may experience flushing of the face and a feeling of warmth following calcitonin injection. This is common and will disappear without treatment.
10. Foods, especially those high in calcium, should not be taken for 2 hours after oral doses of etidronate disodium.
11. Vitamin D may be administered as a supplement to be given with the calcium, because vitamin D facilitates the absorption of calcium.

intravenously. The nurse again ensures that serum electrolyte levels are assessed periodically. The client is observed for untoward effects, such as hypocalcemia, that may occur if excessive amounts of phosphate are given. The nurse observes the client for spasms of the hands and feet and cardiac irregularities. Spasms involving the hands are often noted most easily when a blood pressure cuff is left inflated above the systolic level for 3 minutes (Trousseau's sign). Also, taping the side of the face where the facial nerve emerges allows the health care provider to check for contraction of the side of the face and mouth (Chvostek's sign) as a sign of hypocalcemia. Any sign of hypocalcemia is reported to the physician.

It is important for the nurse to remember that one of the calcitonin preparations most frequently used (Calcimar) is derived from salmon and that systemic allergic reactions may occur. Skin testing or a test dose is recommended before initiating therapy to assess the likelihood of an allergic reaction. If there is evidence of an allergic reaction, switching to a different preparation, e.g., calcitonin-human, may achieve the therapeutic effect without the development of an allergic response. About 20%–30% of clients will experience facial flushing and warmth for about an hour after calcitonin injection. The client is reassured that this is common and will disappear on its own.

Clients receiving etidronate disodium (Didronel) intravenously are administered the drug diluted in at least 250 mL of sterile normal saline over 2 hours. Clients taking oral doses of this medication are advised not to eat for 2 hours after taking the medication, because food, especially that high in calcium, may reduce absorption of the drug.

Evaluation

- Client does not experience injury related to altered calcium and phosphorous levels.
- Client experiences calcium level of 8.4–10.2 mg/dl and phosphorous levels of 2.7–4.7 mg/dl.
- Client does not experience injury related to adverse effects of parathyroid medication regimen.
- Client verbalizes understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits and blood levels.

CLIENTS TAKING PITUITARY HORMONES

Assessment

There are several pituitary hormones that nurses may administer in clinical practice. The use of human growth hormone products such as somatropin (Humatrope) and somatrem (Protropin) require supportive care and continued medical supervision. Only a select group of children with growth disorders associated with a demonstrated deficiency of human growth hormone are treated with these agents. Nursing assessment includes measurement of body height and weight and observations about body image disturbances.

Nursing Diagnoses

Including but not limited to:

- Disturbed body image related to disease process or side effects of pituitary agents
- Excess fluid volume related to side effects of pituitary agents
- Pain related to ulcerogenic effects of various pituitary agents
- Deficient knowledge deficit related to disease process and medication regimen

Planning/Goals

- Client will verbalize and express positive self-image.
- Client will experience fluid balance.
- Client will not experience pain or injury related to pituitary agents.
- Client will verbalize understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits.

Implementation

When the child begins treatment, it is often after considerable diagnostic studies and parental worry. The child may appear much smaller than the stated age, but it is important for the nurse to treat the child in the manner appropriate for other children of that age.

These products must be administered by injection. The ideal time to administer them is in the evening, when blood cortisol levels are

NURSING CARE PLAN

A Client with Diabetes Insipidus Using Lypressin Spray (Diapid Nasal Spray)

Tony Martinelli, age 17, is admitted for observation following an automobile accident in which he lost consciousness for an unknown period. He has a lump on the back of his head but X rays and CT scan are negative. Vital signs are stable throughout the first 24 hours, but Tony complains of being thirsty and is drinking large quantities of caffeinated soda today, as well as water. He is also voiding large quantities of very pale-colored urine. Further tests are completed and he is diagnosed as having diabetes insipidus secondary to head injury. He is ordered lypressin (Diapid Nasal Spray) QID and prn. Tony is taught how to administer lypressin spray.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Thirst, preference for cold or iced drinks, skin turgor.	Deficient fluid volume related to compromised endocrine regulatory mechanism.	Client will maintain normal fluid volume as evidenced by absence of thirst, normal serum sodium level, and stable weight.	Maintain accurate intake and output. Do not restrict fluids, as this leads to dehydration. Weigh daily to assess fluid loss. Provide fluid and electrolytes for replacement.	Client maintains weight. Intake and output are in balance. Adequate tissue turgor is maintained.
Polyuria, frequency, nocturia, low specific gravity of urine.	Risk for deficient fluid volume related to water loss from high urinary output.	Client will maintain normal fluid volume as evidenced by stable weight, good skin turgor, and normal vital signs.	Accurate intake and output to assess losses. Review laboratory work for electrolytes. Report abnormal findings and replace electrolytes as ordered.	Client does not show dehydration or electrolyte imbalance throughout hospitalization.
Anxiety, knowledge of ailment.	Ineffective individual coping related to anxiety over injury and sudden development of diabetes insipidus.	Client will verbalize reduction in anxiety.	Answer questions honestly. Encourage client to participate in self-care as soon as possible. Educate client that ailment is controllable with medication. Advise client that this situation may be temporary.	Client appears more relaxed and is able to verbalize concerns and feelings.
Bowel functions.	Risk for constipation related to fluid losses.	Client will maintain normal bowel function.	Encourage client to maintain diet high in fiber and encourage fluid volume replacement. It is useful to plan time to move bowels at same time each day.	Client maintains normal bowel functions. Constipation does not develop.
Integrity of oral mucous membranes.	Impaired oral mucous membranes due to dehydration secondary to excessive urinary output.	Client will maintain adequate intake of fluids and will not experience excessive dryness or injury to oral mucous membranes.	Teach client to maintain adequate fluid intake, attend to oral hygiene, and use lypressin appropriately.	Client maintains integrity of oral mucous membranes through adequate fluid intake, maintenance of oral hygiene measures, and appropriate use of lypressin.

Knowledge of drug therapy.	Deficient knowledge related to lypressin and use as nasal spray.	Client will be able to explain use of drug and demonstrate proper method of administration.	Teach client that drug should be taken as scheduled, but an additional dose should be used when urinary frequency increases or thirst develops. Nasal stuffiness will delay absorption. Instruct client to call his physician about a substitute method of administration during acute upper respiratory infections. Side effects include nasal irritation, congestion, headache, and conjunctivitis. Excessive nasal sprays may cause heartburn, abdominal cramps, and increased bowel movements. Instruct client in proper administration of lypressin. Should clear nasal passages and be sitting upright and hold bottle upright while spraying. Client should carry medication with him because of its short half-life.	Client demonstrates proper administration of nasal spray. Client knows reportable symptoms.
Self-esteem, body image.	Chronic low self-esteem related to illness.	Client will be able to verbalize his concerns about feeling different than his peer group caused by having a medical condition that requires daily medication.	Encourage client to discuss his concerns about feeling different from his peers because of the diabetes insipidus and its treatment regimen. Plan coping strategies with him regarding what to tell his peers about this illness and how to manage daily medication administration.	Client states that he feels good about himself and is able to fit in with his peer group.

lowest, as enhanced responsiveness to the hormone occurs when blood cortisol level is low.

A second pituitary hormone that the nurse may administer is corticotropin (ACTH). This hormone, given intramuscularly, subcutaneously, or intravenously, is seldom used except for diagnostic purposes. It is less costly, more effective, and more comfortable for the client to receive the hormone(s) produced by the target gland, for example cortisol produced by the adrenal cortex. However, if ACTH is used for a prolonged period for treatment of a health problem, the nurse must be aware that persons with diabetes mellitus may require an increase in their insulin dosage.

The third pituitary hormone that the nurse may administer is vasopressin. Assessment of clients receiving this hormone is focused on fluid balance and includes measurement of body weight, blood pressure and pulse, and intake and output. Observations are made regarding skin turgor, condition of mucous membranes, and adequacy of fluid intake.

Various preparations of this hormone are given to replace deficient natural secretion of vasopressin; this deficiency results in diabetes insipidus. Vasopressin cannot be given orally. Preparations are available for subcutaneous, intramuscular, and intranasal use. Several nursing actions are indicated when administering these preparations. Vasopressin preparations must be given on a regular schedule to avoid diuresis.

Persons using the intranasal preparation are instructed to clear the nasal passages before use, to hold the bottle upright, and to insert the nozzle into their nostril with their head in a vertical position. Gentle pressure is then applied to the bottle while spraying the medication into the nostril. Clients with acute upper respiratory infections may be temporarily unable to use the intranasal preparation because of mucosal swelling and irritation. The physician should be contacted about using a substitute method of vasopressin administration during this hiatus. As this hormone is given for its antidiuretic properties, it is important to watch and record intake and output. Daily weights may also be helpful in determining fluid retention or loss. Too much vasopressin is associated with: (1) water intoxication, (2) low serum sodium levels that may result in drowsiness or mental confusion, and (3) constriction of smooth muscles producing intestinal and uterine cramping. It is useful to take the client's blood pressure at least once a day; a slight elevation in blood pressure is associated with overdose. The nurse must also be aware that vasopressin may cause spasms of the coronary arteries that may produce chest pain. Therefore, it must be used cautiously by those with coronary heart disease and by the elderly.

Too little vasopressin may be detected by diuresis not relieved by the next dose of medication, continuing thirst, and the output of a large quantity of urine with a low specific gravity.

A final nursing action in caring for clients taking vasopressin is providing instruction. Most of these clients will be taking one or more of the preparations of this hormone for long periods.

KEY NURSING IMPLICATIONS 35–4

Pituitary Hormones

1. Children receiving somatropin for the treatment of growth disorders must be treated in a manner appropriate to their actual age. Assess height, weight, and body image disturbances.
2. Evening is the ideal time for the administration of somatropin.
3. Clients with diabetes mellitus receiving ACTH over a prolonged period of time may require an increase in insulin dosage.
4. Vasopressin preparations must be given on a regular schedule to avoid diuresis.
5. Clients receiving vasopressin are weighed daily, and blood pressure and intake and output records are kept while the client is hospitalized. Observe skin turgor and condition of mucous membranes.
6. Too much vasopressin is associated with water intoxication, low serum sodium levels, and constriction of smooth muscle, producing intestinal and uterine cramping.
7. Too little vasopressin is associated with diuresis and thirst.

For some clients, treatment is lifelong. It is necessary, therefore, that they have an understanding of the health problem and its treatment. They are instructed in the appropriate administration of the preparation ordered. They must also learn the important signs and symptoms related to the administration of inadequate or excessive doses of vasopressin. Occurrence of these symptoms is reported to the physician. Finally, as with all clients having chronic health problems requiring long-term treatment, these clients are advised to conscientiously keep follow-up appointments.

Vasopressin infusions have been used with or without nitroglycerin to reduce portal venous pressure in the treatment of bleeding esophageal *varices*. Necrosis of the skin may occur in clients who have vasopressin infused into a peripheral vein. During the infusion, a transparent sterile dressing should be placed over the infusion site and the skin must be inspected hourly. If blanching of the skin occurs, the infusion is stopped and the physician is notified. The administration of vasopressin through a central venous catheter or bolus injection has not been associated with skin necrosis.

Evaluation

- Client verbalizes and expresses positive self-image.
- Client experiences fluid balance.
- Client does not experience pain or injury related to pituitary agents.
- Client verbalizes understanding of disease process, self-medication, signs and symptoms to report to physician, and importance of follow-up visits.

HOME CARE / CLIENT TEACHING

1. Many of the drugs discussed in this chapter are taken for long periods, perhaps years. The nurse working outside of inpatient settings should do a periodic assessment of the person's response to the medication, offer an opportunity for the person to ask questions about drug therapy, and ensure that medications are stored and administered correctly.
2. Clients receiving somatropin should be instructed concerning dosage form and amount and importance of follow-up physician visits.
3. Clients receiving somatropin should discard any discolored or cloudy solutions.
4. Parents of children receiving somatropin should be instructed about keeping a journal of their child's growth measurement.
5. Clients receiving desmopressin should be instructed on proper technique for administering nasal medication including written instructions.
6. Clients receiving desmopressin should be informed not to take over-the-counter cold medications, because the epinephrine in those medications can interact with desmopressin.
7. Clients taking desmopressin should avoid alcohol.
8. Clients taking somatropin, desmopressin, or lypressin should be instructed to always wear a Medic-Alert bracelet with the name of the drug on it.
9. Clients taking lypressin should be instructed not to inhale medication when using nasal spray.
10. Clients receiving thyroid medications should be informed that the therapy is usually long-term and compliance is critical to their well-being.

CASE STUDY

Mrs. Alma Johnson, a 63-year-old widow, is hospitalized for treatment of complications associated with her long-standing arthritic condition. In the course of a routine physical examination, the resident discovers a nodule in the right side of the thyroid. Careful questioning reveals that for many years Mrs. Johnson tended to be warm when others were cold. The resident also notes that the client has very fine hair and soft skin. In addition, the client recently lost about 15 pounds and now appears thin and frail. All of these are indications of a hyperactive thyroid gland.

Based on the history and physical examination, thyroid function studies are ordered. The thyroid scan following a tracer dose of I 131 confirms the location of a thyroid nodule associated with thyroid hypersecretion. The client is started on propylthiouracil (PTU) 100 mg bid p.o. She is instructed to call her physician if she experiences a skin rash or sore throat.

Questions for Discussion

1. As the nurse caring for Mrs. Johnson, what instructions would you give her concerning the treatment of her thyroid condition?
2. What would you answer if Mrs. Johnson asked you why she should report skin rashes and/or sore throat to her physician immediately?
3. What safety precautions need to be taken following administration of a tracer dose of I 131?
4. The initial daily dose of PTU is usually 300 mg daily. What factor(s) might explain why Mrs. Johnson is receiving only 200 mg daily?

CRITICAL THINKING EXERCISES

1. Prepare a client instruction guide for one of the following:
   - an 8-year-old child being treated with somatropin for a growth deficiency
   - a young woman with hyperthyroidism receiving antithyroid drugs (iodine and propylthiouracil) and may later require surgery
   - an older woman taking thyroid hormone replacement for the treatment of hypothyroidism
2. Prepare a nursing care plan for a client with hyperparathyroidism being treated with calcitonin (Cibacalcin).
3. Prepare a short report on one of the following:
   - the use of ACTH for the diagnosis of pituitary and adrenal health problems
   - the diagnostic workup used for children with growth abnormalities
   - the treatment of children with thyroid hormone deficiency
   - nursing care of a client experiencing thyroid storm
4. Examine a copy of the radiation safety precautions that govern the use of radioactive drugs given to clients within the clinical setting where you practice. What specific measures are taken when a client:
   - is given a tracer dose of I 131.
   - who has received a therapeutic dose of I 131 vomits shortly after consuming the dose.
5. Examine a thyroid scan. What kind of information does this provide the physician who is conducting a workup to determine the functioning of a client's thyroid?
6. Prepare a short report on frequently used thyroid function tests (e.g., PBI, T_3 and T_4 determinations). What drugs or nutrients may affect the outcome of these various tests? As a nurse preparing a person for thyroid function studies, what explanation and instruction would you provide for each test?

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36 Agents Used to Treat Hyperglycemia and Hypoglycemia

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify four functions of insulin in the body
- List three adverse effects associated with insulin administration
- Identify the official and common names of insulins currently in use
- Describe the mechanism of action of oral hypoglycemic agents
- Identify adverse effects commonly associated with the use of sulfonylurea oral hypoglycemic agents
- Identify the pancreatic hormones used in treating hypoglycemia and hyperglycemia
- Differentiate among short, intermediate, and long-acting insulins and give an example of each
- Describe the nursing assessment of a person with diabetes mellitus
- Distinguish the signs and symptoms of insulin reaction from those of diabetic ketoacidosis
- Compare the treatment of insulin reaction and ketoacidosis
- List in a stepwise fashion the procedures used in mixing and in administering insulins
- Identify the sites commonly used for insulin administration and plan a rotation pattern
- Describe the local tissue responses possible with repeated insulin injections
- Identify common drug interactions associated with the use of oral antidiabetic agents
- List three factors that may produce a change in a diabetic client's insulin requirement
- Briefly describe how a sliding scale of insulin administration works and describe the use of these pumps
- State the difference between open- and closed-loop insulin pumps
- Apply the nursing process related to care of clients experiencing hypo- or hyperglycemia.

Diabetes mellitus is the seventh leading cause of death in America. It is estimated that 5.9% of the U.S. population (16 million people) currently have this disease and that perhaps 20 million more are potential diabetics. Improved techniques of therapy have greatly prolonged the lifespan of a diabetic person. Young diabetics are more likely to bear children than in the past, thus increasing the number of people with an inherited tendency toward the disease.

Diabetes mellitus is a complex disorder of carbohydrate, fat, and protein metabolism caused by lack or inefficient use of insulin in the body. Insulin is secreted by the beta cells of the islets of Langerhans in the pancreas. Most cases are due to a genetically determined pancreatic insufficiency. However, diabetes may also be the result of other pancreatic or endocrine diseases or an autoimmune response, or it can be precipitated by certain forms of drug therapy. If not effectively controlled, diabetes mellitus may increase the client's susceptibility to cardiovascular disease and potentially cause kidney and nerve damage, as well as vision loss due to diabetic *retinopathy*.

About 5%–10% of the diabetic population has a form of the disease known as insulin-dependent, or type 1, diabetes mellitus (IDDM). In the past, this also was referred to as juvenile-onset diabetes mellitus. These clients have no pancreatic reserve of insulin and must receive daily insulin therapy to control the condition. Such diabetics often exhibit wide fluctuations in their blood glucose levels and the disorder may therefore be referred to as "brittle" diabetes. They are also most prone to the accumulation of toxic *ketones* in the blood (ketosis).

The vast majority (90%) of diabetics are of the noninsulin-dependent, type 2, form (NIDDM). Unlike the type 1 diabetic, type 2 diabetics have some residual pancreatic function and may have normal or even high levels of insulin. Their disease can often be adequately controlled with weight loss and dietary measures alone or with dietary control and oral hypoglycemic agents. Such clients are less likely to develop ketosis than Type 1 diabetics.

Of the type 2 diabetics, 80% have the obese, type 2 form of the disease. An additional 10% have the stable, nonobese, type 2 form. Another 10% have the unstable, or brittle, type 2 form, similar to the type 1 form.

To understand the pathophysiology of diabetes mellitus, one must be aware of how the body normally reacts to the ingestion of nutrients. When carbohydrates are ingested, blood glucose levels begin to rise, thereby triggering the release of insulin from the pancreas. Insulin serves a variety of functions in the body. It promotes:

- the transport of glucose across cell membranes
- the conversion of glycogen into glucose
- the utilization of fatty acids by cells and, at the same time, inhibits ion of *lipolysis*, i.e., the breakdown of fats to fatty acids
- amino acid utilization enhances the synthesis of protein and inhibits protein breakdown

The continued release of insulin causes a reduction in the blood glucose concentration and eventually produces a hypoglycemic state. This results in the inhibition of further insulin release, as well as the release of several hormones (e.g., corticosteroids, epinephrine, and glucagon) which tends to promote increased glucose concentration in the blood. Serum blood sugar levels normally range between 115 to 125 mg/dl, according to the American Diabetes Association. Target blood sugar level for persons with diabetes is 90 to 130 mg/dl before meals.

In the diabetic, the deficiency of insulin and/or the resistance of tissue to insulin action causes blood glucose levels to remain high after a meal. When the blood glucose level exceeds 180 mg/dL, excess glucose can spill into the urine. This may draw body water into the urinary tract and dramatically increase the frequency of urination (polyuria). Such rapid fluid depletion leads to a compensatory increase in thirst (polydipsia) and may produce electrolyte deficiencies. A high concentration of glucose in the urine also establishes an excellent culture medium for bacterial growth. This situation predisposes the diabetic client to the development of urinary tract infections.

Interference with glucose utilization in the cells of the diabetic causes other nutrients to break down to provide fuel for the body's vital functions. Fatty acids are converted to ketones, proteins are broken down to their amino acid constituents, and liver glycogen (a stored form of glucose) is broken down to glucose. These reactions may, in turn, cause the development of *diabetic ketoacidosis* (DKA), the wasting of muscle tissue and even higher and more prolonged levels of glucose in the blood. The appearance of clinical symptoms, such as weight loss, fatigue, constant eating (polyphagia), polyruria, and polydipsia, is frequently associated with untreated diabetes mellitus.

Successful treatment and control of diabetes mellitus with drug therapy is generally dependent on proper dietary management and close client monitoring. The obese diabetic may initially be placed on a weight-reduction plan until normal weight is achieved. If weight reduction and other forms of dietary management are not successful in controlling diabetic symptoms, the use of insulin or oral hypoglycemic agents is often indicated.

INSULIN THERAPY

Commercial insulin preparations are generally available in concentrations of 100 units per milliliter (U-100) and 500 units per milliliter (U-500). The U-500 strength can only be purchased with a prescription and is usually employed only in clients who have a marked insulin resistance and who, therefore, require doses of more than 200 units of insulin daily. This strength is used for implantable pumps.

Insulin preparations differ with respect to their:

- onset and duration of action
- degree of purity
- source (cow, pig or human insulin)

The onset and duration of action of insulin may be controlled by modification of regular insulin. Regular insulin has the most rapid onset and briefest duration of action. By precipitating insulin with zinc, various modified insulins can be produced. Another way of modifying insulin to achieve a longer onset and duration of action is to precipitate insulin with zinc and a large protein, protamine. This results in NPH (intermediate-acting) and protamine zinc (PZI) insulin products. Because of the presence of protamine, some clients may experience an immunological reaction to these products.

The purity of insulin is generally based on the concentration of proinsulin contamination in the insulin product. Proinsulin is a long chain of amino acids used by the beta cells of the pancreas to synthesize insulin. The greater the concentration of this contaminant in the insulin product, the greater the likelihood of adverse immunological reactions, including local or systemic allergic reactions, *lipodystrophy*, and the formation of antibodies. All currently available insulin products in the United States contain no more than 25 parts per million (ppm) of proinsulin. "Purified" insulin products generally contain not more than 10 ppm of proinsulin contamination.

All insulins manufactured in the United States are pig, cow, pig-cow mixtures, or human insulin. Of the insulins derived from animal sources, pig insulin is most similar in chemical structure to human insulin and is, therefore, least likely to produce an immunological reaction in the client. Synthetic human insulin is produced either by recombinant DNA synthesis of human insulin or by chemical conversion of pig to human insulin. Dosage adjustments may be necessary when changing insulin types, particularly when changing from standard cow, pig, or cow-pig mixtures to a "purified" insulin or a synthetic human insulin product. All insulins are administered parenterally.

Maintenance doses of insulin are generally administered subcutaneously. However in some cases, regular insulin may be administered intravenously. Although insulin products are generally stable at room temperature, they are best stored in a cool place, preferably a refrigerator. Exposure for even short periods to freezing or high temperatures can permanently degrade insulin products. Open vials of insulin should be discarded if not used for several weeks. Insulin in prefilled glass or plastic syringes is stable for at least 1 week if kept refrigerated. Regular insulin can also be administered using a *continuous subcutaneous insulin infusion* (CSII) device. These are often referred to as insulin pumps. The mechanism works through a subcutaneous needle connected to the pump via tubing. The needle is placed in the skin of the abdomen and delivers a constant amount of insulin continuously through out each 24-hour period. For effective and safe use of this device, the blood glucose must be monitored frequently. Supplemental insulin may be given as a bolus at mealtimes, either subcutaneously or bolus via the pump. Although there are several different insulin pumps available, all of them have the same basic functional parts—rechargeable battery, syringe, tubing, and programmable computer, with a motor and drive mechanism. These are designed to give people with insulin-dependent diabetes more freedom in their health maintenance, as well as allowing for more normal regulation of blood sugar.

At times it may be desirable to administer insulin mixtures to gain the advantages of different products and to avoid the necessity of multiple injections. Regular insulin may be mixed with **NPH** or crystalline **PZI insulin** in any proportion.

TABLE 36–1

Insulin Preparations

	INSULIN	COMMON NAME	ONSET OF ACTION	PEAK ACTION	DURATION OF ACTION (HR.)	APPEARANCE
rapid-acting	insulin injection	regular	30–60 min	2½–5 hr	6–8	clear
		Humilin R	15 min	30–90 min	≤5	clear
	prompt insulin zinc suspension	semilente	60–90 min	5–10 hr	12–16	cloudy
	crystalline zinc	crystalline zinc	30–60 min	30–90 min	4–6	
intermediate-acting	isophane insulin suspension	NPH	60–90 min	4–12 hr	24	cloudy
	insulin zinc suspension	lente	60–150 min	7–15 hr	24	cloudy
	globulin zinc	globulin zinc	2–4 hr	6–10 hr	12–28	
long-acting	protamine zinc insulin suspension	PZI	4–8 hr	14–24 hr	36	cloudy
	extended insulin zinc suspension	ultralente	4–6 hr	10–30 hr	36	cloudy
	Mixed	Novolin Mix 70%N = 30%R Humulin various mixtures	4–8 hr	16–18 hr	>36	

NPH/regular mixtures of insulin are currently available commercially in a premixed proportion of 70% NPH and 30% regular insulin or in a mixture of 50% NPH and 50% regular insulin. Mixtures of regular and lente insulins generally remain stable for only a few minutes after which the short-acting characteristic of the regular insulin may be lost. It is advisable, therefore, to mix these insulins just prior to administration. It is important not to alter the order of insulin mixing from administration to administration and to mix only insulins having the same concentration, i.e., the same number of units per milliliter. Generally, human insulins are not mixed with animal-derived insulins and "purified" insulins are not mixed with conventional insulin products. Table 36–1 compares the properties of various insulin products.

A number of adverse effects are associated with insulin administration; the most common is hypoglycemia. In an insulin-dependent diabetic client hypoglycemia may be caused by:

- *omission of or irregularly scheduled meals*—If the ingestion of meals is not carefully coordinated with insulin administration, excessively low levels of glucose in the blood will occur.
- *excessive exercise*—Levels of physical activity greater than normal may increase the rate of glucose utilization in the body and reduce insulin requirements. If normal doses of insulin are administered at such times, hypoglycemia is possible.

- *insulin administration errors*—Errors possible in the measurement of insulin dosage include:
  - selecting an insulin syringe calibrated in different insulin units than the insulin the client is using
  - using an incorrect form of insulin; e.g., regular instead of NPH insulin, thereby producing hypoglycemia
  - improper measurement of the insulin dose

Symptoms of hypoglycemia may include sweating, confusion, tachycardia, headache, hunger, weakness, and motor and/or emotional disturbances, as well as coma and death. Treatment of hypoglycemia is by the administration of an appropriate glucose source, a parenteral dose of glucagon (IM, IV or SC), or intravenous 50% dextrose solution.

Glucagon is an agent normally secreted by alpha cells of the islets of Langerhans of the pancreas. Its secretion is promoted by several factors, the most important being lowered blood glucose levels. Some diabetic clients may exhibit impaired glucagon release when a hypoglycemic state occurs. In such clients, the administration of a parenteral dose of 1 mg of glucagon will reverse most hypoglycemic symptoms within 20 minutes by causing glucose to be released from its storage sites in the body.

Diazoxide (**Proglycem**) is a thiazide derivative employed in treating certain cases of hypoglycemia, particularly in malignancies involving the pancreas. It acts to increase blood glucose levels by inhibiting pancreatic insulin release. It is administered orally in doses of 3–8 mg/kg/day in 2–3 equal doses every 8–12 hours.

In addition to hypoglycemia, adverse effects of insulin therapy may include:

- *Allergic reactions*—Local reactions to insulin administration may take the form of erythema, swelling, and/or pain in as many as 50% of all clients who begin insulin therapy. Symptoms usually develop within 20–40 minutes after an injection and may persist for 2–6 hours. If the reaction is not severe, insulin use may be continued, as such reactions often disappear spontaneously after a short period. Sometimes the use of insulin from another animal source or one of the "purified" or synthetic human insulins will be a successful alternative.
- Systemic allergic reactions may occur in rare instances and must be treated aggressively as would any acute allergic reaction. Desensitization over several days and/or the use of "purified" or synthetic human insulins often enable such clients to be safely treated.
- *insulin lipodystrophy*—*Atrophy* or hypertrophy of subcutaneous fat at insulin injection sites may occur in some clients. The use of "purified" or synthetic human insulin products, as well as systematic rotation of injection sites and thorough massage of the site after injection can usually prevent the development of this reaction.
- *insulin insensitivity or resistance*—The need for high daily insulin doses (i.e., greater than 60 units/day) or, in rare instances, complete resistance to insulin action may happen in some clients. This may be managed by attempting to desensitize the client to a specific insulin form and/or correcting conditions that would promote the diabetic state (e.g., obesity, infection, or the use of *diabetogenic* drugs).

ORAL HYPOGLYCEMIC AGENTS

Oral hypoglycemic agents stimulate pancreatic beta cells to secrete insulin. They may also increase the degree of binding between insulin and insulin receptors or increase the number of receptors. Some pancreatic function is required for these drugs to act. Their use is limited to the non-insulin-dependent, type 2 diabetic who does not respond to diet control alone and who is unwilling or unable to use insulin when it may be indicated.

Clinical evidence has evolved that links the use of oral hypoglycemic agents with increased risk of cardiovascular death as compared to treatment with diet-alone or diet-plus insulin use. This has resulted in a decline in the popularity of these agents for diabetic treatment and in a reassessment of their usefulness in the therapy of diabetes mellitus. Most of the drugs currently employed as oral hypoglycemic agents in the U.S. are those in the chemical class known as the sulfonylureas. Table 36–2 lists the properties of these agents. **Metformin HCl** (**Glucophage**) is an oral hypoglycemic agent in a chemical group known as biguanides. This drug is used in clients who have not responded to sulfonylureas or in combination with a sulfonylurea drug to take advantage of the different action of each. The client using metformin should be observed for the possible development of lactic acidosis during treatment. Over time, the use of sulfonylureas may overstimulate the pancreas which, in essence, tires out the pancreas.

TABLE 36–2

Oral Hypoglycemic Agents

Note: These drugs must be used only in conjunction with a thorough client education program and follow-up supervision. Instruction must be provided about diet, foot care, and glucose testing, plus recognizing and treating diabetic acidosis and hypoglycemia.

An increase in dose or use of insulin therapy may be required when clients are under unusual stress.

Clients must avoid alcohol, as it may produce an Antabuse-like reaction, with vomiting, flushing, and excessive perspiration, if using sulfonylureas or increased likelihood of lactic acidosis if using metformin.

Drugs known to interact with oral hypoglycemic agents to enhance their hypoglycemic effect include salicylates, phenylbutazone, sulfonamides, MAO inhibitors, phenytoin, and anticoagulants.

Drugs that may increase blood glucose levels include liquid products sweetened with sugar, as well as oral nasal decongestants, such as phenylpropanolamine.

DRUG	USUAL DOSE	DURATION OF ACTION	NURSING IMPLICATIONS
First Generation Sulfonylureas			
acetohexamide *(**as**-eh-toh-**HEX**-ah-myd)* (Dimelor, Dymelor)	0.25–1.5 g in single or divided doses	8–10 hours	May exert uricosuric effect.
chlorpropamide *(klor-**PROH**-pah-myd)* (Diabinese, Novo-Propamide)	0.1–0.75 g daily in a single dose	72 hours	Use cautiously in clients with renal impairment and in the elderly. Hypoglycemia may occur more often than with other agents because of longer duration of action.
tolazamide *(tohl-**AZ**-ah-myd)* (Tolinase)	0.1–1 g daily in single or divided doses	10–14 hours	—
tolbutamide *(tohl-**BYOU**-tah-myd)* (Mobenol, Orinase)	0.5–3 g daily in divided doses	6–12 hours	Has shortest duration of action of available agents. Usually drug of first choice for oral therapy.
Second Generation Sulfonylureas			
glipizide ***(GLIP**-ah-zyd)* (Glucotrol)	Initial: 5 mg daily; dose may be raised in 2.5–5 mg increments every few days until blood glucose level is satisfactory; maximum recommended dose is 40 mg daily	10–24 hours	Dosage should be given $^{1}/_{2}$ hour before meals. Geriatric clients and those with liver disease should be started with a 2.5 mg dose.
glyburide *(**GLY**-byour-eyed)* (DiaBeta, Euglucon, Glynase, Micronase)	Initial: 2.5–5 mg; dose may be raised at 1.25 mg increments until blood glucose level is satisfactory **Note:** Glynase is initially given in a dose of 1.5–3 mg daily	24 hours	Dosage should be administered with the first main meal of the day. Geriatric clients and those with liver disease should be started with a 1.25 mg dose. Glynase products contain micronized glyburide, which is better absorbed.
glimepiride *(gly-**MEP**-ih-ride)* (Amaryl)	8 mg/day	24 hours	Served with main meal.

continues

TABLE 36–2 *continued*

See **Note** at beginning of Table 36–2, page 701.

DRUG	USUAL DOSE	DURATION OF ACTION	NURSING IMPLICATIONS
Biguanides			
metformin HCl *(meht-**FOHR**-mihn high-droh-**KLOHR**-eyed)* (Glucophage)	500–850 mg once or twice daily	12–24 hours	Avoid the use of alcohol in clients using this drug. Observe client for signs of lactic acidosis (hyperventilation, drowsiness, myalgia, or malaise).
Meglitinide			
repaglinide *(reh-**PAG**-lih-nide)* (Prandin)	0.5–4 mg with each meal	6–8 hours	Serve with meals.
Thiazolidinediones			
rosiglitazone *(roh-zi-**GLIH**-tah-zone)* (Avandia)	4–8 mg once or twice daily	12–24 hours	Monitor liver function.
pioglitazone *(pie-oh-**GLIT**-ah-zone)* (Actose)	15–45 mg once a day	16–24 hours	See rosiglitazone.
Alpha-glucosidases			
acarbose *(ah-**KAR**-bose)* (Precose)	25–100 mg three times a day	6–8 hours	Diet control is essential May decrease digoxin levels. May cause gas and diarrhea.
meglitol *(**MEG**-lih-tohl)* (Glyset)	25–100 mg three times a day	6–8 hours	Tell client to take with first bite of meal. See acarbose.

Clients who seem to respond best to oral hypoglycemic therapy are those who:

- are not diagnosed as having diabetes mellitus until after age 40
- are not overweight
- would require less than 40 units of insulin daily to control their condition if they were not using an oral hypoglycemic agent

Although each of the six sulfonylurea derivatives currently in use has been shown to be effective in appropriately selected clients, they do differ with regard to their potency, toxicity, and duration of action. Tolbutamide (**Orinase**) has the lowest reported incidence of adverse effects and the shortest duration of action. Since it is rapidly converted in the body to inactive metabolites, it is the most suitable of the oral hypoglycemic agents for clients with kidney dysfunction. Three newer "second generation" sulfonylureas, **glipizide** (**Glucotrol**), **glyburide** (**DiaBeta**, **Micronase**, **Glynase**), and **glimepiride** (**Amaryl**) are more potent than older agents and may be administered once daily. Further use will permit assessment of their advantages over older agents.

A number of adverse effects have been associated with the use of the sulfonylurea drugs. They include:

- gastrointestinal distress
- hypoglycemia
- hepatotoxicity and jaundice
- hematological disorders
- hypersensitivity reactions (e.g., rash and pruritus)

In addition, some clients using these drugs may develop a series of adverse symptoms upon ingesting alcohol. The symptoms may first appear within several minutes after alcohol has been consumed and often include flushing, nausea, and/or palpitations.

Repaglinide (**Prandin**) is the first in a new class of oral antidiabetic medications called meglitinides. It causes a decrease in blood sugar by stimulating

insulin release in the pancreas making it dependent on functioning beta cells. As with the other antidiabetic agents, repaglinide is used in conjunction with exercise and diet. One of its main differences from the sulfonylureas is that its onset of action is more rapid. In addition, it is prescribed to be taken before each of three meals per day.

A third class of oral antidiabetic agents was approved in 1999 that act to sensitize the body to the insulin in the system when the agent is administered. The glitazones, including **rosiglitazone** (**Avandia**) and **pioglitazone** (**Actose**), represent a group called the thiazolidinediones. They act by helping insulin work better in the muscles and fat of the body. They are taken once or twice a day with food. Their most significant adverse effect (although rare) is liver damage. Thus, clients using these products need to be monitored closely. Liver function tests should be performed at 2 to 3 month intervals.

The fourth class of oral hypoglycemic agents slow or block the breakdown of starches and certain sugars. Currently there are two drugs in this class—**acarbose** (**Precose**) and **meglitol** (**Glyset**). Their action slows the rise of blood glucose after meals by blocking the breakdown of starches, such as breads, potatoes, pasta, and some table sugars. The most prominent adverse side effects of these agents is abdominal bloating, gas, and diarrhea.

Oral combination therapy has become increasingly more popular. Because the oral hypoglycemic agents now available work in different ways to lower blood sugar, using combinations of these agents have proven effective in controlling type 2 diabetes. One of the newest of these combinations is glyburide with metformin HCl (**Glucovance**). It is available in three strengths, 1.25/250 mg, 2.5/500 mg, and 5/500 mg. The major adverse effect associated with this combination is, in rare cases, lactic acidosis, which can be fatal in up to 50% of the cases.

KEY NURSING IMPLICATIONS 36–1

Diabetes Mellitus: Assessment

1. Ascertain what the person already knows about diabetes.
2. Obtain a medication history and information about dietary and exercise patterns.
3. Measure height, weight, vital signs, and do a general physical assessment with special attention to their legs and feet.
4. Examine laboratory tests for blood glucose levels, evidence of acidosis, and presence of glucose and ketones in the urine.

APPLYING THE NURSING PROCESS

ASSESSMENT

In nearly every instance of caring for diabetic clients, the major nursing goal is to assist the client in becoming independent in self-care. The steps necessary in meeting this goal can perhaps best be understood by examining the nursing activities involved in caring for a newly diagnosed insulin-dependent (type 1) diabetic. At the time of diagnosis, or shortly thereafter, the person may be admitted to the hospital to stabilize the diabetic condition. As part of the nursing assessment process, the nurse ascertains what the person already knows about diabetes. This is an excellent opportunity to identify misconceptions, emotions and level of knowledge to guide the nurse in planning the client education program. As there are often other diabetics in the family, the client may begin the educational program with misinformation and attitudes that influence his/her reaction to the instruction the nurse provides.

The nurse also obtains information about medication use, as well as dietary and exercise patterns, as these factors may significantly influence blood sugar level. Height, weight, and vital signs are measured. A general physical assessment is conducted, with special attention to examination of the legs and feet, noting the presence of stasis ulcers, infection, and structural factors that may predispose the client to future complications often associated with diabetes. The nurse also should note the condition of the skin and amount of subcutaneous tissue in areas that may be used for insulin administration. Information also is obtained about usual daily schedule. Finally, laboratory results are examined for blood glucose level, evidence of acidosis (e.g., low blood pH), and the presence of glucose and ketones in the urine.

NURSING DIAGNOSES

Including but not limited to:

- Ineffective health maintenance related to chronic nature of diabetes
- Deficient fluid volume related to diuresis due to hyperglycemia
- Risk for injury, diabetic ketoacidosis related to uncontrolled diabetes
- Risk for impaired skin integrity related to long term effects of diabetes
- Risk for injury, hypoglycemia related to side effects of insulin therapy
- Deficient knowledge related to disease process and treatment regimen

PLANNING/GOALS

- Client will demonstrate ability to manage diabetic condition through appropriate self-administration of insulin (type 1-IDDM) or oral antidiabetic agents (type 2-NIDDM).
- Client will maintain fluid balance through maintaining control of diabetes through diet, exercise, and medication.
- Client will not experience diabetic ketoacidosis.
- Client's skin will remain intact.
- Client will not experience hypoglycemia related to adverse effects of insulin therapy.
- Client will verbalize understanding of disease process, self-medication, glucose monitoring, signs and symptoms of hyper- and hypoglycemia, diet, exercise, foot care, and importance of follow-up visits.

IMPLEMENTATION

Decreasing Knowledge Deficit

Following the development of a teaching plan based on the assessment, the nurse assembles materials to begin an educational program. The client should receive an overview of the nature of diabetes mellitus, the current status (insulin dependency, present control) and a reiteration of the treatment plan. Printed materials are left with the client for review. Questions and comments about these materials are discussed with the nurse at the next instruction period. Often the first skill that should be taught is insulin injection. It is usually associated with the most anxiety for both the client and the nurse. When this skill is learned, the client feels more confident about managing self-care. Also, one of the early contacts between nurse and client often involves administration of insulin. At that time the nurse can also explain the purpose of insulin therapy and set a time with the client to begin instruction in self-administration.

Usually several people are involved in the teaching of self-care skills; therefore it is important that a record be kept in a prominent place in the nursing care plan or client's chart to identify what has been taught and what has been learned. Learning can be evaluated through the client's ability to perform a skill, explain a concept, or score well on a quiz. A second guideline is to begin instruction as soon as possible, i.e., when the client feels well enough, rather than wait until the client is about to be discharged. It is advisable for the nurse to discuss the teaching plan with the physician to determine the preferred method of blood glucose monitoring, type of insulin to be used, and expected schedule of administration at home. This planning should be done very early in the hospitalization period —usually shortly after admission.

Understanding their health condition and the need for conscientious self-care critically affects the health and well-being of diabetic clients. The facts and skills to be managed include:

- foot care
- role of exercise
- diet therapy
- insulin (and often glucagon) administration
- urine testing (not all clients)
- blood glucose monitoring
- differentiation of diabetic acidosis and insulin reaction and how to manage these states of imbalance
- what to do when illness or unusually stressful conditions occur

It is important not to overwhelm the client with this information. It may be helpful to introduce the new diabetic to a well-taught diabetic early in the program. The new diabetic will generally become more confident about managing self-care when they learn that others have developed ways of managing self-care.

Whether the client, nurse, or family member administers the insulin, there must be an understanding of the types of insulin being employed.

This includes knowledge of the onset, peak, and duration of action, so that the individual knows when a hypoglycemic episode might be most likely to occur. When teaching clients, the use of visual aids, including printed step-by-step instructions and demonstration, is important. A printed information sheet like that in Box 36–1 may be left with the client to guide practice sessions. If more than one type of insulin is being used, instructions are provided for proper mixing of insulins (Box 36–2).

In teaching insulin injection techniques, it is important to stress injection site rotation. The client must know that unsightly lipodystrophy may occur and that absorption may be affected if injection is made into a hypertrophic area. Using a 90° angle of injection for insulin administration and postinjection massage of the injection site may decrease the likelihood of lipodystrophy. The use of human insulin greatly decreases the probability of lipodystrophy.

There are a number of techniques that can be useful in rotating injection sites. The principles of rotation involve identifying appropriate sites, planning injections to make use of these sites in some systematic manner, and avoiding problem areas. The areas that can be used for subcutaneous administration of insulin include the lateral surface of the upper arm, the abdomen, the anterolateral surface of the thighs and, with assistance, the buttocks and scapular areas (Figure 36–1). Most commercially available instruction materials contain diagrams of these sites.

Although the client must be taught to use sites other than the thighs, initially, the client may find it easiest to inject into the thighs. The nurse can help in the identification of this site by telling the client to place one hand on the upper leg (even with the groin) and one hand on the knee of the same leg. The area between the hands—in the middle and the outer aspects of the leg—is the proper area for injection. Within this larger area, a number of sites can then be identified for the first several injections.

It is often difficult for people to accept the idea of injection into the abdomen, but once

BOX 36–1 Adminstering a Single Dose of Insulin

1. Check the order and assemble equipment (e.g., insulin, syringe, needle, antiseptic agent). Bring the insulin to room temperature.
2. Wash your hands. Put on disposable gloves.
3. Unless regular insulin is being used, invert and roll the bottle between hands, to mix the insulin.
4. Cleanse the stopper with antiseptic agent.
5. Check strength of insulin against the medication order and the syringe being used. The strengths must match.
6. Measure the same volume of air as the amount of insulin you wish to withdraw.
7. Puncture the stopper and inject the air into the vial.
8. Invert the bottle and pull the plunger down to obtain the correct amount of insulin.
9. If air bubbles appear in the syringe, hold the bottle upside down and push insulin back into the bottle until you expel the air or draw a little extra insulin into the syringe. Snap the syringe with your fingernail until the air bubbles rise to the hub and can be expelled.
10. Remove the needle from the vial.
11. Select an area for injection and wipe the site with the antiseptic agent. Allow the antiseptic to dry.
12. Pinch up an area for injection or stretch the area for injection if there is much subcutaneous tissue at the site.
13. Insert the needle to its full length at a 90° angle to the skin surface, using a needle appropriate for subcutaneous injection (⅝ inch or shorter).
14. Pull back on the plunger to see if blood is aspirated. If blood appears, prepare a new dose of insulin using new equipment. If there is no blood, inject the insulin.
15. Remove the needle, again apply the antiseptic agent to the injection site and gently massage the site.
16. Remove gloves. Wash your hands.
17. Care for the equipment as instructed and chart the time of administration, type and dose of insulin, and the injection site.

Note: Self-administration does not require glove use.

BOX 36–2 Instructions for Mixing and Administering Two Types of Insulin

1. Check the order and assemble equipment (e.g., insulin, syringe, needle, antiseptic agent). Bring the insulin to room temperature.
2. Wash your hands. Put on disposable gloves.
3. Invert and roll the bottle of intermediate or long-acting insulin between your hands, to mix the insulin.
4. Cleanse the stoppers of both bottles with antiseptic.
5. Compare the strength of both insulins being used against the medication order and the syringe. The strengths must match.
6. Measure the same volume of air as you wish to withdraw of the intermediate- or long-acting insulin.
7. Insert the needle through the stopper and push in the air, withdrawing the syringe empty.
8. Then measure the same volume of air as you wish to withdraw of the regular insulin.
9. Insert the needle into the bottle of regular insulin, invert the bottle and withdraw the correct dosage. Remember to withdraw the clear insulin first, then the cloudy insulin.
10. Remove all air bubbles and remove the needle from the vial.
11. Turn the bottle of intermediate- or long-acting insulin upside down and reinsert the needle into this vial.
12. Slowly pull the plunger to withdraw the dosage of long-acting insulin that is ordered.
13. Remove the needle from the stopper.
14. When mixing regular and PZI insulins, draw a small air bubble into the syringe and invert the syringe several times to mix the insulins. Then, holding the syringe with the needle upward, carefully expel the air bubble.
15. After mixing regular insulin and NPH insulin in the syringe, the insulin must be administered within 30 minutes; otherwise the NPH begins to alter the regular insulin's onset, peak, and duration times.
16. Select an area for injection and wipe the site with the antiseptic agent. Allow the antiseptic to dry.
17. Pinch up an area for injection or stretch the area for injection if there is much subcutaneous tissue at the site.
18. Insert the needle to its full length at a 90° angle to the skin surface, using a needle appropriate for subcutaneous injection (⅝ inch or shorter).
19. Pull back on the plunger to see if blood is aspirated. If blood appears, prepare a new dose using new equipment. If there is no blood, inject the insulin.
20. Remove the needle and again apply the antiseptic agent to the injection site.
21. Remove gloves. Wash your hands.
22. Care for the equipment as instructed and chart the time of administration, type and dose of insulin, and the injection site.

Note: Self-administration does not require glove use.

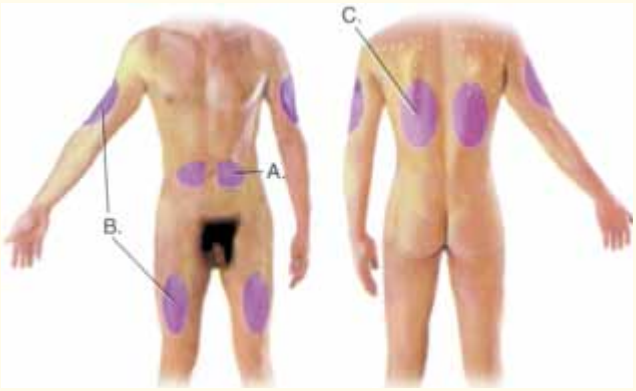


Figure 36–1 Areas of the body which may be used for selection of injection sites. Injection sites should not be used more than once a month.

learned this frequently proves to be a favorite site. It is helpful for the nurse to briefly explain the basic anatomy of the abdomen and to assure the client that the needle will not pierce a vital organ. Watching an experienced diabetic inject this area might be useful. The abdominal injection area is identified by drawing an imaginary line under the ribs and above the hip bone. Then, avoiding a 1-inch area all around the umbilicus and avoiding the belt line, all areas where fat can be pinched up may be used as injection sites.

Injection into the upper arms may be associated with less anxiety, but is often technically difficult for the client and may require consider-

KEY NURSING IMPLICATIONS 36–2

Decreasing Deficit Knowledge

1. Teaching self-care skills is an important nursing task.
2. Self-care requires understanding and skills in foot care, diet therapy, exercise, insulin administration, blood glucose monitoring, differentiating diabetic acidosis from insulin reaction, and knowing what to do when illness or stress occurs.
3. To decrease lipodystrophy, the client is taught to rotate sites, use a 90° angle of injection and massage the site following injection.
4. Insulin may be administered subcutaneously into the lateral surface of the upper arm, the abdomen, the anterolateral surface of the thighs, the buttocks and the scapular areas.
5. Injection of insulin into an infrequently used area may result in hypoglycemia.
6. It is important to establish, maintain, and record a rotational pattern for injection sites.

able coordination. Some clients prefer to save these sites for times when other persons administer insulin to them. The client should know, however, that injection of a dosage of insulin into an infrequently used site may result in hypoglycemia, as absorption is more rapid from such an area. Injection into areas frequently exercised, such as the upper arm and thigh, also promotes absorption. The injection area on the upper arms is identified by placing one hand on the shoulder and the other on the elbow. The middle and outer aspects of the area between the hands is the area for injection. The client can inject into these areas by pressing the back of the upper arm against the back of a firm chair or against the wall and rolling the arm slightly downward to pinch up the injection site (Figure 36–2). Again, watching an experienced diabetic or nurse demonstrate this takes the mystery out of how it can be done. Regardless of which injection site has been chosen, areas with scars, moles, and other skin lesions are avoided.

Recently, a case has been made against truly random rotation of injection sites. Because of

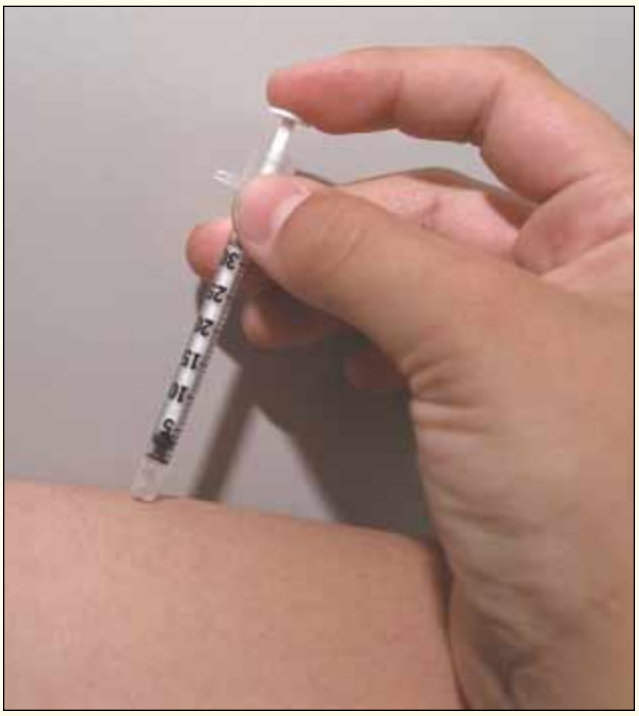


Figure 36–2 Self injection of insulin into the upper arm.

the different rates of absorption from various sites, random rotation may produce erratic blood insulin levels. What may be recommended to a client is to establish a definite pattern of rotation. The client could be advised to begin with the abdominal sites and to exhaust use of these before moving to the arm. Arm sites are then used before moving on to thigh sites. When the client is hospitalized, a chart of the injection sites should be placed on the clinical record. The nurse or client should continue the site selection pattern that has been used by the client before admission. When a particular site has been used, it is checked off on the chart.

Administration of Insulin by Pump

As many long-term consequences of diabetes, such as kidney disease, may be related to blood glucose control, several intensive methods of insulin therapy have become increasingly popular. Among these are multiple daily administrations of insulin and the administration of regular insulin by pump. Pumps continuously deliver a small, previously determined amount of insulin through tubing and a subcutaneously placed needle. Not all diabetic clients are candidates for an insulin pump. Clients selected must

need more than one injection of insulin daily and be emotionally stable, able to learn how to manage administration by pump, conscientious in self-care, and willing to monitor blood glucose levels on a regular basis.

There are a number of different types of pumps on the market. Most cost between $2,000 and $3,000. Currently in the United States, all are open-loop pumps requiring that the client test the blood for glucose level and adjust the insulin dosage accordingly. Closed-loop pumps, which are under refinement, involve a glucose sensor, a microprocessor to calculate the amount of insulin needed, and a pump to deliver the insulin. Open-loop pumps are external portable pumps that deliver insulin from a reservoir by way of thin tubing and a small-gauge needle (e.g., 27 or 28) inserted subcutaneously into the abdomen (Figure 36–3). The pump is programmed to deliver a basal or steady amount of insulin, and the client is instructed to administer a bolus of insulin prior to meals. This delivery system mimics the body's normal insulin pattern.

Figure 36–3 Insulin infusion pump.

Insulin pumps have the following characteristics in common:

- They use regular insulin only.
- Insulin is stored inside the pump in a syringe or disposable reservoir.
- Insulin is delivered at a preset rate determined by the physician.
- Bolus injections are given before meals or based on self-monitoring of glucose.
- Pumps are powered by disposable or rechargeable batteries.
- The pump can be disconnected for brief periods, e.g., for exercise.
- Most have alarms to indicate low batteries, obstruction to outflow of insulin, or pump malfunction.
- Pumps are worn on a belt or in a special holster or pouch.

Insulin pump treatment is initiated in the hospital to ensure proper control of blood glucose. At this time, the client is instructed in the use of the pump and in preventing the most common complications of therapy. These complications include:

- local infection at the injection site, which can be prevented by proper skin preparation and changing the site of needle insertion every 48 hours
- hypoglycemia, which is prevented by carefully calculating the dose of insulin, monitoring pump function, and ensuring regular food intake
- diabetic ketoacidosis, which is prevented by carefully calculating the dose of insulin, administering bolus injections before meals and in response to blood glucose levels, and monitoring pump function. Special attention is given to ensuring that the tubing is not kinked. If two consecutive blood glucose levels of 240 mg/dL occur, clients should replace the battery, infusion reservoir and infusion set.

Once the reservoir is filled with insulin and the pump is ready for use, the client is taught how to insert the needle and care for the injection site. Although the exact procedure will vary depending on physician preference and hospital procedure, the following guidelines can be used in instructing clients:

- The injection site is prepared by washing with soap and water, drying the site, and then applying alcohol or povidone-iodine solution.
- The site should be changed every 2 days.
- The site is selected in the same manner as when a single abdominal site is selected, with special attention given to avoiding the waistline and areas of particular pressure, such as bony prominences.

- The needle is inserted subcutaneously at a 30° to 60° angle.
- The needle is taped in place and covered with a sterile polyurethane dressing.
- A small loop of tubing is also secured with tape.
- Areas that abscess are examined by a physician or nurse. These areas are cleansed with **hexachlorophene** or povidone-iodine solution and clients are instructed to apply an antibacterial ointment. The site is not used again until it is completely healed.

Clients using a pump should be advised that they may not experience the usual symptoms of hypoglycemia, such as sweating and rapid heart rate. The constant infusion of insulin eliminates the sudden drop of blood glucose that normally produces a sympathetic response. Instead, the client may experience signs and symptoms of central nervous system (CNS) response (e.g., confusion or loss of consciousness) when the blood glucose is very low. Blood glucose monitoring and alteration of the rate of insulin infusion may be important in preventing hypoglycemic episodes. Family members must be instructed in glucagon administration, as well as in treatment with readily available sources of glucose.

Finally, clients are instructed that the needle may be capped and the pump disconnected while bathing, exercising, swimming, etc. The pump must not be left off for more than an hour at a time, however. As with any insulin-dependent diabetic, supplemental food may be needed following strenuous exercise.

Storage and Care of Insulin and Supplies

Instruction must be provided on the storage of insulin and care of injection equipment. Many diabetics now use disposable syringes and needles. Most insulin syringes have a capacity of 1 mL and are designed to be used with only one strength of insulin (e.g., U-100). Clients who require injections of 50 units or less of U-100 insulin may find the use of a LO-DOSE syringe more convenient. It has a capacity of only 0.5 mL and has markings that are easier to read. Those who choose reusable syringes and needles must be taught to sterilize them. A wide variety of devices are also available to assist the visually impaired diabetic.

KEY NURSING IMPLICATIONS 36–3

Administration of Insulin by Pump

1. All pumps available in the United States are open-loop pumps requiring that the client monitor blood glucose level.
2. Only regular insulin is administered by pump.
3. The most common complications of therapy with an insulin pump are infection at the injection site, hypoglycemia, and diabetic ketoacidosis.
4. Clients using an insulin pump must be advised that they may not experience the usual symptoms of hypoglycemia.
5. Insulin pumps may be disconnected while bathing, swimming, exercising, engaging in sexual relations, etc. They must not be left off for more than 1 hour.

Insulin should be refrigerated if it is to be used over several months. Otherwise it may be kept at room temperature. Visually impaired or handicapped diabetics may have a week's supply of insulin prepared for them. The filled syringes must be stored in the refrigerator with the needle pointing upward, to prevent the insulin from precipitating in the needle. Syringes containing any insulin except rapid-acting insulins must be rotated to mix the insulin before the dose is administered. Before injection, insulin is always brought to room temperature to minimize local skin reactions. This is usually accomplished by removing the vial from the refrigerator shortly before administration. Even when this is done, some skin reactions may occur 20–40 minutes following injection. These may be treated by changing the skin-cleansing agent, using antihistamines, or, in some cases, changing the insulin.

Glucose Monitoring

Glucose monitoring is a critical aspect of diabetes management. Currently, many diabetics are being taught to monitor their blood glucose level directly, rather than through urine tests. Blood testing at least once and often four or more times a day is common practice. If checking blood glucose only once a day, the client

should be taught to check it at different times each day to see how controlled the diabetes is. Blood may be obtained from the earlobe or fingertip using a sterile lancet or a similar device that aids the client in obtaining a drop of blood painlessly (Figure 36–4). The blood is then placed on a reagent strip. Several methods can be used to determine the blood glucose level. The client is instructed to follow the directions provided by the manufacturer of the reagent strip or meter. Meter reading of strips may be more accurate than comparison with color charts on the reagent bottle. Meters may also be preferred by clients, because of the ease of reading the results (Figure 36–5). The outcome of the testing may be tied to administration of additional insulin delivered as a bolus by pump or injected by syringe.

Although it is becoming uncommon, some clients, such as noninsulin-dependent diabetics and stable diabetics, are still using urine testing to assess diabetes control. The primary value of urine testing is to determine the presence of ketones in the urine. The nurse should discuss the frequency and method of urine testing with these clients. After a method of urine testing has been chosen, the method should not be changed without prior discussion with the health care provider. The client should know which drugs may produce false positive results.

See Table 36–3 for a listing of commonly used diabetic testing agents and Box 36–3 for a list of some commonly used drugs that may cause false-positive tests for urinary glucose.

Routine blood glucose monitoring becomes very important in some clients. In these cases, the dosage of insulin is related to the amount of glucose in the blood. A sliding scale of insulin dosages may be used. The nurse is often responsible

BOX 36–3
Some Drugs That May Cause False-Positive Tests for Urinary Glucose by the Copper Reduction Method (e.g., Clinitest)

ascorbic acid (large doses)

cephalosporin antibiotics

chloral hydrate

isoniazid

nalidixic acid

p-aminosalicylic acid

penicillins (large doses)

probenecid

salicylates

streptomycin

Figure 36–4 This young boy uses a lancet device to test his blood.

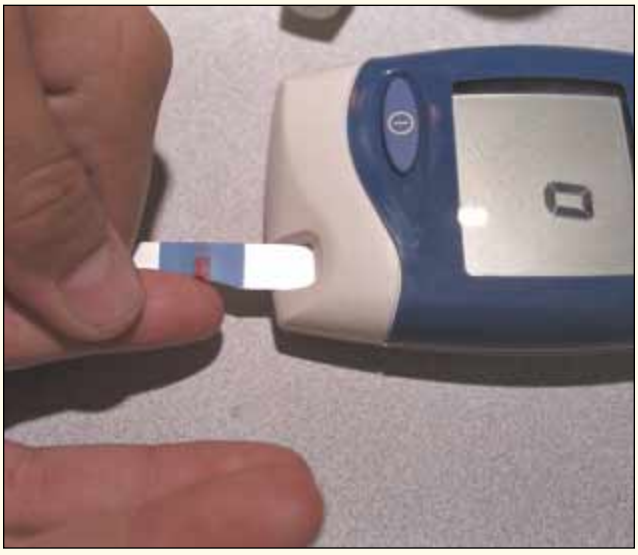


Figure 36–5 Meter that is used to check glucose levels in the blood.

TABLE 36–3

Diabetic Testing Agents

TEST	ACTIVE INGREDIENT OR MECHANISM	DETECTS	TIME REQUIRED TO EVALUATE	PRODUCT FORMULATION	BIOLOGICAL FLUID(S) USED
Acetest	nitroprusside	ketones (acetoacetic acid and acetone)	Urine: 30 sec Plasma: 2 min Whole blood: 10 min	tablet	urine, plasma, whole blood
Chemstrip bG	glucose oxidase	glucose	2 min	strip	whole blood
Chemstrip-K	nitroprusside	ketones	—	strip	urine
Chemstrip uG	glucose oxidase	glucose	—	strip	urine
Chemstrip uGK	glucose oxidase, nitroprusside	glucose, ketones	2 min	strip	urine
Clinistix	glucose oxidase	glucose	10 sec	strip	urine
Clinitest	copper reduction	glucose, reducing substances	15 sec	tablet	urine
Dextrostix	glucose oxidase	glucose	60 sec	strip	whole blood
Diascan-S	glucose oxidase	glucose	—	strip	whole blood
Diastix	glucose oxidase	glucose	30 sec	strip	urine
Glucostix	glucose oxidase	glucose	120 sec from the first application of blood to the device	strip	whole blood
Keto-Diastix	glucose oxidase, nitroprusside	glucose, ketones (acetone, acetoacetic acid)	Glucose: 30 sec Ketones: 15 sec	strip	urine
Ketostix	nitroprusside	ketones (acetoacetic acid and acetone)	15 sec	strip	urine, plasma
Tes-Tape	glucose oxidase	glucose	1 min	strip	urine
Tracer bG	glucose oxidase	glucose	—	strip	whole blood
Visidex II	glucose oxidase	glucose	—	strip	whole blood

for teaching the client the proper technique to use for assessing blood glucose. Although procedures may vary slightly according to the directions provided by manufacturers of glucose testing meters, some general directions can be provided. Clients are first instructed to gather their equipment, such as the meter, testing strips, and blood lancet. They are instructed to wash their hands. They then choose and prepare the site, often the fingertips, and puncture the skin with the lancet. The freshly obtained blood is applied to the testing strip and read according to the manufacturer's directions. Finally, the lancet and other waste products should be

KEY NURSING IMPLICATIONS 36–4

Storage and Care of Insulin and Supplies

1. Before injection, insulin is brought to room temperature. This minimizes local skin reactions.
2. Many clients are instructed in the monitoring of blood glucose levels by use of a visually or machine-read reagent strip.
3. Some drugs may cause false-positive tests for urinary glucose (Box 36–3).

disposed of properly and the results of the test are recorded. Finally, it is important that blood testing records be taken to the physician at each visit, so that the physician can identify times of the day when changes in insulin coverage might be indicated. Some newer glucose meters can store up to 250 test results or download the data onto computers, making it easier to keep and to analyze the results of glucose testing.

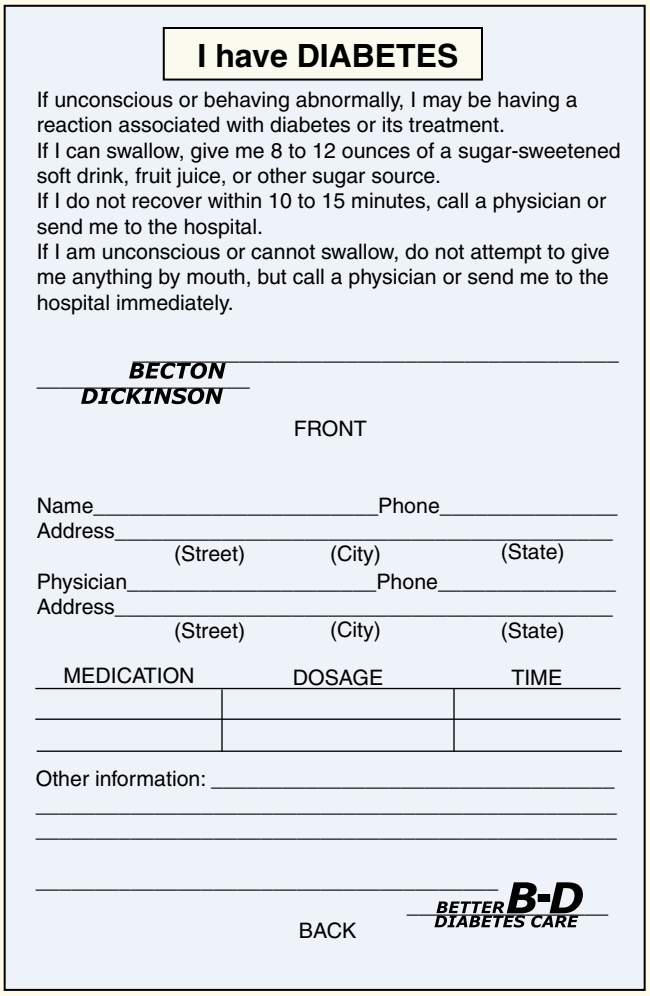
Insulin Reactions and Diabetic Ketoacidosis

Newly diagnosed diabetics need to learn how to recognize insulin reactions and diabetic ketoacidosis (DKA) and what might precipitate these situations. This is often confusing at first and a chart comparing the two, posted at home, can be very helpful. In some cases, it also helps to ask clients to recall how they felt when they were first diagnosed as having diabetes and to emphasize the signs and symptoms indicative of DKA. Clients can be asked to recall signs and symptoms of hypoglycemia that occurred when they may have gone without eating for a long period or when they exercised vigorously. This also provides an opportunity for the nurse to point out that exercise decreases blood sugar and that the consumption of additional carbohydrates may be required before strenuous exercise. Family members must receive instruction in all aspects of diabetic care. Learning to identify and treat insulin reactions is particularly important because the diabetic may not be able to identify or treat such episodes alone, particularly if they occur rapidly or during sleep. Family members are instructed that if they are unsure if they are viewing an insulin reaction or DKA, it is best to treat it like an insulin reaction, as administering unnecessary sugar to a client with DKA is less hazardous than failing to treat the client with an insulin reaction. Insulin reaction or hypoglycemia is more common than DKA and has a more rapid onset. Some families are taught to use a rapid glucose test (e.g., Dextrostix) to determine the blood glucose level of a diabetic experiencing problems.

Insulin reactions may be treated in one of several ways. The easiest way, if the client is conscious, is to give approximately 4 oz of juice or sugar-containing soda or some other rapidly absorbed sugar, such as table sugar, sweet syrups, or hard candy (e.g., 6–7 Lifesavers). It is often a good idea to follow this with a complex carbohydrate, such as crackers. Clients who have difficulty swallowing may have sugar-containing substances, such as syrups or cake-decorating paste, applied to the buccal mucosa. Another method used to treat hypoglycemia in semiconscious or unconscious persons is the injection of glucagon. Family members should receive thorough instruction in reconstituting glucagon and in its administration. They are advised that the client treated for insulin reaction should be sufficiently recovered within 15 minutes to take oral nourishment. If there is no response to this treatment, the physician should be contacted. It may be necessary to take the client to an emergency department to receive intravenous dextrose solutions. Care should be taken to adequately treat, but not to overtreat, insulin reactions to avoid causing too much glucose to be spilled. This may require the administration of supplemental insulin doses and make diabetic control more difficult.

All diabetics, particularly those who are insulin-dependent, must carry a means of identification (card or bracelet) to alert others to the fact that they are diabetics (Figure 36–6). In this way more rapid treatment of diabetic emergencies may be carried out.

Diabetics using rapid-acting insulin are instructed to administer their dosage 30 minutes before meals. Those using intermediate- or long-acting insulins should administer their dosage 1 hour before breakfast. If the client is required to fast (e.g., prior to laboratory examinations) insulin is not administered until it is known


I have DIABETES

If unconscious or behaving abnormally, I may be having a reaction associated with diabetes or its treatment.
If I can swallow, give me 8 to 12 ounces of a sugar-sweetened soft drink, fruit juice, or other sugar source.
If I do not recover within 10 to 15 minutes, call a physician or send me to the hospital.
If I am unconscious or cannot swallow, do not attempt to give me anything by mouth, but call a physician or send me to the hospital immediately.

BECTON DICKINSON

FRONT

Name_____Phone_____
Address_____
(Street) (City) (State)
Physician_____Phone_____
Address_____
(Street) (City) (State)

MEDICATION	DOSAGE	TIME

Other information: _____

BETTER B-D DIABETES CARE

BACK

Figure 36–6 Diabetic identification card *(Courtesy of Becton Dickinson Consumer Products)*

KEY NURSING IMPLICATIONS 36–5

Insulin Reactions and Diabetic Ketoacidosis

1. If unsure whether the client is experiencing an insulin reaction or diabetic ketoacidosis, it is better to treat for an insulin reaction.
2. Insulin reactions are treated by giving approximately 4 oz of a sugar-containing beverage or other rapidly absorbed sugar, if the client is able to swallow. This is usually followed by administration of a complex carbohydrate or regularly scheduled meal.
3. If unable to swallow, sugar-containing syrups or pastes may be applied to the person's buccal mucosa.
4. Family members should be taught how to reconstitute and administer glucagon.
5. Insulin is not administered to clients who are required to fast.
6. Beta-adrenergic blocking agents may mask the signs and symptoms of hypoglycemia. Clients are taught to respond to subtle indicators such as weakness or dizziness.

when the client will again be able to eat. At that time, the guidelines discussed can be followed. In presurgical clients, the physician may alter the client's usual insulin dose, because the client will be receiving intravenous dextrose. In some cases, regular insulin will be added directly to the dextrose infusions. Clients with gastrointestinal illnesses and other problems affecting appetite and/or metabolism are instructed to consult their physician for specific guides to insulin dosage during illness. Diabetic clients who use beta-adrenergic blocking agents may not recognize signs of hypoglycemia (e.g., rapid pulse), because the beta-blockers often mask such signs and symptoms. Diabetic clients using such drugs should, therefore, be taught to respond to subtle signs of hypoglycemia—for example, weakness, dizziness, and inability to concentrate. Persons who have had diabetes for several years may experience a decrease in the effectiveness of the body's regulatory mechanisms that increase blood glucose. They also may have damage to the autonomic nervous system, resulting in blockage of early signs of hypoglycemia.

Safety Precautions

Two groups of diabetics require special consideration during their initial instruction. These are visually impaired diabetics and children. An assortment of equipment has been developed for use by diabetics with limited vision to allow them to be self-sufficient in administering insulin. Whenever the nurse is engaged in teaching diabetics with limited sight, the local chapter of the American Association for the Blind, the American Diabetes Association, and journal articles may prove to be helpful resources.

There are no hard-and-fast rules concerning when children should begin to administer their

NURSING CARE PLAN

A Client With Diabetes Using an Oral Hypoglycemic, Glipizide (Glucotrol)

Dan Martin, age 48, has been working for a construction firm for the previous 15 years. While putting up a scaffolding, he fell about 8 feet and broke his left leg. While he was having X rays done and a cast put on his leg, blood work was drawn that showed an elevated blood glucose level of 356 mg/dL (normal is 80–120 mg/dL). Mr. Martin indicated that he has no previous history of diabetes, although his mother was diabetic. He was admitted to the hospital for further evaluation and diagnosed as having type 2 diabetes mellitus. He was started on glipizide (Glucotrol) 5 mg daily along with an 1800 calorie ADA diet. The physician recommends that Dan attend diabetic teaching classes.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Hunger, thirst, weight.	Imbalanced nutrition: more than body requirements related to intake greater than need.	Client will plan an 1,800-calorie ADA diet prior to discharge.	Teach client an 1,800-calorie ADA diet with the exchange lists. Assess client's food preferences. Using restaurant menus have the client practice selecting meals. Review diet with client's wife.	Client is able to use exchange lists to maintain 1,800-calorie ADA diet.
Nocturia, polyuria.	Deficient fluid volume related to fluid loss via urine secondary to diabetes mellitus.	Client will maintain adequate fluid balance as evidenced by normal vital signs, skin turgor, and electrolytes.	Assess skin turgor. Monitor electrolytes. Maintain low-calorie fluids for replacement.	Client has no signs of dehydration. Fluids have been replaced as needed.
Muscle weakness, fatigue.	Fatigue related to altered body chemistry.	Client will maintain moderate exercise.	Teach client benefits and risks of exercise. Diet, activity, and medication are used for control of diabetes. Identify his exercise preferences and encourage him to plan an exercise program.	Client identifies daily activity schedule.
Assess feet for pressure changes, circulation.	Risk for impaired skin integrity related to decreased sensation and recent fracture.	Client will not have evidence of skin breakdown.	Teach client good foot care. Wash feet and change socks daily, cut toenails straight across. Avoid soaking feet and apply lanolin between toes.	Client demonstrates understanding of proper foot care. No skin breakdown occurs.
Cold extremities, skin shiny, weak pedal pulses.	Ineffective peripheral tissue perfusion related to inadequate circulation secondary to diabetes mellitus.	Client will maintain adequate tissue perfusion as evidenced by normal peripheral pulses.	Assess pedal pulses and color and temperature of feet. Teach client to avoid crossing knees and use of Buerger-Allen exercises.	Client has no signs of decreased tissue perfusion.
Skin changes, infection, elevated body temperature, white blood cell count.	Risk for infection related to poor circulation and elevated blood glucose.	Client will not have infection during this hospitalization as evidenced by normal temperature and white blood count.	Teach client to report signs of infection promptly. Remind client that infection and stress increase insulin needs.	Client has no signs or symptoms of infection. Normal temperature and white blood cell counts.

Lifestyle, negative feelings.	Anxiety related to threat to biological integrity and effects of lifestyle changes.	Client will be able to verbalize anxieties and identify methods of coping.	Client has demonstrated understanding of lifestyle changes. Client verbalizes fears. Teach client that prolonged exercise, alcohol ingestion, or deficient food intake can cause hypoglycemia. Introduce client to an experienced diabetic who manages diabetes well.	Client expresses feeling of being less anxious. Client asks for address of local American Diabetes Association chapter.
Ability to do blood glucose testing.	Deficient knowledge related to disease process and methods of control.	Client will be able to monitor glucose.	Teach client how to do home blood glucose checks. Client should know signs of hypo- and hyperglycemia and when to call physician. Teach family member also. Stress importance of regular testing.	Client demonstrates proper performance of blood glucose checks. Client can list signs and symptoms of hypo- and hyperglycemia and describes appropriate intervention.
Knowledge of drug therapy.	Deficient knowledge in proper administration and understanding of glyburide therapy.	Client will be able to explain how drug is used to control disease and how to take properly. Client verbalizes signs and symptoms of overdose and drug interactions.	Teach client to store drug in a dark bottle at room temperature, tightly closed. Take drug as ordered, usually once daily. Teach client that overdose causes hunger, hypoglycemia, fatigue, drowsiness, and headache. Remind client of importance of keeping this and other drugs away from young children.	Client adheres to drug regimen. Client verbalizes signs of overdosage and avoids drugs like sulfonamides and aspirin that interact with glyburide.

KEY NURSING IMPLICATIONS 36–6

Safety Precautions

1. Special aids to promote self-care are available for use in diabetic clients with limited vision.
2. Children who are diabetics should be involved in self-care as soon as emotionally and physiologically capable.
3. Never assume that a diabetic who has been treated for several years thoroughly knows or practices appropriate self-care.
4. Only regular insulin can be administered IV.

own insulin. Most are capable of doing so by age 9 or even earlier. As soon as a child is emotionally and physiologically capable, he/she should be involved in self-care. This may help to decrease excessive dependency on parents. In the school environment, teachers and nurses should be made aware that the child is a diabetic and should know what to do in case of emergency.

Regarding the person who has been a diabetic for a number of years, it is hazardous to assume that they know everything they should about self-care and, further, that they actually practice it. Many are confused about some aspects of care. For example, one diabetic measured all the vegetables he ate, but allowed himself as much cake as he wanted. Also, many diabetics are not aware that some over-the-counter (OTC) drugs contain sugar. (See Box 36–4 for a listing of some sugar-free OTC products.) Every contact between the nurse and client needs to be viewed as a teaching opportunity. When the experienced diabetic is hospitalized the nurse encourages continued self-care, if the client's condition permits it.

It is beyond the scope of this chapter to thoroughly discuss the treatment of complications of diabetes, including DKA. It is, however, currently believed that blood sugar should be maintained at a level as close to normal as possible in an effort to decrease the likelihood or severity of complications. If DKA does develop, hospitalization is generally required and regular insulin may be administered intravenously and subcutaneously until the blood sugar is under control. Accurate records of laboratory values, insulin treatment, intake and output of fluids, electrolytes, and nourishment, as well as supportive care, must be kept. Potassium levels should be monitored closely, as this electrolyte moves along with insulin into the intracellular compartment. Clients should be monitored for signs and symptoms of hypokalemia (muscle weakness, cardiac dysrhythmias, dizziness), and supplemental potassium may need to be administered IV.

BOX 36–4
Some Sugar-Free Liquid Over-the-Counter Products

Antacids
Citrocarbonate Effervescent Granules
All Titralac Products

Antidiarrheals
Pepto-Bismol Tablets and Liquid
Pepto-Bismol Maximum Strength

Cough and Cold Preparations
Cerose DM Liquid
Contac Cough and Sore Throat Liquid
Naldecon Products
Novahistine Elixir
Ryna Liquid
Trind DM Liquid

Vitamins and Minerals
Unicap Products
Vi-Daylin Multivitamin Drops
Vi-Daylin Multivitamin & Iron Drops

Laxatives and Fecal Softeners
Agoral Emulsion products
Citrucel Sugar Free
Fiberall Powder
Fleet Phospho Soda
Kondremul Plain
Metamucil Sugar Free

Nursing Care for Type 2 Diabetics

Type 2 diabetics are often treated with diet alone or with a combination of diet and oral

KEY NURSING IMPLICATIONS 36–7

Nursing Care for Type 2 Diabetics

1. Clients are instructed that diet and exercise are the mainstays of treatment.
2. Excessive hypoglycemia may occur in clients taking oral hypoglycemics.
3. Drugs that intensify the hypoglycemic action of oral hypoglycemics include salicylates, phenylbutazone, sulfonamides, MAO inhibitors, clofibrate, probenecid, dicumarol, nonsteroidal anti-inflammatory agents and chloramphenicol.

hypoglycemic agents. Clients must understand that at present there is no cure for diabetes, only control. Diet continues to be the mainstay of treatment. Some clients taking oral hypoglycemic agents mistakenly believe that they do not need to pay much attention to diet because their diabetes is not very severe. They feel that the oral medication, often mistakenly referred to as oral insulin, will take care of the problem. There is great stress on dietary control in type 2 diabetes. Many studies have shown that once body weight has been reduced to near the ideal range, diabetes mellitus can be controlled by diet, alone. Type 2 diabetics should also understand that under some conditions of physical or emotional stress—infection or surgery, for example—they may temporarily require insulin injections.

Clients taking oral hypoglycemics need to learn about foot care, exercise, and the recognition and treatment of hypoglycemia and DKA, just as insulin dependent diabetics do. It is possible to become hypoglycemic from an excessive dose of oral hypoglycemics or by engaging in too much exercise. Hypoglycemia can also occur through an imbalance of food and/or medication, or because of significant drug interactions. The hypoglycemia that occurs in type 2 diabetics is often not severe. Once recognized, it can be readily treated. Drugs known to interact with sulfonylureas, increasing their hypoglycemic action include:

- salicylates
- cimetidine and other H_2 antagonists
- phenylbutazone
- sulfonamides
- clofibrate
- gemfibrozil
- MAO inhibitors
- methyldopa
- probenecid
- anticoagulants
- nonsteroidal anti-inflammatory agents
- tricyclic antidepressants
- chloramphenicol

Finally, because the administration of oral hypoglycemics is often tied to mealtimes, these drugs are frequently found on the kitchen or dining table. Special care must be taken to ensure that children do not obtain and ingest these drugs.

EVALUATION

- Client demonstrates ability to manage diabetic condition through appropriate self-administration of insulin (type 1-IDDM) or oral antidiabetic agents (type 2-NIDDM).
- Client maintains fluid balance by maintaining control of diabetes through diet, exercise, and medication.
- Client does not experience diabetic ketoacidosis by maintaining blood glucose level at 80–120 mg/dl.
- Client's skin remains intact by performing appropriate daily foot care.
- Client does not experience hypoglycemia related to adverse effects of insulin therapy.
- Client verbalizes understanding of disease process, self-medication, glucose monitoring, signs and symptoms of hyper- and hypoglycemia, diet, exercise, foot care, and importance of follow-up visits.

HOME CARE/CLIENT TEACHING

1. To assist visually impaired persons with diabetes in retaining independence, a week's supply of insulin may be drawn up into syringes and stored in the refrigerator. Instruct the person to store the syringes in a horizontal position to prevent crystallization at the needle tip and to bring the insulin to room temperature before using. If cloudy insulin is used (e.g., NPH, lente), the syringe is gently rolled or inverted to resuspend the particles before injection.
2. Persons with diabetes who engage in exercise, especially those exercising away from home, should be instructed to eat or drink complex carbohydrates such as bread, milk, crackers, or pasta 30 minutes before engaging in exercise. Also, they should carry a source of simple carbohydrates, for example hard candy, to use if necessary. When exercising away from home, the person with diabetes should be instructed to carry a form of identification (Figure 36–6).
3. Nurses making home visits to persons with diabetes, especially elderly diabetic clients or those who have had the disease for many years, should inquire about wounds that may be slow in healing and should inspect the person's lower extremities and feet. Reinforce good foot hygiene and measures to promote optimal circulation.
4. When in the home of a diabetic client, ask to see the blood glucose diary or record.
5. Refer to client teaching discussed under "Implementation."

CASE STUDY

George Marshall, a 25-year-old manual laborer, visits his physician to have the stitches removed from a wound on his right arm. Dr. Geer notes that the incision is not healing well. He also observes that Mr. Marshall seems lethargic, so he decides to do a physical examination and some routine laboratory work. Mr. Marshall's history reveals a recent weight loss of 8 pounds, lethargy, polydipsia, and polyuria. His fasting blood glucose is elevated (425 mg/dL) and the urine is positive for ketones. There is a family history of diabetes mellitus.

Dr. Geer admits Mr. Marshall to the hospital to control his diabetes. The client is started on 10 units of U-100 regular insulin and 25 units of NPH U-100 insulin before breakfast. A sliding scale of U-100 regular insulin dosage based on the results of the qid blood glucose testing is established.

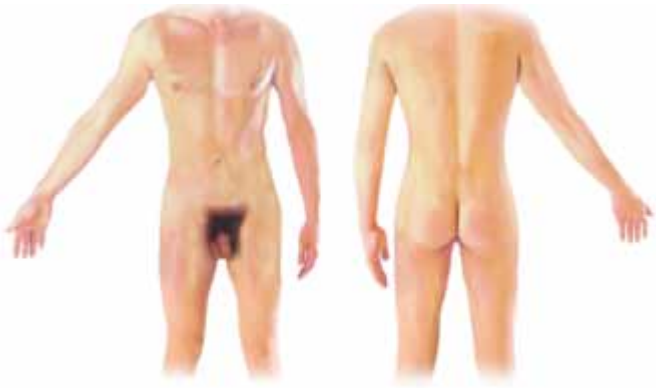
<150 mg	0 units
150–200 mg	4 units
200–250 mg	6 units
250–300 mg	8 units
300–350 mg	10 units

In addition to this treatment, Mr. Marshall receives instruction concerning a 2,200-calorie diabetic diet. After several days, his fasting blood glucose is approaching normal value (150 mg/dL). He reports feeling better. A client education program is begun, with individual sessions 4 days a week and group sessions once a week. Mr. Marshall seems to be doing well and is able to administer his own insulin, but one day, a setback occurs. At about 4:00 PM he begins to perspire profusely, develops a headache, and experiences a tremor in his hands. In addition, he feels nauseated. He calls the nurse, who urges him to drink 4 oz of fruit juice and to rest in bed for a short time. After ½ hour Mr. Marshall reports feeling better.

continues

Questions for Discussion

1. What type of diabetes (type 1 or 2) does Mr. Marshall appear to have? Are his initial symptoms characteristic of this type of diabetes mellitus?
2. Why is Mr. Marshall placed on two types of insulin? Can the regular insulin and the NPH insulin be mixed in the same syringe?
3. What skills and knowledge about diabetes must Mr. Marshall acquire to care for himself adequately?
4. What was the nature of the setback that Mr. Marshall experienced? Did the nurse handle it appropriately? What should Mr. Marshall be instructed to do if this happens once he leaves the hospital?
5. Using the sketch (below), indicate the sites that can be used for insulin injections. Once these areas have been identified, make a 1-month rotation plan that Mr. Marshall could use at home.



CRITICAL THINKING EXERCISES

1. Prepare a teaching plan for a person newly diagnosed with diabetes.
2. Prepare a brief report on the treatment and nursing care required for pregnant diabetics.
3. Obtain information on blood glucose monitoring meters and compare them with regard to price and ease of use.
4. Compile a collection of diabetic teaching aids in various languages for various age groups that can be used by you and your classmates in individual and group diabetic instruction.
5. Prepare a visual aid for a particular diabetic group, e.g., pregnant diabetics, children, or type 2 diabetics, on some aspect of self-care.
6. Design a form that can be used to record the results of urine or blood testing for glucose at home.
7. Design a form that can be placed on a client's chart to record the progress of client instruction.
8. Prepare a brief form for recording the treatment and nursing care of a client with ketoacidosis.
9. Conduct a group discussion with classmates or clients on the special management problems of adolescent diabetics.
10. Explain the pathophysiology of diabetes mellitus.
11. Identify clinical symptoms commonly associated with diabetes mellitus—type 1.
12. State the differences between type 1 and type 2 diabetes mellitus.
13. List three causes of hypoglycemia in the type 1 diabetic client.
14. Discuss the dietary needs of a diabetic client who is taking a sulfonylurea antidiabetic agent.
15. Identify major areas of self-care that should be included in an educational program for a newly diagnosed diabetic.

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SECTION 11

Agents Affecting the Reproductive System

MAJOR NURSING DIAGNOSES

- Ineffective Sexuality Patterns
- Disturbed Personal Identity
- Ineffective Role Performance
- Anticipatory Grieving Related to Anticipated or Actual Fetal Loss
- Disturbed Body Image Related to Actual or Perceived Changes in Sexual Functioning
- Sexual Dysfunction
- Ineffective Breastfeeding

37 Sex Hormones

OBJECTIVES

After studying this chapter, the student will be able to:

- List the classes of sex hormones and give an example of an agent in each class
- Identify estrogens and progestins commonly employed in hormonal drug products
- Identify common adverse effects associated with the use of estrogens and progestational agents
- List five therapeutic uses for estrogens
- List five therapeutic uses for progestational agents
- Identify the mechanism(s) by which estrogens and progestins act to prevent conception
- Describe the usual method of administration for "combination" and "minipill" types of oral contraceptives
- Describe the difference between monophasic, biphasic, and triphasic combination oral contraceptive products
- Identify the mechanism by which clomiphene citrate, human chorionic gonadotropin (HCG), menotropins, and gonadorelin acetate act as ovulation stimulants
- Identify and discuss two common adverse effects associated with the use of ovulation stimulants
- List five therapeutic uses for androgens
- Identify the therapeutic uses and adverse effects associated with the use of anabolic agents
- Apply the nursing process for clients receiving long-term treatment with sex hormones
- Describe the content of an instructional program for women taking oral contraceptives

The development and function of the human reproductive system is primarily controlled by *endocrine* glands, particularly the hypothalamus and the anterior pituitary gland. This system, which in females includes the ovaries, fallopian tubes, uterus, and vagina and in males includes the testes, penis, *seminal vesicles*, *prostate gland*, and *bulbourethral glands*, is present in immature forms at birth. On approaching puberty, the pituitary begins to secrete greater quantities of hormones, some of which stimulate the gonads (the ovaries in females and the testes in males). Such hormones are known as gonadotropins. This gonadal stimulation causes the reproductive organs to mature and to begin forming ova and sperm, respectively. At the same time, the gonads begin to synthesize and secrete hormonal agents of

their own; these act to initiate and regulate the development of secondary sexual characteristics.

In females, the secretion of estrogen and progesterone by the ovaries results in the development of breast tissue, the deposition of fat in the area of the thighs and hips and hair growth in the pubic and axillary parts of the body. In males the secretion of androgen by the testes results in the development of the external genitalia, the deepening of the voice and the growth of hair in pubic, axillary, body, and facial areas.

FEMALE SEX HORMONES

The ovaries synthesize and secrete the female sex hormones, estrogen and progesterone, in response to stimulation by follicle-stimulating hormone (FSH) and luteinizing hormone (LH) both synthesized and released by the anterior pituitary gland. Estrogen and progesterone regulate the development and maintenance of the female reproductive system and secondary sex characteristics. Figure 37–1 illustrates the relationship between the anterior pituitary gland and the ovaries. It also shows the effects of the female sex hormones on the *endometrium*.

When an ovarian follicle *(Graafian follicle)* is stimulated by FSH, estrogen is secreted. As estrogen continues to be secreted, its concentration in the blood rises. At about the middle of the menstrual cycle, it tends to suppress further FSH release. This cycling of FSH and estrogen concentration influences the female menstrual cycle during its early, or proliferative, phase. As the estrogen concentration in the blood reaches its peak, the release of LH by the anterior pituitary begins. This activity stimulates the development of the *corpus luteum* during the last 2 weeks of the menstrual cycle (the secretory phase). Progesterone works in conjunction with estrogen to prepare the uterus for conception. It is also secreted by the placenta during pregnancy and serves to protect the viability of the embryo, to promote placental growth, and to prepare the mammary glands for lactation. Estrogen and progesterone also exert wide-ranging effects on many metabolic processes, including the maintenance of fluid and electrolyte balance and protein metabolism.

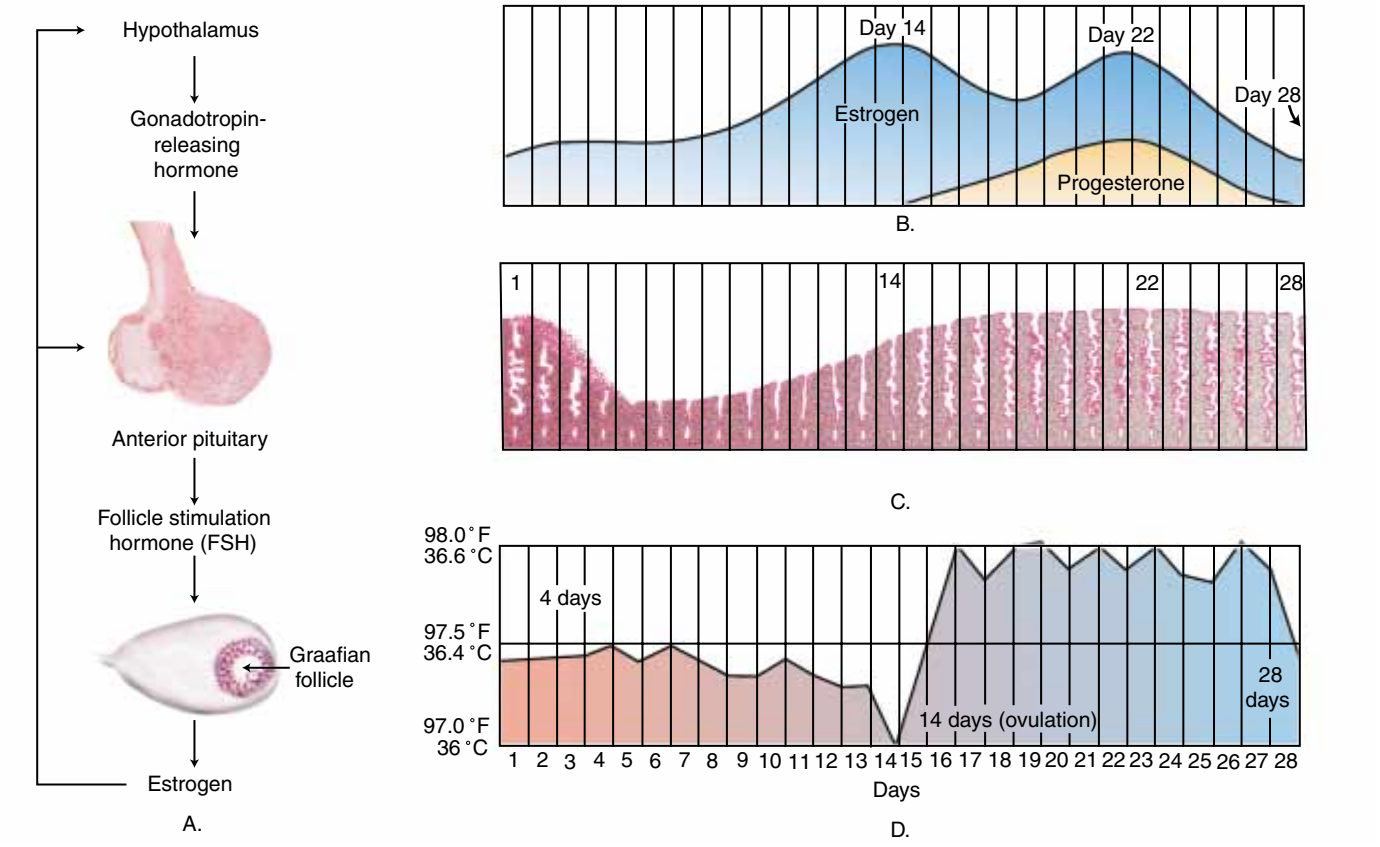

Figure 37–1 Secretion and selective effects of female sex hormones: (A) feedback control of the release of estrogen, (B) monthly variation in the release of female sex hormones, (C) influence of hormones on the endometrium, and (D) influence of hormones on body temperature.

Estrogen

Estrogens are substances capable of producing estrus, or sexual receptivity, in females. They are important in the development and maintenance of the female reproductive system and secondary sex characteristics. They influence the retention of fluid, the growth of tissue, and the shaping of the skeleton. Naturally occurring estrogens include estrone, estradiol, and estriol. These substances are synthesized by a variety of animals and plants and are found in the blood of both males and females. Most naturally occurring estrogens are not effective when administered orally, as they are rapidly inactivated by the liver. Chemical derivatives of the natural estrogens, such as **ethinyl estradiol** and **mestranol**, are only slowly inactivated by the liver and may be administered orally. Both natural estrogens and their derivatives may be administered by the intramuscular or subcutaneous route. Completely synthetic estrogens, such as **diethylstilbestrol** (DES), do not share the chemical structure of the natural estrogens, but exert quite similar pharmacological effects. They are suitable for both oral and parenteral use.

Although the exact mechanism of estrogen action is still not clear, it appears that certain tissues are more responsive to estrogen action than others. These appear to have specific estrogen receptors capable of binding with estrogen and producing characteristic estrogenic effects. Such estrogen-responsive tissue includes various parts of the female reproductive tract (e.g., the cervix and the uterus), as well as tissue in the breast, hypothalamus, and pituitary gland.

Estrogens are capable of causing a wide variety of adverse effects. The most common of these are nausea, vomiting, breast swelling, and fluid retention. This latter effect is often the cause of rapid weight gain experienced by some women who take estrogens. The use of estrogens has also been associated with a greater risk of *thromboembolic* disease. Although estrogen has not been shown to cause any forms of cancer, there is evidence to indicate that women with estrogen-dependent cancers (e.g., some forms of breast cancer, endometrial cancer, and cervical cancer) may have their disease worsened, if estrogens are used. Also of importance is the finding that daughters of women who received diethylstilbestrol (DES) while they were pregnant have a higher than normal risk of developing *adenocarcinoma* of the vagina, cervix, and infertility. Male offspring of such women appear to have a greater incidence of genitourinary abnormalities and infertility.

One of the newest "designer estrogens" is **raloxifene HCl** (**Evista**), marketed specifically to help prevent osteoporosis. **Note:** Beware of confusing Evista with E-Vista, a trade name for hydroxyzine HCL, no longer marketed. Raloxifene HCl exhibits both agonist-estrogen activity (increasing bone mineral density) and estrogen-antagonist effects (similar to tamoxifen), which may lead to its use at some future point in the fight against breast cancer. This also provides estrogen-like strengthening effects on the bones without many of the adverse effects associated with estrogen. It does not create the bone mineral density to the extent of conjugated estrogens (Premarin) and **alendronate** (**Fosamax**), but also doesn't carry the risks. It also is not associated with the gastrointestinal irritability associated with most of the estrogens.

Alendronate (Fosamax) is not an estrogen, but is classified as a bone reabsorption inhibitor. It is administered orally and is also used for postmenopausal bone thinning (5mg daily), postmenopausal osteoporosis (10 mg daily), and to treat Paget's Disease (40 mg daily).

Estrogens are employed in a wide variety of therapeutic applications. Box 37–1 summarizes some of these. Table 37–1 compares the estrogen products in current use. Note that estrogen products are available for oral, parenteral, transdermal and intravaginal use.

BOX 37–1
Therapeutic Uses for Estrogens

- oral contraception
- alleviation of menopausal symptoms
- treatment of dysmenorrhea
- treatment of neoplastic disorders involving the male sex organs (e.g., inoperable tumor of the prostate) or in some postmenopausal women with inoperable tumors of the breast
- suppression of postpartum lactation
- acne treatment in females
- primary ovarian failure
- treatment of female hypogonadism
- treatment of osteoporosis

TABLE 37–1

Estrogen Products

Note: Monitor client for development of nausea, vomiting, diarrhea, fluid retention, breast engorgement, and increase in serum calcium level.

Contraindicated in thrombophlebitis and thromboembolic disorders.

Check blood pressure and weight periodically in clients on long-term therapy.

May influence laboratory tests and analysis of pathological specimens. Note on lab slip that client is receiving estrogens.

Female clients should be instructed in breast self-examination.

Because of relationship of estrogens and thrombophlebitis, these drugs may be discontinued several weeks before major surgery.

Barbiturates and rifampin may reduce the effectiveness of estrogens.

Clients taking estrogens may require an increase in the dosage of anticoagulants and antidiabetic drugs and a decreased dosage of anti-inflammatory corticosteroids.

In women receiving estrogen substitution therapy, the importance of compliance must be emphasized in order to delay osteoporosis.

Report abnormal uterine bleeding.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
conjugated estrogens *(**KON**-jyou-gay-ted **ES**-troh-jens)* (C.E.S. ✱, Congest ✱, Premarin)	oral, vaginal, IM, IV	Oral: 0.3–1.25 mg daily Parenteral: 25 mg IM or IV 10 mg tid for breast cancer	Parenteral product must be refrigerated. Do not use parenteral product if solution has darkened or if precipitate has formed.
dienestrol *(dye-en-**ES**-trol)* (Ortho Dienestrol, DV)	vaginal	—	Teach client proper administration technique (see Chapter 2 for procedures and illustrations).
diethylstilbestrol *(dye-**eth**-ill-still-**BES**-trol)* (DES)	oral	1–3 mg daily	Used as a postcoital contraceptive in emergency situations by administering 25 mg twice daily for 5 consecutive days beginning ideally within 24 hours and not later than 72 hours after intercourse. Not used during pregnancy because of high incidence of genital tumors in offspring. Male clients may develop gynecomastia and impotence, which disappear when drug is discontinued.
diethylstilbestrol diphosphate *(dye-**FOS**-fate)*	oral, IV	50–200 mg 3 times daily	Prostate cancer treatment
esterified estrogens *(es-**TER**-ih-fyd **ES**-troh-jens)* (Estratab, etc.)	oral	1.25–7.5 mg daily	—
estradiol *(es-trah-**DYE**-ohl)* (Neo-Estrone ✱, Estrace, Estraderm)	oral, transdermal, vaginal	0.5–2 mg daily Transdermal: 0.025–0.1 mg/week	Transdermal system is applied twice weekly to control vasomotor and other symptoms of menopause.

continues

TABLE 37–1 *continued*

See **Note** at beginning of Table 37–1, page 725.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
estradiol cypionate in oil *(es-trah-**DYE**-ohl **SIGH**-pee-on-ayt)* (Depo-Estradiol Cypionate, etc.)	IM	1–5 mg every 3–4 weeks	Rotate vial between palms to distribute medication evenly. Inject IM into a large muscle.
estradiol valerate in oil *(es-trah-**DYE**-ohl **VAL**-er-ayt)* (Delestrogen, Neo-Diol, etc.)	IM	10–20 mg every 4 weeks	30 mg every 1–2 weeks may be employed in treating prostatic carcinoma. Rotate vial between palms to distribute medication evenly. Inject into a large muscle.
estrone, estrogenic substance, combined estrogens ***(ES**-trohn)* (Theelin Aqueous)	IM	0.1–5 mg 2–3 times weekly	Estrogenic substance and combined estrogen contain mainly estrone. Male clients may develop gynecomastia and impotence, which disappear when drug is discontinued.
estropipate *(**es**-troh-**PY**-payt)* (Ogen, OR tho-Est)	oral, vaginal	Oral: 0.75–9 mg daily	—
ethinyl estradiol ***(ETH**-in-ill **es**-trah-**DYE**-ohl)* (Estinyl)	oral	0.15–3 mg daily	Male clients may develop gynecomastia and impotence, which disappear when drug is discontinued.
quinestrol *(kwin-**ES**-trohl)* (Estrovis)	oral	Initially 0.1 mg daily for 7 days, then 0.1 mg weekly	—
raloxifene HCl *(rah-**LOX**-ih-**fene**)* (Evista)	oral	60 mg daily	Monitor for side effects, including signs and symptoms of menopause. Contraindicated for clients with history of deep vein thrombosis. Used as drug to prevent osteoporosis. Do not used concurrently with Questran.

Progesterone

Progesterone is a hormone secreted primarily by the corpus luteum, a temporary structure within the ovary that forms once each month on or about the time of ovulation during the female reproductive years (except during pregnancy). The corpus luteum secretes progesterone only during the last 2 weeks of the menstrual cycle. The greatest amount is secreted during the week after ovulation has taken place. During this time, progesterone changes the uterine lining (endometrium) from a proliferative structure to a secretory one. If fertilization does not take place, the corpus luteum diminishes in size, progesterone and estrogen production drops, and menstruation follows. If the ovum is fertilized, the corpus luteum continues to function for several months and progesterone and estrogen levels remain high. When the corpus luteum no longer produces progesterone, the placenta continues to secrete it. During pregnancy, progesterone is essential for the maintenance of the integrity of the placenta and the embryo.

When natural progesterone is taken orally, it is quickly inactivated by the liver and provides little pharmacological activity. By chemically modifying the progesterone molecule, the compound can be protected from rapid inactivation and a sustained effect can be achieved.

BOX 37–2
Therapeutic Uses for Progestational Agents

treatment of uterine bleeding
amenorrhea
dysmenorrhea
premenstrual tension
endometriosis
infertility
threatened or habitual miscarriage
toxemia of pregnancy
contraception

Progesterone and synthetic compounds having progestational activity (progestins) are employed for many therapeutic applications (see Box 37–2). All of the progestational agents are capable of eliciting adverse effects that may interfere with therapy. These may include nausea, fever, weight gain, headache, dizziness, and diminished sex drive. More serious adverse effects may include menstrual irregularities, jaundice, and thrombotic disease. Because of their potential for causing such effects, progestational agents should be used with caution in clients with a history of cardiac disorders, asthma, epilepsy, or migraine headaches. Progestins also should not be used during the first 4 months of pregnancy, because there is evidence of potential harm to the fetus with such use. Table 37–2 lists some of the natural and synthetic progestational agents.

Oral Contraceptives

Combinations of estrogens and progestins may be employed as oral contraceptives in women. They present a means of contraception close to being 100% effective, if properly used. During the last two decades such combinations, often referred to as "the pill," have been successfully used by hundreds of millions of women throughout the world.

There are three types of combination oral contraceptives: monophasic, biphasic, and triphasic. Monophasic products provide a fixed dosage of estrogen and progestin throughout the cycle. In biphasic products, the estrogen content remains constant throughout the cycle, but the progestin content is varied. During the first half of the cycle, the dosage of progestin is low to permit endometrial wall proliferation. In the second half of the cycle, the amount of progestin is high to promote secretory activity of the endometrium. In triphasic products, both estrogen and progestin dosage may vary during the cycle to more closely mimic the normal hormonal fluctuations that occur in females of childbearing age.

The estrogen component of these contraceptive products acts to suppress the release of FSH from the anterior pituitary gland. In doing so, FSH-induced ovulation is prevented and a viable ovum is not released by the ovary. At the same time, the progestin component of the combination acts to suppress the release of LH from the pituitary. It also reduces fertility by altering the viscosity of cervical mucus, by reducing the motility of the fallopian tubes, and by altering the nature of the endometrial lining of the uterus. These actions tend to impair the normal transport of sperm and ova and may prevent a fertilized ovum from properly implanting on the endometrial surface.

The use of estrogen-progestin combinations in a cyclic fashion generally results in the inhibition of conception without preventing menstruation. Many oral contraceptive products are taken daily from the Sunday after the first day of menstrual bleeding for 20–21 days according to the instructions accompanying each product. If the menstrual period begins on Sunday, the first tablet is taken the same day. Within several days after discontinuing the use of such a product, menstrual bleeding usually begins. Other oral contraceptive products have, in addition to the 20–21 active tablets, a number (usually 7–8) of inert tablets containing no hormonal agent. Such products are meant to minimize the possibility of dosage error by having a woman take a tablet every day of the cycle.

By combining different estrogens with different progestins and by altering the dosage strength of each, one can obtain products with a wide variety of beneficial and adverse effects. Those products with relatively high estrogenic effect as compared to the progestin effect will often tend to produce estrogen-related adverse effects (e.g., nausea, edema, breast swelling, rapid weight gain). Those with a relative excess of progestin activity will tend to cause progestin-related adverse effects (e.g., headache, acne, fatigue, depression, slow weight gain). Many adverse effects can be avoided or managed by carefully selecting the appropriate estrogen-progestin balance for each client. During

TABLE 37–2

Progestational Products

Note: Nausea and irregular menses may occur with short-term use.
Longer use is associated with edema, weight gain, gastrointestinal disturbances, breast swelling, and depression.
Monitor blood pressure and weight in clients on long-term therapy.
Contraindicated in thrombophlebitis and thromboembolic disorders.
Call physician if visual disorders or migraine occur.
Instruct female clients in breast self-examination technique.
Avoid use of these drugs during pregnancy.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
hydroxyprogesterone caproate in oil *(hy-**drock**-see-proh-**JES**-teh-rohn **KAP**-roh-ayt)* (Hylutin, etc.)	IM	125–375 mg	Drug has a 9–17-day duration of action. Give deep IM in large muscle mass.
medroxyprogesterone acetate *(meh-**drock**-see-proh-**JES**-teh-rohn **AH**-seh-tayt)* (Provera, Cycrin, etc.)	oral	5–10 mg daily	May cause photosensitivity reactions. Use with caution in clients with conditions that may be worsened by sodium and fluid retention. May be taken with food to minimize GI upset.
megestrol acetate *(megg-**ESS**-trohl **AH**-seh-tayt)* (Megace)	oral	400–800 mg daily	Available only as a flavored suspension. Used in treating breast and uterine cancer as well as in clients with AIDS to improve appetite and decrease weight loss.
norethindrone *(nor-**ETH**-in-drohn)* (Norlutin)	oral	5–20 mg daily	See medroxyprogesterone acetate.
norethindrone acetate *(nor-**ETH**-in-drohn AH-seh-tayt)* (Norlutate, Aygestin)	oral	2.5–10 mg daily	See medroxyprogesterone acetate. Norethindrone acetate is twice as potent as norethindrone.
progesterone *(proh-**JES**-teh-rohn)* (Gesterol ✱, Progestasert, etc.)	IM, intrauterine	IM: 5–10 mg daily for 6–8 consecutive days	See medroxyprogesterone acetate. Give IM deep into large muscle mass. Clients with intrauterine device may experience cramps for several days after insertion, also heavier menstrual bleeding. Teach client how to check for proper placement of the intrauterine device. Progestasert system must be replaced 1 year after insertion.

the last several years, many oral contraceptive products that contain relatively low doses of hormonal agents have appeared on the market. These have proven to be virtually identical in effectiveness when compared to older, higher dose products, but they cause fewer serious side effects.

A number of important adverse effects related to the use of estrogen-progestin combinations have been reported. Cardiovascular effects, particularly *thromboembolism*, seem to occur with greater fre-

quency in women who use such combination oral contraceptives. This risk is enhanced if the product contains more than 50 mcg of estrogen per dose in women over the age of 35, and in women who smoke more than 15 cigarettes daily. It should be noted that many other medications can decrease the effectiveness of oral contraceptives. Some of these drugs include phenobarbital, rifampin, phenytoin, and some antibiotics. When a woman uses these medications with an oral contraceptive product, another form of contraception (e.g., condom and/or spermicide) should be used. Clients should be encouraged to inform all health care professionals that they are using oral contraceptives.

The use of oral contraceptives containing only a progestin has been advocated as a means of reducing some of the risk associated with the use of oral contraceptives. These products, which are sometimes referred to as "minipills," are generally taken continuously rather than cyclically. As they contain no estrogen, they do not suppress ovulation. They do interfere with sperm and ovum transport and the ability of a fertilized ovum to implant on the endometrial wall. The use of such products has been associated with "breakthrough bleeding," a phenomenon characterized by vaginal bleeding that occurs in the cycle other than during menstruation. They also may exhibit a slightly lower level of contraceptive effectiveness than combination products. A novel form of contraception, **levonorgestrel** implants (**Norplant System**), consists of a set of six special capsules, each containing 35 mcg of levonorgestrel, a type of **progesterone**. The system is surgically implanted under the upper arm skin and may be left in place for up to 5 years. The medication is slowly released from the capsule into the bloodstream, providing constant protection from pregnancy. Studies indicate that the Norplant system may be slightly less effective than the progestin-only oral contraceptives. Early information also suggests the system may be less effective in women who weigh over 130 pounds. Clients should be advised, as with oral contraceptives, to use another form of birth control for the first month after insertion of this system. Like levonorgestrel **depot-medroxyprogesterone acetate** (**Depo-Provera**) is also a long-acting progestin. It provides highly effective birth control for 3 months when administered as a single injection of 150 mg. Depot-medroxyprogesterone acetate acts primarily by providing levels of progesterone high enough to suppress the leutinizing hormone and, thus, suppress ovulation. It has been proven safe and relatively inexpensive. Many women find this method more convenient than the daily oral contraceptives.

Emergency postintercourse contraception is indicated when a women is worried about pregnancy because of unprotected sex or possible contraceptive failure (broken condom, displaced diaphragm). The most commonly prescribed "postcoital contraceptive," or "morning after pill," is **norgestrel and ethynil estradiol** (**Orval**) containing 50 ug of estrogen. The term "morning after pill" is actually a misnomer, as the woman is to take the first dose as soon after intercourse as possible and another dose 12 hours later. **Mifepristone** (**RU 486**) is also marketed as a safe and effective postintercourse contraceptive. It acts by blocking progesterone, thereby making the endometrium unsuitable for implantation of a fertilized egg. Table 37–3 lists the oral contraceptive products currently available in the United States.

ESTROGEN AND PROGESTERONE COMBINATIONS

Enovid 5 mg and Enovid 10 mg both contain mestranol (an estrogen) and **norethynodrel** (a progesterone). These products are used to treat *endometriosis* and hypermenorrhea. Similar cautions should be used with these medications as with oral contraceptives.

OVULATION STIMULANTS

Stimulation of ovulation is often employed in clients who do not ovulate, but desire pregnancy. This technique may also be employed as part of an in vitro fertilization procedure. This can only be performed successfully, if primary pituitary and ovarian function exist.

Five agents are currently employed as ovulation stimulants: **clomiphene citrate** (**Clomid**, **Serophene**), **human chorionic gonadotropin** (**Follutein**, **Pregnyl**, A.P.L., etc.), **menotropins** (**Pergonal**), **urofollitropin** (**Metrodin**), and **gonadorelin** (**Lutrepulse**).

Clomiphene Citrate (Clomid, Serophene)

Clomiphene citrate appears to stimulate the production of pituitary gonadotropins, which in turn induces the maturation of the ovarian follicle and, eventually, ovulation. Its use has been

TABLE 37–3

Oral Contraceptive Products

PRODUCT	ESTROGEN CONTENT	PROGESTIN CONTENT
Monophasic Products		
Genora 1/50	mestranol 50 mcg	norethindrone 1 mg
Nelova 1/50 M 21 & 28	mestranol 50 mcg	norethindrone 1 mg
Norethin 1/50 M 21 & 28	mestranol 50 mcg	norethindrone 1 mg
Norinyl 1+50 21 day & 28	mestranol 50 mcg	norethindrone 1 mg
Ortho-Novum 1/50 21 & 28	mestranol 50 mcg	norethindrone 1 mg
Ovcon-50 21 & 28	ethinyl estradiol 50 mcg	norethindrone 1 mg
Demulen 1/50-21 & 28	ethinyl estradiol 50 mcg	ethynodiol diacetate 1 mg
Ovral-21 & 28	ethinyl estradiol 50 mcg	norgestrel 0.5 mg
Brevicon 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg
Demulen 1/35 21 & 28	ethinyl estradiol 35 mcg	ethynodiol diacetate 1 mg
Genora 1/35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Genora 0.5/35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg
Modicon 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg
N.E.E. 1/35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Nelova 1/35E 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Nelova 0.5/35E 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg
Norethin 1/35 E 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Norinyl 1+35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Ortho-Cyclem	ethinyl estradiol 35 mcg	norgestimate 0.25 mg
Ortho-Novum 1/35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 1 mg
Ovcon-35 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.4 mg
Alesse	ethinyl estradiol 30 mcg	levonorgestrol 0.15 mg
Desogen	ethinyl estradiol 30 mcg	desogestrel 0.15 mg
Loestrin Fe 1.5/30	ethinyl estradiol 30 mcg	norethindrone 1.5 mg
Loestrin 21 1.5/30	ethinyl estradiol 30 mcg	norethindrone 1.5 mg
Lo/Ovral-21 & 28	ethinyl estradiol 30 mcg	nogestrel 0.3 mg
Levlen 21 & 28	ethinyl estradiol 30 mcg	levonorgestrel 0.15 mg
Levora 21 & 28	ethinyl estradiol 30 mcg	levonorgestrel 0.15 mg
Nordette-21 & 28	ethinyl estradiol 30 mcg	levonorgestrel 0.15 mg
Ortho-Cept	ethinyl estradiol 30 mcg	desogestrel 0.15 mg
Loestrin Fe 1/20	ethinyl estradiol 20 mcg	norethindrone 1 mg
Loestrin 21 1/20	ethinyl estradiol 20 mcg	norethindrone 1 mg
Biphasic Products		
Jenest-28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg for 7 tablets, then norethindrone 1 mg for 14 tablets
Mircette	ethinyl estradiol 20 mcg (days 1–21) 10 mcg (days 24–28)	desogestrel 0.15 mg (days 1–21)

continues

TABLE 37–3 *continued*

PRODUCT	ESTROGEN CONTENT	PROGESTIN CONTENT
Biphasic Products, *continued*		
Nelova 10/11 21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg for 10 tablets, then norethindrone 1 mg for 11 tablets
Ortho-Novum 10/11-21 & 28	ethinyl estradiol 35 mcg	norethindrone 0.5 mg (first 10 tablets) then norethindrone 1 mg (next 11 tablets)
Triphasic Products		
Estrostep 21 & Estrostep Fe	ethinyl estradiol 20 mcg for 5 days, 30 mcg for 7 days, 35 mcg for 9 days	norethindrone 1 mg
Ortho-Novum 7/7/7	ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg	norethindrone 0.5 mg (first 7 tablets) norethindrone 0.75 mg (next 7 tablets) norethindrone 1 mg (next 7 tablets)
Ortho-Tricyclen 21 & 28	ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg	norgestimate 0.18 mg (first 7 tablets) norgestimate 0.215 mg (next 7 tablets) norgestimate 0.25 mg (next 7 tablets)
Tri-Levlen 21 & 28	ethinyl estradiol 30 mcg ethinyl estradiol 40 mcg ethinyl estradiol 30 mcg	levonorgestrel 0.05 mg (first 6 tablets) levonorgestrel 0.075 mg (next 5 tablets) levonorgestrel 0.125 mg (next 10 tablets)
Tri-Norinyl 21 & 28	ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg ethinyl estradiol 35 mcg	norethindrone 0.5 mg (first 7 tablets) norethindrone 1 mg (next 9 tablets) norethindrone 0.5 mg (next 5 tablets)
Triphasil 21 & 28	ethinyl estradiol 30 mcg ethinyl estradiol 40 mcg ethinyl estradiol 30 mcg	levonorgestrel 0.05 mg (first 6 tablets) levonorgestrel 0.075 mg (next 5 tablets) levonorgestrel 0.125 mg (next 10 tablets)
Progestin Only Products		
Micronor	—	norethindrone 0.35 mg
Nor-Q.D.	—	norethindrone 0.35 mg
Ovrette	—	norgestrel 0.075 mg

associated with the development of blurred vision and other adverse ocular effects. It may also result in overstimulation of the ovary and the development of ovarian cysts. Of particular concern is the enhanced likelihood of multiple fetuses, if conception takes place during clomiphene therapy. Clomiphene is initially administered orally in a dose of 50 mg daily for 5 days, usually beginning on the fifth day of the menstrual cycle. If ovulation is not achieved with this regimen, the dosage may be increased to 100 mg daily for 5 days. Ovulation may be achieved in clients who have ovaries and a pituitary capable of becoming functional when stimulated. Pregnancy occurs in about 35% of such women when they undergo clomiphene therapy.

Human Chorionic Gonadotropin (Follutein, Pregnyl, A.P.L., Profasi HP, Etc.)

Human chorionic gonadotropin (HCG) is a hormone secreted by the placenta. Its action is virtually identical to that of pituitary LH, although it may also exert some small degree of FSH activity. During pregnancy, its release maintains the integrity of the corpus luteum after pituitary LH production diminishes. It thereby sustains the release of

estrogen and progesterone and prevents menstruation. HCG is generally used with menotropins to treat infertility in anovulatory females.

Menotropins (Pergonal)

Menotropins is a purified preparation of gonadotropins extracted from the urine of postmenopausal women. It contains biologically standardized concentrations of follicle-stimulating hormone (FSH) and luteinizing hormone (LH). When administered intramuscularly to anovulatory women whose ovaries are capable of releasing an ovum, it stimulates the growth and maturation of the follicle. When signs of follicle maturation appear (e.g., changes in cervical mucus volume and appearance, increased urinary excretion of estrogen), human chorionic gonadotropin is administered intramuscularly to stimulate ovulation. When such a regimen is employed, it is capable of inducing ovulation and the likelihood of pregnancy. It is also capable of producing adverse effects, which may include hyperstimulation of the ovary and/or multiple fetuses.

Urofollitropin (Metrodin)

Urofollitropin is pharmacologically similar to menotropins. It is also a purified preparation of gonadotropins extracted from the urine of postmenopausal women. Administration is followed by the administration of human chorionic gonadotropin as is menotropin. Urofollitropin is indicated for the induction of ovulation in clients with polycystic ovarian disease who have failed to respond to clomiphene citrate therapy and who have a high ratio of luteinizing hormone (LH) to follicle-stimulating hormone (FSH). The drug is categorized in pregnancy category "X" by the FDA and must not, therefore, be administered if there is any chance that the client is pregnant.

Gonadorelin Acetate (Lutrepulse)

Gonadorelin acetate is a compound that contains the same amino acid sequence as human gonadotropin-releasing hormone (GnRH). The drug aids in the synthesis and release of LH and, to a lesser degree, FSH. This, in turn, stimulates the gonads to produce steroids, thereby regulating reproductive hormones. Gonadorelin is administered in a pulsatile fashion using the Lutrepulse pump to automatically inject the medication intravenously. The pump is attached to a belt that is placed around the client's waist. Tubing from the pump is taped to the client as the tubing goes up the chest to the shoulders and then down the arm to the needle that is inserted into the cephalic vein or into the subcutaneous tissues of the forearm. A dressing is placed over the needle to protect it. Through the pump, 5 micrograms are injected into the vein or under the skin slowly over 1 minute, every 90 minutes for 21 days. Clients using the Lutrepulse pump need instructions concerning dressing changes, care of the injection site, and care of the pump. This mimics normal GnRH release from the hypothalamus. Like other agents used to stimulate ovulation, the client should be told of the possibility of multiple fetuses.

MALE SEX HORMONES

Androgens, or male sex hormones, are primarily synthesized and secreted by the interstitial cells of Leydig in the testes. This process is initiated and controlled by the gonadotropic hormones secreted by the anterior pituitary gland, i.e., the follicle-stimulating hormone (FSH) and interstitial cell-stimulating hormone (ICSH). The most important androgen secreted by the testes is testosterone. This agent is present in only very minute concentrations in the plasma until the age of puberty (11–13 years). At this time testosterone production increases rapidly. After age 40 testosterone output gradually declines. By the age of 80 the output of testosterone is only about 20% of what it was at its peak output level.

The release of a large quantity of testosterone at puberty enhances the functional capacity of the penis, prostate, seminal vesicles, and the *vas deferens*. It also initiates the process of *spermatogenesis* and reproductive capacity, as well as the development of male secondary sex characteristics.

In addition to its androgenic effect, testosterone also exerts an anabolic effect. This is manifested as increased formation of muscle tissue and enhanced ability to retain dietary protein nitrogen, a necessary building block for amino acid and protein synthesis.

Testosterone, which is derived naturally from animal testes, is not effective when administered orally since it is rapidly inactivated by the liver. Synthetic forms of testosterone (e.g., **methyltestosterone**) are effective when administered orally, subcutaneously, or intramuscularly. Synthetic preparations are the forms most commonly employed in client treatment.

BOX 37–3
Therapeutic Uses for Androgens

IN MALES

hypogonadism (eunuchism and eunuchoidism)

climacteric symptoms caused by androgen deficiency delayed puberty

cryptorchidism (failure of testicles to descend into the scrotum)

oligospermia (deficient number of spermatozoa in seminal fluid)

impotence due to androgen deficiency

IN FEMALES

inoperable breast cancer

prevention of postpartum breast pain and engorgement in the nonnursing mother

In males, testosterone derivatives are usually prescribed for their androgenic effect, primarily for the treatment of hypogonadism. This condition may be caused by a developmental disorder prior to puberty or by disease or surgical removal of the testes. Testosterone is also used to treat a wide variety of conditions which respond to androgen therapy in both males and females. Box 37–3 lists some of these uses.

The administration of testosterone is associated with a number of adverse drug effects. In young boys the use of this agent may cause premature epiphyseal closure and impaired bone growth. In all clients on testosterone, retention of sodium, potassium, chloride, and water may occur. Some clients may experience jaundice, and/or hypercalcemia. Table 37–4 lists the oral androgens in current use.

Estrogen and Androgen Combinations

Various combinations of estrogens and androgens are currently available for oral or parenteral use. These products are used to treat postpartum breast engorgement and vasomotor symptoms of menopause in clients previously treated unsuccessfully with estrogens alone. Examples include **estradiol cypionate** and **testosterone cypionate** injection (**Depotestogen**, **Depo-Testadiol**, etc.) and conjugated estrogens and methyltestosterone tablets (Premarin with methyltestosterone, **Estratest**, **Halodrin**, etc.).

IMPOTENCE

Erectile dysfunction, also known as impotence, affects up to 30 million men and their sexual partners in the United States. It is defined as the consistent inability to obtain and maintainan erection sufficient for sexual intercourse. The term erectile dysfunction was adopted by the medical community to differentiate it from other problems associated with impotence, including lack of sexual desire, problems with ejaculation, and difficulties with orgasm. It can occur at any age, although it is more common in men more than 50 years old.

At one time, impotence was considered an inappropriate condition to talk about, but with the increasing number of men experiencing erectile dysfunction, it has become a problem the medical and pharmaceutical companies have found is a treatable condition. In March of 1998, the FDA approved **sildenafil citrate** (**Viagra**), the first oral medication to treat erectile dysfunction. When taken 1–2 hours prior to sexual activity, sildenafil acts by enhancing the effects of nitric oxide, a chemical that relaxes smooth muscle in the penis during sexual stimulation. This allows an increased blood flow to the penis. Unlike other drugs used for impotence, sildenafil does not cause automatic erection, but only works in response to sexual stimulation. The usual dose is 50 mg, however, the physician may adjust this from 25–100 mg, depending on individual client needs. The drug should not be taken more often than once a day. At this time it has only been approved for male impotence.

ANABOLIC AGENTS

A number of compounds derived from or closely related to testosterone may exhibit considerable anabolic effects without causing significant androgenic effects. These anabolic agents, or steroids, are employed to promote weight gain in underweight clients, in the treatment of some cases of senile and postmenopausal osteoporosis, and for the reversal of catabolic states caused by extensive use of anti-inflammatory corticosteroids. During the past several years, the misuse of anabolic agents (anabolic steroids) has become widespread among athletes. This is based on the premise that anabolic agents can increase muscle

TABLE 37–4

Androgen Products

Note: Sodium and water retention may occur.
Check blood pressure frequently.
Gastrointestinal upset may occur.
If jaundice appears, drug is discontinued or dosage decreased.
Masculinizing effects may occur in women (deepening of voice, acne, changes in body hair).
Clients on anticoagulants may require a downward adjustment of dose while receiving androgens.
May cause masculinization of female infants.
May enhance hypoglycemia in clients taking insulin or oral hypoglycemic agents.
May be discontinued in men who develop erection or ejaculatory disturbances.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
fluoxymesterone *(floo-**ock**-see-**MES**-teh-rohn)* (Halotestin, etc.)	oral	5–40 mg daily	See note above.
methyltestosterone ***(meth**-ill-tes-**TOS**-teh-rohn)* (Oreton, Methyl, Testred, etc.)	oral, buccal	10–50 mg daily	Buccal administration (using buccal tablets) provides twice the bioavailability of oral tablets. Instruct client not to eat, drink, or smoke while buccal tablet is in place.
testosterone transdermal system (Testoderm)	transdermal	one 4- or 6-mg transdermal patch applied to scrotum daily and worn for 22–24 hours	Used for testosterone replacement therapy.
testosterone aqueous suspension *(tes-**TOS**-teh-rohn)* (Histerone)	IM	10–100 mg 3–4 times weekly	Testosterone pellets are also available. These are implanted subcutaneously and release drug for 3–6 months. Shake suspension well before using.
testosterone cypionate in oil *(tes-**TOS**-teh-rohn **SIGH**-pee-on-ayt)* (Depo-Testosterone, etc.)	IM	50–400 mg every 4–6 weeks	Should be administered deeply into gluteal musculature. Use of Z-track injection technique is suggested (Chapter 32).
testosterone enanthate in oil *(tes-**TOS**-teh-rohn en-**AN**-thayt)* (Delatestryl, Malogex ✱, etc.)	IM	50–400 mg every 4–6 weeks	See testosterone cypionate.
testosterone propionate in oil *(tes-**TOS**-teh-rohn **PROH**-pee-on-ayt)*	IM	10–100 mg 3–4 times weekly	Use of Z-track injection technique is suggested (Chapter 32).
testosterone undocanoate *(tess-**TOSS**-teh-roan un-do-cu-**NO**-ate)*	oral	120–160 mg two doses a day for 2-3 weeks	Taken with meals. After first 2-3 weeks dosage is 40–120 mg twice a day.

TABLE 37–5

Anabolic Products

Note: Sodium and water retention may occur.
Check blood pressure frequently. Sodium restriction may be necessary.
If jaundice occurs, drug is discontinued or dosage decreased.
May cause masculinization in women (deepening of voice, acne, and changes in body hair).
Unless contraindicated, encourage consumption of a diet high in protein and calories.
May enhance hypoglycemia in clients taking insulin or oral hypoglycemic agents.
Report menstrual irregularities.
Periodic blood tests for serum calcium and cholesterol levels should be done.

DRUG	ROUTE(S)	USUAL DOSE	NURSING IMPLICATIONS
nandrolone decanoate *(**NAN**-droh-lohn deh-**KAN**-oh-ayt)* (Deca-Durabolin, etc.)	IM	25–200 mg every 3–4 weeks	See note above.
nandrolone phenpropionate *(**NAN**-droh-lohn fen-**PROH**-pee-on-ayt)* (Durabolin, etc.)	IM	50–100 mg weekly	See note above.
oxandrolone *(ocks-**AN**-droh-lohn)* (Oxandrin)	oral	2.5–20 mg 2–4 times daily	See note above.
oxymetholone *(**ock**-see-**METH**-oh-lohn)* (Anadrol, Anapolon ✱)	oral	1–5 mg/kg/day	See note above.
stanozolol *(stan-**OH**-zoh-lohl)* (Winstrol)	oral	2 mg 3 times daily	See note above.

size and performance. To a certain extent, this premise is true, but what is generally overlooked is the array of serious adverse effects produced by such agents. These may include liver toxicity, inhibition of testicular function, increased serum cholesterol levels, and liver cell tumors. Because of the potential of these drugs to cause serious adverse effects, the United States government has placed stringent restrictions on the availability and use of anabolic agents. As none of the drugs currently used as anabolic agents are totally free of androgenic effects, serious alterations of normal growth and sexual development may be induced if they are administered to young children. Table 37–5 lists the anabolic agents in current use.

DANAZOL (CYCLOMEN ✱, DANOCRINE)

Danazol (**Danocrine**) is a synthetic androgen used primarily in suppressing the output of gonadotropins from the pituitary gland. In suppressing the release of FSH and LH, a reduction in ovarian estrogen production occurs. This drug is employed in the treatment of endometriosis and in relieving the symptoms of *fibrocystic* breast disease.

Clients using danazol generally receive up to 800 mg daily in 2 divided oral doses. Therapy often continues for as long as 6 months. During this time, adverse effects related to the androgenic

action of the drug may occur. These may be manifested as masculinization (e.g., deepening of the voice, abnormal hair growth), fluid retention, and/or changes in hepatic function. The drug should not be used during pregnancy or lactation or when the client has impaired renal, hepatic, or cardiac function.

NAFARELIN ACETATE (SYNAREL) AND HISTRELIN ACETATE (SUPPRELIN)

Nafarelin acetate and **histrelin acetate** are chemically similar to **gonadotropin-releasing hormone**. These drugs stimulate the release of FSH and LH and are used to treat endometriosis or premature onset of puberty (before age 8 in girls or 9.5 in boys). Nafarelin is available as a nasal spray. The client uses one spray in one nostril in the morning and one spray in the other nostril in the evening. This drug should not be given during pregnancy. If the client uses topical nasal decongestants, the decongestant should be used at least 30 minutes after nafarelin. Side effects include hot flashes, headaches, vaginal dryness, and decreases in libido.

Histrelin is available only in a parenteral form. Single daily doses of 10 mcg/kg of the drug are administered subcutaneously. Vials of the drug solution should be stored in a refrigerator and protected from light. The solution should be allowed to reach room temperature before it is injected.

FINASTERIDE (PROSCAR)

Finasteride is an androgen hormone inhibitor used primarily in the treatment of benign prostatic hyperplasia (BPH). When administered in a dose of 5 mg once daily for 6–12 months, finasteride often reduces prostate volume in BPH clients and thereby improves urine flow and decreases the need for surgery.

APPLYING THE NURSING PROCESS

The multiple uses for sex hormones create difficulties in attempting to discuss nursing care. In addition to this chapter, the student should consult Chapter 38 for information about drugs used in labor and delivery and Chapter 39 on the use of sex hormones in the treatment of cancer. Another major use of female sex hormones is as a replacement for deficient hormonal production. In all cases in which female sex hormones, particularly estrogens, are used, it is important that the nurse: (1) be aware of the side effects that can occur, (2) monitor the client for the development of these effects, (3) provide information about drug therapy and administration, and (4) encourage cooperation with the treatment program.

ASSESSMENT

A general health history and current use of medication should be obtained on all persons who are or will be using sex hormones. For women, this includes information about the menstrual cycle (e.g., pattern, volume of flow), if any. The number of pregnancies and information about current pregnancy and date of last menstrual period are important in planning nursing care, particularly instructions about medication use. Also, obtain information on allergies, particularly to medications, and past history of cancer, endocrine disorders, or blood clotting problems, such as thrombophlebitis.

Physical assessment includes obtaining measures of body weight and vital signs, especially blood pressure. The nurse examines the client for fluid retention that may be associated with use of sex hormones. While conducting the assessment, the nurse is alert to indications of body image or self-concept disturbances that are often associated with reproductive disorders.

Oral or parenteral use of estrogen-containing products is likely to be associated with common side effects. These include nausea, vomiting and diarrhea, fluid retention, breast engorgement, and an increase in blood calcium level. The nurse must be alert for the development of these side effects and should periodically check the blood pressure of individuals taking estrogen preparations (especially oral contraceptives), as elevated blood pressure may occur.

NURSING DIAGNOSES

Including but not limited to:

- Disturbed body image related to physiologic and/or pathophysiologic changes related to hormone levels
- Risk for excess fluid volume related to side effects of hormone therapy
- Low self-esteem related to infertility
- Risk for injury, thrombus formation related to side effects of estrogen therapy
- Deficient knowledge related to sex hormone therapy

PLANNING/GOALS

- Client will verbalize positive body image and understanding of effects of hormone levels.
- Client will not experience fluid volume excess, but will maintain fluid balance.
- Client will verbalize understanding of infertility process and positive self-esteem.
- Client will not experience thrombus formation related to adverse effects of estrogen therapy.
- Client will verbalize understanding of sex hormone therapy, including safe self-medication, signs and symptoms to report to physician, and importance of follow-up visits.

IMPLEMENTATION

In addition to monitoring clients for the development of side effects, the nurse must be aware of the possibilities for interactions of estrogens with other drugs and the effects of estrogen preparations on laboratory test outcomes. For example, clients on estrogens may require an upward adjustment of anticoagulant and antidiabetic drug dosages and a reduction of anti-inflammatory corticosteroid dosages (see Chapters 30, 36, and 12, respectively). The laboratory tests that can be affected by estrogens, particularly by oral contraceptives, include hepatic, adrenal and thyroid function tests, Pap smears, and blood clotting determinations. Clients taking estrogens should have this fact noted on request forms for these laboratory tests.

There is a correlation between use of estrogens and thrombophlebitis. Therefore clients taking these hormonal drugs, who are scheduled for major surgery requiring bedrest, are advised to check with their physician about discontinuing the medication several weeks before surgery.

Nurses are frequently asked for advice about the use of oral contraceptives. The knowledge that many women have about these drugs is based largely on discussions with friends and on articles in women's magazines. The nurse should be prepared to discuss how these drugs work, their side effects, the types of preparations available, and the situations in which a woman should consult with her physician. It is particularly important when instructing new users to review the directions for administration carefully. Detailed instructions are usually available with the first month's tablets, but these can be confusing and ought to be reviewed with the client.

New users of a combination oral contraceptive product should be instructed to review the directions for use included with their prescription. In general, this information includes:

1. Begin to take your tablets as instructed, usually on the 5th day of your menstrual period, counting the first sign of bleeding as day 1. Take the tablet, even if you have not stopped bleeding. If you have just recently had a baby, consult the physician about when to begin your tablets.
2. Take 1 tablet every day until all the tablets for the month have been taken. Take your tablet at the same time every day (for example after you brush your teeth in the morning or with your evening meal) to establish a habit.
3. If you forget to take a tablet, take it as soon as you remember and continue with your regular schedule. If two tablets have been missed, take both as soon as remembered. Whenever one or two tablets have been missed, use an additional means of contraception for 7 days.
4. If you develop breakthrough bleeding, use a panty liner and continue to take the tablets, but consult your physician.
5. If you should become nauseated or experience other unpleasant gastrointestinal side effects from taking the tablets, continue to take them. These effects usually decrease with use. It may help to take the tablet with meals. If the unpleasant effects continue beyond several weeks consult your physician about a change in medication.

6. After taking a month's tablets, you should experience onset of menstrual bleeding within several days. If no menses occurs, begin your tablets again on the 7th day of the new cycle, unless you have reason to believe you are pregnant. If pregnancy is possible, contact your physician, as birth control tablets should not be taken during a pregnancy.
7. You may notice after several months that your menstrual flow has decreased in amount. This is normal in many women taking oral contraceptives and is no cause for alarm.
8. Remember to see your physician at least once a year for a check-up.

Nurses should not assume that clients understand the proper use of oral contraceptives and the adverse effects of these agents, which is why every opportunity is taken to counsel clients about their use. It is noteworthy, also, that many women taking oral contraceptives may experience a decrease in folate absorption, which could result in anemia, if proper supplementation is not provided (see Chapter 32). Clients should be informed that smoking enhances their risk of developing adverse cardiovascular effects while using oral contraceptive products. Finally, because some women may experience fluid retention while taking oral contraceptives, difficulty may be experienced in wearing contact lenses. These women are referred to their physicians for examination and possible change of medication. Fluid retention also may result in an increase in epileptic seizures, frequent migraine headaches, or elevated blood pressure.

On admission to the hospital, when the client is asked about medications, women of childbearing age are asked if they take oral contraceptives. If so, and if the client is scheduled for a short stay, the nurse makes arrangements for the client to continue her monthly schedule of drug use.

Client instruction is a part in caring for women who are taking estrogen for replacement therapy; for example, women who have had their ovaries removed or have experienced symptomatic menopause. These women may believe that estrogen is only being given to control symptoms, such as hot flashes and/or to preserve secondary sexual characteristics. They may not understand that estrogen plays an important role in forestalling the development of osteoporosis. The product information that accompanies estrogens stresses the hazards of therapy, including concerns about thromboembolic disease, and may fail to point out the positive aspects of such therapy. Nurses should take the opportunity to explain these positive aspects (e.g., protection from ovarian cancer), as well as to encourage regular medical checkups.

If the transdermal estrogen (**Estraderm**) is being used, the patch is placed on the abdomen or trunk in a nonhairy area. It is changed twice a week. Clients are instructed to cleanse the area well and to apply the patch firmly. Some persons experience redness or skin irritation, so the nurse explains the importance of rotating the site.

KEY NURSING IMPLICATIONS 37–1

Sex Hormones

1. When female sex hormones are used, the nurse must be aware of possible side effects, monitor the client for their development, provide information about drug therapy and administration and encourage compliance with the treatment program.
2. Clients on prolonged estrogen therapy should have their blood pressure checked periodically and be assessed for the development of thrombophlebitis.
3. On admission to the hospital, women of childbearing age are asked about the use of oral contraceptives, as these drugs may affect laboratory test results and, as arrangements may need to be made for the client to continue therapy while hospitalized.
4. Do not assume that clients understand the proper use and adverse effects of oral contraceptives. Counsel persons about their use.
5. Clients taking androgens may experience sodium and water retention, with an increase in blood pressure. Gastrointestinal intolerance, jaundice, priapism, and masculinization of females may also occur.
6. Danazol (Danocrine) must not be taken by pregnant women.
7. Clients taking danazol may experience fluid retention, with an increase in blood pressure and virilization.

Nurses must be aware of the adverse effects of short-term progestin therapy including nausea and irregular menses. Long-term therapy may be associated with gastrointestinal disturbances, edema, weight gain, breast swelling, and mental depression. When progestin "minipills" are used for contraception, irregular menstrual bleeding may occur. For this reason, clients may discontinue their use. These clients are counseled to use some other means of birth control temporarily and to explore alternative methods of contraception. It is also important to counsel clients who believe they may be pregnant to discontinue progestin use and to see their physicians.

For clients using Norplant for family planning, the nurse explains how the health care provider will insert the capsules. Inflammation or infection may occur at the insertion site, and the nurse advises the client to contact the physician or nurse midwife if a local reaction or signs of infection occur. Clients should be advised that the major problem associated with the use of this contraception method is disturbance in the menstrual bleeding pattern.

Most nurses have little contact with persons receiving short-term androgen therapy, as this often occurs in outpatient settings. Greater contact occurs, however, if the client is on long-term substitution therapy or taking androgens for their anabolic effect. Clients are advised that sodium and water retention may occur, resulting in elevated blood pressure. This may require treatment with diuretics or a low-sodium diet (see Chapter 31). Gastrointestinal intolerance may also occur. If jaundice appears, androgenic therapy may need to be discontinued. Male clients should be advised that priapism (persistent painful erection of the penis) may occur. Female clients should be aware that some masculinizing effects may result from therapy. These include deepening of the voice, acne and changes in the nature and distribution of body hair. Anabolic agents may enhance the action of oral antidiabetic drugs, thus requiring an adjustment in dosage of the oral hypoglycemic. In addition, androgens may enhance the actions of oral anticoagulants, requiring a downward adjustment in anticoagulant dosage.

When androgens are being taken for an anabolic effect, the nurse must remember that the effectiveness of the drug depends on the nutritional state of the client. Efforts are made to provide nutritious foods that are acceptable to the individual.

Clients taking androgens, like those taking other sex hormones, are encouraged to visit the physician regularly. This is important both for persons taking oral preparations and for those receiving longer acting preparations.

Clients taking danazol (Danocrine) are advised that a nonhormonal method of contraception should be used during therapy. If the client becomes pregnant, the danazol is usually discontinued to prevent the development of masculine characteristics in the fetus.

Some clients taking danazol experience significant fluid retention. Clients who must be monitored most closely are epileptics and those with cardiac or renal disease. Weight and blood pressure are monitored periodically to assess fluid retention. Female clients are assessed for indications of *virilization*, such as deepening of the voice and excessive growth of hair. Some of these effects may not be reversible when the drug is discontinued.

Finally, danazol therapy should be initiated during the bleeding phase of the monthly cycle, to ensure that the client is not pregnant. If therapy is begun at another point during the cycle, pregnancy tests should be done to be certain that the client is not pregnant. Once therapy has begun, it is continued uninterrupted for 3–9 months. It is important, therefore, that the client understand the length of therapy and the necessity for complying with the treatment.

CLIENTS TAKING OVULATION STIMULANTS

Clients receiving ovulation stimulants are generally those who wish to conceive but who have experienced difficulty in doing so. Many of them have been through a detailed workup and other types of therapy and have been disappointed in the results. In addition, some have read or heard warnings about "fertility drugs" and are apprehensive about taking these ovulatory stimulants. The nurse, therefore, will need to provide emotional support to the client and her spouse during the course of therapy.

Before therapy begins, clients receiving clomiphene citrate (Clomid, Serophene) are

NURSING CARE PLAN

A Client with Endometriosis Treated with Danazol (Danocrine)

Marie Nagy, age 30, has a history of infertility and painful menstrual periods with heavy flow. She visits her gynecologist for an examination and discovers that she has an ovarian cyst. A laparoscopy is performed to remove the ovarian cyst. The laparoscopy and tissue examination reveal that Marie also has endometriosis. The physician recommends that she use danazol to treat the endometriosis, provided she is willing to use mechanical contraception and delay any attempts at pregnancy for the ensuing 6 months. She agrees and is begun on danazol (Danocrine) 200 mg BID. The therapy is initiated during her next menstrual period and she is told that danazol may cause her menstrual periods to change. She is also taught to report androgenic changes, such as acne, edema, mild hirsutism, deepening voice, and weight gain. She is advised that the reduction in estrogen levels will give her typical symptoms of menopause, such as hot flashes, vaginitis, nervousness, and emotional lability.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Painful menstruation. Heavy flow.	Chronic pain related to menstruation.	Client will verbalize relief of pain after pain relief interventions.	Teach client to take mild analgesic and reduce activity when pain occurs. Diversional therapy is useful as distractor.	Client verbalizes less pain with menstrual period following removal of ovarian cyst.
Knowledge about endometriosis.	Deficient knowledge (understanding diagnosis and treatment).	Client will verbalize understanding of disease, symptoms, and therapy.	Teach client that etiology of endometriosis is unknown. Remind client that it is not caused by tampons. Explain that pain is caused by endometrial tissue bleeding into confined spaces.	Client is able to describe disease process and reason for her symptoms.
Knowledge of hormonal therapy.	Deficient knowledge [understanding use of danazol (Danocrine)].	Client will verbalize understanding of drug action and how taken and will list possible side effects.	Teach client the importance of avoiding pregnancy while on this medication. Explain that the drug causes atrophy of endometrial tissue and menstrual changes. Teach client to report acne, edema, hirsutism, weight gain, hot flashes, vaginitis, nervousness, and emotional lability.	Client adheres to drug regimen and identifies and reports symptoms related to use of this medication. Client successfully uses contraception to avoid pregnancy during drug therapy.
Anxiety.	Anxiety related to seriousness of condition and side effects of treatment.	Client will be able to verbalize fears and will report feelings of decreased anxiety.	Provide emotional support to woman and significant other. Encourage them to discuss their questions and fears.	Client is able to report feeling less anxious. Client demonstrates ability to express concerns.
Emotional tension.	Ineffective individual coping related to desire for children and difficulty with conceiving.	Client will be able to verbalize concerns. Client will identify personal methods of coping.	Encourage client to review and utilize appropriate methods of stress management to develop coping skills. Pregnancy may not be possible even with treatment and the couple will need time to adjust to that possibility. Support client in dealing with emotional aspect of lifestyle changes.	Client identifies available resources and support systems. Client initiates appropriate coping strategies.

informed that multiple births are relatively common. They are also instructed in the technique and recording of basal body temperature. They should be advised that therapy is not long term, but is usually confined to 3 courses of administration. The adverse effects they need to be most aware of are visual symptoms, such as blurring. If these symptoms do occur, the physician is contacted at once, the drug is discontinued and referral to an ophthalmologist may be made. In addition, the client may also experience nausea, vomiting, hot flashes, pelvic discomfort and changes in menses.

Clomiphene citrate therapy is usually initiated on the fifth day of the menstrual cycle. Instructions are given, based on basal body temperature readings, as to the ideal timing for coitus.

Some clients will receive sequential therapy with menotropins (Pergonal) or urofollitropin (Metrodin) to promote follicular growth and maturation followed by human chorionic gonadotropin (HCG) to produce ovulation. Again, before therapy the client and sexual partner are informed that the risk of multiple births is relatively high (20%). The primary adverse effect the nurse will be observing for is ovarian enlargement and possible hyperstimulation syndrome. The client is also taught to watch for sudden enlargement of the ovaries, which may be associated with ascites and *hemoperitoneum* from ruptured cysts. The development of hyperstimulation syndrome is cause for immediate hospitalization.

Treatment with human chorionic gonadotropin (HCG) begins when menotropins or urofollitropin injections are completed. The most common side effect of HCG treatment is pain at the site of injection. Clients receiving HCG are generally encouraged to engage in daily sexual intercourse from the day before the HCG is given until ovulation occurs as determined by basal body temperature.

KEY NURSING IMPLICATIONS 37–2

Ovulation Stimulants

1. The nurse provides emotional support and information to the client and her spouse.
2. Clomiphene citrate (Clomid, Serophene) therapy is usually confined to three courses of administration. If visual symptoms occur while using this drug, it is discontinued.
3. Clients taking sequential therapy with menotropins and human chorionic gonadotropin are observed for ovarian enlargement and hyperstimulation syndrome. The latter is cause for immediate hospitalization.

EVALUATION

- Client verbalizes positive body image and understanding of effects of hormone levels.
- Client does not experience fluid volume excess, but will maintain fluid balance.
- Client verbalizes understanding of infertility process and positive self-esteem.
- Client does not experience thrombus formation related to adverse effects of estrogen therapy.
- Client verbalizes understanding of sex hormone therapy, including safe self-medication, signs and symptoms to report to physician, and importance of follow-up visits.

HOME CARE / CLIENT TEACHING

1. Women taking oral contraceptives and estrogen replacement therapy should be reminded about the importance of monthly breast self-examination and yearly Pap testing.
2. Remind women taking oral contraceptives that condoms must be used to prevent sexually transmitted diseases. The oral medication will not protect them from acquiring such diseases.
3. Drug education programs for adolescents should include information about the risks associated with unsupervised use of anabolic steroids.
4. Clients taking sex hormones should be instructed concerning potential adverse effects of of these medications, such as risk of thrombus formation when taking oral contraceptives.

continues

5. Clients taking fertility drugs should be advised of the possibility of multiple fetuses.
6. Clients beginning a new/different contraceptive agent should be advised to use a second additional form of contraception for the first month of the new therapy.
7. Clients taking estrogens should be advised of potential for gastric upset, fluid retention, breast engorgement, and increased serum calcium levels.
8. Clients taking sex hormones should be encouraged to keep follow-up appointments with their physician.
9. Clients using the Lutrepulse pump should be instructed concerning injection site care, dressing changes, and pump care, including protection of the pump and injection site during sleep and bathing.
10. Clients using emergency postintercourse contraception should be instructed on proper use of these medications including need for two doses—one as soon after intercourse as possible and the second dose 12 hours later.
11. Review instructions concerning oral contraceptive teaching of clients beginning on medications.

CASE STUDY

Mrs. Anya Prawdzik, 38 years old, began using a combination oral contraceptive product when she was 21. At that time, she was using a product relatively high in estrogen content. She experienced nausea, vomiting and fluid retention for several months. The symptoms disappeared when she began to use a product with lower estrogen content.

When she was 28, Mrs. Prawdzik developed a deep vein thrombus in her right leg. The physician was uncertain about whether this was related to the use of oral contraceptives, but recommended that an alternative method of birth control be used.

In her early 30s, the client developed endometriosis with irregular heavy bleeding, severe menstrual cramps, and anemia. Because of her history of thrombophlebitis, the physician selected a progestin to treat this condition. The client was instructed to keep records of her menses and pain episodes while the dosage of medroxyprogesterone acetate (Provera) was gradually increased. After using 10 mg daily for 2 weeks, the client reported that she was experiencing fluid retention and severe mental depression.

After seeing the client, the physician discontinued the progestin and scheduled a *laparoscopy* and other diagnostic tests. These revealed severe endometriosis that the physician felt could only be resolved by doing a complete hysterectomy, including removal of both ovaries.

The client tolerated the surgery well and on the 3rd postoperative day began to take 1.25 mg of conjugated estrogens (Premarin) orally, which she would continue to take every day of the month except the last 7 days.

Questions for Discussion

1. What is the current belief about the relationship between the use of oral contraceptives and the development of thromboembolic disease?
2. Are the mental depression and fluid retention which Mrs. Prawdzik experienced common side effects of medroxyprogesterone therapy? What side effects should the nurse look for in clients taking progestins?
3. Why did the physician order estrogen therapy to be started postoperatively?
4. As a nurse, what information would you give Mrs. Prawdzik about long-term estrogen therapy?

CRITICAL THINKING ACTIVITIES

1. Prepare a visual aid showing how oral contraceptives prevent conception.
2. Prepare a presentation for your classmates on methods of contraception, including the expected rates of pregnancy associated with each method.
3. Prepare a brief report on the techniques that can be used to aid women in remembering to take their daily oral contraceptive dose.
4. Prepare a brief report on the relationship between the use of oral contraceptives and thromboembolic disease.
5. Prepare a brief report on the use of long-acting androgen preparations, such as pellets designed for subcutaneous implantation.
6. Explain the role of sex hormones in the development of the human body.
7. Identify the origin and role of follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen and progesterone in the menstrual cycle.
8. Prepare a paper or class presentation of the social and public health issues related to the use of levonorgestrel implants (Norplant).

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38 Agents Used in Obstetrical Care

OBJECTIVES

After studying this chapter, the student will be able to:

- List the classes of agents most commonly used in obstetrical care and give an example of each class
- Identify the therapeutic uses of oxytocic agents
- Explain why the action of oxytocin increases during the last several weeks before term
- Identify the desired actions, side effects, and usual modes of administering the agents commonly used in labor and delivery
- List several agents secreted in breast milk
- Identify appropriate areas for assessment in women receiving agents as part of their obstetrical care
- Apply the nursing process related to caring for clients receiving:
  - agents to promote labor and delivery
  - agents to control postpartum hemorrhage
  - uterine relaxants for the treatment of preterm labor
  - agents to induce abortion
  - agents to promote or to suppress lactation

Many agents are employed in providing care for the obstetrical client. Some of these have been considered in other chapters (e.g., local anesthetics, analgesics, antianxiety agents, and vitamins). This chapter focuses on agents used during labor and delivery. Such agents include those that:

- increase uterine motility
- decrease uterine motility
- suppress or stimulate postpartum lactation
- induce abortion

UTERINE STIMULANTS

In its nulliparous state, the uterus is a pear-shaped organ that measures approximately 7.5 cm in length, 5 cm in width at its widest part, and 3 cm in thickness. It is a highly muscular organ that normally has a rich blood supply. The wall of the uterus is composed, in part, of smooth muscle fibers that extend longitudinally, circularly, and obliquely and give the uterus great strength.

During pregnancy, dramatic changes take place in the uterus. Its weight increases from 30 g to approximately 700 g. Its capacity may increase tenfold. Although the uterus not in the *gravid* state may exhibit slight and infrequent peristaltic movement, such contractions increase in frequency and strength during the third

trimester of pregnancy and culminate in powerful peristaltic waves during labor and delivery. The strong rhythmic muscle contractions cause labor pain.

Although many drugs are capable of stimulating the smooth muscle of the uterus, few are sufficiently selective for uterine smooth muscle to be of use. Agents that are selective stimulants of uterine smooth muscle are known as oxytocic agents. Such agents are now commonly employed in obstetrics to initiate and/or increase uterine contractions in clients for whom a more rapid vaginal delivery is desirable. Oxytocic agents are also used to:

- control postpartum hemorrhage
- correct uterine atony postpartum
- cause uterine contraction after cesarean section or other types of uterine surgery
- induce therapeutic abortion after the first trimester

Three types of oxytocic agents are now commonly employed: oxytocin, ergot derivatives, and prostaglandins.

Oxytocin (Pitocin, Syntocinon)

Oxytocin is one of two hormonal agents secreted by the posterior pituitary gland; the other is vasopressin (antidiuretic hormone, ADH). Although oxytocin exhibits some slight antidiuretic and vasopressor actions, its primary effects are in stimulating the smooth muscle of the uterus and the mammary gland. All commercial oxytocin products currently available in the United States utilize synthetic oxytocin.

Oxytocin increases both the frequency and force of contractions of uterine smooth muscle. Although the precise mechanism of oxytocic action is not clear, it appears to be dependent on the presence of estrogen. When estrogen levels are low, the action of oxytocin is greatly reduced. During the first two trimesters of pregnancy, relatively large doses of oxytocin are therefore required to initiate rhythmic uterine contractions. During the last trimester, particularly during the last 9 weeks of pregnancy, the uterine musculature becomes much more responsive to oxytocin. This drastically reduces the dose of oxytocin required to initiate uterine contractions. During sexual intercourse, oxytocin is also released in the female and is believed to facilitate the transport of sperm from the vagina to the fallopian tubes.

Oxytocin is also capable of stimulating the contraction of smooth muscle that surrounds the milk-secreting cells of the mammary gland. Such muscle contraction forces milk into relatively large reservoirs or sinuses, making the milk readily available to the suckling infant. This action is known as milk ejection or milk letdown.

When oxytocin is used to initiate or stimulate labor, it is generally administered by intravenous infusion. Other forms of administration are not generally acceptable, because of the need to maintain precise control of the rate of drug infusion. The use of an infusion pump to regulate drug administration and the use of devices that can monitor the strength of uterine contractions and fetal heart rate are essential.

When administered by IV infusion, oxytocin is usually diluted in 0.9% aqueous sodium chloride or other IV fluid to produce a solution containing 10 units per liter (10 milliunits/mL). The infusion of this solution is initiated slowly at a rate of approximately 1–2 milliunits (0.001–0.002 units) per minute. If no response is evident within 15 minutes, the administration rate may be increased in increments of 0.1–0.2 mU/minute to a maximum of 20.0 mU/minute. Using the IV fluid that contains 10 units per liter, the total dose required to initiate labor in most clients is about 4,000 mU (400 mL of the solution). However, it may range from 600 to 12,000 mU (60–1,200 mL).

If the client's uterine contractions become too forceful or too frequent during oxytocin administration and/or if fetal distress develops, the infusion should be discontinued immediately. As the half-life of oxytocin in the body is quite short (about 1–6 minutes), reversal of oxytocin's uterine-stimulating effects occurs rapidly when the administration of the drug is discontinued. Throughout the administration the infusion rate should be maintained at the lowest possible level which will permit adequate progression of labor.

When oxytocin is used to control postpartum bleeding, an infusion containing 10–40 units of oxytocin per liter is administered at a rate necessary to control uterine atony. As an alternative, a single intramuscular injection of 10 units of oxytocin may be given, generally after the placenta has been delivered. Intramuscular preparations usually contain 10 units per milliliter.

A nasal spray containing oxytocin (**Syntocinon Nasal Spray**) is available, but is only indicated for inducing initial milk letdown. When used for this purpose, one spray is administered into one or both nostrils 2–3 minutes prior to nursing or pumping the breasts. Alternatively, the solution may be administered in drop form into the nostrils.

Ergot Derivatives

Ergot is a complex mixture of substances derived from the fungus Claviceps purpurea, which grows on a number of grains, particularly rye. Because of the potent pharmacological actions exhibited by chemical substances derived from ergot (ergot alkaloids), any grains contaminated with more than a trace of ergot are considered to be unfit for consumption.

Ergot alkaloids produce varied pharmacological actions. Of particular interest is the ability of these agents to stimulate uterine smooth muscle. Although all ergot alkaloids affect the uterus in a similar fashion, ergonovine and its chemical derivative methylergonovine have emerged as the most commonly used oxytocic agents.

Ergot alkaloids cause powerful contractions of the uterus. This action permits them to be used to control uterine bleeding. As the action of the ergot alkaloids results in powerful uterine contractions that may damage the fetus, their use is not advisable for induction or augmentation of labor. They are, however, suitable for use postpartum or postabortion to control bleeding and maintain uterine contraction.

Ergonovine maleate (**Ergotrate**, etc.) and **methylergonovine maleate** (**Methergine**) may be administered orally, intramuscularly, or intravenously. Intravenous use is only recommended in emergency situations (e.g., in the presence of excessive uterine bleeding), as it may result in a high incidence of adverse effects such as nausea, dizziness, and hypertension (due to its potent vasoconstrictive effect). When such administration is attempted, it should be performed slowly and the client's blood pressure monitored carefully. When administered intramuscularly, 0.2 mg is usually employed. This dose may be repeated, if necessary, at intervals of 2–4 hours. When used orally, one or two 0.2 mg tablets of ergonovine maleate or methylergonovine maleate may be administered 3–4 times daily. Although the likelihood of serious adverse effects with IM or oral administration is relatively small, the client should be observed carefully for sharp elevations of blood pressure and the development of headache.

Prostaglandins

The prostaglandins are chemically related agents that exert wide-ranging effects in the human body. **Dinoprostone** (**Prostin E2**, **Prepidil**) and **carboprost tromethamine** (**Hemabate**) are prostaglandins with oxytocic activity that are commercially available in the United States.

The prostaglandins have been shown to be fairly comparable to oxytocin when used as oxytocic agents. Unlike oxytocin, however, the prostaglandins are capable of stimulating uterine contractions during any stage of pregnancy. They are most commonly used in terminating pregnancy between the 12th and 20th weeks, as well as in treating incomplete abortion, death of the fetus within the uterus, and other conditions that call for expulsion of uterine contents before full term. The use of prostaglandins for induction and/or augmentation of labor has not yet been approved by the FDA, although scientific evidence has confirmed their usefulness for this purpose.

The prostaglandins currently approved for use as uterine stimulants are used for induction of second trimester abortion. Carboprost tromethamine (Hemabate) is administered intramuscularly. An initial dose of 250 mcg is generally administered deep into the muscle. Subsequent doses of 250 mcg are generally administered at 1.5–3.5-hour intervals depending on the uterine response. The total dose administered should not exceed 12 mg (12,000 mcg). The drug solution should be refrigerated during storage.

Dinoprostone (Prostin E2) is administered vaginally in a suppository dosage form. Initially, 1 suppository containing 20 mg of the drug is inserted high into the vagina, with the client in a supine position. This position is maintained for 10 minutes after insertion. Additional 20 mg doses may be administered at 3–5 hour intervals until abortion takes place. During storage, dinoprostone suppositories should be kept frozen. The suppository should be brought to room temperature just before use.

Dinoprostone is also available in a gel form (Prepidil) for use in promoting cervical ripening in a pregnant woman who is at or near term and who is about to have labor induced. The gel is placed directly into the cervical canal using a syringe device provided and the client remains in a supine position for 15–30 minutes after administration.

Adverse effects may occur with the use of any of the prostaglandin agents. Most are the result of their smooth muscle stimulant action, particularly involving the smooth muscle of the gastrointestinal tract. Such effects are therefore generally manifested as nausea, vomiting, and/or diarrhea.

ABORTIFACIENTS

The technique to perform an abortion varies, depending on the stage of gestation. During the first trimester, abortion is usually accomplished by suction curettage. During the second trimester, several options are available. One option is the intra-amniotic injection of a hypertonic (20%) sodium chloride solution. This method is best used between the 16th and 22nd week of gestation. It is performed by instilling up to 250 mL of the hypertonic solution into the amniotic cavity. This results in rapid and generally complete emptying of the gravid uterus. Particular care must be taken to avoid extra-amniotic injection, particularly into a blood vessel.

Although oxytocin has been used alone or in combination with a hypertonic saline solution as an abortifacient, it is not particularly effective and often requires a high dose to be of value.

Prostaglandins are perhaps the most useful second trimester abortifacients, as they are more effective than oxytocin and act more rapidly and reliably than hypertonic saline. Also, they offer a choice of administration routes, as they may be used intramuscularly, intra-amniotically, or intravaginally.

Dilatation and evacuation also may be used to induce second trimester abortion.

UTERINE RELAXANTS

Premature birth is responsible for most *neonatal* deaths. When labor begins before term, it may be desirable to stop labor and postpone delivery to increase the likelihood of the infant's survival. Such a practice is generally attempted only in cases in which labor begins spontaneously after 20 weeks of gestation. Spontaneous labor that begins prior to this period is generally associated with an abnormal fetus and prolongation of gestation is usually not attempted.

A variety of drugs have been used in the attempt to prevent premature labor. These have included progesterone, ethanol, inhibitors of prostaglandin synthesis, and beta-adrenergic stimulants. **Ritodrine** (**Yutopar**) and terbutaline sulfate are the most commonly employed in current practice.

Ritodrine HCl (Yutopar)

Ritodrine is a beta-adrenergic stimulant that has been shown to exert a preferential effect on $beta_2$ adrenergic receptors such as those found in the respiratory tract and in uterine smooth muscle. It also exerts some stimulatory action on $beta_1$ receptors in the heart.

When administered orally or by IV infusion, ritodrine inhibits the contractility of uterine smooth muscle and prolongs the gestation period. Initially, ritodrine is administered intravenously to arrest the acute episode of premature labor. When this is performed, an initial dose of 0.1 mg/minute is employed. The dosage may gradually be increased in 0.05 mg/minute increments every 10 minutes until contractions cease. The dosage usually required for successful control is in the range of 0.15–0.35 mg/minute. Once uterine contractions cease, the drug should continue to be infused for at least an additional 12 hours. Because of the importance of careful dosage control, the use of a controlled infusion device is recommended. Solutions of ritodrine intended for intravenous administration should be used within 48 hours after preparation. A solution should be discarded if it is discolored or contains any particulate matter.

Oral ritodrine therapy is generally begun 30 minutes prior to discontinuing the IV therapy. During the first 24 hours of oral therapy, 10 mg is generally administered every 2 hours. Thereafter, 10–20 mg is given every 4–6 hours. Treatment is continued as long as prolongation of pregnancy is desired.

The administration of ritodrine is associated with a number of adverse effects, mostly stemming from the drug's beta-adrenergic stimulation property. Oral administration is usually associated with a small but significant likelihood of adverse effects. These effects may include palpitation or tremor, nausea, nervousness, and skin rash. Intravenous administration of ritodrine may result in an increase in maternal and fetal heartbeat and increased maternal blood pressure. Such effects are generally proportional to the dose administered. The drug may also cause palpitations, nervousness, insomnia, anxiety, headache, and/or nausea. The state of hydration of clients receiving ritodrine should be monitored, as well as the possible development of pulmonary edema. In addition, the possible unmasking of hidden cardiac disease should be considered in such clients, the first sign of which may be chest pain.

Ritodrine should not be administered to clients with mild-to-moderate pre-eclampsia, hypertension, or diabetes mellitus, unless the benefits clearly outweigh the risks.

Terbutaline Sulfate (Brethine)

Terbutaline sulfate (**Brethine**) is also indicated for inhibiting preterm labor. When the pregnant client is hospitalized in premature labor, terbutaline is administered intravenously at a rate of 10 ug/minute to a maximum of 80 ug/minute. After labor has been successfully stopped, a maintenance dose of 2.5–5 mg by mouth every 4–6 hours of terbutaline can be used to help maintain the pregnancy until term. Terbutaline stimulates $beta_2$ receptors in the uterus, thereby relaxing the uterus. This agent may be given either orally or intravenously.

LACTATION SUPPRESSANTS

In spite of the many advantages of breastfeeding, some women wish to suppress lactation. The agent bromocriptine mesylate (Parlodel) has emerged as a lactation suppressant. It is a nonhormonal ergot derivative that acts to inhibit prolactin secretion. Therapy with this drug is begun no sooner than 4 hours after delivery. Generally 2.5 mg is administered orally twice a day with meals and is continued for 14–21 days.

In past years, estrogens and androgens have been employed in suppressing lactation. Estrogens are believed to act by inhibiting the action of the hormone prolactin and are most effective if administered immediately postpartum rather than after lactation is established. Combinations of estrogens and testosterone, e.g., Deladumone, may also be successfully employed to decrease postpartum lactation. They are effective if administered for 1–5 days after delivery.

In recent years, the effectiveness of estrogens in suppressing lactation postpartum has been questioned. In addition, the potential of causing thromboembolism and cancer of the reproductive system with high estrogen doses also has placed the safety of such products in question.

As all drugs used to suppress lactation are administered only briefly and at relatively low doses, severe adverse effects are rarely seen. The client should, however, be carefully monitored for adverse effects while receiving these drugs.

RH_0(D) IMMUNE GLOBULIN (GAMULIN RH, HYPRHO-D, RHOGAM, MICRHOGAM, MINI-GAMULIN RH)

Rh_0(D) immune globulin is a sterile concentrated solution of gamma globulin prepared from the plasma of donors with high *Rh* antibody *titers*. It is administered intramuscularly to nonsensitized Rh-negative mothers after delivery of an Rh-positive infant or abortion of an Rh-positive fetus. This suppresses the formation of active antibodies in such mothers and provides protection against hemolytic disease (*erythroblastosis fetalis*) in the next Rh-positive pregnancy. To be effective, the immune globulin must be administered to the mother within 72 hours after delivery or abortion. **Note:** Under no circumstances should this immune globulin be administered to an infant.

Although adverse effects from the administration of Rh_0(D) immune globulin are uncommon, some clients may experience pain and tenderness at the site of injection. They may also have mild headache and low-grade fever. In rare instances anaphylactic shock and/or other severe hypersensitivity reactions have been reported. Rh_0(D) immune globulin should be stored in a refrigerator before use. It should not be allowed to freeze.

APPLYING THE NURSING PROCESS

The pregnant client requires supportive care throughout the pregnancy. In addition to diet modifications, exercise, and counseling, drug therapy may be necessary.

CLIENTS TAKING DRUGS THAT INFLUENCE LABOR AND DELIVERY

Following admission to a maternity unit, clients may receive drugs to induce and/or regulate labor. One of the drugs administered most frequently is oxytocin. To induce labor, oxytocin is given intravenously. Clients who are receiving intravenous infusions are prepared for labor and positioned comfortably in bed before the infusion of oxytocin is started.

Assessment

The nurse observes and records the frequency, intensity, and duration of contractions,

maternal vital signs, and fetal position, as well as heart rate and tone. In addition, the integrity of the membranes, nature and quantity of vaginal discharge, and client's response to therapy are assessed. The nurse assesses discomfort and transition from one stage of labor to another.

Nursing Diagnoses

Including but not limited to:

- Risk for injury, uterine rupture, or fetal injury related to use of oxytocin to induce or augment labor
- Deficient knowledge related to oxytocin effect on labor

Planning/Goals

- Client will not experience injury related to adverse effects of oxyticin therapy.
- Client will verbalize understanding of oxytocin and its effects on the labor and delivery process.

Implementation

The rate of infusion, preferably controlled by a pump, is increased gradually until the desired response is obtained; about 3–4 effective contractions within 10 minutes. To determine if a contraction is effective, the fingertips are placed lightly on the fundus at the onset of the contraction. If the contraction is of good quality, the uterine wall cannot be indented with the fingers. A nurse remains with the client during the infusion to check the progress of labor and to ensure client safety and comfort. An electronic fetal monitoring device is used when oxytocin is administered.

The nurse assists with breathing and relaxation techniques, and encourages the client to void to prevent distention of the bladder. In addition, the nurse offers support and comfort measures, such as linen change, backcare, positioning, and analgesics, if ordered and desired. The nurse is responsible for maintaining the infusion in working order and for early identification of adverse effects related to the infusion. These include depression of fetal heart rate (normal rate is 120–160 beats per minute), excessive number or length of contractions, poor relaxation of the uterus and circulatory overload indicated by increased blood pressure, pounding pulse, and moist respirations. These signs indicate that the rate of infusion should be decreased; if sufficiently serious, the infusion should be stopped while the physician is summoned. Early identification of adverse effects is important, as serious problems such as hypertensive crisis, uterine rupture, and fetal arrhythmia or death could occur.

For oxytocin-induced labor to be successful, the cervix must be ripe (prepared for labor). Prostaglandin gel (e.g., Prepidil) is used to prepare the cervix in some clients and may be applied intracervically or intravaginally. Before application, an assessment of the degree of cervical ripening is obtained and the client is attached to an external fetal monitor. The nurse administers or assists in administering the gel and records the time of administration, the amount of drug administered, the method, side effects if any, and the client's reaction to the procedure. If given intracervically, the client is instructed to remain in bed for 1 hour. If given intravaginally, the client remains in bed for 15 minutes. During this time, the nurse monitors vital signs of the woman and fetus. Contractions and/or backache may begin within minutes of administration or may not occur for several hours. Continuous supportive nursing care is provided.

Following delivery of the placenta, methylergonovine maleate (Methergine) or occasionally ergonovine maleate (Ergotrate) may be given to increase uterine tone and to decrease postpartum bleeding. It is important to keep the client's bladder empty to permit contraction of the uterus, thereby decreasing the likelihood of postpartum hemorrhage. After delivery, the nurse continues to monitor the mother's vital signs, massages the uterine fundus if it becomes boggy (not firm) and provides comfort measures. Side effects from single doses of ergonovine maleate or methylergonovine maleate are not very common. However, nausea, vomiting, allergic reactions, dyspnea, palpitations, and transient hypertension can occur.

Evaluation

- Client does not experience injury related to adverse effects of oxyticin therapy.
- Client's labor is successfully induced/augmented and client's delivers healthy neonate.
- Client verbalizes understanding of oxytocin and its effects on the labor and delivery process.

CLIENTS TAKING ABORTIFACIENTS

The client admitted for preterm termination of her pregnancy requires both physical and psychosocial assessments. The physical assessment factors are similar to those of a client entering the hospital for induction of labor in terms of assessing the status of the pregnancy, fetal condition (heart rate and tone, if present), the integrity of the membranes, and any vaginal discharge. After the abortion is induced, the nurse needs to assess for contractions and, ultimately, the expulsion of the products of conception.

Because terminating a pregnancy is an emotional experience for any woman, the client needs to be assessed for her psychological preparation for this experience. The nurse should assess what the client understands of the process. Does she realize that the medications will cause her to experience contractions like those in labor? Does she understand that this process may take from 24–36 hours and that a live fetus may be delivered, especially if the abortion is done at the end of the second trimester or later? The client must be assessed for support systems—family, spiritual support, etc.

Nursing Diagnoses

Including but not limited to:

- Anxiety related to the unknown
- Grieving related to loss of pregnancy
- Risk of injury related to adverse effects of abortifacient therapy
- Deficient knowledge related to the abortifacient therapy and the abortion process

Planning/Goals

- Client will verbalize/demonstrate effective coping mechanisms.
- Client will experience grieving process without psychosocial injury.
- Client will not experience injury from abortifacient therapy.
- Client will verbalize understanding of abortion process.

The primary functions of the nurse caring for a woman having an abortion are to provide emotional support and comfort measures and to monitor the client's response to the abortifacient. To minimize anxiety, the client is informed before the procedure begins that labor is involved in expelling the fetus.

KEY NURSING IMPLICATIONS 38–1

Drugs That Influence Labor and Delivery

1. The nurse assesses the frequency, nature, and duration of contractions, maternal vital signs, fetal position, heart rate and tone, integrity of the membranes, nature and quantity of vaginal discharge, and response to therapy.
2. Intravenous infusions of oxytocin are generally controlled by pump. The goal is to produce 3–4 effective contractions within 10 minutes.
3. Adverse effects of oxytocin infusion include fetal hypoxia, depression of fetal heart rate, excessive number or length of contractions, poor relaxation of the uterus, uterine rupture, and circulatory overload. These observations indicate that the infusion rate must be decreased or stopped if sufficiently severe.
4. Clients receiving prostaglandin gel for cervical ripening are connected to fetal monitoring equipment before the gel is administered.
5. Side effects from ergonovine maleate or methylergonovine maleate include nausea, vomiting, allergic reactions, dyspnea, palpitations, and transient hypertension.

At present, any one of several agents may be used to produce abortion. Selection depends on the length of gestation, client's history and present health, and physician's preference. When 20% sodium chloride solution is used, the nurse observes for inadvertent intravascular injection that may produce signs of hypernatremia, such as increased body temperature, flushing, water intoxication, and cardiovascular shock. Instillation of 20% sodium chloride solution may be accompanied by a local tingling and general sensation of warmth, which are normal reactions.

When 20% sodium chloride solutions are used by intra-amniotic instillation, the nurse assists the physician in doing the amniotic tap under aseptic conditions and monitors the client's response to the instillation of the abortifacient. To reduce anxiety, the client should be provided with an explanation of what is happening, including explanation of the local anesthetic used to decrease discomfort. When 20% sodium chloride solution is used, life support equipment

KEY NURSING IMPLICATIONS 38–2

Abortifacients

1. Clients must understand that labor is involved in expelling the fetus.
2. All clients receiving abortifacients must receive emotional support and monitoring of their physical condition. Life support equipment must be readily available when parenteral abortifacients are used.
3. Clients receiving hypertonic saline are assessed for inadvertent intravascular injection indicated by increased body temperature, flushing, water intoxication and cardiovascular shock.
4. Clients receiving dinoprostone intravaginally may develop a self-limiting fever.

must be readily available. The catheter inserted in the amniotic cavity may be connected to a three-way stopcock to permit instillation of additional solution. The administration set must be carefully secured to the client to prevent dislocation, which might result in the administration of the solution into a site other than the amniotic cavity.

When dinoprostone (Prostin E2) is used intravaginally, the nurse should be aware that drug-induced fever may occur. This is usually self-limiting and is treated with sponge baths of water or alcohol and with increased fluid intake. Aspirin has not been an effective control agent. If vaginal bleeding is heavy, the suppository may be accidentally expelled. In such cases, carboprost tromethamine (Hemabate) may be preferred, as this drug is administered intramuscularly, deep into a muscle.

Whenever prostaglandins are used, unpleasant gastrointestinal side effects are likely to occur. These drugs have been known to produce cervical trauma when the cervix is not sufficiently dilated. Therefore, the course of fetal expulsion must be carefully monitored. The nurse needs to be aware that a live fetus may be delivered, particularly if abortion is done at the end of the second trimester or later. Physical and emotional support must be given to the client. No client should be alone at the time the fetus is delivered.

Once the abortifacient has been administered, the nurse initiates supportive care and client monitoring similar to the care given to laboring clients, without concern for the viability of the fetus. The process of abortion is usually completed within 24–30 hours, although a dilation and curettage procedure may be necessary to remove retained products of conception.

Evaluation

- Client verbalizes/demonstrates effective coping mechanisms.
- Client experiences grieving process without psychosocial injury.
- Client does not experience injury from abortifacient therapy and therapy is successful.
- Client verbalizes understanding of abortion process.

CLIENTS TAKING UTERINE RELAXANTS

Assessment

Clients receiving uterine relaxants are routinely assessed for vital signs, fluid and electrolyte balance, and signs of preterm labor such as contractions and vaginal discharge. Fetal heart rate and activity are also assessed. Clients treated with uterine relaxants at home may have their uterine activity monitored electronically and the information transmitted over telephones to nurses who interpret the results.

Nursing Diagnoses

Including but not limited to:

- Anxiety related to risk of loss of fetus secondary to preterm labor
- Risk for injury fetal injury related to use of medications to relax uterus and stop preterm labor.
- Deficient knowledge related to treatment regimen and care during rest of pregnancy

Planning/Goals

- Client will verbalize/exhibit effective coping mechanisms and utilize support systems.
- Client will not experience injury related to administration of uterine relaxants.
- Client will verbalize understanding of treatment regimen and care during rest of pregnancy.

Implementation

The client in premature labor requires sustained emotional support from nursing staff. In

addition, specific nursing measures are related to drug therapy.

Whenever a uterine relaxant is given, the nurse monitors the effectiveness of the therapy through determination of the frequency of contractions and presence of discharge or other signs of labor. The client is told that therapy is often continued for a time after labor stops to prevent recurrence of contractions.

The two uterine relaxants in current use are ritodrine (Yutopar) and terbutaline sulfate. The nurse assists with initiating and maintaining the intravenous infusion of this drug. Again, frequent monitoring (every 15 minutes) of the maternal and fetal vital signs is important. If heart rate begins to increase or if palpitations become frequent, the rate of infusion can be slowed or a beta-adrenergic blocking agent may be given to counteract the effects of the ritodrine. To decrease maternal hypotension, it is recommended that the client lie on her left side and that she receive sufficient fluids to maintain a normal blood volume. A central venous pressure line may be introduced to permit detection of circulatory overload.

Oral ritodrine or terbutaline is begun approximately 12 hours after contractions stop and shortly before the intravenous infusion is discontinued. If there are no further indications of labor, the client may be discharged on oral therapy. Before discharge, the nurse provides self-care instructions. These include modified bedrest—with the conditions being specified by the physician—avoidance of sexual intercourse and orgasm and avoidance of preparing the breasts for nursing (e.g., massage) until 2 weeks prior to the due date. The client must also be instructed in the recognition of symptoms of preterm labor. including low back pain, increased vaginal discharge, or cramping. The client is instructed to report the occurrence of these signs and symptoms as soon as possible. The client must be instructed in how to take her pulse, as guidelines are generally provided for the administration of ritodrine based on the pulse rate. Any rate in excess of 130 beats per minute is reported before the next dose is taken.

A cost-effective means to administer uterine relaxant therapy at home is by using a portable subcutaneous terbutaline pump. This method permits the administration of a small amount of medication over a long period, with demand bolus administration of additional medication in response to excessive contractions of the uterus. Generally, the client is assessed and stabilized in the hospital and then taught how to manage the continuous subcutaneous administration of medication at home. The client education program includes explaining the physiologic basis for using this type of treatment, describing the basal and bolus administration of medication, teaching clients about the safety features of the pump and programming the pump, selecting demonstration sites for subcutaneous injection, and performing the injection. Clients also are taught to record their uterine contractions in a log and to report excessive contractions not controlled by the medication, usually if more than two boluses have been needed over a 4-hour period. Bolus doses may be used as long as the pulse rate is less than 110 beats per minute.

The nurse providing care at home for clients using a terbutaline pump assesses vital signs, weight gain, fetal heart tones and movement, condition of the client's lungs, height of the fundus, condition of the cervix regarding dilation and effacement, uterine activity, condition of

KEY NURSING IMPLICATIONS 38–3

Uterine Relaxants

1. Assess all clients for signs of labor.
2. Ritodrine HCl (Yutopar) and terbutaline may produce rapid heart rate or palpitations. These may be alleviated by decreasing the rate of infusion or by administering a beta-blocking agent if ordered.
3. Maternal hypotension resulting from ritodrine or terbutaline therapy is treated by encouraging the woman to lie on her left side and ensuring sufficient fluid intake.
4. Oral therapy at home requires modified bedrest, avoidance of sexual intercourse and orgasm, and avoidance of preparing the breasts for nursing until 2 weeks before the due date.
5. Any maternal pulse rate in excess of 130 beats per minute is reported before the next dose of ritodrine is administered.

the gastrointestinal tract and general nutritional status, and the client's psychosocial status. The nurse also may be responsible for obtaining specimens for laboratory work and interpreting blood studies and urinalysis. The nurse should examine the injection site for signs of irritation or infection. The usual sites are the anterior thigh or abdomen, and the infusion set is usually changed every 5–7 days, with site changes more frequent if necessary.

Evaluation

- Client verbalizes/exhibits effective coping mechanisms and utilize support systems.
- Client does not experience injury related to administration of uterine relaxants.
- Client verbalizes understanding of treatment regimen and care during rest of pregnancy.

CLIENTS TAKING LACTATION SUPPRESSANTS OR STIMULANTS

Assessment

During pregnancy, the nurse should assess the pregnant woman's attitudes toward breastfeeding and her knowledge about its benefits to both mother and infant. In late pregnancy, the integrity of the nipples is assessed in women who plan to breastfeed.

Women at high risk for preterm labor can benefit from an education and counseling program. Nurses are often responsible for such programs stressing the importance of rest, adequate fluid intake, decreasing strenuous activity, and avoiding breast massage and preparation for breastfeeding until 2 weeks before the due date. Some clients may need to avoid sexual relations and to limit their exercises in prenatal classes to breathing exercises. Stress management also is important, and clients with social and economic concerns may benefit from referral to a social worker.

Nursing Diagnoses

Including but not limited to:

- Risk for injury related to adverse effects of lactation suppressant medications
- Deficient knowledge related to treatment regimen and home care

Planning/Goals

- Client will not experience injury related to administration of lactation suppressant drugs.
- Client will verbalize understanding of treatment regimen and home care.

Implementation

The decision as to whether a woman will breastfeed an infant should be made well in advance of her due date. This permits preparation of the breasts, instruction in the techniques of feeding, and care of the nipples. Early preparation may help to decrease postpartum confusion and anxiety. It also permits the rapid initiation of therapy to suppress breast engorgement and discomfort if the woman does not plan to breastfeed her infant.

Little difficulty should be encountered if the breasts have been prepared before delivery and if the mother is relaxed when she first attempts to breastfeed. Oxytocic drugs may be used initially to encourage ejection of milk. When oxytocin nasal spray is used, the client is instructed first to clear her nasal passages. Then she should hold the bottle upright and spray the drug solution into the nostril while seated.

When a woman decides not to nurse the infant, estrogens may be given orally or parenterally over several days to decrease postpartum breast engorgement and discomfort. A number of androgenic preparations may be given orally or buccally for several days to decrease breast engorgement in nonnursing mothers. In general, the side effects from these drugs are minimal because of the low dosages and short-term therapy employed. The nurse is alert, however, for signs of drug sensitivity as well as androgenic side effects, including acne, edema, oily skin, *hirsutism* and hoarseness. When estrogens are used, the nurse observes the client for nausea, which is relatively common, and for cardiovascular problems such as thrombophlebitis and thromboembolism.

When bromocriptine mesylate (Parlodel) is used to suppress lactation, the nurse observes the client for nausea, seizures, headache and dizziness. The client may experience slight hypotension. Blood pressure readings should be taken several times a day. Care should be taken when changing positions, such as rising from a supine position. If side effects do occur, a decrease in dosage may be required.

The nurse advises that some women (18%–40%) experience breast engorgement when bromocriptine mesylate is stopped. This engorgement is usually mild, but women can be advised to call the physician if they experience discomfort.

Although adverse effects are rare when drugs are used to suppress lactation, some individuals believe using these drugs is unnecessary. Instead, they favor using nondrug measures, such as ice, pain relievers and supportive bras or binders, to ease discomfort associated with engorged breasts in nonnursing mothers.

In counseling nursing mothers, the nurse can provide guidance and answer questions about the use of drugs during lactation. Instruction includes a discussion of the influence of drugs and nutrition on the quality and quantity of breast milk. Many women now know that agents such as tobacco, alcohol and caffeine may adversely affect fetal development. They may not be aware, however, that such substances may appear in breast milk. An explanation can be given that most drugs that appear in maternal blood also appear at some level in breast milk and that the infant may react adversely to these substances because of immature fetal hepatic and renal mechanisms. Questions related to the use of specific drugs and dosages may be referred to the physician or pharmacist. The client is instructed to make her family dentist and physicians aware that she is breastfeeding. Box 38–1 lists some drugs that have been reported to be secreted in breast milk.

Evaluation

- Client does not experience injury related to administration of lactation suppressant drugs.
- Client verbalizes understanding of treatment regimen and home care.

KEY NURSING IMPLICATIONS 38–4

Lactation Suppressants or Stimulants

1. Assess the pregnant woman's attitude toward and knowledge about breastfeeding.
2. Oxytocic drugs may be used initially to encourage ejection of milk.
3. Clients using oxytocin nasal spray are advised to clear the nasal passages and to spray the drug into the nostril while seated and holding the bottle upright.
4. When androgens are used to suppress lactation, the nurse observes the client for drug sensitivity and masculinization.
5. When estrogens are used to suppress lactation, the nurse observes the client for nausea and cardiovascular problems.
6. When bromocriptine mesylate (Parlodel) is used to suppress lactation, the nurse observes the client for nausea, headache, dizziness, and hypotension.
7. Most drugs that appear in maternal blood also appear in breast milk.

BOX 38–1 Some Drugs That Have Been Reported To Be Secreted in Breast Milk

alcohol (ethanol)
barbiturates
bromocryptine
cascara-containing laxatives
chloral hydrate
chlorpromazine
clindamycin
contraceptives, oral
cyclophosphamide
danthron
diazepam
dicumerol
ergonovine
ergot alkaloids
estrogens
ether
ethosuximide
gold
heroin
iodine, radioactive
iodides
iron
isoniazid
lincomycin
lithium carbonate
methadone
methotrexate
methylergonovine maleate
metronidazole
morphine
nalidixic acid
nicotine
nitrofurantoin
oxytocin
penicillins
phenolphthalein
phenylbutazone
phenytoin
prednisolone
prednisone
propylthiouracil
senna compounds
tetracyclines
theophylline

NURSING CARE PLAN

A Pregnant Client Using Ritodrine HCl (Yutopar)

Jennifer Jackson, age 24, is 28 weeks pregnant with her first child when she starts having uterine contractions. By the time she gets to the hospital, contractions are every 5 minutes. Examination reveals that the cervix is not yet dilated or effaced. The contractions stop shortly after Jennifer is admitted. Twice during the next 24 hours, contractions start and stop. Fetal heart tones are strong at a rate of 140 per minute. An amniocentesis is done to check for fetal maturity, and the results indicate that the baby's lungs are not developed adequately. The next time contractions start, the physician begins ritodrine HCl (Yutopar) via IV drip at 0.1 mg per minute. Contractions stop within 30 minutes of administration. Jennifer is monitored for possible cardiovascular effects. Jennifer is on IV drip for 13 hours then started on ritodrine HCl tablets 10 mg q2h. After 24 hours Jennifer is discharged with a prescription for ritodrine 20 mg q6h. She is told to rest at home and call the physician if contractions start or if she has signs of overdosage or side effects. All of the following should be reported: tachycardia, palpitations, arrhythmias, dizziness, dyspnea, nervousness, tremor, nausea, or vomiting.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Frequency and nature of uterine contractions.	Acute pain related to uterine contractions.	Client will begin breathing exercises and relaxation techniques.	Encourage client to take deep breaths and practice relaxation techniques as taught in prenatal classes.	Client demonstrates proper use of breathing and relaxation techniques.
Nervous, anxious.	Anxiety related to consequences of early labor.	Client will verbalize her concerns.	Encourage client to discuss her fears. Remind her how the medication works and explain the goal of therapy.	Client is able to talk about her concerns and verbalizes feeling less anxious.
Pattern of contractions, sleep pattern.	Disturbed sleep pattern related to contractions.	Client verbalizes feeling rested. Client sleeps for 1–2 hour intervals.	Encourage client to sleep and rest between contractions. Position comfortably. Provide calm, quiet environment.	Client sleeps and appears rested during hospitalization.
Knowledge of diagnostic testing.	Fear related to not understanding the process of amniocentesis.	Client will be able to verbalize knowledge of the testing.	Explain the procedure to the client. Encourage her to ask questions. Be sure she has the opportunity to ask questions about and understands the risks associated with amniocentesis.	Client is able to verbalize feeling of relief when procedure is finished.
Knowledge about drug therapy.	Deficient knowledge related to the use of ritodrine to stop contractions.	Client will be able to identify how medication works and possible side effects.	Encourage client to relax and let medication work. Remind her that the IV drip is to provide rapid action that can then be maintained with oral therapy. Teach client to report fast or irregular heartbeat, dizziness or painful breathing, nausea and vomiting, and tremors. Prepare client for discharge through instruction regarding medication and indications of labor.	Client is able to explain purpose of medication. She can list side effects and knows to report them to nursing staff while hospitalized. Client takes medication as ordered and reports indications of labor and adverse effects of medication to physician after discharge.

HOME CARE/CLIENT TEACHING

1. Clients receiving drugs used in obstetrical care should be instructed concerning action, use, and adverse effects associated with the medications they receive.
2. Clients receiving oxytocic medications should be informed that contractions may be stronger and more frequent than contractions not stimulated by drug therapy.
3. Clients receiving abortifacients need to be instructed that they will experience labor and that use of breathing and relaxation techniques may be helpful.
4. Clients receiving dinoprostone intravaginally should be informed that they may experience a self-limiting fever associated with the use of this medication.
5. Client receiving uterine relaxants need to be instructed regarding prescribed home care which may include modified bedrest, avoidance of sexual intercourse and orgasm, and avoidance of preparing the breasts for lactation until 2 weeks prior to due date.
6. Clients receiving uterine relaxants is to be instructed to report symptoms preterm labor to physician.
7. If a woman is receiving terbutaline by subcutaneous pump at home, the nurse assesses vital signs, weight gain, fetal heart tones and movement, condition of the client's lungs, height of the fundus, uterine activity, general nutritional status and gastrointestinal functioning, and psychosocial status. The injection site is examined for signs of irritation or infection.
8. Women at high risk for preterm labor should be engaged in education and counseling programs that focus on proper self-care, limitation of strenuous activity, and stress management.
9. Clients taking ritodrine should be instructed in how to take her pulse.
10. Clients receiving lactation suppressant medications should be informed to avoid activities that could stimulate milk production, including even intermittent suckling of the infant and that if they experience breast engorgment, they should report this to physician if it's uncomfortable.

CASE STUDY

Mrs. Liu, a 21-year-old female, gravida 3, *para* 0, abortions 2, begins to have contractions at 10 am on her due date. She is admitted to the hospital at 2 pm. At 6 pm she has a bloody show, but the membranes remain intact. At this time she complains of nausea, but is otherwise comfortable.

During the first trimester, Mrs. Liu experienced vaginal bleeding. The bleeding subsided following several days of bedrest. An ultrasound test at 28½ weeks showed one fetus with a breech presentation, placenta posterior. Other relevant items in the history include:

- Weight gain of 23 pounds during pregnancy
- Penicillin allergy
- A history of smoking one-third of a pack of cigarettes a day

Vital signs on admission are: BP 120/88, P 86, R 20, temperature 97°F. Six hours after admission the client's contractions are still very irregular and ineffective. She is given secobarbital sodium (Seconal) 100 mg p.o. She refuses pain medication. After being seen by the physician, she is sent home and instructed to rest and return when contractions become regular.

Forty-eight hours later Mrs. Liu is readmitted with irregular, but more frequent, contractions. After pelvic examination, the physician orders 10 units oxytocin (Pitocin) in 1,000 mL 5% dextrose in water to be run at 250 mL/hour. As a result, contractions become more intense and regular. Several hours later, she delivers a healthy 7-pound male infant. The episiotomy is repaired following infiltration of

continues

the perineum with 2 mL of mepivacaine hydrochloride (Carbocaine). Mrs. Liu is then moved to a recovery area where the intravenous oxytocin (Pitocin) is continued until her fundus is firm and the vaginal discharge is moderate in amount.

Questions for Discussion

1. What nursing measures are indicated during the time Mrs. Liu is receiving the intravenous infusion of oxytocin (Pitocin)?
2. If the client experiences a boggy uterus (not firm) and excessive uterine bleeding once the oxytocin infusion has been discontinued, what drugs might be used to increase the tone of the uterus?
3. What drugs could be administered following delivery to promote or to suppress lactation?

CRITICAL THINKING EXERCISES

1. Conduct a discussion group for nursing mothers in which issues related to maternal nutrition and drug use are discussed.
2. Compile a collection of materials explaining various types of abortion procedures. Evaluate these materials with your classmates.
3. Examine women's magazines (e.g., *Cosmopolitan*, *Good Housekeeping*) for the past year to see how many articles have dealt with labor and delivery, infertility, and abortion. Prepare a brief report on the material covered and how well it was presented to a lay audience.
4. Prepare a presentation for a prenatal class on some aspect of labor and delivery, including the drug therapy that may be used.
5. Attend a meeting of the La Leche League to see what peer support is available to a woman who wishes to breastfeed her infant.

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SECTION 12

Additional Therapeutic Agents

MAJOR NURSING DIAGNOSES

- Impaired Physical Mobility
- Ineffective Protection
- Risk for Injury
- Imbalanced Nutrition: Less Than Body Requirements
- Impaired Skin Integrity
- Pain: Acute/Chronic
- Disturbed Sensory Perception
- Disturbed Thought Processes
- Ineffective Individual Coping
- Disturbed Body Image
- Low Self-Esteem
- Deficient Knowledge (Illness and Its Treatment)
- Anticipatory Grieving
- Deficient Volume Due to Nausea and Vomiting

39 Agents Used in the Treatment of Cancer

OBJECTIVES

After studying this chapter, the student will be able to:

- Describe the cell cycle and how it is affected by the use of antineoplastic agents
- List the major classes of antineoplastic agents and give an example of an agent in each class
- Identify the major therapeutic actions and adverse effects of each class of antineoplastic agents
- Describe important aspects of nursing assessment for clients receiving cancer chemotherapy
- Apply the nursing process for clients receiving anticancer agents
- Apply the nursing process for clients receiving each of the classes of antineoplastic agents
- State two methods of preventing loss of scalp hair in clients receiving intravenous anticancer agents
- Describe general principles of nursing care for clients receiving therapy via tunneled catheters, implanted vascular access devices and pumps, and peritoneal catheters
- Discuss measures taken to ensure the safe administration of antineoplastic agents
- Describe the role of the nurse in the care of clients receiving investigational agents

Cancer is a broad term encompassing many different related diseases all sharing the common characteristic of uncontrolled cell proliferation. Cancer cells can arise in any body tissue at any age. They can invade local tissues by directly spreading from a primary focal point or they can spread throughout the body by way of lymphatic channels or the bloodstream.

In contrast to normal cell growth, cancer should not be regarded as abnormal growth, but as an abnormality in the regulation of growth. Although both normal and cancer cells have a similar replication process, cancer cells appear to be unable to regulate their population growth and do not stop replicating when they have achieved a high density of cells. Without treatment, this uncontrolled cell growth may cause tissue damage and death.

The factors inducing a normal cell to become cancerous have been difficult to identify. It appears, however, that genetic, environmental, infectious, and/or immunological factors may be responsible for the development of cancer.

To understand cancer treatment, an awareness of the replication process that occurs in normal and malignant cells is essential. This process is known as the cell cycle (Figure 39–1). The cell cycle may be as brief as 24 hours or may last many days.

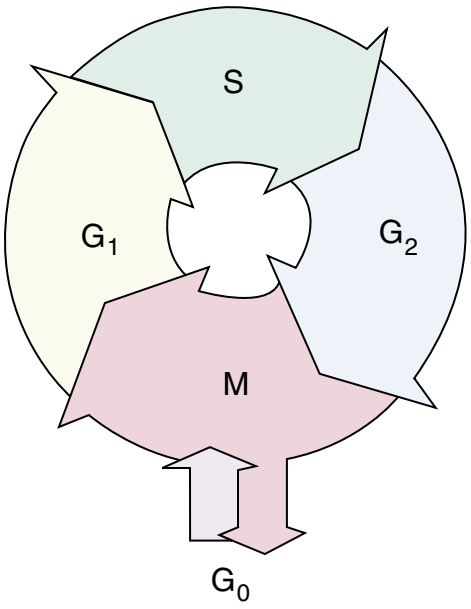

Figure 39–1 The phases of the cell cycle are: a first growth phase (G_1), synthesis (S), a second growth phase (G_2), mitosis (M) and a resting phase (G_0).

During the cell cycle, the cell passes through four phases, or stages, of activity. These are referred to as the *G_1*, *S*, *G_2* and *M* phases. During the G_1 (first growth) phase the cell prepares for the synthesis of deoxyribonucleic acid (DNA) which occurs in the S (synthesis) phase. During the G_2 (second growth) phase the cell prepares for division, which occurs in the M (mitosis) stage. The two new daughter cells formed contain the same genetic information as the parent cell. These cells may either mature and undergo replication or enter a fifth phase, the *G_0* (cell resting) phase. During this stage the cell temporarily leaves the cycle and awaits activation, which permits it to reeenter the cycle. During the *G_0* phase, cells do not multiply. The time required for a given population of cancer cells to complete the cell cycle (generation time) depends on which tissue is involved.

Cancer treatment is generally based on selection of the regimen of therapy or treatment protocol that will be most successful in treating the client's cancer while producing the least amount of damage to normal body function and structure. The specific mode of therapy may also be chosen on the basis of:

- overall aggressiveness of the cancer
- potential for spreading of the cancer
- potential hazards of the therapy, itself
- established success rate of the therapy

The treatment of cancer is generally most successful when the cancerous cells are localized and have not been disseminated throughout the body. When cancerous cells are localized and accessible (e.g., in some forms of skin cancer), the optimal treatment may be surgical removal of the affected tissue and/or exposure of the area to an appropriate form and dose of damaging radiation.

Drug therapy, or chemotherapy, of cancer is generally used when the cancerous cells are widely disseminated in the body (e.g., in clients with leukemia), when the use of surgery and/or radiation is not feasible or practical, or in cases where chemotherapy has been demonstrated to be an effective means of treatment. In the past, chemotherapy was often only palliative. Today, it frequently results in prolonged client survival and even long-term remissions or "cures" (see Table 39–1). Chemotherapy has also been shown, in some types of cancer, to be an effective adjunct to surgery or radiotherapy in improving client survival.

Antineoplastic drugs exert their lethal effects by interfering with the cell cycle of both normal and malignant cells. As currently available drugs cannot distinguish between normal and cancerous cells, it is almost impossible to destroy malignant cells without also destroying many normal cells. The normal cells particularly at risk during many forms of chemotherapy are those that normally rapidly proliferate, i.e., the blood-forming system in the bone marrow, the cells lining the GI tract, and the hair follicles. The great sensitivity of these cells to chemotherapy results in the common emergence of blood disorders, nausea and vomiting, and hair loss during antineoplastic therapy.

In some cases, therapy with antineoplastic drugs may not eradicate all cancerous cells, as some of them may leave the cell cycle and enter the *G_0* phase, in which they can escape the lethal effects of the drug(s). Once drug therapy has been discontinued or the drug's concentration in the body is no longer lethal, cancer cells in the *G_0* phase may again reenter the normal cell cycle and replace destroyed cells.

Many antineoplastic drugs are meant to interfere with either the cell mitosis (*M*) phase or the synthesis of DNA (*S* phase). Drugs that act at these or some other specific portion of the cell cycle are known as cycle-specific drugs. These tend to be most effective in destroying rapidly proliferating cells and generally exert greater toxicity on a rapidly growing cancer cell than on a slower growing normal cell. Because, at any given time, different

TABLE 39–1

Neoplastic Disorders in Which Chemotherapy Has Significantly Prolonged Survival

DISEASE	DRUGS CURRENTLY PREFERRED FOR TREATMENT
acute lymphoblastic leukemia	asparaginase daunorubicin prednisone vincristine
acute myeloblastic leukemia	cytarabine daunorubicin idarubicin
breast cancer	cyclophosphamide doxorubicin fluorouracil methotrexate tamoxifen toremifene citrate
Burkitt's lymphoma	cyclophosphamide methotrexate vincristine
choriocarcinoma	dactinomycin methotrexate
embryonal rhabdomyosarcoma	cyclophosphamide dactinomycin doxorubicin ifosfamide vincristine
Ewing's sarcoma	cyclophosphamide dactinomycin doxorubicin ifosfamide vincristine
Hodgkin's disease	bleomycin dacarbazine doxorubicin mechlorethamine prednisone procarbazine vinblastine vincristine
lymphoma, non-Hodgkin's	cytarabine
lymphoma, diffuse histiocytic	cyclophosphamide doxorubicin methotrexate rituximab vincristine
osteogenic sarcoma	bleomycin cisplatin cyclophosphamide dactinomycin doxorubicin methotrexate
prostate cancer	flutamide goserelin leuprolide
testicular cancer	bleomycin cisplatin etoposide
Wilms' tumor	cyclophosphamide dactinomycin doxorubicin vincristine

cancer cells may be at different phases of their individual cell cycle, single cycle-specific drugs may only affect a portion of the cancer cells to be destroyed. For this reason, combinations of antineoplastic drugs acting at different stages of the cell cycle have become popular. This strategy often greatly increases the effectiveness of treatment and decreases the likelihood that a cancer cell will become resistant to therapy. Selecting combination therapy drugs that exert toxic effects on different tissues of the body may spare a client the severe toxicity with use of large doses of a single drug.

Some drugs destroy cancerous cells, but do not appear to act on a specific stage of the cell cycle. These agents are known as cycle-nonspecific drugs and are primarily employed in maintenance therapy to suppress the development of newly proliferating cancer cells.

The antineoplastic drugs are generally classified according to their mechanism of action or derivation, Box 39–1.

ALKYLATING AGENTS

This class of agents was developed from poison mustard gases first used in World War I. They appear to act by interfering with the chemical structure of DNA and by causing abnormal chemical bonding between adjacent DNA molecules. The defective DNA molecules produced are unable to carry out normal cellular reproductive functions. Unlike most other classes of antineoplastic

BOX 39–1 Classification of Antineoplastic Agents

ALKYLATING AGENTS
busulfan
carboplatin
carmusine
chlorambucil
cisplatin
cyclophosphamide
ifosfamide
lomustine
mechlorethamine HCl
melphalan
pipobraman
streptozocin
thiotepa
uracil mustard

ANTIBIOTICS
bleomycin sulfate
dactinomycin
daunorubicin HCl
doxorubicin HCl
idarubicin HCl
mitomycin
mitoxantrone HCl
pentostatin
plicamycin
valrubicin

ANTIMETABOLITES
capecitabine
cytarabine
floxuridine
fludarabine phosphate
fluorouracil
hydroxyurea
mercaptopurine
methotrexate
thioguanine

HORMONES
Androgens:
fluoxymesterone
testolactone
Antiandrogens:
bicalutamide
flutamide
nilutamide
Antiestrogens:
goserelin implant
letrozole
tamoxifen citrate
toremifene citrate
Corticosteroids:
dexamethasone
prednisone
Estrogens:
diethystibestrol diphosphate
estramustine phosphate sodium
polyestrodiol phosphate
Gonadotropin-Releasing Hormone Analog:
leuprolide acetate
Progestins:
medroxyprogesterone acetate
megestrol acetate

MISCELLANEOUS ANTINEOPLASTIC AGENTS
altretamine
asparaginase
BCG
cladribine
dacarbazine
denileukin diftitox
flutamide
levamisole HCl
paclitaxel
pegaspargase
porfimer sodium
procarbazine HCl
rituximab
tretinon

MITOTIC INHIBITORS
etoposide
teniposide
vinblastine sulfate
vincristine sulfate
vinorelbine tartrate

RADIOACTIVE AGENTS
chromic phosphate P 32
sodium iodide I 131
sodium phosphate P 32
strontium chloride Sr 89

TOPOISOMERASE 1 INHIBITORS
irinotecan CHl
topotecan

BIOLOGIC RESPONSE MODIFIERS
interferon alfa-2a
interferon alfa-2b
interferon alfa-n3
aldesleukin

drugs, the alkylating agents are cycle nonspecific in their action and may act on cells at any stage in their growth cycle.

The alkylating agents affect all rapidly proliferating cells and often cause toxicity to the hematopoietic, or blood-forming, system of the body. Within a short period after the administration of any of these agents, the production of new blood cells in the bone marrow is suppressed. Such suppression may be evident for several weeks after therapy has been discontinued and is generally followed by gradual recovery. Most of these agents also disrupt cells within the GI tract and produce nausea and/or vomiting.

Selection of an alkylating agent is generally based on the proven superiority of a given agent in treating a specific type of cancer as well as its route of administration and toxicity.

ANTIMETABOLITES

The antimetabolites are a diverse group of agents having the ability to interfere with various metabolic actions of the cell and thereby result in the cell's destruction or inability to replicate itself. All of these compounds closely resemble substances normally used by cells in their growth or metabolism (for example, folic acid). Because of their similarity to these agents, they are capable of being mistakenly incorporated by the cells, thereby resulting in the antagonism of normal cellular processes.

The antimetabolites are cycle-specific agents that appear to act only on dividing cells during the S phase of the cell cycle. They are most effective in treating rapidly proliferating cancers. Virtually all of the antimetabolites commonly produce nausea and vomiting, as well as bone marrow depression.

MITOTIC INHIBITORS

A number of antineoplastic drugs act by specifically interfering with cell division or mitosis, i.e., the M phase of the cell cycle. The oldest of these, **vinblastine** and **vincristine**, are derived from the periwinkle plant (*Vinca rosea*). The major form of toxicity exhibited by vinblastine is bone marrow depression, with neurotoxicity a the major form of vincristine toxicity.

Vinorelbine tartrate is a semisynthetic *Vinca* derivative that may also cause bone marrow suppression and, specifically, granulocytopenia.

Etoposide and **teniposide** are agents derived from the Mayapple (*Podophyllum*) plant. Etoposide appears to exert its primary effect at the G_2 portion of the cell cycle although it also appears to affect cell mitosis. Teniposide appears to act in the late *S* or early G_2 phase of the cell cycle. The most severe toxic effect of these agents is bone marrow depression and the accompanying reduction in circulating platelets and white blood cells.

ANTIBIOTICS

Many effective antineoplastic drugs are antibiotics, i.e., they are derived from microorganisms. These agents should not be confused with antibiotics employed in the treatment of infection (see Chapter 7) since they are not selectively toxic to bacterial cells and tend to disrupt the cellular function of human cells. All currently available antineoplastic antibiotic agents appear to act by interfering with one or more stages of RNA and/or DNA synthesis. This action interferes with the cell's ability to grow and reproduce normally. Because the antibiotic agents generally interfere with several parts of the cell cycle, they are considered to be cycle nonspecific antineoplastic drugs.

HORMONES

Hormonal agents are widely used in antineoplastic therapy, as they are often capable of selectively suppressing the growth of certain tissues of the body without exerting a cytotoxic action. The sex hormones—estrogens, androgens and progestins—are generally employed to alter the hormonal environment of tissues dependent on these agents for their growth. For example, the use of estrogen or antiandrogen therapy may be beneficial in treating prostatic cancer since these agents will inhibit the growth of prostatic tissue. Likewise, androgenic or antiestrogen agents may be useful in treating tumors of the breast or endometrium. (See Chapter 37 for coverage of the sex hormones.)

Corticosteroids such as prednisone and prednisolone are frequently used in conjunction with antineoplastic agents in the treatment of acute lymphoblastic leukemia and malignant lymphomas to suppress lymphocyte production. Their immunosuppressant activity often produces dramatic symptomatic improvement in critically ill clients and elicits an overall feeling of well-being. With prolonged therapy the corticosteroids produce a wide variety of adverse effects (see Chapter 12).

RADIOACTIVE DRUGS

Radioactive drugs are agents that, once administered, tend to concentrate in a specific tissue and emit damaging radiation, which destroys some or all of the tissue in which the drug is localized. Such radioactive compounds generally lose their ability to emit damaging radiation within a relatively short period and are, therefore, not generally destructive to normal cells throughout the body.

BIOLOGIC-RESPONSE MODIFIERS

Biologic-response modifiers are another type of cancer treatment. They work by targeting and enhancing the immune system. Recombinant DNA technology, which is a genetic engineering process to produce mass quantities of human proteins, and hybridoma technology, which involves mass producing monoclonal antibodies using mice, are two biochemical advances that have led to the production of biologic-response modifiers. These enhance the immunologic function of the host, destroy or interfere with the cellular activities of tumors, and promote the differentiation of stem cells. Blood cells are formed by a process called hematopoiesis. During this process, they are formed from stem cells that are undifferentiated mesenchymal cells called hemocytoblasts. These cells go through many stages of maturation during the process of becoming blood cells. Through the actions of the biologic response modifiers, such as **interferons** (interferon alfa-2a, interferon alfa-2b, **interferon alfa-n-3**), and **aldesleukin**, a person's own immune system is activated to fight the cancer.

MISCELLANEOUS ANTINEOPLASTIC AGENTS

A number of antineoplastic drugs are not easily classified into one of the preceding groups because their mechanism of action is not clear or because they exert a very specific action not shared by any other currently available drug.

Table 39–2 reviews the properties of the antineoplastic drugs available in the United States. Before using, it is important to review the storage, reconstitution, and chemical stability after reconstitution of each injectable antineoplastic agent. The nurse should always refer to the package insert accompanying these products when preparing such medication for administration.

COMBINATION THERAPY

During the last several years, it has become increasingly evident that a single chemotherapeutic agent is rarely as effective in treating a given cancer as a combination of carefully selected agents. The rationale for such combinations is to use drugs that:

- exhibit different toxicities
- have different mechanisms of action, i.e., act on different portions of the cell cycle
- are individually active against the specific cancer
- have a more pronounced beneficial effect when used together than when used alone

Typical combinations that have been successfully employed in clinical practice are listed in Table 39–3.

TABLE 39–2

Antineoplastic Agents' Potential for Causing Nausea/Vomiting

HIGH	MODERATELY LOW
(> 90% Occurence)	**(0%–30% Occurrence)**
cisplatin dacarbazine irinotecan HCl mechlorethamine stretozocin cytarabine (high dose)	bleomycin hydroxyurea etoposide melphalan cytarabine (usual dose) teniposide vinblastine 6-mercaptopurine methotrexate (low dose) thiotepa lomustin
(60%–90% Occurrence)	**(< 10 % Occurrence)**
actinomycin carmustine cyclophosphamide ifosfamide procarbazine methotrexate (usual dose) topotecan HCl	androgens busulfan chlorambucil corticosteroids estrogens progestin 6-thioguanine
(30%–60% Occurrence)	
daunorubicin doxorubicin floxuridine fluorouracil L-asparaginase mitomycin	

ADJUVANT AGENTS

Adjuvant agents are drugs used in combination with chemotherapy. They are also referred to as "rescue drugs." The two agents in this group are **Mesna** (**Mesnex**) and **leucovorin calcium** (**Citrovorum Factor**, **Folinic acid**), which are used to combat specific adverse effects associated with particular antineoplastic agents.

Mesna is used to "rescue" the urinary bladder from the potential hemorrhagic cystitis associated with the alkylating agents **ifosfamide** (**IFEX**) and **cyclophophamide** (**Cytoxan**). The total dose of mesna is 60% of the ifosfamide dose equally divided into 3 doses. The first dose is administered immediately following the ifosfamide infusion and repeated at 4 and 8 hours following the first dose. The first dose of mesna may be mixed with the ifosfamide.

Leucovorin is the rescue used in conjunction with **methotrexate sodium**. Methotrexate sodium interferes with folic acid metabolism and causes elevated uric acid levels in the body. Leucovorin competes at the cellular level with methotrexate to neutralize it and causes it to be excreted. Because methotrexate's antineoplastic action against such cancers as lymphoma; osteogenic sarcoma, cancers of the breast, head, neck and lung; and meningeal lymphocytic leukemia, it is considered to have reached its peak action at the completion of its adminstration. The first dose of leucovorin is administered immediately following the infusion of methotrexate. Follow-up doses of leucovorin are then administered every 3 hours following the first dose until the methotrexate blood level is less than 0.05 micromoles. In addition to the use of leucovorin to decrease elevated uric acid level,

TABLE 39–3

Examples of Combination Chemotherapeutic Regimes

REGIMEN	COMBINED AGENTS	TYPE OF CANCER
AMV	adriamycin, mitomycin, vinblastine	cervical cancer
BM	bleomycin, mitomycin	cervical cancer
ABV	doxorubicin, bleomycin, vinblastine	Hodgkin's disease
ABVD	adriamycin, bleomycin, vinblastine, dacarbazine	Hodgkin's disease relapse
B-DOPA	bleomycin, dacarbazine, Oncovin, prednisone, adriamycin	Hodgkin's disease relapse
MOPP	mechlorethamine, Oncovin, procarbazine, prednisone	Hodgkin's disease relapse
BEP	bleomycin, etoposide, platinol	testicular carcinoma
VB-3	vinblastine, bleomycin	testicular tumors
CHOP	cytoxan, hydroxyldaunorubicin, oncovin, prednisone	non-Hodgkin's lymphoma
COP	cytoxan, Oncovin, prednisone	non-Hodgkin's lymphoma
COPP	cyclophosphamide, vincristine, procarvazine, prednisone	Hodgkin's disease
CMV	cisplatin, methotrexate, vinblastine	advanced bladder cancer
CMF	cyclophosphamide, methotrexate, 5-flourouracil	breast cancer
CVFMP	cytoxan, vincristine, 5-flourouracil, methotrexate, prednisone	breast cancer
FAC	5-flourouracil, adriamycin, cyclophosphamide	breast cancer
CAP	cytoxan, adriamycin, Platinol (cisplatin)	lung cancer
OAP	Oncovin (vincristine), cytarabine, prednisone	leukemia
COAP	cyclophosphamide, Oncovin, Ara-C (cytarabine), prednisone	leukemia
Ad-OAP	adriamycin, Oncovin, Ara-C, prednisone	leukemia
DAT	daunorubicin, Ara-C, thioguanine	leukemia
MOF	Semustine (methyl CCNU), Oncovin, 5-flourouracil	Colon (adjuvant therapy)
BACOP	bleomycin, doxorubicin, cyclophosphamide, vincristine, and prednisone	non-Hodgkin's lymphoma
Saltz	irinotecan, leucovorin, flourouracil	colon/rectal
Stanford V	doxorubicin, bleomycin, vinblastin, etoposide mechlorethamine, vincristine, prednisone	Hodgkin's lymphoma

maintenance intravenous fluids containing sodium bicarbonate are administered prior to and concurrently with the methotrexate infusion.

Epoetin (Procrit) is a synthetic version of erythropoietin that stimulates the bone marrow to produce red blood cells. It is used following chemotherapy in clients whose red blood cell count drops so significantly that tissue perfusion is altered. It is administered parenterally (either intravenous or subcutaneous injection) and the usual dose is 50–100 units/kilogram of body weight three times a week until the red blood cell count reaches a level sufficient to maintain tissue perfusion.

APPLYING THE NURSING PROCESS

Many factors influence the nursing care given to an individual with cancer. Examples of these factors are the nature, location, duration, and severity of the disease and the type of treatment. In addition to these factors, one must consider the personal and social characteristics of the client. It is possible, however, to identify some common nursing needs of cancer clients who are receiving chemotherapy. Specific nursing activities related to clients receiving a particular drug are found in Table 39–4.

ASSESSMENT

A thorough nursing assessment must be conducted on all clients scheduled to receive chemotherapy for the treatment of malignancy. The health history should focus on recent changes in weight, nutrition, activity tolerance, bowel habits, and prior treatment for cancer. The nurse also obtains information on the client's feelings about the illness and attitudes about chemotherapy.

A thorough physical assessment includes measuring vital signs, body height, and weight, as the dosage of many antineoplastics is based on body surface area. A general review of body systems is conducted. Special attention is given to information about the fastest growing cells, as they are most likely to show the effects of drug toxicity. This means the nurse carefully assesses the gastrointestinal tract, especially the integrity of the oral mucous membranes; the amount, quality, and distribution of body hair; and the functioning of bone marrow. Laboratory tests are generally ordered to assess the functioning of bone marrow before treatment and periodically thereafter. These tests include complete blood count (CBC), with differential and platelet count. Urinalysis and often renal function tests are ordered to assess the effectiveness of kidney functioning and to determine if hematuria is present. Electrolyte studies provide information on fluid and electrolyte balance. Some drugs are toxic to the heart and cardiac functioning is assessed by electrocardiogram before treatment is started.

It is also important to determine if female clients are pregnant, as the drugs that will be administered have been associated with fetal loss and abnormality. Finally, it is important to determine the client's social supports. Many courses of chemotherapy are given at home or in outpatient settings and clients will need transportation to the treatment site or someone to help them administer and monitor drug therapy in the home.

Nurses are very involved in selecting clients who will receive chemotherapy at home. An assessment must be made of the clients' ability to manage self-care. This may involve a home visit to assess the safety of the home environment, for example, that adequate refrigeration for medications and solutions is available. The nurse also assesses the clients' cognitive skills, adaptation to the illness and its treatment, personal hygiene and concepts about cleanliness, vision, and coordination. All of these factors, along with the clients' financial status, influence whether clients are selected for ambulatory treatment programs.

NURSING DIAGNOSES

Including but not limited to:

- Risk for injury, infection related to bone marrow suppression secondary to chemotherapy
- Risk for injury, bleeding related to bone marrow suppression secondary to chemotherapy
- Risk for ineffective tissue perfusion related to bone marrow suppression secondary to chemotherapy
- Imbalanced nutrition, less than body requirements related to anorexia secondary to chemotherapy
- Chronic pain related to disease process, adverse effects of chemotherapy
- Disturbed body image related to alopecia secondary to chemotherapy
- Deficient fluid volume related to nausea and vomiting secondary to chemotherapy
- Risk for injury related to adverse effects of chemotherapy
- Anticipatory grieving related to disease process and diagnosis of cancer
- Deficient knowledge related to health alteration and chemotherapy regimen

TABLE 39–4

Commonly Used Anticancer Drugs

Note: Because many anticancer drugs affect rapidly growing cells, the nurse must routinely assess the integrity of these cells, especially mucous membranes. Routine inspection of the oral cavity is important. Routine mouth care may decrease the likelihood of developing stomatitis. Also note evidence of gastrointestinal upset.

If the drug depresses bone marrow myelosuppressions, observe the client for bleeding, especially from the nose or skin. These structures are also checked for infection.

If anticoagulants must be used, monitor their use carefully. Also monitor clients for the development of skin rashes or alopecia. Alopecia may be minimized through the use of scalp hypothermia or by applying a tourniquet around the head during drug administration.

Intake and output is recorded on all clients receiving parenteral therapy. Cell destruction may result in a high serum uric acid level. Force fluids to prevent deposition of urates in the kidneys.

If nausea becomes a persistent problem, give an antiemetic before administering the anticancer drug. As these drugs are toxic, it is important to prevent or to promptly treat any extravasation of the drug into body tissues. Protect client from sources of infection.

Contraceptive measures are recommended during therapy, because of abortion and anomaly risks.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
Alkylating Agents				
busulfan *(byou-**SUL**-fan)* (Myleran)	oral, IV	4–8 mg daily IV: 0.8 mg/kg every 6 hours for 4 days	bone marrow depression, nausea, vomiting, and pulmonary fibrosis	If nausea or vomiting occurs, administer drug on an empty stomach. Monitor for signs of hematological changes. Administer 2,500–3,000 mL of fluid daily. Persistent cough and dyspnea may indicate drug toxicity. Premedicate with phenytoin.
carboplatin *(**kar**-boh-**PLAH**-tin)* (Paraplatin)	IV infusion	up to 360 mg/m^2 on day 1 every 4 weeks	bone marrow depression, hearing loss, nausea and vomiting, electrolyte loss, hemolytic anemia	Monitor for signs of hematological changes. Drug may lose potency if it comes in contact with aluminum. Avoid use of needles or IV sets containing aluminum parts. Discard drug solutions 8 hours after dilution. Anaphylactic-like reaction may occur within minutes of administration. Have epinephrine, corticosteroids, and antihistamines readily available. Platelet count must be above 100,000/mm^3 and neutrophils must be greater than 2,000/mm^3 before using carboplatin.
carmustine, BCNU *(kar-**MUS**-teen)* (BiCNU)	IV infusion	150–200 mg/m^2 every 6 weeks	bone marrow depression, nausea and vomiting, burning and phlebitis at injection site, transient flushing of the skin	Monitor for signs of hematological changes. Administer dose over a 1–2 hour period to minimize local irritation and pain. Accidental contact of drug solution with skin may cause hyperpigmentation. Wash thoroughly after contact. Decomposition of powder is indicated by liquid or oily appearance. Discard if this is evident.

continues

TABLE 39–4 ***continued***

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
carmustine, BCNU *(continued)*				Refrigerate before and after drug has been reconstituted. Monitor client for cough, shortness of breath. Periodic chest X rays and pulmonary function tests should be obtained.
chlorambucil *(klor-**AM**-byou-sill)* (Leukeran)	oral	0.1–0.2 mg/kg/day	bone marrow depression, seizures, nausea and vomiting, skin rash, hair loss	Monitor for signs of hematological changes. Administer 2,500–3,000 mL of fluid daily. Monitor for infection.
cisplatin *(**SIS**-plah-tin)* (Platinol, Platinol-AQ)	IV	20–100 mg/m^2/day (schedule depends on type of cancer)	anaphylactic reactions, renal damage, nausea and vomiting, ototoxicity, bone marrow depression, neurotoxicity	Avoid contact of drug with needles or IV sets containing aluminum. Avoid contact of drug with skin. Monitor client for development of renal damage, bone marrow depression, ototoxicity, or hypersensitivity reaction. Produces severe nausea and vomiting especially when given by IV push. Protect infusion solution from excessive light. Observe client for convulsions. Give 1–2 liters of fluid prior to administration. Store reconstituted drug at room temperature. Do not refrigerate. Reconstituted solution is stable for 20 hours at room temperature.
cyclophosphamide *(**sigh**-kloh-**FOS**-fah-myd)* (Cytoxan, Neosar, Procytox ✱)	oral, IV	Oral: 1–5 mg/kg/day IV: 10–15 mg/kg every 7–10 days or 3–5 mg/kg twice weekly	nausea and vomiting, bone marrow depression, hemorrhagic cystitis, alopecia, hypersensitivity, blurred vision	Provide adequate daily fluid intake to avoid hemorrhagic cystitis. Monitor client for signs of hematological changes. Drug is potentially teratogenic. Avoid pregnancy during treatment and for 4 months after. Administer in the morning so that the kidneys can eliminate it by bedtime.
ifosfamide *(eye-**FOS**-fah-myd)* (IFEX)	IV	1.2 g/m^2/day for 5 consecutive days	bone marrow depression, hemorrhagic cystitis, cardiac toxicity, hair loss, nausea and vomiting	Monitor client for signs of hematological changes. Determine whether hematuria is present prior to each dose. If present, withhold subsequent administration. Provide at least 3 liters of oral or IV fluid daily during therapy.
lomustine, CCNU *(loh-**MUS**-teen)* (CeeNu)	oral	130 mg/m^2 every 6 weeks	nausea and vomiting, bone marrow depression, hair loss, pulmonary fibrosis	Administer on empty stomach to reduce nausea. Monitor client for signs of hematological changes. Changes may take 4–6 weeks to develop.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
mechlorethamine HCl, nitrogen mustard *(**meh**-klor-**ETH**-ah-meen **hy**-droh-**KLOR**-eyed, **NIGH**-troh-jen **MUS**-tard)* (Mustargen)	IV, intracavity	0.4 mg/kg in 1–4 divided doses	bone marrow depression, nausea and vomiting, irritation at injection site, alopecia, phebitis, diarrhea	Monitor client for signs of hematological changes. Avoid contact of drug with skin. Wash thoroughly if contact occurs. Treat extravasation with cold compresses for 6–12 hours and by infiltrating area with sterile isotonic sodium thiosulfate solution (⅙ molar). When drug is given by intracavity method, turn client from side to side every 30–60 minutes or as ordered to distribute the drug. Prepare solution immediately before use. Administer antiemetic, ondansetron or dolasetron mesylate, prior to administration and for ondansetron continue to administer every 4 hours after first dose for 24 hours.
melphalan, PAM, L-PAM, phenylalanine mustard *(**MEL**-fah-lan, **fen**-ill-**AL**-ah-nine **MUS**-tard)* (Alkeran)	oral	2–10 mg daily (0.15 mg/kg/day) for 7 days	bone marrow depression, nausea and vomiting, skin rash	Monitor client for signs of hematological changes. Administer 2,500–3,000 mL of fluid daily. Protect tablets from light and store in a glass container.
pipobroman *(**py**-poh-**BROH**-man)* (Vercyte)	oral	0.1–2.5 mg/kg/day	bone marrow depression, nausea and vomiting, diarrhea, skin rash	Monitor client for signs of hematological changes. Administer antiemetic.
streptozocin *(**strep**-toh-**ZOH**-sin)* (Zanosar)	IV	500–1,000 mg/m^2	nausea and vomiting, renal toxicity, altered glucose tolerance, diarrhea	Monitor renal, hepatic, and hematological changes. Avoid contact of drug with skin. Wash thoroughly if contact occurs. Refrigerate unopened vials and protect from light.
thiotepa triethylenethiophosphoramide *(**thigh**-oh-**TEE**-pah try-**eth**-ill-een-**thigh**-oh-fos-**FOR**-ah-myd)* (TSPA, TESPA)	IV, intratumor, intracavity	IV: 0.3–0.4 mg/kg Intratumor or intracavity: 0.6–0.8 mg/kg	bone marrow depression, nausea and vomiting, pain at injection site, amenorrhea, skin rash	Monitor client for signs of hematological changes. Refrigerate drug powder and reconstituted solution. Female clients may experience amenorrhea. When given by intracavity method, to distribute drug, turn client from side to side every ½ to 1 hour or as ordered. Provide diligent mouth care with mouth rinses. Monitor CNS status. Monitor respiratory status.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
uracil mustard *(**YOU**-rah-sill **MUS**-tard)*	oral	*Adults:* 0.15 mg/kg/week for 4 weeks *Children:* 0.30 mg/kg/week for 4 weeks	bone marrow depression, hyperuricemia, nausea and vomiting, diarrhea, skin rash	Monitor client for signs of hematological changes. Provide adequate fluid intake. May be given at bedtime to reduce nausea.
Antibiotics				
bleomycin sulfate, BLM *(blee-oh-**MY**-sin **SUL**-fayt)* (Blenoxane)	IV, IM, SC	0.25–0.50 units/kg/day	pneumonitis, pulmonary fibrosis, cutaneous reactions, nausea and vomiting, fever	Monitor client for development of pulmonary toxicity. When drug is administered to lymphoma clients, monitor for development of anaphylactic-like reaction after first or second administration. Powder should be stored in refrigerator. Reconstituted solution is stable for 24 hours at room temperature. Assess the client's skin for scaliness, blisters, and pustules.
dactinomycin, actinomycin D, ACT *(**dack**-tih-noh-**MY**-sin, **ack**-tih-noh-**MY**-sin)* (Cosmegen)	IV	*Adults:* up to 15 mcg/kg/day for 5 days *Children:* 15 mcg/kg/day for 5 days	bone marrow depression, stomatitis, oral ulceration, nausea and vomiting, alopecia, irritation at injection site, esophagitis	Monitor client for bone marrow depression. Avoid leakage of drug solution into surrounding tissue during injection. Use only sterile water without preservatives for reconstitution. Protect drug from light. Monitor client for abdominal pain and tarry stools. Severe esophagitis may require opiate therapy during acute phase.
daunorubicin HCl, DNR *(**daw**-noh-**ROO**-bih-sin **hy**-droh-**KLOR**-eyed)* (Cerubidine)	IV	30–60 mg/m^2/day	bone marrow depression, cardiac toxicity, alopecia, nausea and vomiting, irritation at injection site	Monitor for bone marrow depression and cardiotoxicity, particularly congestive heart failure. Avoid leakage of drug solution into surrounding tissue during injection. May produce red urine for 1–2 days, but this is not hematuria. May keep reconstituted refrigerated solution for 48 hours. Do not mix with heparin or other drugs. Sodium bicarbonate oral rinses every 4 hours and prn.
doxorubicin HCl, ADR *(**dock**-soh-**ROO**-bih-sin **hy**-droh-**KLOR**-eyed)* (Adriamycin, Rubex)	IV	20–75 mg/m^2	bone marrow depression, cardiac toxicity, nausea and vomiting, alopecia, irritation at injection site	Monitor for development of bone marrow depression and cardiotoxicity. Avoid leakage of drug solution into surrounding tissue during injection. May produce red urine for 1–2 days, but this is not hematuria. Observe for changes in nailbeds of fingers and toes. Refrigerated, reconstituted solution is stable for 48 hours.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
idarubicin HCl *(**eye**-dah-**ROO**-bih-sin **hy**-droh-**KLOR**-eyed)* (Idamycin)	IV	12 mg/m^2 daily for 3 days	bone marrow depression, infection, nausea and vomiting, hair loss, diarrhea, hemorrhage	Monitor for development of bone marrow depression. Administer slowly into tubing of freely running IV infusion. Refrigerated reconstituted solutions are stable for 7 days.
mitomycin, mitomycin-C, MTC *(**my**-toh-**MY**-sin)* (Mutamycin)	IV	10–20 mg/m^2	bone marrow depression, nausea and vomiting, irritation at injection site	Monitor for development of bone marrow depression. Avoid leakage of drug solution into surrounding tissue during injection. Treat extravasation promptly with ice packs. Reconstituted solution may be kept for 2 weeks in the refrigerator or 1 week at room temperature.
mitoxantrone HCl *(**my**-toh-**ZAN**-trohn **hy**-droh-**KLOR**-eyed)* (Novantrone)	IV	10–12 mg/m^2/day for 5 days	bone marrow depression, nausea and vomiting, diarrhea, stomatitis, systemic infection, alopecia	Monitor for development of bone marrow depression. Do not mix with other drugs. May produce blue-green discoloration of urine and/or sclera for 24 hours after administration.
pentostatin *(pehn-toh-**STAT**-in)* (Nipent)	IV	4 mg/m^2/every other week	bone marrow depression, nausea and vomiting, fever	500–1,000 mL of 5% dextrose in half-normal saline should be administered to client before drug is administered. An additional 500 mL should be administered after the drug has been given. Unopened drug vials should be stored in refrigerator.
plicamycin, mithramycin *(**ply**-kah-**MY**-sin, **mith**-rah-**MY**-sin)* (Mithracin)	IV	25–30 mcg/kg/day for 8–10 days	bone marrow depression, nausea and vomiting, diarrhea, hepatic damage, irritation at injection site	Monitor for development of bone marrow depression and bleeding. Avoid leakage of drug solution into surrounding tissue during injection. Promptly treat extravasation with ice packs. Monitor for drop in serum calcium level, including muscle cramps and carpopedal spasms. Refrigerate unreconstituted vials of drug.
valrubicin *(val-**ROOB**-ih-sin)* (Valstar)	instilled into the urinary bladder (intravesically)	800 mg in 75 ml of solution once a week for 6 weeks	Urinary frequency, dysuria, urgency, hematuria, cystitis, bladder pain	Used for those clients with bladder carcinoma in situ who are not immediate candidates for cystectomy, which is the treatment of choice.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
Antimetabolites				
capecitabine *(cap-eh-**SIT**-ah-bean)* (Xeloda)	oral	2,500 mg/m^2/day in 2 divided doses for 2 weeks	diarrhea, bone marrow suppression-leukopenia, nausea and vomiting	Administer after meals 12 hours apart. Tablets should be swallowed with water. Monitor for toxicity. If client is taking antacids containing either aluminum or magnesium, may experience elevated capecitabine serum level.
cytarabine, cytosine arabinoside, ARA-C *(sigh-**TAY**-rah-been, **SIGH**-toh-seen air-ah-**BIN**-oh-syd)* (Cytosar-U)	IV, SC, intrathecal	100–200 mg/m^2/day for 5 days	bone marrow depression, nausea and vomiting, hyperuricemia, diarrhea, fever, rash	Monitor client for signs of hematological changes. High doses are best administered by rapid IV injection. Force fluids (2,500–3,000 mL daily). Allopurinol may be used to inhibit formation of uric acid. Reconstituted solution may be kept at room temperature for 48 hours. Discard solution if a haze develops. Monitor neurological status every day with high doses. Although most neuro symptoms are reversible, some have been fatal. Decadron eye drops used prophylactically for eye problems.
floxuridine *(flocks-**YOUR**-ih-deen)* (FUDR)	intra-arterial	0.1–0.6 mg/kg/day	bone marrow depression, nausea and vomiting, oral and GI ulceration, diarrhea, alopecia	Monitor client for signs of hematological changes. Floxuridine is converted to 5-fluorouracil in body. Drug is best administered with infusion pump. May take up to 6 weeks for improvement to be noted. Refrigerated solution may be kept for up to 2 weeks. Frequently check intra-arterial line for blockage or leakage. If precipitate forms, heat solution to 60°C with vigorous shaking. Cool to body temperature before administering.
fludarabine phosphate *(floo-**DAIR**-ah-been **FOS**-fayt)* (Fludara)	IV	25 mg/m^2 daily for 5 days	bone marrow depression, fever, chills, infection, pain, nausea and vomiting, diarrhea, fatigue	Store drug powder under refrigeration. Use reconstituted solution within 8 hours.
fluorouracil, 5-fluorouracil, 5-FU *(**floo**-roh-**YOU**-rah-sill)* (Adrucil)	IV	6–12 mg/kg/daily	See floxuridine	See floxuridine. Do not refrigerate. Protect solution from light.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
hydroxyurea *(hi-**DROCK**-e-your-e-ah)* (Hydrea)	oral	20–80 mg/kg/dose	bone marrow suppression	Assess for infection and bleeding. Assess for dyspnea and fatigue.
mercaptopurine, 6-mercaptopurine, 6-MP *(mer-**kap**-toh-**PYOU**-reen)* (Purinethol)	oral	1.5–2.5 mg/kg/day	bone marrow depression, nausea and vomiting, hyperuricemia, diarrhea	Monitor client for signs of hematological changes. Give 2,500–3,000 mL of fluid daily. Give ⅓ to ¼ of usual mercaptopurine dosage if client is also receiving allopurinol. Monitor liver function.
methotrexate, amethopterin, MTX *(**meth**-oh-**TRECK**-sayt, ah-meth-**OP**-ter-in)* (Folex)	oral, IM, IV, intra-arterial, intrathecal	10–30 mg IV: 20–500 mg/m^2	ulcerative stomatitis, nausea and vomiting, bone marrow depression, diarrhea	Leucovorin (citrovorum factor) is used to neutralize the toxic effects of methotrexate on the hematological system. Avoid use with nonsteroidal, anti-inflammatory drugs (NSAIDS). Also indicated for use in the treatment of rheumatoid arthritis and psoriasis. Sunscreen should be used to protect skin exposed to sunlight. Because of abortion and anomaly risks, client should avoid conception during and immediately following treatment.
thioguanine, 6-thioguanine, TG *(**thigh**-oh-**GWAH**-neen)* (Lanvis ✱)	oral	2–3 mg/kg/day	bone marrow depression, nausea and vomiting, stomatitis, hyperuricemia	Monitor client for signs of hematological changes and hepatotoxicity. Give 2,500–3,000 mL of fluid daily.
Biologic Response Modifiers				
aldesleukin *(ahl-dess-**LYOU**-kin)* (Proleukin)	IV	600,000 IU/kg every 8 hours for 5-day treatments	hypotension, bone marrow depression, nausea and vomiting	Monitor hematological status of client. Store unreconstituted and reconstituted drug vials in refrigerator. Monitor central venous catheter.
interferon alfa-2a *(in-ter-**FEAR**-on **AL**-fah-2a)* (Roferon-A)	SC, IM	3–36 million IU	flu-like syndrome, anorexia, nausea and vomiting, diarrhea, dizziness, coughing, weight loss	Client should be kept well hydrated. Refrigerate product. Subcutaneous route is recommended in clients who are thrombocytopenic. Monitor vital signs.
interferon alfa-2b *(in-ter-**FEAR**-on **AL**-fah-2b)* (Intron A)	SC, IM	1–30 million IU/m^2 3 times weekly	flu-like syndrome, dizziness, nausea, diarrhea, rash	Refrigerate product. Client should be kept well hydrated. Monitor CBC.
interferon alfa-n3 *(inter-**FEAR**-on **AL**-fah-n3)* (Alferon N)	intralesional	250,000 IU per wart	fever, chills, myalgias, dizziness, fatigue	Refrigerate drug solution. Dose is injected into base of each wart using a 30-gauge needle. Observe client for possible hypersensitivity reaction.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
levamisole HCl *(lee-**VAM**-ih-sohl **hy**-droh-**KLOR**-eyed)* (Ergamisol)	oral	50 mg orally every 8 hours for 3 days	dermatitis, nausea, diarrhea, fatigue	Disulfiram reaction may occur if drug is used with alcohol. Commonly used in combination with fluorouracil.
Hormones				
Androgens				
fluoxymesterone *(floo-**ock**-see-**MES**-ter-ohn)* (Halotestin, Android-F, etc.)	oral	10–40 mg daily in divided doses	fluid retention, nausea and vomiting, alopecia, acne	Monitor client for development of edema or jaundice. May result in masculinizing effects in women (deepening of voice, acne, etc.) Encourage client to wear wig, scarf, or cap. Monitor fluid intake; decrease salt intake. Monitor lab values.
testolactone *(**tes**-toh-**LACK**-tohn)* (Teslac)	oral	250 mg 4 times daily	fluid retention, nausea and vomiting, renal failure	See fluoxymesterone.
Antiandrogens				
bicalutamide *(bye-kal-**YOU**-tah-mide)* (Casodex)	oral	50 mg daily	diarrhea, constipation, hot flashes, bleeding, infection, anemia	Monitor CBC. Assess for changes in bowel habits. Monitor PSA. Monitor liver function.
flutamide *(**FLOO**-tah-myd)* (Euflex, Eulexin)	oral	250 mg 3 times daily at 8 hour intervals	hot flashes, loss of libido, impotence, diarrhea, nausea and vomiting	Monitor liver function in clients receiving long-term therapy.
nilutamide *(nye-**LOOT**-ah-mide)* (Anandron, Nilandron)	oral	300 mg once daily for 30 days.	hepatotoxicity, dizziness, elevated blood pressure, visual difficulty adapting to darkness.	Monitor chest X ray. Monitor for dyspnea. May increase blood glucose levels. BUN, creatinine.
Progestins				
medroxyprogesterone acetate *(meh-**drock**-see-proh-**JES**-teh-rohn **AH**-sih-tayt)* (Depo-Provera)	IM	400–1,000 mg/week	fluid retention, pain at injection site, thromboembolism, nausea and vomiting	Administer as deep IM injection.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
megestrol acetate *(meh-**JES**-trohl **AH**-sih-tayt)* (Megace, etc.)	oral	40–320 mg daily in divided doses	fluid retention, alopecia, nausea and vomiting, diarrhea, constipation, vaginal bleeding, hypercalcemia	Continuous therapy is generally required for 2 months before efficacy of drug can be established. Use cautiously in clients with history of thrombophlebitis. Assess bleeding. Monitor CBC. Monitor intake and output, weight gain. Restrict fluids as needed. Monitor calcium levels.
Estrogens				
diethylstilbestrol diphosphate *(dye-**eth**-ill-still-**BES**-trohl dye-**FOS**-fayt)* (Stilphostrol)	oral, IV	Oral: 50–200 mg 3 times daily IV: 250–1,000 mg	fluid retention, nausea and vomiting, headache, decreased glucose tolerance, gynecomastia in men, breakthrough uterine bleeding	Monitor client for development of thrombotic disorders or vision changes. After reconstitution, drug solution is stable for 5 days at room temperature. Monitor stools, intake and output, nutrition. Monitor for edema and weight gain. Give emotional support to men experiencing gynecomastia. Assess for deep vein thrombosis (DVT)—calf pain, red streak, heat. Assess neurological status. Report vaginal bleeding to physician.
estramustine phosphate sodium *(**es**-trah-**MUS**-teen **FOS**-fayt **SOH**-dee-um)* (Emcyt)	oral	10–16 mg/kg/day in 3–4 divided doses for up to 3 years	fluid retention, nausea and vomiting, diarrhea, skin rash, decreased glucose tolerance	Product acts as an estrogen and an alkylating agent. Monitor for development of thrombotic disorders or elevated blood pressure. Store drug in refrigerator.
polyestradiol phosphate *(**pol**-ee-**es**-trah-**DYE**-ohl **FOS**-fayt)* (Estradurin)	IM	40–80 mg every 2–4 weeks	See diethylstilbestrol diphosphate	See diethylstilbestrol diphosphate. Administer as deep IM injection.
Antiestrogens				
goserelin implant *(**GOE**-see-rel-lin)* (Zoladex)	subcutaneous	3.6 mg q28days	headaches, spinal cord compression, depression, CVA, breakthrough bleeding	Monitor intake and output. Palpate bladder for distention. Monitor for bleeding. Assess for decreased bone pain.
letrozole *(**LET**-tro-zohl)* (Femara)	oral	2.5 mg daily	nausea, vomiting, diarrhea, anorexia, hepatotoxicity	Monitor renal function. Monitor for infection. Monitor liver function. Monitor for hematologic disorders.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
tamoxifen *(tah-**MOCK**-sih-fen)* (Nolvadex, Tamofen ✱)	oral	10–20 mg twice daily in the morning and evening	bone marrow suppression, nausea and vomiting, hot flashes, ocular changes, hypercalcemia, depression	Monitor client for development of hematological changes. Monitor intake and output, weight gain, vaginal bleeding. Administer mild analgesics. Assess for infection, shortness of breath, fatigue. Monitor lab values.
toremifene citrate *(tor-**EM**-ih-feen)* (Fareston)	oral	60 mg daily	thrombocytopenia, leukopenia, nausea, vomiting, hot flashes	Monitor for bleeding. Monitor for infection. Withhold drug if WBC is $<3,500/mm^3$ or platelet count is $<100,000/mm^3$. Give drug after evening meal.
Gonadotropin-Releasing Hormone Analog				
leuprolide acetate *(loo-**PROH**-lyd **AH**-sih-tayt)* (Lupron)	SC, IM	1 mg/day SC 7.5 mg IM monthly as depot injection	hot flashes, peripheral edema, nausea and vomiting, headache	Only syringes provided with product or low-dose insulin syringes should be used with injection. For depot injection do not use needles smaller than 22 gauge. Reconstitute depot injection only with diluent provided.
Corticosteroids				
dexamethasone *(decks-ah-**METH**-zone)* (Decadron)	oral, IM, IV	0.5–24 mg daily	Infection, gastric irritation, may increase insulin needs in clients with diabetes, fluid retention, edema	Avoid administering IV bolus to children, as it causes rectal itching and burning. May be used as an antiemetic premedication for emesis-inducing chemotherapy. Monitor for infection. Monitor intake and output, weight.
prednisone *(**PRED**-nih-sohn)*	oral	40–60 mg/m^2/day	sodium and fluid retention, ocular changes, GI upset (see Chapter 12)	Administer with food to reduce GI upset. Monitor client for development of edema, ocular changes or GI ulceration. Check blood pressure frequently. Protect client from bruising. May produce osteoporosis. Monitor for hyperglycemia. May cause insomnia if taken late in evening. Monitor for infection.
Miscellaneous Antineoplastic Agents				
altretamine *(al-**TRET**-ah-meen)* (Hexalen)	oral	200–260 mg/m^2/day in 4 divided doses after meals and at bedtime	nausea and vomiting, peripheral neuropathy, anemia, bone marrow suppression	Drug is administered either for 14 or 21 days in a 28-day cycle.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
anastrozole *(an-a-**STROH**-zole)* (Arimidex)	oral	1 mg daily	weight gain, fatigue, bone marrow suppression, headache, hot flashes	Monitor intake and output, weight, edema. Medicate for headache and back pain. Monitor CBC for infection.
asparaginase *(as-**PAR**-ah-jin-ays)* (Elspar, Kidrolase 🍁)	IV, IM	200–1,000 IU/kg/day	hypersensitivity reactions, hepatotoxicity, nausea and vomiting, fever, hyperglycemia	Monitor for development of hypersensitivity reaction. An intradermal skin test with the drug should be performed prior to initial administration. IM injections are limited to 2 mL per site. Force fluids to 3,000–4,000 mL daily. Monitor for development of hyperglycemia. Reconstituted solution may be kept for 8 hours if refrigerated. Discard sooner if solution is cloudy.
BCG, Bacillus Calmette, and Guérin (TheraCys, TICE BCG)	intravesical	50–81 mg, instilled into bladder in 50 mL of preservative-free saline	dysuria, urinary frequency, hematuria, fever	Product contains bacteria that can induce an inflammatory response in the bladder. Monitor client for development of cough. Clients should sit while voiding following drug administration.
cladribine *(**KLAHD**-rih-been)* (Levstatin)	IV	0.01 mg/kg/day	bone marrow depression, fever, fatigue, nausea, headache, infection	Monitor hematological system. Store unopened drug vials in refrigerator.
dacarbazine, DTIC, imidazole carboxamide *(dah-**KAR**-bah-zeen, **im**-id-**AZ**-ohl kar-**BOCK**-sah-myd)* (DTIC-Dome)	IV	150–375 mg/m^2 daily	bone marrow depression, hepatotoxicity, anorexia, nausea and vomiting, alopecia, pain at injection site	Monitor client for development of bone marrow depression, liver toxicity, and hypersensitivity reaction. Avoid leakage of drug solution into surrounding tissue during administration. Reconstituted refrigerated solution may be retained for 72 hours.
denileukin diftitox *(den-ill-**LU**-kin diff-tie-tox)* (Ontak)	IV	9–18 mcg/kg/day	Flulike symptoms, hypersensitivity reaction, nausea and vomiting	Monitor blood pressure, weight, and edema. If infusion-related reactions occur, slow or stop infusion. Never IV bolus this medication. Don't use in-line filter or mix infusion with other medications.
flutamide *(**FLU**-tah-mide)* (Eulexin)	oral	250 mg every 8 hours for total daily dose of 750 mg	nausea, vomiting, anemia, thrombocytopenia, leukopenia, gynecomastia	Monitor for bleeding, infection, anemia. Provide emotional support.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
paclitaxel *(pack-lih-**TAX**-el)* (Taxol)	IV	135–175 mg/m^2 every 3 weeks	bone marrow depression, hypersensitivity reaction, peripheral neuropathy	Clients should be premedicated with corticosteroids, antihistamines, and H_2-receptor antagonists before paclitaxel administration to prevent severe hypersensitivity reactions.
pegaspargase *(peg-**ASS**-pahr-gays)* (Oncaspar)	IM, IV	2,500 IU/m^2 every 14 days	hypersensitivity, pancreatitis, seizures, bleeding	Monitor client for hypersensitivity reactions and bleeding. Do not shake drug solution. Keep drug vials refrigerated.
portimer sodium *(**POR**-tih-mer)* (Photofrin)	IV, slow push	2 mg/kg/dose	photosensitivity, pleural effusion, constipation, nausea and vomiting, chest pain, atrial fibrillation, back pain, pharyngitis	Instruct client to avoid direct sunlight and bright indoor lighting for 1 month after infusion. Monitor cardiac status. Monitor breath sounds, oxygen saturation.
procarbazine HCl, N-methylhydrazine, MIH *(proh-**KAR**-bah-zeen **hy**-droh-**KLOR**-eyed)* (Matulane, Natulan ✱)	oral	1–6 mg/kg/day	bone marrow depression, nausea and vomiting, dermatitis, CNS depression	Avoid the use of alcohol and tyramine-rich foods. Monitor client for development of bone marrow depression. Advise client to avoid prolonged exposure to sunlight since photosensitivity reaction may occur. Use sunscreen to protect exposed skin.
rituximab *(rih-**TUX**-ih-mob)* (Rituxan)	IV	375 mg/M^2	hypersensitivity, tumor lysis syndrome (TLS), bone marrow suppression, infections	This drug is the first of its class of recombinant monoclonal antibody. Premedicate with acetaminophen and diphenhydramine. Monitor CBC. Monitor for TLS.
tretinon *(**TRET**-tih-non)* (Retin-A)	oral	45 mg/M^2/day until remission is accomplished	rash, nausea and vomiting, hemorrhage, diarrhea	Assess liver function. Assess coagulation. Monitor cholesterol and triglycerides. Store at room temperature.
Mitotic Inhibitors				
etoposide, VP-16-213 *(ee-**TOH**-poh-side)* (VePesid)	oral, IV	35–100 mg/m^2/day	bone marrow depression, nausea and vomiting, anorexia, diarrhea, fatigue, hypotension	Monitor clients for signs of hematological changes. Do not administer by IV push. Capsules should be kept refrigerated. Assess respiratory status for dyspnea and wheezing. Monitor liver function. Monitor vital signs.

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
teniposide *(tehn-**IH**-poh-side)* (Vumon)	IV	165 mg/m^2 in combination twice weekly for 4–4½ weeks	bone marrow depression, mucositis, diarrhea, nausea and vomiting	Must be administered by IV infusion over 30–60 minutes or longer. Hypotension may occur with rapid administration. Unopened ampules containing drug should be stored in refrigerator. Usually used in combination with cytarabine 300 mg/m^2.
vinblastine sulfate, VLB *(vin-**BLAS**-tin **SUL**-fayt)* (Velban, Velbe ✱, Velsar, etc.)	IV	*Adults:* 3.7–11.1 mg/m^2 *Children:* 2.5–7.5 mg/m^2	bone marrow depression, nausea and vomiting, alopecia, irritation at injection site, neurotoxicity, constipation, vesicant extravasation	Monitor client for signs of hematological changes. Avoid leakage of drug solution into surrounding tissue during injection. Stool softeners may be useful in preventing constipation. Stop infusion if extravasation occurs and promptly administer local injection of hyaluronidase and apply moderate heat to area. Reconstituted refrigerated solution may be kept for 30 days. Refrigerate unopened vials. Assess for jaw pain, numbness, tingling, loss of deep tendon reflexes. Force fluids and encourage fiber in diet to help offset constipation.
vincristine sulfate, VCR *(vin-**KRIS**-tin **SUL**-fayt)* (Oncovin, Vincasar PFS)	IV	*Adults:* 1.4 mg/m^2 *Children:* 2.0 mg/m^2	peripheral neuropathy, alopecia, irritation at injection site	Avoid leakage of drug solution into surrounding tissue during injection. Monitor client for development of neuromuscular changes. Do not mix with anything but normal saline or glucose in water. Stool softeners may be useful in preventing constipation. Reconstituted refrigerated solution may be kept for 2 weeks. See vinblastine.
vinorelbine tartrate *(vihn-ohr-**ELL**-been tahr-trayt)* (Navelbine)	IV	15–30 mg/m^2	bone marrow depression, nausea and vomiting, constipation, asthenia	Monitor client for hematological changes. Avoid leakage of solution into surrounding tissue during administration. Unopened vials of drugs should be kept refrigerated and protected from light. See vinblastine.
Radioactive Drugs				
chromic phosphate, P 32 *(**KROH**-mick **FOS**-fayt)* (Phosphocol P 32)	intracavity, interstitial	Intracavity: 6–20 mCi* Interstitial: 0.1–0.5 mCi*/g of estimated weight of tumor	radiation sickness, bone marrow depression	Monitor hematological status of client. Take appropriate precautions in caring for client and in handling drug to prevent contamination.

*milliCuries (mCi), a measure of radiation intensity

continues

TABLE 39–4 *continued*

See **Note** at beginning of Table 39–4, page 768.

DRUG	ROUTE(S)	USUAL DOSAGE RANGE	COMMON SIDE EFFECTS	NURSING IMPLICATIONS
sodium iodide, I 131 *(**SOH**-dee-um **EYE**-oh-dyd)* (Iodotope)	oral	50–150 mCi*	bone marrow depression, radiation sickness, sore throat, cough	See chromic phosphate P 32.
sodium phosphate, P 32 *(**SOH**-dee-um **FOS**-fayt)*	IV	1–15 mCi*	See chromic phosphate P 32	See chromic phosphate P 32.
strontium chloride, Sr 89 *(**STRAHN**-tee-um **KLOR**-eyed)* (Metastron)	IV	4 mCi*	bone marrow suppression	Bone pain may increase for 2–3 days beginning 2–3 days after administration. See chromic phosphate P32.
Topoisomerase 1 Inhibitors				
irinotecan HCl *(i-rin-o-**THE**-can)* (Camptosar)	IV	125 mg/M^2	bone marrow suppression, diarrhea, nausea and vomiting, alopecia, dehydration, stomatitis	Monitor for infection. Premedicate with antiemetics, such as ondansetron or granisetron at least 30 minutes prior to administration of irinotecan HCl. Monitor for bleeding. Monitor intake and output, weight, nutrition. Rinsing mouth with Magic Mouthwash should help stomatitis. Monitor for neurologic changes that could indicate potentially fatal complications.
topotecan *(top-**PO**-tee-can)* (Hycamtin)	IV	1.5 mg/M^2 daily for first 5 days of 21-day course	bone marrow suppression, nausea, alopecia, abdominal pain, anorexia, vomiting	Monitor for infection. Monitor for bleeding. Premedicate with antiemetic (see irinotecan). Monitor intake and output, weight, nutrition. Used for treatment of ovarian cancer.

*milliCuries (mCi), a measure of radiation intensity

PLANNING/GOALS

- Client will not experience infection.
- Client will not experience bleeding.
- Client will not experience reduced tissue perfusion as evidenced by skin color, skin temperature, brisk capillary refill.
- Client will maintain body weight within normal limits for height.
- Client will verbalize pain control at a level of 3–4/10.
- Client will verbalize acceptance of alopecia and demonstrate acceptance as evidenced by use wig, scarf, cap, etc.
- Client will maintain hydration as evidenced by balanced intake and output.
- Client will not experience adverse effects of chemotherapy or, if any occur, effects will be promptly treated.
- Client will effectively work through anticipatory grieving.
- Client will verbalize understanding of cancer and chemotherapy regimen.

KEY NURSING IMPLICATIONS 39–1

Assessment

1. The health history focuses on recent changes in weight, nutrition, activity tolerance, bowel habits, and prior treatment for cancer, as well as on the client's feelings about the illness and its treatment.
2. Physical assessment includes vital signs, height and weight, and a review of body systems. Special attention is given to the gastrointestinal tract; the nature, quality, and distribution of body hair; and bone marrow functioning.
3. Determine if the client is pregnant.
4. Assess the client's social supports.
5. A home visit may be necessary to determine if the client will be accepted into a home-care program.

IMPLEMENTATION

One common nursing diagnosis is deficient knowledge about the illness and its treatment. The client may have received an adequate explanation from the physician about the nature of the illness and its treatment, the reasons for using a particular drug or drug regimen, and the expected outcomes. Clients, however, are sometimes not able to benefit from such an explanation because of their emotional state or unfamiliarity with this type of therapy or the vocabulary used in the explanation. Therefore, for many clients, the nurse can provide simple reinforcement about the nature of the illness and its treatment, the expected therapeutic effects and possible adverse effects of drug therapy. The nurse can also provide information about the schedule of administration, special considerations regarding the route of administration, and ways in which the client can cooperate with the treatment plan. A number of sophisticated techniques are being used in the administration of chemotherapy, for example, tunneled catheters and implanted ports and pumps. The client and family may be unfamiliar with these technologies, why they are used, and what special care may be required. Explanation of the treatment is especially important if the client will be taking the medication at home. Detailed questions about drug therapy may be referred to the physician. Such clients should be provided with information about the person to call in case questions arise and when to notify someone about problems they may have. When the nurse is teaching a client about home treatment, possible problems should be anticipated and ways suggested to minimize them. For example, if the client will be taking corticosteroids, the nurse can tell the client that these may cause wakefulness if taken late in the evening. The nurse may also offer dietary guidance—for example, recommend what to do in case of nausea and provide information on the foods high in protein and vitamin C, as these can be expected to promote strength and healing.

An important goal of treatment is ensuring maximum therapeutic and minimal toxic effects from drug therapy. For this reason drugs may be administered locally or regionally, rather than systemically. The nurse can also contribute to this goal by becoming knowledgeable about the effects of the drugs being used and by maintaining an ongoing assessment of the client. Such an assessment is based on a knowledge of the particular drugs being used. Many anticancer drugs affect all rapidly growing cells in the body. Therefore, in observing for early signs and

symptoms of side effects, the nurse assesses the integrity of these cells, especially the mucous membranes of the mouth. Assessment of the integrity of the gastrointestinal tract is accomplished by observing the client for nausea, vomiting, diarrhea, anorexia, and/or blood in the stool or emesis. Because of the depressant effect of many of these drugs on the bone marrow, the nurse observes the client for bleeding, especially from the nose and skin. The nurse also observes for the possible development of infections. Skin and hair also contain rapidly growing cells and mirror the client's general state of health. The nurse therefore observes the client for alopecia and rashes.

Clients receiving intravenous **mechlorethamine** or **doxorubicin** and other antibiotics are observed for local tissue damage at the injection site. If extravasation of fluid occurs, the institution's procedure for treatment of extravasation is followed. This may include the administration of an antidote, steroids, or sodium bicarbonate. Cold compresses can be applied for 6 to 12 hours to decrease sloughing and necrosis, although some physicians prefer the use of warm compresses.

Evaluation of the client's emotional status is as important as physical assessment. Clients are observed for mood changes that may result from drug treatment, as well as changes that reflect concerns about their disease and its treatment. Such assessment is an essential basis for providing appropriate supportive care.

Alteration in comfort related to the disease process or its treatment is another common nursing diagnosis. Control of pain is very important, and the student is referred to Chapter 10 for a discussion of analgesic drugs and pain management.

The nurse follows the client's laboratory studies carefully and alerts the physician to significant changes in these tests. Several studies are of particular importance in clients receiving cancer chemotherapy. Depression of the bone marrow may occur following the administration of many anticancer drugs. The white blood cell (WBC) and platelet counts reflect this depression. A WBC count below 4,000/mm^3 (normal 5,000–10,000/mm^3) or platelet count below 200,000/mm^3 (normal 200,000–350,000/mm^3) should be brought to the physician's attention. Elevated uric acid levels may occur when many cells are destroyed by anticancer drugs. Elevations above 35 mg/100 mL (normal 8–25 mg/100 mL) should be reported. Finally, periodic blood glucose determinations are frequently ordered for clients receiving corticosteroid therapy, because steroids can cause an elevation of the blood glucose level (see Chapter 12 for a discussion of corticosteroids). A fasting or 2-hour postprandial blood sugar of more than 120 mg/dL (normal 80–120 mg/dL) should be reported to the physician.

Especially when methotrexate is used, the client's uric acid level needs to be monitored closely. Because methotrexate is excreted through the urine, clients receiving this agent usually are hydrated with intravenous fluids with sodium bicarbonate in 5% dextrose and water to neutralize and dilute the fluids and these antineoplastic agents in the bladder. In addition, leucovorin is ordered to be administered immediately following the infusion of methotrexate. An important nursing responsibility is to be sure the leucovorin doses to be infused following the initial dose are administered at the specific times indicated. Leucovorin is administered every 3 hours following the initial dose until the methotrexate serum blood level is less than 0.05 micromoles. The nurse should also monitor the client's urine pH to be sure it stays at 7 or above. If the pH drops, the sodium bicarbonate intravenous fluids should be increased and the methotrexate infusion held until the pH returns to the more alkaline level. These clients may also be placed on **allopurinol** (**Zyloprim**) to inhibit the formation of uric acid. (See Chapter 13 for an explanation of the actions of this drug.)

Another client need is the maintenance of fluid and electrolyte balance. Accurate measurement of intake and output is important, especially in clients receiving parenteral therapy and those with frequent periods of vomiting. It is important to force fluids to prevent deposition of urates in the kidneys. A high uric acid level may result from increased cell breakdown. Fluids should be offered to maintain a urine output of at least 2 liters per day. This may mean offering adults 3,000 mL of fluids a day, if such action does not endanger the client because of overhydration. Cardiac clients, clients with renal impairment, older clients, and children are particularly susceptible to overhydration. Forcing fluids is especially indicated in clients receiving

cyclophosphamide (Cytoxan) or ifosfamide (Ifex) to prevent hemorrhagic cystitis. Clients receiving these agents are usually placed on mesna as an adjunct medication. The initial dose of mesna is administered immediately following the infusion of these agents to "rescue" the bladder from the urotoxic metabolites of ifosfamide and cyclophosphamide. Mesna reacts chemically in the kidney with the metabolites of ifosfamide or cyclophophamide to detoxify them and, thus, inhibit hemorrhagic cystitis. An important nursing action is to be sure that the mesna is administered according to the standard protocol for its use. The nurse should also monitor the client's urine and report the presence of blood in the urine to the physician immediately.

Another nursing intervention concerned with maintaining fluid and electrolyte balance is the careful monitoring of intravenous infusions to ensure compliance with the administration schedule. As clients receiving corticosteroids may retain fluid, they should be weighed at the same time each day on the same scale. Also, blood pressure should be measured 2 times a day. If elevation of the blood pressure is noted, it is reported to the primary health care provider and measurement frequency is increased to 4 times a day.

Alteration in nutrition related to anorexia may occur. For these clients, it is important to offer foods that they enjoy frequently in small amounts. It is especially important to provide foods high in protein and vitamin C to encourage cellular growth and repair. In addition, because of the drain on body metabolism caused by the tumor cells and poor food intake, some clients may require vitamin and mineral supplements. This is especially true in clients experiencing nausea and vomiting. To encourage such clients to eat, an antiemetic such as ondansetron (Zofran), granisetron (Kytril), dolasetron mesylate (**Anzemet**), lorazepam (Ativan), **dronabinol** (**Marinol**), or metoclopramide (Reglan) may be ordered. If the client is receiving a drug known to cause nausea and vomiting, premedication with an antiemetic drug before the anticancer drug is administered and periodic doses after administration may be helpful in controlling these side effects. Limiting excess physical activity, restricting the diet to liquids before drug treatment, and the use of relaxation techniques, hypnosis, and guided imagery may also be helpful in decreasing nausea.

An additional problem in client nutrition occurs with the development of stomatitis or mouth ulcers. Daily assessment of the integrity of the oral mucous membranes is important. Several instruments are now available to assist the nurse in assessing the integrity of oral mucous membranes. Routine mouth care offered every 2–4 hours may decrease the likelihood of developing severe stomatitis. The mouth should be thoroughly rinsed after meals. If stomatitis does develop, mouth care is offered every 2 hours. A mixture of 1 teaspoon of baking soda in 500 mL of water provides good cleansing action. Commercial mouthwashes are generally avoided, as they may lead to drying of the mucous membranes. It is also important to use a soft bristle toothbrush or toothette to minimize trauma to the gums when the teeth are cleansed. Bland, high-caloric liquids are better tolerated by the client than mechanically or chemically irritating foods. Local anesthetics, such as lidocaine (**Xylocaine Viscous**), may be offered ½ hour before meals to decrease discomfort. When these agents are given to children, they should be administered about an hour before meals to prevent aspiration of food which could result from interference with swallowing.

Xerostomia, or dry mouth, may occur as a result of treatment and may interfere with a client's ability to eat. Encourage the client to drink fluids and to rinse the mouth with a solution of baking soda in water. Some clients benefit from the use of artificial saliva, with most benefiting from frequent lubrication of the lips with a water-soluble gel.

Clients also have a need to be protected against infection, especially if they are receiving drugs that cause decreased white cell production, particularly neutrophils. On the average, people have a bone marrow reserve of cells that lasts 9–10 days. The lowest point of chemotherapy-induced *neutropenia* can be expected at the end of this time, and when this occurs, the client is most open to infection. The most common sites of infection are the lower respiratory tract, perineal area, pharynx, genitourinary tract, and skin. In many cases, the usual signs and symptoms of infection are absent. The most common indication of infection is fever, although the

client taking steroids may not develop this sign. Prevention of infection requires attention to all of: improving host resistance, reducing exposure to new organisms, and suppressing organisms the client has already acquired.

Aseptic technique must be used in providing physical care and in performing procedures. The nurse observes the client for signs and symptoms of infection, giving special attention to monitoring the client's temperature and wound healing. It is important for clients with a low white cell count to be isolated from infectious persons, including roommates, visitors, and staff. Protective isolation may range from limiting contact with persons known to be infectious to the use of life support islands for persons with life-threatening leukopenia. The client's own body flora or opportunistic organisms are often responsible for infection. It is important, therefore, to ensure good hygienic care and a clean environment. To achieve this, special perineal care, cleansing of the axillae, perineum, and groin or using an antifungal powder on specified areas of the skin may be employed. A liquid oral preparation of nystatin (**Mycostatin**) or **clotrimazole** troches (**Mycelex**) may be used to treat or to prevent the development of fungal infections in the mouth. Also, visitors are limited and are instructed in handwashing and wearing of masks. Often the client is permitted no uncooked foods, such as fruits and vegetables, as these may harbor fungi or bacteria. Cut flowers and plants are also avoided, as potential sources of organisms.

Meeting the client's need for safety includes handling clients gently to prevent bruising in those subject to hemorrhage caused by platelet formation depression. Clients are instructed to avoid using drugs, such as aspirin and alcohol, which are known to interfere with the action of platelets. Gentle handling also prevents fractures from osteoporosis in clients receiving large doses of corticosteroids. Padding the bed rails may help prevent bruising and fractures in children. Maintaining pressure on injection sites for 3–5 minutes helps prevent bleeding after injection. As a final safety measure, the nurse should know the antidotes for the various anticancer agents and make certain these are available for use, if necessary.

Often clients receiving chemotherapy experience disturbances in self-concept related to changes in appearance, physical abilities, or social roles. The nurse should do whatever is possible to minimize side effects of drugs and the emotional consequences of these side effects. Alopecia, for example, is one side effect of the administration of several anticancer drugs. This can be minimized by the use of scalp hypothermia. This may be accomplished by directing chilled air to the scalp or by placing a commercially available cap or plastic bags containing crushed ice on the scalp. Cold is generally applied for 10 minutes before injection of the drug and left in place for 30 minutes after injection. The application of cold is not used when there are indications that the drug should reach the scalp area (e.g., in leukemias and other types of cancer in which malignant cells are present in the scalp). The use of a wig or bandanna to camouflage the hair loss should be discussed with the client.

SPECIAL DRUG DELIVERY METHODS

Clients with cancer may be receiving drugs by way of special technologies. These technologies are useful in targeting the drug to a specific area of the body and limiting systemic absorption or in facilitating long-term treatment while minimizing the continuous need for venipuncture. Currently these technologies include peritoneal ports, tunneled catheters, implanted vascular access devices, and implanted pumps.

The original technology developed to permit parenteral fluid and drug administration and frequent sampling of blood for laboratory analysis was a tunneled catheter. This catheter was fitted with a Dacron cuff and was tunneled under the skin from a venous access site to an exit site on the client's midchest. Modification of the original catheter has produced double- and triple-lumen catheters permitting the infusion of blood and blood products, parenteral nutrition, chemotherapy, and the sampling of blood. Some clients receiving long-term chemotherapy will have a Hickman or Broviac catheter inserted. These catheters are of silicone and are radiopaque, having one or more lumens, and are generally inserted into the cephalic or subclavian vein.

The catheter exits onto the client's skin in the area between the nipple and the sternum. Instead of the Hickman or Broviac catheter, a more recently developed device, the Groshong catheter, may be used. This catheter has a special tip with a valve design that eliminates the need to clamp the catheter and decreases the risk of air embolism or blood loss when the catheter is not in use.

An important aspect of caring for a client with a tunneled catheter is the prevention of infection at the catheter exit site. Institutional procedures vary, but daily care of the exit site by the nurse, client, or a family member is important. After handwashing and gloving, the exit site is cleaned, using alcohol followed by povidone-iodine or another ordered antiseptic. Cleansing is done in a circular pattern from the site outward for 3 to 5 inches. This may be followed by the application of povidone-iodine ointment. A sterile preslit dressing or transparent dressing is often placed over the exit site. More frequent dressing changes may be required if diaphoresis occurs. The nurse should be familiar with the procedure used in a particular health care setting. This procedure and the assessment of the site for evidence of infection (for example, pain, redness, swelling, tenderness, or drainage) are often taught by the nurse to persons who will be responsible for the care of the client at home.

A primary concern in caring for persons with tunneled catheters is maintaining device patency. Again, procedures vary by health care setting. Most settings have procedures that use routine flushing of the catheter to prevent clotting. Some use a heparin solution, whereas others use saline only. The frequency of flushing also varies from flushing after each use of the catheter to once a week. The nurse must be familiar with the institution's procedure and should consult the current literature, because research is currently being done in this area.

The next type of technology developed to permit fluid and drug administration and frequent blood sampling is that of implanted vascular access devices. These devices, totally implanted under the skin, eliminate the need for daily site care and reduce the risk of infection. Clients often find them more comfortable and acceptable. Figure 39–2 shows such a device connected to a blood vessel. The port (Port-a-Cath) has two major parts, a radiopaque catheter placed in a large vein and a port that is a self-sealing chamber that permits access to the catheter. The veins most commonly used are the cephalic, jugular, or internal jugular. The port is implanted into a subcutaneous pocket surgically created over a bony prominence. The most common site is the upper anterior chest wall, but the groin, abdomen, or antecubital area of the arm may be used. The silicone catheter is placed in a vein for systemic delivery of drug or into an artery for regional drug delivery. Once the device has been inserted, drugs can be administered by needle puncture through the skin and into the port.

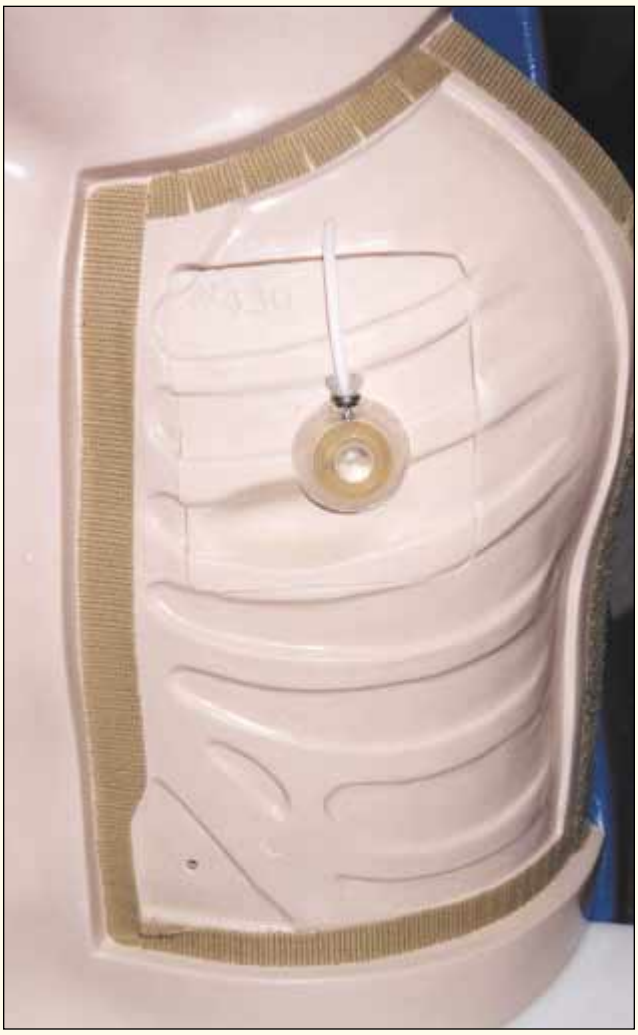

Figure 39–2 A Port-a-Cath device connects to one of the body's blood vessels as demonstrated on this model.

The port is entered only by the use of a special, noncoring needle called a Huber needle. For injection of medication or fluid administration, a 1-inch, right-angled Huber is used most often.

To inject heparin into the port to maintain patency or for bolus injections, a straight 22-gauge Huber needle is used. To avoid air embolism, the needle or intravenous tubing should never be left open to the air. The needle should be attached to a short extension set and the tubing of this set should be clamped. All extension sets used for fluid or medication administration must be flushed to remove air before the port is accessed.

The procedure for using the port requires the usual handwashing and gloving, plus usual procedures for preparation of the medication and client identification. The nurse then palpates the skin over the port to identify its contours. The port is stabilized between the index finger and thumb of the nondominant hand while the port membrane or septum is palpated with the dominant hand. Some newer ports have two septa, with a built-in ridge between them to aid in identification of the septa. The skin overlying the port is cleansed with povidone-iodine. The nurse begins at the center of the septum and works outward for about 3–5 inches using a circular motion. This scrub procedure is repeated 3 times. The skin is allowed to air dry. To enter the port with a straight Huber needle (for heparinization), attach the syringe containing the ordered heparin solution to the needle. Expel air from the syringe and hold the syringe like a dart at a 90° angle over the membrane while stabilizing the port with the nondominant hand. Insert the needle between the thumb and forefinger of the hand holding the port. Gently push the needle through the skin until it hits the needle stop at the back of the port. Instill all but 0.5 mL of the heparin solution and then begin withdrawing the needle while simultaneously injecting the remaining solution. This technique should minimize the development of fibrin clots. When the port is not in use, monthly heparinization may be conducted to maintain patency.

This same procedure is used for entering the port with a bent Huber needle, except that slight pressure is exerted on the right angle of the needle as it is pushed through the skin. This prevents rotation of the needle at its hub. When the Port-a-Cath is used for long-term fluid administration, the needle is changed weekly or whenever necessary if it becomes contaminated.

Before any fluid is injected into the port, placement of the needle and patency must be ensured. The nurse checks for blood return on aspiration and ability to instill a small amount of priming solution to indicate placement. Also, there should not be any sign of subcutaneous tissue infiltration when the priming solution is instilled. Inability to aspirate blood or to instill the priming solution may indicate that the catheter is clotted or is positioned against a vessel wall. The client is repositioned and another attempt is made to ensure patency. A second failure should be reported to the charge nurse or physician because a fibrinolytic agent may be necessary to clear the catheter. The nurse should consult the institution's procedures for specific guidelines regarding the care of clients with ports.

On completion of an infusion, the system is often flushed with a heparinized saline solution. The nurse should press down on the port with two fingers while withdrawing the needle. Following withdrawal of the needle, the skin is cleansed with antiseptic, and a light dressing may be applied.

Clients with vascular access devices are advised to report fever, malaise, inflammation, pain, or swelling at the site because these may indicate localized infection. They are also instructed to advise physicians and dentists that a port is in place because antibiotics may be used to prevent infection when surgery or dental work is scheduled.

Some clients receive regional chemotherapy by way of peritoneal dialysis or an implantable pump that delivers a continuous infusion of the drug into a regional artery for up to 2 weeks at a time. The pump is implanted and sutured into a subcutaneous pocket of the abdominal cavity and the catheter is inserted into an appropriate blood vessel. The newly implanted pump contains the first dose of the medication. When this medication has nearly been exhausted, the drug chamber of the implanted pump is refilled by percutaneous injection using a special noncoring Huber needle. A template is available from the manufacturer to help locate the inlet septum, which is the area of the *percutaneous* injection. Always check the manufacturer's directions and the institution's procedure regarding the technique to use in refilling the pump chamber. Clients are advised to avoid deep sea diving and mountain climbing, which both affect the rate of infusion, and to avoid contact sports. They should also be advised to report fevers to the

KEY NURSING IMPLICATIONS 39–2

Implementation

1. Clients need information about the illness and its treatment.
2. An initial and ongoing system-based assessment of the client is an important nursing responsibility.
3. Extravasation of intravenously administered drugs must be treated immediately, according to the institution's procedure or with cold compresses.
4. Assessment of the client's emotional status and control of pain are important aspects of nursing care.
5. Monitor laboratory studies and report significant deviations from normal to the physician.
6. Fluid and electrolyte balance are monitored. Intake and output are recorded, fluids are encouraged and blood pressure is checked routinely.
7. Ensuring adequate nutrition is accomplished by alleviating nausea, providing small frequent feedings and preventing or treating stomatitis.
8. Protect client from infections in the environment and from their own body flora.
9. Safety needs are met by handling clients carefully, avoiding the use of drugs known to interfere with platelets and having antidotes for the various anticancer drugs available.
10. Whenever possible, the nurse minimizes the side effects and adverse effects of drugs.

physician and to avoid hot baths and saunas because elevated temperatures increase drug flow. Periodic nuclear scans are necessary to check the operation of the pump, and regular follow-up visits must be made to refill the drug chamber. Clients should carry an identification card informing health personnel about the presence and purpose of the pump. Figure 39–3 provides an example of a totally implantable pump.

Intraperitoneal chemotherapy is frequently used for treatment of ovarian cancer and malignant peritoneal masses. It exposes tumor cells to high drug concentrations, while keeping systemic toxicity low. This treatment may be given in the client's home.

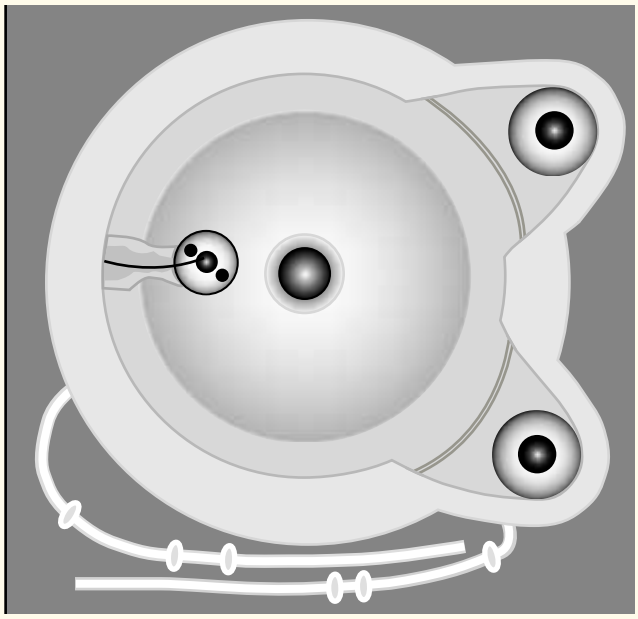

Figure 39–3 This is an example of a totally implantable self-powered pump used to administer cancer chemotherapy.

A special implanted catheter, either a Tenckhoff peritoneal catheter or a Port-a-Cath is used to access the peritoneal cavity. The antineoplastic drug, diluted in normal saline that has been warmed to body temperature, is infused through the port into a catheter into the peritoneal cavity. A noncoring Huber needle is used to access the port. After the infusion is completed, the client is assisted in rolling from side to side every 10–15 minutes to move the solution around in the body cavity. The fluid remains in the peritoneal cavity for a set time—the dwell period—before it is removed. To remove the fluid, the now empty bag used for fluid instillation is lowered below the level of the abdomen, and the clamp is opened to allow fluid drainage. The client is assisted in changing position or is asked to perform the *Valsalva maneuver* to facilitate fluid drainage. Following fluid drainage, the catheter is flushed with preservative-free normal saline followed by heparinized normal saline. As with other implanted ports, institutions have their own procedures regarding the procedure for accessing the device, administering chemotherapy, and maintaining patency. The nurse should be familiar with these procedures.

During the procedure, the nurse assesses the client for respiratory distress, gastrointestinal

KEY NURSING IMPLICATIONS 39–3

Special Drug Delivery Methods

1. Tunneled multilumen catheters may be used for the administration of blood and blood products, parenteral nutrition, chemotherapy, and fluid, as well as for obtaining frequent blood samples.
2. Prevention of infection at the exit site and maintaining patency of tunneled catheters are important nursing responsibilities.
3. The catheter of an implanted vascular device may be placed into a vein for systemic delivery of a drug or into an artery for regional drug delivery.
4. Only noncoring Huber needles are used for injection into an implanted vascular access device or other implanted ports.
5. The skin overlying implanted ports must always be cleaned thoroughly before an injection is made into the device.
6. When using a bent Huber needle, exert slight pressure on the right angle of the needle as it is pushed through the skin.
7. Never leave a Huber needle or intravenous tubing accessing an implanted port open to the air.
8. To complete an infusion, the system may be flushed with heparinized saline, the port is held steady with two fingers while the needle is withdrawn and the skin at the withdrawal site is cleansed.
9. Clients with ports are advised to report the development of fever or malaise and indications of local infection to the physician.
10. Some clients receive regional chemotherapy by an implantable pump. They should avoid deep sea diving, mountain climbing, contact sports, and saunas or hot baths. They are advised to carry an identification card, to report fevers, and to keep regular follow-up visits to have the drug chamber refilled.
11. During intraperitoneal chemotherapy by catheter or port, clients are assessed for respiratory distress, gastrointestinal upset, chills, abdominal discomfort, fluid and electrolyte balance, and changes in vital signs.
12. The drainage solution resulting from intraperitoneal chemotherapy is considered a biohazard and should be handled according to the institution's procedures for such substances.

upset, chills, abdominal discomfort, and changes in vital signs. If **cisplatin** has been infused, the client may develop *hypomagnesemia* as shown by weakness, tremor, paresthesias, change in mental status, or muscle twitching. Report signs of hypomagnesemia and decreased urinary output to the physician.

During treatment, the nurse provides for the client's safety and comfort. Elevating the head of the bed may relieve respiratory distress. Antiemetic and analgesic medications are administered as indicated by the physician's order and the client's need.

The resulting peritoneal drainage is labeled as a biohazard, according to the institution's procedures, is sent to the laboratory for analysis or disposed of according to procedure.

SAFE HANDLING OF CYTOTOXIC AGENTS

Long-term exposure to cytotoxic drugs may be associated with teratogenic or *carcinogenic* effects. In addition, adverse effects can occur from direct contact with or inhalation of some of these drugs. As many cytotoxic drugs are administered parenterally, requiring preparation of the drug, and measurement and administration procedures, there are multiple opportunities for exposure to the toxic drug. To minimize the risk to staff, many institutions are developing procedures for the safe handling of cytotoxic drugs. The procedures differ from institution to institution, and the nurse must become familiar with those used by the employing facility. The guidelines and procedures discussed in this section are based on those developed by the American Society of Hospital Pharmacists (ASHP) and the Occupational Safety and Health Administration (OSHA).

Whenever possible, a biological safety cabinet is used when preparing the medication for administration. If a cabinet is not available, the ASHP recommends wearing a surgical mask, protective goggles or glasses, gloves, and a long-sleeved, and protective gown, plus handwashing. During drug administration, always wear gloves and ensure that all connections of the infusion set and pump are tight. Bleed the infusion line onto a gauze square inside a sealable plastic bag, while protecting the client and bed by placing a plastic-backed absorbent pad under the tubing at

NURSING CARE PLAN

A Client Receiving Chemotherapy for Lung Cancer

Ronald Lewis, age 52, was admitted to the hospital for a diagnostic workup for persistent cough. His chest X ray showed a right hilar mass. Tomograms were positive for malignancy. Both bone scans and liver scans were negative for presence of metastasis. The physician recommends that Mr. Lewis receive outpatient chemotherapy. The physician explains that combination therapy is usually more effective than single drug therapy and orders Mr. Lewis to receive the CAMP regimen in which four drugs are used together (cyclophosphamide, Adriamycin [doxorubicin HCl], methotrexate, and procarbazine). The first three drugs will be given intravenously, and Mr. Lewis will need to report to the outpatient department for administration. The procarbazine is a capsule that he will begin on the day of the treatment and continue until white blood count falls below 4,000 mm^3, usually about 10–14 days. Mr. Lewis is told that CAMP treatments are scheduled 3 weeks apart and he will probably have about six, depending on repeat scans and carcinoembryonic antigen (CEA) levels. Mr. Lewis is told he will not be able to drive himself to therapy as most clients feel weak following treatment. Mr. Lewis says this is a problem because his wife does not drive and his children live out of state. Mr. Lewis is referred to social services for assistance with transportation.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Appetite, nutritional patterns, nausea, vomiting.	Imbalanced nutrition: less than body requirements related to anorexia, nausea, and vomiting.	Client will maintain body weight by eating 2,400 calories a day.	Give antiemetic prior to chemotherapy. Weigh daily. Record intake and output. Encourage client to eat foods he prefers, along with high-calorie liquids.	Client maintains optimal nutritional status as evidenced by eating 90% of meals, no weight loss, good skin turgor, and absence or control of nausea and vomiting.
Anxiety, denial of disease.	Powerlessness related to inability to control disease and difficulty accepting diagnosis.	Client will verbalize feelings of his response to diagnosis and treatment. Identify factors that can be controlled by self.	Encourage client to talk about his feelings about diagnosis. Explain medications in language client understands. Establish positive aspects of treatment. Keep client informed of treatment options. Encourage decision making.	Client verbalizes his feelings to the nursing staff. Client makes decisions regarding care and treatment.
Hair loss.	Disturbed body image related to hair loss secondary to treatment regimen.	Client verbalizes positive feelings about self. Client verbalizes understanding of temporary nature of side effects.	Client should be told before treatment that hair loss is expected. Remind client that all body hair is lost, but will grow back following therapy. (**Note:** The nurse could discuss with the physician the use of a technique to preserve scalp hair because all scans are negative for metastasis.) Refer to support groups. Assist in obtaining wig or hat if desired.	Client demonstrates enhanced self-image by maintaining eye contact, looking at and talking about hair loss, and socializing with others.
Temperature elevation, white blood counts.	Risk for infection related to decreased immune response.	Client will not manifest infection as evidenced by an afebrile state and absence of signs and symptoms of infection during chemotherapy treatment.	Observe carefully for infection. Teach client to take own temperature and report elevations. Monitor white blood count. Teach client to avoid persons with infection and those who have recently been immunized with live viral agents such as polio vaccine. Provide instruction about the importance of handwashing and personal hygiene. Isolate client when white blood count is very low.	Client does not acquire an infection.

Bleeding time, prothrombin time, partial thromboplastin time, platelet count.	Risk for injury related to thrombocytopenia.	Client will not have overt or occult bleeding during chemotherapy treatment.	Teach client to observe carefully for bleeding, e.g., gums, stool, and skin and report to health care provider. Avoid injury, trauma, and intramuscular injections. Teach client to avoid trauma at home.	Client does not have occult or overt bleeding.
Mouth care, mucous membranes.	Impaired oral mucous membranes related to side effects of chemotherapy.	Client will demonstrate knowledge of optimal oral hygiene.	Inspect oral mucous membranes. Provide mouth care with nonirritating fluid. Avoid hot, spicy food or fluids. Perform preventive oral hygiene. Avoid commercial mouth washes.	Client maintains integrity of mucous membranes.
Red urine, no blood in urine, intake and output.	Risk for injury related to hemorrhagic cystitis secondary to cyclophosphamide (Cytoxan) use.	Client will identify ways to prevent hemorrhagic cystitis.	Teach client to drink a full glass of water and void every hour to clear drugs from urine. Adriamycin causes red urine which should clear within 48 hours. Fluid intake should total 2,500–3,000 mL/day.	Client follows routine for forcing fluids and voiding frequently. Red urine clears and client does not develop hemorrhagic cystitis.
IV site.	Risk for injury related to extravasation of drugs.	Client is free of complications of drug extravasation or promptly reports signs and symptoms of discomfort at site.	Observe IV site for redness, tenderness or puffiness. Ensure adequate blood return. Instruct client to report signs and symptoms of pain, tingling, or burning immediately.	Client has no area of irritation or necrosis at the IV site.
Liver and renal function.	Risk for injury related to liver or renal failure.	Client will be able to identify signs of renal or liver failure.	Client instructed about reporting for lab work to monitor renal and liver function. Also instructed about signs and symptoms of renal and liver dysfunction and advised of who to call if these occur.	Client's lab work indicates normal renal and liver function.
Skin integrity.	Risk for impaired skin integrity related to photosensitivity secondary to methotrexate use.	Client describes etiology and prevention measures to prevent impaired skin integrity.	Advise client to use sunscreen on exposed skin and lips. Suggest use of protective clothing (e.g., long sleeves) and avoidance of prolonged exposure to direct sunlight.	Client maintains skin integrity.
Drug therapy.	Deficient knowledge related to the drug regimen.	Client will be able to explain why these drugs are being used and importance of follow-up visits.	Explain schedule of drug administration and why several drugs are being used. Stress the importance of keeping appointments.	Client verbalizes the rationale behind the treatment regimen. All follow-up appointments are kept.

the injection port. Sterile gauze is placed over the fitting or needle tip when the infusion set is primed or when expelling air from the syringe. It is important not to let the tip of the needle touch any unintended object. After administration of the drug, all contaminated materials, including the gown and gloves, are disposed of in an appropriate hazard container and the hands are washed thoroughly. Do not clip the needles, break the syringes, or remove the needle from the syringe before disposal.

Special attention must be given to managing spills of these medications. Many institutions maintain spill kits that must be available wherever these drugs are being stored and used. The kit should contain all the supplies necessary in dealing with a spill. If the spill occurs on a nursing unit, the person responsible for cleaning it must wear gloves, a disposable gown, and goggles. A disposable respirator mask and shoe covers are also suggested. The spill is confined and carefully cleaned. Following this, all items not cleanable are placed in a special waste collection bag marked to indicate its contents. Contaminated glassware and washable supplies are placed in a plastic bag and transferred to the sink, where they are washed by someone wearing clean gloves. It is important to avoid splashing during washing. All gloves and other protective clothing are carefully removed and placed in an appropriate disposal container. The hands are washed thoroughly.

Each institution should have a procedure for dealing with accidental contact with cytotoxic drugs. A copy of this procedure ought to be posted wherever these drugs are used. When accidental contact has occurred, the procedure must be followed immediately.

In most health care institutions, containers of anticancer drugs for infusion are marked with a special hazard label. This alerts personnel to use special safety precautions when handling the equipment. Also, pregnant nurses are generally not assigned to care for clients receiving parenteral cytotoxic drugs.

These guidelines and procedures are designed for staff safety, and it is important to remember that, although procedures vary, significant deviation from these procedures may place a staff member at risk of injury.

KEY NURSING IMPLICATIONS 39–4

Safe Handling of Cytotoxic Drugs

1. The nurse must be familiar with the employing institution's procedures for handling cytotoxic drugs.
2. During preparation of cytotoxic drugs, a surgical mask, goggles, gown, and gloves should be worn.
3. During administration of cytotoxic drugs, measures are taken to avoid leaks from the administration sets or pump, to protect the bed and client, and to avoid contamination. Parenteral infusions containing cytotoxic drugs are marked with special hazard labels. Pregnant nurses are not usually assigned to care for clients receiving parenteral cytotoxic agents.
4. All materials contaminated by cytotoxic agents must be disposed of properly in clearly marked containers.
5. A spill kit must be available on nursing units to deal with accidents.
6. The institution's procedure for dealing with accidental contact should be posted on the nursing unit and must be followed immediately after contact.

CLIENTS RECEIVING INVESTIGATIONAL AGENTS

It is in caring for clients with cancer that the nurse is most likely to be responsible for administration of investigational drugs. Some basic guidelines governing nursing actions in such situations are:

- The nurse should first become familiar with the policies established by the hospital and by medical and nursing services that govern involvement in the use of investigational treatments. For example, is the nurse permitted to prepare the drug for intravenous administration or must this be done by a pharmacist or physician?
- The nurse should require a written order for the administration of experimental drugs

and have an opportunity to question the physician about aspects that may be unclear.
- The nurse protects the client's rights by insisting on a signed consent form of the type used by the employing institution before the first dose of the drug is administered. Also, all investigational drugs must be dispensed by the hospital pharmacy, not brought in from the outside.
- Any available information on the use of the experimental drugs, including rationale for their use, dosage, and expected or suspected therapeutic and adverse effects must be accessible to the staff on the nursing unit.
- Because the drug dosage is often based on the client's body surface area, an accurate height and weight must be obtained. A nomogram should be available for the nurse to verify the dosage calculation.
- The nurse consults with the physician to determine what the client knows about the proposed treatment. The physician is generally responsible for obtaining the client's consent for use of the drug, and has therefore provided some information to the client about the proposed treatment.
- The nurse assures the validity of drug studies by following the research protocol precisely. This includes special attention to the timing and route of administration and to the nature of the information that may be given to clients in both the experimental and control groups, if these are being used.
- The nurse must keep thorough records about the administration of the drug, including the dosage, route, site, and times of administration. Notations are also made about the client's condition, based on a careful ongoing assessment of physical and mental condition.
- The nurse must be responsive to the client's emotional reaction to receiving such drugs. Some clients may view it as the treatment of last resort, some as a miracle cure and others as a chance for the physician to experiment on a human being. Continued supportive care and information about treatment are essential.

KEY NURSING IMPLICATIONS 39–5

Clients Receiving Investigational Drugs

1. The nurse must be familiar with the institution's policies regarding the use of experimental drugs.
2. There must be a written order for use of the drug.
3. There must be a signed consent form for use of the drug.
4. Information about the drug must be available on the nursing unit.
5. A nomogram should be available for verification of the drug dosage.
6. The nurse should know what the physician has told the client about the drug.
7. The research protocol is followed precisely.
8. Thorough records are kept on administration and on client response.
9. The nurse must be responsive to the client's emotional reaction to treatment.

EVALUATION

- Client does not experience infection, as evidenced by temperature within normal limits, no drainage or redness at central venous access site.
- Client does not experience bleeding.
- Client does not experience reduced tissue perfusion as evidenced by skin color, skin temperature, brisk capillary refill within normal limits.
- Client maintains weight within normal limits for height.
- Client verbalizes pain control at a level of 3–4/10.
- Client demonstrate acceptance of alopecia and uses wig, scarf, cap, etc.
- Client maintains hydration as evidenced by balanced intake and output.
- Client does not experience adverse effects of chemotherapy or if any occur, they will be promptly treated.
- Client effectively works through anticipatory grieving.
- Client verbalizes understanding of cancer and chemotherapy regimen.

HOME CARE / CLIENT TEACHING

1. The nurse should provide information (including reinforcement of information given by physician) to clients with cancer about the nature of the disease, its treatment, the expected therapeutic effects, and possible adverse effects of therapy.
2. The nurse should also inform clients (and significant others) about the schedule of administration of antineoplastic agents, routes of administration, importance of compliance with therapy, and how the clients can cooperate with the therapeutic regimen to achieve the greatest benefits from the therapy.
3. Clients may require repeated reinforcement of the information and instructions given because of the psychosocial impact of the diagnosis.
4. Clients with central venous catheters need specific procedural instructions regarding the home care of these devices, including dressing changes, heparinization, and accessing and deaccessing of the catheter and should provide return demonstrations of these instructions to ensure clients can care for the catheters and prevent sepsis.
5. Clients need to be instructed concerning signs and symptoms to report immediately to physician if they occur, such as temperature elevations, bruising, bleeding, and signs of infection at central venous catheter site, that would indicate the presence of one of the most common and potentially dangerous adverse effect of chemotherapy—bone marrow suppression.
6. Clients receiving cancer chemotherapy at home must have spill kits available. They should be instructed in the use of these kits and advised to take a kit with them when they are traveling with their medication.
7. The home environment and social supports of all clients who will be taking anticancer drugs other than orally should be assessed before the client is sent home to administer medication. Important factors in assessment include whether refrigeration is available (if the medication requires it), general cleanliness of the environment, access to handwashing facilities, presence of a telephone, and facilities for handling medical waste. A reliable adult besides the client should be instructed in the administration procedure and who to call if problems arise.

CASE STUDY

Mrs. Brown, age 49, was admitted to the hospital with cancer of the left breast. A lumpectomy was performed, and seven lymph nodes were removed. Three of these were found to contain cancer cells. Mrs. Brown was discharged with follow-up radiation treatment. Two years later she developed shortness of breath, and a bone scan showed metastasis to the left lung. The physician performed a bilateral oophorectomy (removal of both ovaries) and started Mrs. Brown on **fluoxymesterone** (**Halotestin**), an androgen, 10 mg 3 times a day.

Two months later, Mrs. Brown reported that her shortness of breath was becoming more severe. A left thoracentesis was performed in which 500 mL of fluid were removed and 25 mg of **triethylenethiophosphoramide** (**Thiotepa**) were instilled. One week later a drug protocol was begun and Mrs. Brown received:

- **Doxorubicin HCl** (**Adriamycin**) 50 mg/m^2
- Cyclophosphamide (Cytoxan) 500 mg/m^2
- **5-fluorouracil** (**5-FU**) 500 mg/m^2

The physician planned to repeat this regimen every 22 days. Following the first course of therapy, Mrs. Brown began to lose her scalp hair. Her WBC was 4400/mm^3. There was little therapeutic response to this course of treatment. Two months later Mrs. Brown was started on a five-drug protocol consisting of:

- Cyclophosphamide (Cytoxan) 100 mg once daily p.o.
- 5-fluorouracil (5-FU) 12 mg/kg by IV daily for 4 doses, then once a week

continues

- Methotrexate (**Mexate**) 25 mg IV once a week
- Vincristine sulfate (**Oncovin**) 1.5 mg by IV once a week
- Prednisone 40 mg once daily p.o.

Mrs. Brown tolerated this drug treatment poorly and developed fever, loose stools, nausea, anorexia, mouth ulcers, and a WBC of 14,500/mm^3. After a 2-week trial, this protocol was discontinued. Mrs. Brown was started on letrozole (Femara), 2.5 mg each day. Although Mrs. Brown's metastasis was slowed for about 6 months, she began to do poorly again and expired approximately 9 months following the discontinuation of the five-drug protocol.

Questions for Discussion

1. To what class of anticancer drugs do each of the drugs received by Mrs. Brown belong?
2. Why was Mrs. Brown initially placed on fluoxymesterone (Halotestin) following the bilateral oophorectomy?
3. What is the purpose of administering drugs according to a protocol or regimen of several drugs at a time?
4. What measures could have been used to help Mrs. Brown cope with her alopecia?
5. What nursing interventions are indicated while Mrs. Brown is receiving the five-drug protocol?

CRITICAL THINKING EXERCISES

1. Obtain a sample of informational and instructional material for clients prepared by the American Cancer Society and present it in class.
2. Write a report on the regional administration of anticancer drugs.
3. Visit a hospital's radiology department and obtain information about the various types of equipment used to administer treatment to cancer clients. In addition, review a copy of the radiation safety precautions for clients who have received therapeutic doses of radioactive isotopes.
4. Discuss the benefits of hospice care for terminally ill clients and their families.
5. Visit the hospital pharmacy to learn how records of investigational drugs are kept.
6. Interview a representative of Reach for Recovery or a similar self-help group and learn about the group's activities. Share your findings at a class session or conference.
7. Interview a social worker about effective ways of relating to terminally ill clients and their families.
8. Prepare a report on bone marrow transplantation, with special emphasis on protecting the client from infection.

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Agents Used in the Treatment of Skin Disorders

40

OBJECTIVES

After studying this chapter, the student will be able to:

- Identify the properties of and specific uses for:
  - ointments
  - creams
  - pastes
  - lotions
  - gels
  - aerosol sprays
  - aerosol foams
  - powders
  - oils
  - tapes

  when used in the treatment of dermatological disorders
- List five causes of dry skin
- Explain the role of emollients in relieving dry skin
- Describe the therapeutic use and appropriate method of application of keratolytic agents
- Identify adverse effects and contraindications related to the use of local anesthetic agents on the skin
- Discuss the appropriate use of griseofulvin in the treatment of topical fungal disorders
- Identify agents employed in dermatological therapy as:
  - emollients
  - keratolytics
  - local anesthetics
  - antimicrobial agents
  - therapy for burns
  - antifungal agents
  - debriding agents
  - anti-inflammatory agents
  - antineoplastic agents
  - antiviral agents
- State the factors to be assessed in clients receiving treatment for skin disorders
- Describe in a stepwise manner the procedure used in the application of a cream or ointment
- Apply the nursing process related to the administration of agents used in the treatment of dermatological disorders
- Discuss the nursing process for clients being treated for burns

The skin is an indispensable organ that serves a multitude of functions. It:

- is an effective barrier preventing the loss of water, electrolytes, and proteins from the body and thereby stabilizing the environment in which all of the internal organs function
- prevents the entry of chemical, physical, and microbiological intruders into the body, and thus, prevents bodily injury

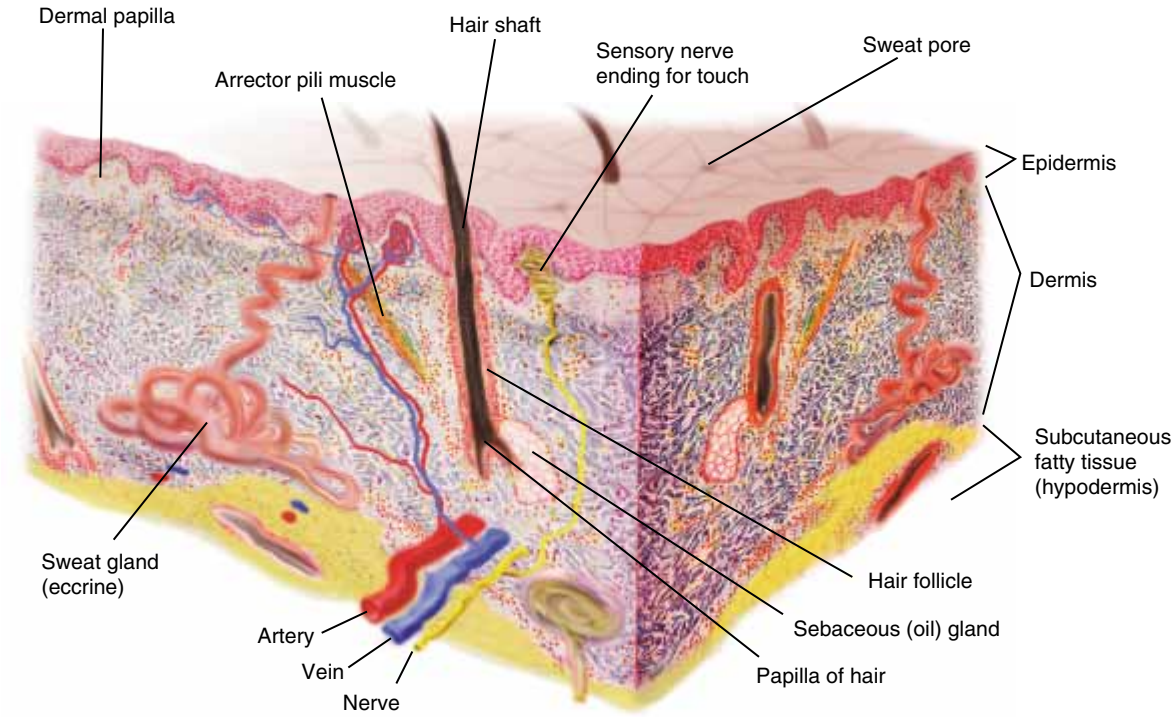

Figure 40–1 Skin cross section. Observe the skin layers. Note the location of glands in the dermal layer.

- is a component of the thermoregulatory system of the body. By regulating the release of sweat onto the skin surface, the temperature of the body can be controlled.
- is a receptacle for a wide variety of sensory structures that permit the body to sense pressure and temperature changes, as well as pain
- provides support for the underlying muscles and fat that maintains the shape and form of the body
- acts as an excretory organ, allowing waste products to be secreted and dispersed from the body
- is the site for hair and nail tissue manufacture
- is capable of manufacturing vitamin D in the presence of ultraviolet light
- is a barometer of health of the individual. By observing the color, texture, and reaction of the skin to stimuli, the nurse may be able to identify the presence or absence of disease

The skin consists of a number of different layers and structures (Figure 40–1). The outermost layer is known as the epidermis (Figure 40–2). The thickness of this layer is variable. At its thinnest point, on the eyelids and lips, the thickness is about 0.06 mm, with its thickest point, on the palms of the hands and soles of the feet, approaching 1 mm. The base of the epidermal layer is

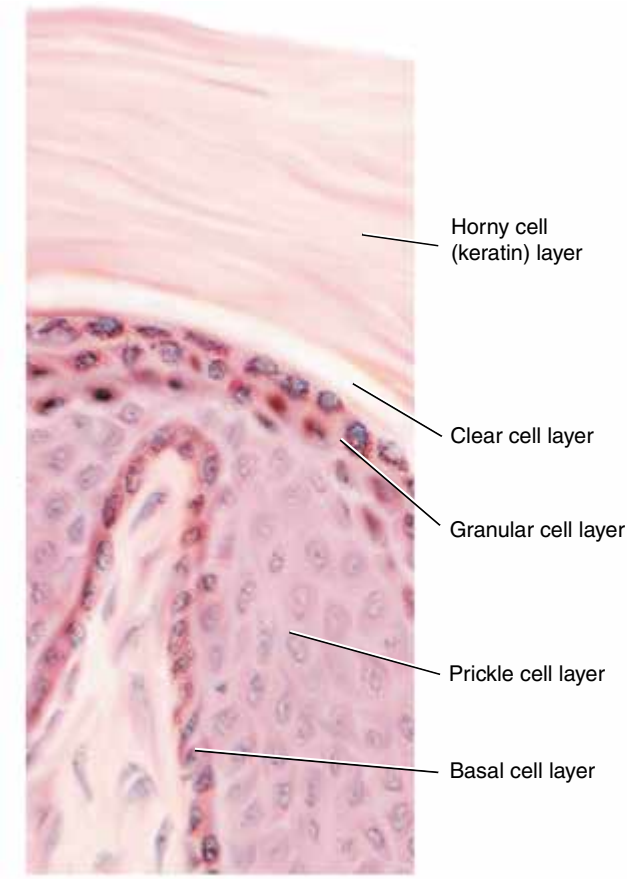

Figure 40–2 The epidermis.

known as the basal, or germinative, layer. It is here that new cells are formed and are arranged in an orderly pattern. As new cells are formed, older ones travel toward the skin surface.

Above the basal layer lies the prickle layer, so named because of the protein projections that connect adjacent cells. As cells continue to travel upward, they die and become flattened and pressed together. In the upper portion of the epidermis, these compressed cells become the keratin, or cornified, layer. It is this layer that is most effective in acting as a barrier to the passage of substances in and out of the skin. As newer cells pass upward to the keratin layer, the surface of the layer gradually sloughs off into the environment. The entire process, from the time new epidermal cells are formed to the eventual sloughing off of the cell fragments from the keratin layer, normally takes about 28 days.

Below the epidermis is the dermis, a structure that is thicker than the epidermis and which is responsible for providing support and nourishment to the epidermis. It contains a rich supply of blood vessels, nerves, and various structures, such as sweat glands and hair follicles.

Several specialized structures are found within the skin. These include hair and nail tissue (both being modified forms of keratin) and eccrine and apocrine sweat glands. Eccrine sweat glands are widely distributed throughout the body, although they are in greatest abundance in the palms of the hands and soles of the feet. Eccrine sweat glands respond to thermal and emotional stimuli. They release a fluid onto the skin surface consisting primarily of water and also containing a number of waste products, including lactic acid.

Apocrine sweat glands are always associated with a hair follicle and are, therefore, not as uniformly dispersed throughout the body as are the eccrine glands. They are found mainly in the axillary and pubic areas of the body. When the body is subjected to emotional stimuli these glands secrete an electrolyte solution which also contains proteins and amino acids. When skin bacteria cause the decomposition of these waste materials, body odor may develop.

Sebaceous glands are usually connected to hair follicles throughout the body although they are present in particularly large numbers on the head and face. These glands are relatively dormant until puberty and then secrete an oily mixture of fats, proteins, and other debris into the hair follicle. This eventually reaches the skin surface and is the cause of skin oiliness experienced by some people.

DRUGS USED IN DERMATOLOGICAL THERAPY

Literally thousands of commercial products are available for the treatment of dermatological disorders. These contain an assortment of drugs and are available in a wide variety of different dosage forms. Selection of the proper dosage form is often essential in order to treat a dermatological disorder successfully. Table 40–1 describes some of the properties and uses of different topical dosage forms.

The discussion which follows will consider the classes of drugs commonly employed in dermatological therapy.

Emollients

Dry skin may be caused by a number of different factors including:

- wind and high velocity air flow over skin
- low environmental humidity (e.g., in heated rooms during cold weather conditions)
- skin diseases (e.g., psoriasis)
- malnutrition, dehydration, and chronic diseases such as diabetes mellitus
- aging of the skin
- excessive bathing
- use of strong soaps or detergents

Dry skin causes considerable discomfort, which may be manifested as pruritus, cracking, and a greater predisposition to the development of skin diseases.

Treatment of dry skin is often best accomplished by the use of emollients. These are substances, generally oily in nature, which, when applied to the skin surface, prevent the loss of additional skin moisture by forming an occlusive barrier on the skin surface. Although many different emollient products are available commercially, most contain waxes, fats, and/or oils such as mineral oil, petrolatum, and lanolin or its components. Several products also contain urea, a substance that is not oily but appears to enhance the skin's ability to hold moisture.

Emollients are available in several different dosage forms, ranging from ointments and creams to lotions and bath oils. These products are most effective if they are applied to the skin either during or just following a bath or shower, one or more times daily. They should not generally be used on skin lesions that are moist or *exudative* in nature. Table 40–2 lists some popular emollient products.

TABLE 40–1

Dermatological Dosage Forms

Note: Record observations about skin integrity and appearance.
Teach client appropriate administration technique.

TYPE	CHARACTERISTICS	USES	EXAMPLES
ointment	• greasy • not water removable • occlusive • semisolid • usually contains no water	ideal for application to dry lesions of the skin	petrolatum (Vaseline) zinc oxide ointment A &D ointment
cream	• usually white • not generally greasy • always contains water • not generally occlusive • semisolid • can generally be removed with water	usually best employed on areas which are moist and/or when cosmetic appeal is desired	hydrocortisone cream triamcinolone acetonide cream
paste	• same as ointment but contains high powder content • stiff consistency	good protective qualities; may be useful in absorbing secretions from skin lesions	zinc oxide paste
lotion	• liquid having varying viscosities • may be clear solution, suspension or emulsion • contains water, alcohol and/or other solvents	best used when drug is to be applied without rubbing, when large areas of skin are to be treated or when hairy portions of the body are to be treated	calamine lotion Lubriderm lotion Kwell lotion
gel, jelly	• usually clear or translucent • semisolid but liquifies upon application to skin • good lubricating properties • easily removed • contains water and sometimes alcohol	useful when cosmetic appeal and/or lubricant property is desirable	K-Y Jelly Saligel
aerosol spray	• deposits thin liquid or powder film on area of application	useful when drug is to be applied to large areas of the skin and/or when manual application would be painful (e.g., in treating burns)	Kenalog spray Solarcaine spray Desenex aerosol powder
aerosol foam	• spreads drug over wide area	useful when drug is to be applied into body cavity (e.g., vagina, rectum) or for application onto hairy areas of body	ProctoFoam Epifoam
powder	• can be shaken or blown onto affected area • promotes drying at area of application • may have lubricant properties	useful for application to moist body areas and/or when friction is to be reduced (e.g., between thighs, between toes)	Desenex powder talcum powder Tinactin powder
oil	• liquid • not water removable • occlusive	for emollient action	Lubriderm bath oil Jeri-Bath oil
tape	• drug uniformly released from tape • occlusive action • may have splinting action on area of application	useful when small, straight areas require drug application and when occlusion is desirable	Cordran tape
beads	• large surface area • capillary action develops suction in spaces between beads	useful when rapid removal of exudate is needed	Debrisan beads

TABLE 40–2

Popular Emollient Products

PRODUCT	AVAILABLE DOSAGE FORMS
Aquacare	cream, lotion
Dermassage	lotion
Desitin	ointment
Keri	lotion, cream
Lubriderm	cream, lotion, bath oil
Masse	cream
Neutrogena	lotion, oil
Nivea	cream, lotion, oil
Wondra	lotion

Keratolytics

Some disorders of the skin (e.g., acne, warts, psoriasis, corns, calluses, and fungal infections) are characterized by a thickening of the keratin layer of the skin. This may make the skin unsightly, brittle, and easily cracked. They may also cause pruritus and general discomfort.

Keratolytics are agents that aid in removing excess keratin. They act by breaking down the protein structure of the keratin layer, thereby permitting easier removal of compacted cellular material. The most commonly used keratolytic agents are salicylic acid, lactic acid, and acetic acid. Products containing one or more of these agents are generally applied to the hyperkeratotic region of the skin after the area has been bathed or soaked in water for several minutes. The keratolytic substance is usually more effective if the area to which it has been applied is occluded with a dressing and/or plastic wrap. Most keratolytics are kept on the skin overnight and removed in the morning. With repeated application of such products, hyperkeratotic skin can be successfully controlled and only occasional reapplication may be required to maintain a state of remission. Table 40–3 lists some popular keratolytic products.

TABLE 40–3

Popular Keratolytic Products

PRODUCT	ACTIVE INGREDIENTS
Compound W	salicylic acid
Duofilm	salicylic acid and lactic acid in flexible collodion
Keralyt	salicylic acid

Local Anesthetic and Antipruritic Agents

Local anesthetics are agents that inhibit the conduction of nerve impulses from sensory nerves and thereby reduce pain and pruritus. They are generally used topically to minimize discomfort associated with conditions such as insect bites, burns, plant allergies (e.g., poison ivy dermatitis), and many other disorders. Many local anesthetics are poorly absorbed through intact skin, but their absorption may be greatly enhanced through damaged or diseased skin. This may make the client more likely to exhibit local or systemic adverse effects related to the topically administered drug, particularly if the agent is applied to a large area of skin. Such effects may appear as a localized allergic reaction at the site of application and may be manifested as erythema, urticaria, and/or edema. Systemic hypersensitivity reactions may appear as central nervous system (CNS) stimulation, hypotension, myocardial depression, and possibly, cardiac arrest. Topical anesthetic administration should, therefore, only be employed when absolutely necessary and should be avoided in clients with a prior history of drug hypersensitivity or in clients whose skin is severely traumatized.

Most topical anesthetic drugs are of the "caine" type and include such agents as:

- lidocaine
- **tetracaine**
- **dibucaine**
- **pramoxine**
- **benzocaine**
- cocaine

For topical use, an ointment, cream, or spray dosage form is appropriate. A few local anesthetic agents (e.g., lidocaine, dyclonine) are also available in a liquid or jelly form suitable for use in providing local anesthesia for mucous membrane surfaces.

Some topical antipruritic products contain antihistamines (see Chapter 23). Many of these agents have some local anesthetic activity when applied topically. The use of most of these, however, has been associated with the development of local irritation and hypersensitivity reactions, particularly

TABLE 40–4

Topical Local Anesthetics

DRUG	USUAL STRENGTH	AVAILABLE DOSAGE FORMS
benzocaine *(**BEN**-zoh-kayn)* (Americaine, Solarcaine, Topicaine, Unguentine, Dermoplast, etc.)	0.5%–20%	cream, lotion, spray, ointment, liquid, gel
butamben picrate *(byou-**TAM**-ben **PY**-krayt)* (Butesin Picrate)	1%	ointment
cocaine (Koh-kayn)	1%–4%	solution
dibucaine *(**DYE**-byou-kayn)* (Nupercainal, etc.)	0.5%–1%	cream, ointment
dyclonine HCl *(**DYE**-kloh-neen **hy**-droh-**KLOR**-eyed)* (Dyclone)	0.5%, 2–3 mg	solution, lozenge
lidocaine *(**LY**-doh-kayn)* (Xylocaine, etc.)	0.5%–10%	cream, ointment, jelly, solution, viscous solution
pramoxine HCl *(pram-**OCK**-seen **hy**-droh-**KLOR**-eyed)* (Tronothane, Prax)	0.5%–1%	cream, lotion
tetracaine *(**TEH**-trah-kayn)* (Pontocaine)	0.5%–1%	cream, ointment, solution

when applied to damaged skin. Table 40–4 lists some local anesthetic products intended for topical use.

Antibacterial Agents

Topical antibacterial agents are used to prevent infection associated with minor skin abrasions and to treat superficial skin infections caused by susceptible bacteria. Topical antibacterial agents are also popularly used to treat acne vulgaris. The topical use of antibiotics has been associated with the development of sensitivity to the agent employed. When such sensitized clients are subsequently reexposed to the antibiotic agent, a hypersensitivity reaction is possible. Such reactions are serious and may be potentially life threatening if the agent is subsequently administered parenterally. For this reason, antibiotics used topically are generally those not likely to be employed systemically (see Chapter 7). Several antibiotic agents are often combined in a single product to take advantage of the different antimicrobial spectrum of each drug. The most popular of these combinations include bacitracin, polymyxin and neomycin.

Caution must be used when applying antibiotic products to extensively damaged skin, as appreciable amounts of drug may be systemically absorbed. This is of particular importance when the antibiotic product contains neomycin, as systemic absorption of this drug has been associated with the development of nephrotoxicity and ototoxicity, as well as widespread hypersensitivity.

Table 40–5 lists some of the topical antibiotic products currently in use.

Antifungal Agents

Antifungal drugs are most commonly employed in the treatment of two types of fungal infections of the skin, those caused by dermatophyte organisms and those caused by yeast-like organisms.

TABLE 40–5

Topical Antibiotic Products

SINGLE ANTIBIOTIC PRODUCTS

DRUG	USUAL STRENGTH	AVAILABLE DOSAGE FORMS
bacitracin *(bass-ih-**TRAY**-sin)* (Baciguent, etc.)	500 units/g	ointment
chloramphenicol *(klor-am-**FEN**-ih-kohl)* (Chloromycetin)	1%	cream
chlortetracycline *(**klor**-tet-rah-**SIGH**-kleen)* (Aureomycin)	3%	ointment
clindamycin *(klin-dah-**MY**-sin)* (Cleocin T, Dalacin T ✱)	0.1%	solution
erythromycin *(eh-**rih**-throw-**MY**-sin)* (A/T/S, Eryderm, Erygel, etc.)	2%	solution
gentamicin *(jen-tah-**MY**-sin)* (Garamycin)	0.1%	cream, ointment, gel
meclocycline sulfosalicylate *(mek-loh-**SIGH**-kleen **sul**-foh-sah-**LIS**-ih-layt)* (Meclan)	1%	cream
mupirocin *(myou-**PEER**-oh-sin)* (Bactroban)	2%	ointment
neomycin sulfate *(nee-oh-**MY**-sin **SUL**-fayt)* (Myciguent, etc.)	0.5%	cream, ointment
tetracycline HCl *(**tet**-rah-**SIGH**-kleen **hy**-droh-**KLOR**-eyed)* (Achromycin, Topicycline)	0.22%–3%	ointment, solution

COMBINATION ANTIBIOTIC PRODUCTS

PRODUCT	Neomycin	Bacitracin	Polymyxin
Mycitracin	X	X	X
Neosporin (Oint.)	X	X	X
Polysporin	—	X	X

Dermatophyte infections are usually caused by *Tinea* and similar organisms. The most common of these infections are the "ringworm" type, so called because of the circular pattern that often appears at the site of infection. Such infections usually affect the scalp, nails and/or skin. They are always superficial and do not spread to the interior of the body. Depending on the location of the lesions on the body and the specific causative organism, such Tinea infections may be known as "athlete's foot," "jock itch," or by other common terms.

Dermatophyte organisms can live only on dead keratin tissue and can only be successfully eliminated if the affected area is entirely replaced by fungus-free tissue. Therapy with oral or topical antifungal agents must, therefore, be continued for prolonged periods ranging from several weeks (when infection involves thin skin areas) to as long as 1 year (when slow-growing toenails are involved). Even with appropriate therapy, many clients develop relapses or never completely rid themselves of the causative organism(s).

Topical therapy of dermatophyte infections generally involves the use of drugs such as those listed in Table 40–6.

Many of these products are available in ointment, cream, aerosol, lotion, and powder dosage forms. They are generally applied to the affected areas twice daily, in the morning and evening, for the duration of therapy. If burning or irritation of the application site occurs during therapy, drug application should be discontinued.

Oral treatment of many superficial fungal infections of the skin has been successfully accomplished with the use of griseofulvin. This drug has *fungistatic* activity against many different fungal organisms, particularly dermatophytes. When the drug is administered orally and absorbed into the blood, it is deposited in newly formed skin cells. As the new cells gradually reach the outer keratin layer, they exhibit resistance to the fungal organism and eventually result in its disappearance.

Griseofulvin is best absorbed when administered with or after a fatty meal. Clients on the drug must be continuously monitored for the development of hypersensitivity reactions. In adults, single daily or divided doses of 500 mg of **griseofulvin microsize** (Grisactin, Grifulvin V, **Fulvicin U/F**) are generally adequate to treat most susceptible fungal infections. **Griseofulvin ultramicrosize** products (**Grisactin Ultra**, **Fulvicin P/G**, **Gris-PEG**) contain griseofulvin in a smaller crystalline state, have twice the activity of the microsize form, and require only one-half the dose.

Yeast and yeast-like fungal organisms are responsible for many types of dermatological infections and often involve warm, moist areas of the skin (e.g., diaper areas, beneath the breasts) and mucous membranes (e.g., vagina and mouth). Most dermatological yeast infections are caused by *Candida albicans* (Monilia) and other *Candida* species.

Several drugs are useful in the treatment of yeast infections of the skin and mucous membranes. These include nystatin (Mycostatin, **Nilstat**) and amphotericin B (**Fungizone**). Broad spectrum antifungal agents such, as **miconazole nitrate** (**Monistat**, **Micatin**), clotrimazole (**Lotrimin**, Mycelex), **econazole nitrate** (**Spectazole**), ketoconazole (Nizoral), **ciclopirox olamine** (**Loprox**), and others, are useful in treating both dermatophyte and yeast infections of the skin (Table 40–6).

As moisture promotes yeast growth, an attempt should be made to provide adequate ventilation to the affected skin area. The antifungal product should be applied 2–4 times daily and continued for 1 week after disappearance of lesions. Topical therapy of yeast infections is generally successful within 1 month.

Antiviral Agents

Topical skin lesions caused by viral infection are among the most difficult topical disorders to treat. Infections caused by *Herpes simplex* types 1 and 2 are particularly serious and have become relatively common in the United States. No topical form of therapy is available that can completely eradicate such topical infections. **Acyclovir** (**Zovirax**) is an antiviral agent that does not cure viral skin infections, but does appear to decrease their healing time and associated pain (see Chapter 7).

Acyclovir is currently available as a 5% topical ointment, as an orally administered capsule, tablet, or suspension and as a parenteral product intended for IV infusion only. The ointment is generally applied every 3 hours, 6 times daily for 1 week. Approximately ½ inch of ointment is applied for each 4 square inches of affected surface area. A finger cot or rubber glove should be used to apply the ointment to prevent spread of infection. Some clients treated with this product may develop burning, stinging, itching or rash. The appearance of any of these should be reported to the prescriber if they become pronounced.

TABLE 40–6

Topical Antifungal Agents

DRUG	USUAL STRENGTH	ACTIVE AGAINST		AVAILABLE DOSAGE FORMS
		DERMATOPHYE	*CANDIDA*	
amphotericin B *(**am**-foh-**TER**-ih-sin bee)* (Fungizone)	3%	—	X	cream, lotion, ointment
ciclopirox olamine *(**sigh**-kloh-**PEER**-ocks **OH**-lah-meen)* (Loprox)	1%	X	X	cream
clioquinol* *(**kly**-oh-**KWIN**-ol)* (Vioform, etc.)	3%	X	—	cream, ointment
clotrimazole *(kloh-**TRIM**-ah-zohl)* (Canesten, Lotrimin, Mycelex)	1%	X	X	cream, solution, lotion, vaginal tablets 100 mg
econazole nitrate *(eh-**KON**-ah-zohl **NIGH**-trayt)* (Ecostatin, Spectazole)	1%	X	X	cream
gentian violet* *(**JEN**-shun **VY**-oh-let)*	1%–2%	X	—	solution
haloprogin *(**hah**-loh-**PROH**-jin)* (Halotex)	1%	X	—	cream, solution
ketoconazole *(**kee**-toh-**KON**-ah-zohl)* (Nizoral)	2%	X	X	cream, shampoo 1% & 2%
miconazole nitrate *(mih-**KON**-ah-zohl **NIGH**-trayt)* (Micatin, Monistat-Derm)	2%	X	X	cream, lotion, powder, vaginal suppositories
naftifine HCl *(**NAF**-tih-feen **hy**-droh-**KLOR**-eyed)* (Naftin)	1%	X	X	cream, gel
nystatin *(ny-**STAT**-in)* (Mycostatin, Nilstat, etc.)	100,000 units/g or mL	—	X	cream, lotion, ointment, powder, oral suspension, vaginal tablets
oxiconazole nitrate *(**ock**-see-**KON**-ah-zohl **NIGH**-trayt)* (Oxistat)	1%	X	X	cream
sulconazole nitrate *(sul-**KON**-ah-zohl **NIGH**-trayt)* (Exelderm)	1%	X	X	cream, solution
terbinafine HCl *(tehr-**BIHN**-ah-feen hy-droh-**KLOR**-eyed)* (Lamisil)	1%	X	—	cream, spray

continues

TABLE 40–6 *continued*

DRUG	USUAL STRENGTH	ACTIVE AGAINST		AVAILABLE DOSAGE FORMS
		DERMATOPHYE	*CANDIDA*	
tolnaftate *(tol-**NAF**-tayt)* (Aftate, Pitrex, Tinactin, Ting)	1%	X	—	cream, gel, aerosol, liquid, powder, solution
triacetin* *(try-**AS**-eh-tin)* (Fungoid)	25%	X	X	cream, ointment, gel, aerosol, liquid, powder, solution
undecylenic acid *(un-**dess**-sigh-**LEN**-ick **AH**-sid)* (Desenex, Cruex, etc.)	2%–22%	X	—	cream, liquid, foam, ointment, aerosol, powder, soap

*Also has antibacterial action.

Orally, acyclovir is administered initially in a dose of 200 mg every 4 hours, while awake, for a total of 5 doses daily for 10 days. For chronic suppressive therapy in clients with recurrent genital herpes disease, 200 mg may be administered 3–5 times daily for up to 6 months. Less frequent dosing is employed in clients with acute or chronic renal impairment.

When the parenteral form of acyclovir is administered, it must be given by intravenous infusion. In adults, 5 mg/kg of body weight is infused at a constant rate over 1 hour every 8 hours for 7 days. The nurse must check the injection site frequently during the infusion, as the most common adverse effect of treatment is inflammation or phlebitis, which may occur following infiltration of the IV infusion. In addition, the client is monitored for the development of hypersensitivity reactions, such as skin rash or hives.

Anti-Inflammatory Agents

Topically applied corticosteroids (see Chapter 12) have revolutionized the treatment of many dermatological disorders because of their great effectiveness in alleviating inflammatory symptoms. They are particularly useful in the treatment of inflammatory skin conditions (dermatitis) caused by irritation or allergic disorders. They are also useful in controlling psoriasis, a disorder that affects a substantial proportion of the population.

Corticosteroids have anti-inflammatory, antipruritic, and vasoconstrictive action. When applied to the skin, they interfere with normal immunological responses and reduce redness, itching, and edema. They also slow the rate of skin cell production and turnover. It is this latter action believed to make the corticosteroids useful in psoriasis treatment, as it is believed that the lesions of psoriasis are caused, at least in part, by accelerated production and turnover of skin cells (7 days versus the normal 28 days).

The effectiveness of a topical corticosteroid product depends on: (1) the potency of the drug used, (2) the vehicle used in carrying the corticosteroid to the skin, (3) the thickness and integrity of the skin at the site of application, and (4) the amount of moisture present in the skin. The presence of damaged skin at the site of drug application may greatly increase the amount of drug absorbed into the bloodstream and may result in systemic side effects associated with corticosteroid use (for example, sodium and fluid retention, adrenal suppression). The use of an occlusive vehicle (such as a greasy ointment) or plastic wrap over the area of drug application will increase moisturization of the skin and promote absorption of the drug. This may be desirable in treating thick, hyperkeratotic lesions, such as those found in clients with psoriasis, for which normal drug penetration into the skin may be impaired.

The least potent topical corticosteroid is hydrocortisone. It is suitable for use on thin skin areas such as the face and/or for long-term topical corticosteroid therapy. Hydrocortisone-containing topical products are available without a prescription and may be safely used for minor skin conditions. Topical corticosteroids containing a fluorine atom in their chemical structure (e.g., **fluocinolone**, **fluocinonide**) are among the most potent topical corticosteroid products. They must be used

sparingly and with extreme caution on thin skin areas because with regular use they may cause atrophy and thinning of the skin resulting in ulceration and infection of the affected areas.

Topical corticosteroid products should not be used in the presence of a topical fungal infection as suppression of the immune response produced by the corticosteroid will promote fungal growth. The student is referred to Table 12–5 in Chapter 12 for a list of topical corticosteroid products.

Antiparasiticidal Agents

Parasites live on the outer surfaces of the body, with the most common including lice and scabies. Lice are transmitted from person to person and can establish themselves on the head (pediculosis capitus), on the body (pediculosis corporis), or in the pubic area (pediculosis pubis). Scabies is caused by a mite that burrows under the skin and lays its eggs, causing severe pruritis.

The drug of choice for both lice and scabies is lindane (Kwell, **Scabene**). Lindane is applied to the entire body and left on for 12 hours. During this time, all bed linens and other cloth products shared by the client and any family members are washed. After 12 hours, the lindane is washed off. Usually one application is sufficient treatment.

Because of the possible adverse effects of lindane, including eczematous skin rash and CNS toxicity, especially in children (if applied to open wounds, it can cause seizures). Lindane should not be used in children under the age of 2 years. Although CNS toxicity is rare, the FDA has recently recommended labeling changes encouraging lindane to be used in children only after other agents have been tried. Among those agents are permethrin (Elimite, Nix) and crotamiton (Eurax).

Debriding Agents

Drugs that promote the removal of dead tissue at the site of skin damage are known as debriding agents. Such drugs are useful because, by removing dead tissue, they enhance the formation of new tissue and wound healing occurs more rapidly. Such action is of particular importance in the treatment of second- and third-degree burns, decubitus and other skin ulcers, and in other serious wounds of the skin.

Virtually all debriding agents are enzymes that selectively digest dead tissue as opposed to living tissue. Some are proteolytic agents that specifically digest protein of dead tissue (e.g., **sutilains**, trypsin, **papain**). Others are more specific in their action and destroy only certain components of the necrotic tissue mass. For example, **collagenase** (**Santyl**) specifically digests collagen, a substance that accounts for about 75% of the dry weight of skin tissue. The combination of the enzyme **fibrinolysin** and **desoxyribonuclease** (**Elase**), on the other hand, is designed to dissolve the fibrin structure of blood clots as well as the deoxyribonucleic acid (DNA) strands that often make up a substantial portion of necrotic tissue. Table 40–7 compares the debriding agents currently in use.

DIABETIC FOOT ULCERS

Foot ulcers are the leading cause of amputations in clients with diabetes. They occur as a result of microvascular and neurologic changes due to long-term elevated blood glucose levels. **Becaplermin** (**Regranex**) is the first drug of its kind to be approved by the FDA specifically to promote healing in diabetic foot ulcers. Its structure is similar to endogenous platelet-derived growth factor and as such increases the migration of cells responsible for wound healing to the site of the ulcer. This enhances the formation of granulation tissue. It is indicated for diabetic foot and leg ulcers that involve subcutaneous tissue or deeper that have adequate blood supply.

Becaplermin comes in a gel form, which is spread over the ulcer. This is then covered with 0.9% saline-soaked gauze. It is applied once a day and 12 hours after its application, the dressing is changed, the becaplermin gel is removed, and a sterile saline-soaked gauze is placed on the wound (without medication). This is repeated each day for as long as 20 weeks. The ulcer should decrease in size by approximately 30% by the 10th week of therapy.

ANTINEOPLASTIC AGENTS

Fluorouracil (Efudex, Fluoroplex) is an antineoplastic agent that acts with some specificity to destroy cells that grow rapidly (e.g., premalignant and malignant cells). It is used topically in the treatment of *solar* or *actinic keratoses* of the skin. These disorders are considered to be premalignant skin lesions and commonly develop in fair-skinned persons in areas of the body heavily exposed to sunlight (for example, the face and

TABLE 40–7

Topical Debriding Agents

Note: Before application of debriding agent, clean wound thoroughly with normal saline or mixture of normal saline and hydrogen peroxide. Dry area gently with sterile gauze. Ointments are applied in a thin layer to completely cover the wound. Work from the interior to the exterior of the wound.

Powders and aerosols are applied to cover the wound evenly. Following application of the debriding agent, cover wound with sterile dressings unless otherwise directed. Use of a nonadhering dressing (like petrolatum gauze) may be more comfortable for the client.

Observe all clients for signs of systemic infection. Routinely monitor body temperature. Record observations about response to therapy.

If ointment gets in eyes, immediately flush with water.

DRUG	AVAILABLE DOSAGE FORMS	NURSING IMPLICATIONS
collagenase *(kohl-**LAJ**-eh-nays)* (Santyl)	ointment 250 u/gram	Wound must be free of antiseptic and antibacterial agents. Product is compatible, however, with neomycin-polymyxin-bacitracin ointments. Application of Burow's solution will stop enzymatic action.
fibrinolysin and desoxyribonuclease *(**fye**-brih-**NOL**-ih-sin and des-**ock**-see-**ry**-boh-**NOO**-klee-ays)* (Elase)	powder, ointment iu: 666.6 u/gram	Observe client for development of hypersensitivity reaction.
papain *(pah-**PAYN**)* (Panafil)	ointment 106 u/gram	Product also contains urea and chlorophyll derivatives. Use of hydrogen peroxide to cleanse wound may decrease effectiveness of papain. Mild itching or stinging may be associated with the first application.
sutilains *(**SOO**-tih-layns)* (Travase)	ointment	Wound must be free of antiseptic and antibacterial agents. When used in conjunction with a topical antimicrobial agent, apply sutilains first.
trypsin *(**TRIP**-sin)* (Granulex)	aerosol	Solution is flammable, so do not expose to flames. Shake well before using. Avoid spraying on fresh arterial clots. Product also contains Peru balsam and castor oil.

hands). The drug may also be used to treat basal cell carcinomas of the skin when surgical and other techniques might be impractical (e.g., when multiple lesions are present).

Special instructions for applying fluorouracil topically include using a nonmetallic applicator or using the fingertips protected by rubber gloves. The hands must be washed immediately following application. Always avoid contact of the drug with the eyes, nose, or mouth. If an occlusive dressing is used to cover the treated lesion, the dressing must be limited to the lesion itself because covering the surrounding skin may cause an inflammatory reaction in normal skin. Clients should be advised to avoid exposure to sunlight or to wear sunscreen and protective clothing.

AGENTS USED TO TREAT BURNS

Treatment of serious burns of the skin (second- and third-degree) is generally aimed at preventing infection of the burned area without causing the absorption of toxic drugs into the systemic circulation. As blood supply to the burned area may be impaired, topical anti-infective products may represent the only possible source of therapy to prevent infection at the burn site. Such products may also serve to occlude the site so as to prevent contamination of the burned area by airborne microorganisms.

Those topical agents commonly employed in the treatment of burns include:

- **silver sulfadiazine (Silvadene, Flint SSD)**

TABLE 40–8

Topical Burn Preparations

Note: Sterile technique must be used in applying burn preparations.

Client is frequently placed in reverse isolation to protect against infection.

Before application of burn preparations, the area must be cleansed with the solution ordered and dried with sterile gauze pads. The burn preparation is then applied in a thin layer (2–4 mm) and the area is left uncovered or the drug may be applied to gauze, which is then applied to the wound and dressed as directed.

Record observations about the response to therapy.

Provide supportive care, including a diet high in protein and calories.

Provide analgesic before painful dressing procedures.

DRUG	USUAL STRENGTH	AVAILABLE DOSAGE FORMS	NURSING IMPLICATIONS
mafenide *(**MAF**-en-eyed)* (Sulfamylon)	85 mg/gram	cream	May cause metabolic acidosis due to carbonic anhydrase inhibition. Watch for hyperventilation. Monitor for development of hypersensitivity reaction (itching, edema, rash). Safe use in pregnancy has not been established. Use with caution in clients with renal failure.
nitrofurazone *(**nigh**-troh-**FYOU**-rah-zohn)* (Furacin, etc.)	0.2%	soluble dressing, topical solution, topical cream	May cause local irritation. When absorbed systemically, drug may turn urine to dark red color. Safe use during pregnancy has not been established. Avoid exposure of products to direct sunlight, excessive heat, strong fluorescent lighting, and alkaline materials.
silver sulfadiazine *(**SIL**-ver **sul**-fah-**DYE**-ah-zeen)* (Flamazine ✱, SSD Cream, Thermazine, Silvadene)	1%	cream	Monitor for development of hypersensitivity reaction. Monitor serum sulfa concentration and check urine for sulfa crystals. Should not be used in pregnant women at or near term or in infants under 2 months of age.

- **mafenide** (**Sulfamylon**)
- **nitrofurazone** (**Furacin**)

Products containing these agents are generally applied to the burn after the wound has been cleaned and debrided. When possible, the affected area should be carefully bathed and debrided daily and a new application of drug provided. Therapy is continued until healing is progressing well or until the site is ready for grafting.

The proper use of topical products for burn treatment cannot be overemphasized, as it may make the difference between an uneventful healing or a potentially life-threatening infection. Clients on such products must be carefully monitored for the development of hypersensitivity reactions or adverse reactions caused by the systemic absorption of the topically applied drug. Table 40–8 lists topical products used in burn therapy.

DEXTRANOMER (DEBRISAN)

Dextranomer is a polymer that has a strong affinity for water and is available as small synthetic beads or as a paste. Each gram of beads will absorb approximately 4 milliliters of liquid. This

product is employed clinically for cleaning wet ulcers and wounds, such as venous stasis ulcers, decubitus ulcers, infected traumatic and surgical wounds, and infected burns. When applied to the lesion, the dextranomer swells and causes a suction effect that removes exudates and particles that could impede tissue healing. When saturated, the dextranomer is removed and a new supply is applied. This process is continued until the area is free of exudate or healthy granulation tissue is present. After each application, the area should be covered with a dry dressing and closed on each side. Saturation of the dextranomer is accompanied by a change in color. As dextranomer is not a debriding agent, the wound or ulcer should be debrided and cleaned prior to dextranomer use.

MINOXIDIL (ROGAINE)

Minoxidil is a drug used systemically as an antihypertensive agent. Also, it is employed topically to stimulate hair growth in males and females with baldness or hair thinning. Although its mechanism of action is unknown, it may be related to the drug's ability to dilate local blood vessels. At least 4 months of twice daily applications of the drug are required to see hair growth.

Clients with a history of heart disease must use minoxidil with caution because the drug may cause tachycardia, fluid retention, and/or weight gain in such clients. Systemic effects are more likely to occur if the drug solution is applied to damaged or irritated scalp. Using this drug with topical corticosteroids also may enhance systemic absorption.

MASOPROCOL (ACTINEX)

Masoprocol is an agent used in the topical treatment of actinic (solar) keratoses. When applied to the actinic keratoses twice daily (am and pm for 28 days), the drug reduces the growth of the keratoses and clears the lesions. Contact of the cream with the eyes, nose, or mouth should be avoided. No occlusion should be used when the drug is applied.

APPLYING THE NURSING PROCESS

ASSESSMENT

Assessment of clients with skin disorders entails taking a health history, including information on medications and cosmetic agents currently in use and obtaining a history of allergy. Inspection of the skin is important and should focus on the skin's color, texture, moisture, turgor, and temperature. Examination of the hair and nails should be included in the assessment. Lesions are described by noting their color, distribution, and shape, as well as symptoms, such as itching or burning associated with the lesion. Clients are asked about the length of time they have had the lesion and whether it occurred in association with trauma, infection, or allergic reactions.

Assessment of clients with burns includes obtaining information on the cause (e.g., chemical, electrical, or thermal) and describing the degree and severity of the burns. Burn severity depends on the depth of the burn (first-, second-, or third-degree), percentage of body burned (determined by using a burn chart), part of the body burned, client's age, and general preburn condition. Vital signs are taken, with height and weight obtained. Burn clients may be suffering from smoke inhalation, so gas exchange is assessed through observation and laboratory studies.

NURSING DIAGNOSES

Including but not limited to:

- Impaired skin integrity related to disease process
- Disturbed body image related to skin lesions
- Risk for injury related to application of topical medications
- Deficient knowledge related to disease process and medication regimen

PLANNING/GOALS

- Client will experience healing of skin lesions as evidenced by daily reduction of redness, drainage, itching, eschar, discomfort, rash, etc.

- Client will verbalize positive body image as skin regains integrity.
- Client will not experience injury related to administration of dermatologic agents.
- Client will verbalize understanding of disease process and medication regimen.

IMPLEMENTATION

As the skin plays so many important roles, including serving as a barrier to infection, the nurse must assist in maintaining skin integrity. Steps are taken, particularly in elderly and debilitated persons, to minimize the impact of factors associated with drying of the skin, which can lead to integrity loss. These factors include low humidity, excessive air conditioning, wind, frequent bathing with hot water, and the use of harsh soaps and detergents. Prevention of dry skin is usually accomplished more easily than treatment. Susceptible persons should bathe only in lukewarm water using a mild soap. In most cases, it is not advisable to add oils to the bath water, as they are less effective than oils applied following the bath and because of the danger of slipping when taking a tub bath containing oil. Following the bath, the person is instructed to avoid vigorous towel drying and to apply an appropriate oil, lotion, or ointment to the skin.

Nurses caring for clients with skin disorders need to be aware of the emotions that often occur in response to these problems. There may be embarrassment, shame, and a desire to limit social contact until a condition improves. Nurses can be helpful in encouraging persons with skin disorders to seek appropriate help, in providing emotional support during treatment, and in reinforcing the physician's instructions concerning treatment. Reinforcement includes frequent skin care and use of topical and systemic therapies.

Many clients with skin problems are ambulatory and can be responsible for their own care. Specific guidelines should be followed whenever topical medications are to be applied. First, it is important that the area to which the medication is applied be clean and dry. This involves the removal of any residue from previous applications of the agent. Following cleansing, drying, and careful observation of the area, the agent may be applied. If the skin is cracked or ulcerated, precautions such as the use of sterile applicators are taken to prevent infection. Suspensions must be thoroughly shaken before application is attempted. Before application, the client is made comfortable and clothes and bed linens are protected. If medication is being used on the face, it is first placed on the forehead and applied downward, while avoiding contact with the eyes and lips. The medication is applied with strokes moving from the midline of the forehead outward and from the cheekbones downward to the chin. The medication is only applied in one direction, generally in the direction of hair growth (Figure 40–3). When applying medication to a lesion, it is first placed at the center of the lesion and worked outward to avoid introducing bacteria and other skin contaminants into the lesion.

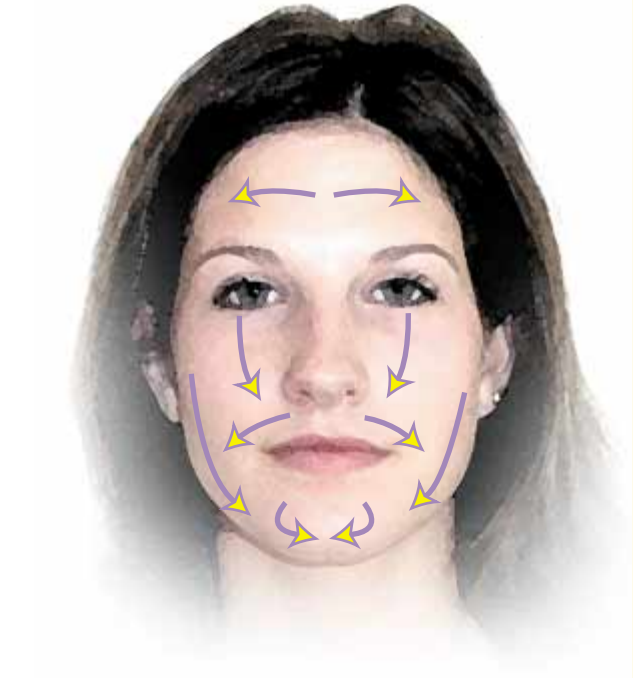

Figure 40–3 Applying medication to the face, starting with the forehead and spreading down each side of face in one direction.

If greater absorption of the medication is desired, hot packs or a warm bath may be used just prior to application of the agent. A technique used to promote absorption of certain topical preparations involves the occlusion of the treated area with a plastic food wrap. As this technique may dramatically affect the client's response to the applied medication, it is employed only when the prescriber requests it.

KEY NURSING IMPLICATIONS 40–1

Skin Disorders: Assessment and Implementation

1. Assessment focuses on obtaining a history, inspecting the skin for color, texture, moisture, turgor, and temperature and describing skin lesions.
2. Assessment of burn clients seeks information on the cause and severity of the burn, the client's vital signs, and gas exchange.
3. In the elderly and debilitated, the nurse takes particular care to minimize factors associated with drying of the skin.
4. Nurses must be aware of the emotions the client with a skin disorder is experiencing.
5. Instruction of clients about the use of topical medications is an important nursing function.
6. Suspensions should be shaken thoroughly before use.
7. Occlusive dressings increase absorption of medications. They are used only when ordered.

Following application of the medication, chart the procedure on the client's record, being certain to record observations about the area of skin or the lesion which is being treated.

In some skin conditions, such as widespread psoriasis, medicated baths will be ordered. Nurses provide for both the privacy and the safety of the client. The client should be comfortable and protected from drafts. Persons who are debilitated, medicated or experiencing limited sensory integrity are assisted in and out of the tub. Following the bath, application of additional agents may be ordered. After the client is comfortable, chart the procedure and arrange for appropriate cleaning of the bath area to prevent accidents.

CLIENTS RECEIVING ANTIFUNGAL AGENTS

Fungal infections of the skin and mucous membranes are not uncommon. These require the use of antifungal agents and special nursing measures. The nurse must know that griseofulvin use may be associated with gastrointestinal symptoms, skin rash, and blood dyscrasias. If blood abnormalities appear, the drug is discontinued. Also, because griseofulvin is a penicillin derivative, cross sensitivity may appear. Therefore, clients should be questioned about penicillin allergy before treatment is begun. Treatment with oral antifungal agents may be prolonged and combined with use of topical agents. The client's continued cooperation is essential. Attention must be paid to client education and ensuring follow-up visits. When a skin infection is the reason for treatment, the client must be taught good hygiene practices: for example, thoroughly towel drying the skin. The importance of preventing the spread of infection is emphasized, such as by using clean towels and not allowing others to use them.

Because griseofulvin may cause photosensitivity, clients are instructed to avoid intense direct sunlight. Clients are also told that gastrointestinal symptoms may be minimized and absorption increased when griseofulvin is taken following meals, particularly high-fat meals.

Nursing care for clients using topical antifungal agents is discussed elsewhere. (See Chapter 3 for instructions regarding the insertion of vaginal medications and Chapter 7 for additional information on the use of antifungal medications.) Primary functions of the nurse are to provide instruction in client hygiene, to give directions concerning the application of the drug and the control of infection, and to encourage the client to continue treatment for the prescribed period. Clients are informed that treatment is often continued for 1–2 weeks after symptoms improve to avoid reinfection.

Nystatin oral suspension (Mycostatin, etc.) is used in the treatment of oral candidiasis, also called thrush. Clients are instructed to hold the suspension in the mouth for several minutes and to swish it around before swallowing it. This permits contact of the drug with all parts of the oral cavity. In infants, unconscious clients, and others unable to cooperate with this procedure, nystatin is applied to the oral mucosa with a sterile applicator. Clients who might be prone to thrush—for example, those on broad-spectrum antibiotics—are instructed in good oral hygiene, including the avoidance of overusing commercial mouthwash, as this may alter the normal oral flora. Persons susceptible to the development of thrush are instructed to advise the physician about this and are observed daily for the development of this infection.

KEY NURSING IMPLICATIONS 40–2

Antifungal Agents

1. Observe the client taking griseofulvin for gastrointestinal symptoms, skin rash, and blood dyscrasias.
2. Clients scheduled to receive griseofulvin are questioned about penicillin allergy, since cross-sensitivity can occur.
3. Client hygiene and compliance are important factors in treating fungal disease.
4. Gastrointestinal symptoms may be minimized and absorption improved in clients taking griseofulvin when the drug is taken following meals, especially high-fat meals.
5. Clients are instructed to hold nystatin suspension in the mouth for several minutes and to swish it around before swallowing it.

NURSING THE BURN CLIENT

The quality of nursing care received by clients with severe burns is a critical element in their survival. Throughout the client's hospitalization, attention must be given by the nurse to maintaining an environment free of contamination. Reverse isolation is used to protect the client from infection. This requires the use of gowns and masks, as well as sterile gloves and techniques for dressing changes. In addition, aseptic care of urinary catheters and intravenous infusions is extremely important. As half of all burn clients who die do so from infection, the nurse must take special precautions to prevent infection in any part of the body. This includes the prevention of *stasis pneumonia* by providing adequate hydration, encouraging movement, changing the client's position, and encouraging coughing and deep breathing exercises. In most clients, the use of systemic antibiotics will be reserved for treating infections identified by culture and for the periods before and after surgery related to burn care. Nurses monitor the client for indications of infection, frequently obtain cultures for analysis, administer oral and/or parenteral antibiotics, and make observations related to the therapeutic and side effects of the medications. When systemic antibiotics are used, it is critical to maintain a therapeutic blood level of the drug. This means that daily antibiotic administration is spaced over 24 hours and that doses must be delivered on time. When antibiotics are administered by injection, it is important to rotate sites to preserve the integrity of the sites and to prevent problems related to absorption. Location of appropriate sites is often difficult because of the distribution of the burns. Consult Chapter 3 for the location of sites for intramuscular administration of drugs.

A major responsibility of the nurse is the care of the burned areas of the body. It is difficult to make generalizations about wound care, as several general methods may be used, and a host of therapeutic agents may be applied to the wounds. The general methods of wound care are the:

- *open or exposed method*—in which the wound is left uncovered. This permits the drying effect of the air to form a protective crust on the wound and also permits observation of the burned area.
- *semiopen method*—in which the wound is covered with a topical antimicrobial agent. A thin layer of dressing may then be used to cover the area.
- *closed or occlusive method*—in which topical medications are applied, followed by absorbent dressings and often elastic bandages or a net dressing. These dressings are frequently left intact for 1–2 days before they are changed.
- *wet to dry method*—in which wet dressing is applied to wound—allowed to dry and removed. At the same time it protects and debrides the wound. These dressings are usually done twice daily.

If the closed method is used, dressings must be removed carefully. As this procedure is frequently painful, clients should receive pain medication 15–20 minutes before the change. The final layers of dressing need to be removed carefully. This can be done in a bath or by wetting the dressing with various solutions, frequently normal saline solution or a solution of saline and hydrogen peroxide. Once the dressing has been removed, the wound is cleaned with the solution that has been ordered, working from the interior of the wound to the exterior in a circular fashion. The wound is then rinsed with normal saline and dried with sterile gauze pads. At this time, the wound can be debrided

NURSING CARE PLAN

A Child with Burns Being Treated with Mafenide (Sulfamylon)

Omar, age 2½, was toddling around the kitchen table when he reached up and grabbed the coffee pot cord, causing hot coffee to pour over him. His mother placed him in the shower immediately and then wrapped him in a blanket and brought him to the emergency room. When he is undressed, he is found to have first- and second-degree burns over his chest and abdomen. The physician orders mafenide (Sulfamylon) for the burned areas. The nurse tells Omar that this medication looks just like ice cream, although it is not, but will feel warm on contact. The burned area is dressed and the mother is given a prescription for mafenide and acetaminophen (Tylenol) elixir. Each teaspoon of elixir contains 160 mg of acetaminophen. Omar's mother is told the child can have 1 teaspoonful every 4 to 6 hours. She is also instructed to observe for blisters, swelling, and infection. The wound should be dressed twice daily and prn with a thin layer of mafenide spread gently with gloves or a tongue blade. Omar should take plenty of fluids and be kept quiet. He is referred to a pediatrician for follow-up care.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Area of burn extent and depth.	Acute pain related to burned area.	Child verbalizes relief of pain following pain relief interventions.	Teach mother how to dress wound with least amount of pressure. Keep wound covered with medications and dressing, as air on burned tissue causes pain. Encourage her to medicate child with acetaminophen before dressing changes.	Child cried when medication was applied topically to wound, but then settled down in mother's arms.
Fear, child crying.	Fear related to unfamiliar environment and pain of burn.	Child will have support of mother through treatment.	Allow mother to stay with child while being treated. Explain to child what is being done and why. Let child handle some dressing material to get familiar with it.	Child was held by mother while dressings were applied. Child appears less in pain with mother present.
Open wound, burned tissue.	Risk for infection related to loss of protective barrier of skin.	Child will not have infection of burned area as evidenced by normal temperature, white blood count, and healing wounds.	Teach mother to observe for infection. Watch for blisters. Do not puncture them if they occur. Keep wound covered with thin layer of medication. Report areas of pain, heat, increased redness, or swelling. Take child's temperature daily.	Child does not develop infection.
Appetite. Food preferences.	Imbalanced nutrition; less than body requirements related to increased calories needed for new tissue growth.	Child will increase food intake during healing period.	Encourage mother to provide supplements, such as milkshakes, for child during healing period. Advise mother to increase protein, vitamin C, and calories.	Child continues to maintain growth pattern while healing from burn.
Activity. Need for play therapy.	Deficient diversional activity related to inability to participate in usual play activities.	Child will be able to participate in play activities that will use less energy.	Encourage mother to have child play quietly in bed under close supervision. Provide toys that will not take energy.	Child alternates play and rest periods.

Client and family reaction to injury.	Deficient knowledge related to preventive health care.	Child's family will be able to demonstrate understanding of how to prevent future accidents and treatment for this one.	Teach parents that cords have to be kept out of reach. Teach parents that preschoolers need consistent supervision. Encourage parents to talk about their feelings of guilt related to this incident.	Child's parents are able to identify ways to "child-proof" their home.
Knowledge of drug therapy and dressings.	Deficient knowledge related to drug therapy and proper way to dress wound and apply mafenide.	Child's family will be able to demonstrate proper dressing technique.	Teach parents to apply mafenide in thin layer of 1/16 inch with gloves or a tongue blade. Demonstrate application of mafenide. Dressings are to keep drug on the burned area and should be changed twice a day or when they fall off. Teach parents to premedicate child with acetaminophen 15–20 minutes before dressing change, as he may experience pain when mafenide is first applied.	Child's parents apply child's dressing correctly and premedicate child.

surgically or by application of an enzymatic debriding agent applied in a thin layer directly to the wound.

After hydrotherapy or debridement, topical drugs are reapplied to the wound. When the open method of treatment is being used, a thin layer (2–4 mm) of the agent is applied directly to the burn *eschar* and the area is left uncovered. When treating burns with this method, it is important to apply the cream or ointment periodically to keep the eschar covered. If a semiopen or closed method is being used, the topical medication may be applied to gauze, which is then applied to the wound. The area may be further dressed according to the method being used. When applying dressings, the nurse ensures that opposing skin surfaces are not in contact with each other and that limbs are maintained in anatomical position.

In addition to the use of creams or ointments, solutions of various types are frequently applied to burned areas. These solutions may be applied in two ways. The dressings can be soaked in the solution, applied to the wound, and covered by a dry dressing or they can be soaked, applied, and kept wet by frequent irrigation using the topical solution. Physician's orders and/or a protocol, as well as the nature of the agent being used, determine the method employed.

In an effort to prevent or treat infection, drug therapy may be changed frequently based on the results of wound cultures and/or the client's response to treatment. Many topical products are available and nurses who care for clients with burns need to be familiar with the precautions and side effects associated with the use of these products. For example, it is important to keep dressings saturated with silver nitrate solution wet to prevent the solution from becoming caustic to the tissues. Also, silver nitrate solutions may stain the skin, clothing, floors, etc., and precautions must be taken to protect the environment. Some agents, such as mafenide (Sulfamylon), may be painful when applied and may also affect electrolyte balance. Nitrofurazone (Furacin) may be applied directly to a burn or it may first be applied to gauze. It is excreted by the kidneys and may turn the urine dark red. The client and family should be informed about this to avoid concern caused by the color change of the urine draining through a retention catheter into a collection bag. The nurse must also remember that hypersensitivity reactions can occur with topical agents. It is important to identify these reactions as soon as possible so that a substitution may be made.

Many burn care centers are now using early excision of burn tissue and grafting to close the wound, rather than a prolonged course of debridement and dressings. The clean wound may be covered with grafts of the client's own skin (autograft), with skin from a cadaver (heterograph or xenograft), or with a synthetic skin substitute.

There are many other aspects of nursing care for burn clients; important among them are ensuring the client receives adequate hydration and nutrition and providing emotional support. Because of the hypermetabolic state and negative nitrogen balance often evident in burn clients, clients may require nutritional supplements high in calories and protein. This helps maintain an adequate defense system to fight infection.

KEY NURSING IMPLICATIONS 40–3

Nursing the Burn Client

1. Burn wounds may be treated by an open, semiopen, closed, or wet to dry method.
2. Always remove burn dressings carefully and cleanse the wound with the ordered agent, working from the center of the wound outward.
3. Dressings saturated with silver nitrate must be kept wet to avoid the solution becoming caustic to tissues.
4. Silver nitrate solutions stain skin, clothing, and the environment.
5. Mafenide may be painful when applied and affect fluid and electrolyte balance.
6. Nitrofurazone may turn the urine dark red.
7. Burn clients require emotional support, attention to fluid and electrolyte balance and nutrition, protection from infection, and control of pain.

Emotional support of the client is required at all stages of treatment. Clients frequently fear dying, remaining disfigured, or suffering pain. In doing procedures that may be painful, the nurse ensures that pain medication has been given and performs the procedure as gently as possible. Explanations are given before procedures are done and, in general, measures are taken to encourage trust and confidence in the health team and to promote the client's cooperation with treatment.

EVALUATION

- Client experiences healing of skin lesions as evidenced by daily reduction of redness, drainage, itching, eschar, discomfort, rash, etc.
- Client verbalizes positive body image as skin regains integrity.
- Client does not experience injury related to administration of dermatologic agents.
- Client verbalizes understanding of disease process and medication regimen.

HOME CARE / CLIENT TEACHING

1. Clients using topical dermatologic agents should be instructed on proper application and use of these agents.
2. Clients using suspensions should be informed that suspensions must be shaken thoroughly before use.
3. Particularly during winter, the nurse should counsel older persons about methods to prevent dry skin. These methods include increasing the humidity by using a humidifier, limiting the frequency of bathing, using tepid rather than hot water for bathing, and using an emollient following bathing. The emollients listed in Table 40–2 are examples of easily obtainable products. The client also should be counseled to maintain an adequate fluid intake.
4. Clients with diabetes need to be instructed regarding proper foot care, including daily washing with nondrying soap; careful drying of feet after washing; daily inspection of feet for areas of dryness, redness, or breakdown; and always wearing shoes.
5. Clients with diabetic foot ulcers should be encouraged to maintain follow-up with their physician and adhere to diabetic treatment plan to control blood glucose levels to WNL.
6. Clients using nystatin oral suspension should be instructed to hold nystatin suspension in the mouth for several minutes and to swish it around in the mouth before swallowing it.
7. Nurses must be actively involved in preventing burns. They may discuss burn hazards in the home and general fire safety while doing home visits.
8. Nurses should counsel clients about skin cancer and the ways they can protect their skin from excessive exposure to the sun.

CASE STUDY

Luis Rosado is a 57-year-old mason who sees a dermatologist because of the gradual development of dry, thickened skin on his elbows that is accompanied by considerable pruritus. The dermatologist makes the diagnosis of psoriasis and prescribes the following:

- **DuoFilm** (salicylic acid 17%) 15 mL
- Sig: Apply to affected area with brush applicator at bedtime and remove in AM
- Temovate cream 0.05% 30 g
- Sig: Apply daily in AM

After 2 weeks of therapy, the appearance of Mr. Rosado's lesions has improved, but the pruritus has become worse.

continues

Questions for Discussion

1. What is the role of the medications prescribed for Mr. Rosado in the treatment of psoriasis?
2. How should Mr. Rosado be instructed to use the DuoFilm?
3. Why did the pruritus fail to respond to the prescribed therapy?
4. What changes or additions to Mr. Rosado's therapy would seem to be indicated?
5. What nursing measures would be appropriate in the administration of the prescribed drugs?

CRITICAL THINKING EXERCISES

1. Describe the functions of the human skin.
2. Describe the anatomical changes of the life cycle of an epidermal cell.
3. Discuss the function of the eccrine and apocrine sweat glands and the sebaceous glands.
4. Prepare a brief report on the immediate treatment of burns.
5. Prepare a visual aid for use in discussing the prevention of dry skin.
6. Prepare a visual aid to be used when instructing an adolescent in an acne treatment program.
7. Prepare a brief report about psoriasis, focusing on the drugs used to treat this condition.
8. Prepare a brief paper on the identification and treatment of conditions that are most common in the skin of black persons.
9. Prepare a visual aid on the identification and treatment of ringworm.

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Substance Abuse

41

OBJECTIVES

After studying this chapter, the student will be able to:

- Define the terms substance misuse, substance abuse, habituation, physical dependence, psychological dependence, addiction, tolerance, cross-tolerance, and alcoholism.
- Identify the major pharmacological effects and usual method of abuse for each of the substances:
  opiate and opiate-like drugs
  sedative/hypnotics
  alcohol
  amphetamine and amphetamine-like drugs
  cocaine
  cannabis
  psychedelic drugs
  tobacco
  inhalants
- Describe appropriate ways by which dependency or abuse of each substance listed can be managed
- Describe the use of methadone maintenance and narcotic antagonist therapy in the treatment of the opiate abuser
- Discuss appropriate nursing assessment for persons who abuse substances
- Describe the emergency nursing care given to substance abusers
- Apply the nursing process for persons who are chronic or recurrent substance abusers
- Discuss the management of health care workers who are substance abusers
- List several resources for information on substance abuse

During the last several decades, substance abuse and dependence have become critical public health problems. Although substance abuse has existed throughout history, it generally involved a relatively small minority of the population. Today, substance abuse is a pervasive problem that affects persons of all ages from all socioeconomic groups. Of particular recent concern has been the growing trend toward the abuse of chemical substances, particularly drugs, alcohol, and tobacco by preteenage children, as well as the apparent acceptance of substance abuse by many as the norm rather than the exception. Literally billions of dollars have been spent by all levels of government in attempting to eradicate illicit drug use and drug trafficking, with only limited positive results.

The abuse of chemical substances, particularly drugs, alcohol, and tobacco, is a complex problem, the product of interaction between an individual, his/her social and cultural environment, and the availability of abusable substances. The margin between appropriate and improper use of a substance is also difficult to define. Some have defined substance abuse as the use of any substance in a manner deviating from the accepted medical, social or legal patterns of a given society. Although virtually any chemical substance can be abused, this chapter deals primarily with the most commonly abused substances in our society. These include:

- opiate and opiate-like drugs
- central nervous system (CNS) depressants, including hypnotics, sedatives, antianxiety agents, and alcohol
- CNS stimulants, including cocaine and the amphetamines
- the cannabis derivatives, **hashish** and **marijuana**
- psychedelic agents, including **LSD** and **mescaline**
- tobacco
- inhalants

Before studying the specific forms of substance abuse, it is important to understand the terminology often used in describing abuse, as much confusion about this topic is related to the misuse of terminology. The following definitions, although subject to debate, represent currently popular views on the issue of substance abuse.

Substance misuse is the improper use of drugs and/or other chemical substances that have been prescribed or acquired for a legitimate therapeutic or other nonrecreational purpose. Such misuse is generally the result of ignorance rather than a conscious attempt to get "high." For example, the elderly often misuse laxatives in an attempt to prevent or counteract perceived or actual cases of constipation. This misuse often results in further, more severe, constipation and an endless cycle of potentially harmful and costly drug use. The use of alcoholic beverages is widespread in our society and is generally safe when consumption is moderate. When misused, alcohol consumption may result in impairment of vision, coordination, and judgment that may seriously affect the ability to drive a vehicle or engage in other potentially hazardous tasks.

Substance abuse, as was previously noted, is difficult to define because it relates to a society's subjective view of what constitutes abuse. In general, however, substance abuse can be defined as socially unacceptable use of drugs or other chemical substances for nontherapeutic purposes.

Habituation is a pattern of repeated substance use in which a person feels better when using the substance than when not using it. A habituated person can generally discontinue use of the substance abruptly without experiencing severe physical or psychological discomfort. A person who regularly relies on a cup of coffee or other caffeine-containing beverage to "get going" in the morning or during the day or the person who "must" have a cigarette after a meal exhibits a form of habituation to the chemical agents found in these products.

Substance dependence is a broad term describing a state in which a person has difficulty functioning unless under the influence of a drug or other chemical substance. Chemical substances may produce a wide spectrum of dependence, which may include psychological and/or physical dependence.

Psychological dependence is a compulsive need to experience the effect(s) produced by a chemical substance. Such need may range from a moderate desire to use the substance to an overwhelming compulsion superseding all other sources of satisfaction (family, friends, work) in the person's life. Although abstinence from the substance may produce profound discomfort, it does not result in physical withdrawal symptoms.

Physical dependence is a state in which one or more physiological functions of the body become dependent on the presence of a particular chemical substance in the body. Such dependence usually results from prolonged use of a substance. Abrupt discontinuation of the substance results in the development of an abstinence or withdrawal syndrome, the severity being related to the type and duration of substance use.

Addiction is a term that has been used freely in the lay and scientific literature to the point where its meaning is no longer clear. In general, however, addiction implies a person's loss of control over use of a chemical substance and a strong compulsion to obtain and use the substance.

Tolerance is reduced effect from the use of a substance resulting from its repeated use. In many cases, tolerance develops because a substance has stimulated its own metabolism in the body. In other cases, cells in the body adapt to the presence of a substance. In either case, a greater amount of the substance must be used in order to produce

the same response produced by a smaller quantity of the substance in the past.

Cross-tolerance is reduced effect of a substance resulting from repeated use of a chemically related substance.

OPIATE ABUSE

Opiates or narcotic analgesics include natural or synthetic drugs that have pharmacological actions similar to those of the drugs derived from opium. Opium is a substance derived from the poppy plant *Papaver somniferum*. More than twenty different drugs have been derived from opium. Those shown to be capable of causing dependence include morphine, heroin, codeine, and Dilaudid. Meperidine (Demerol), methadone, **dextropropoxyphene** (Darvon, etc.) and diphenoxylate (Lomotil) are synthetic drugs with opiate-like activity that can also produce opiate-like dependence.

Opium has been used since ancient times for medical, religious, and recreational purposes. During the nineteenth and early twentieth century, opium was a common ingredient in many patent medicines sold in the United States. The Harrison Narcotic Act of 1914, as well as various court decisions in the 1920s, made the use of opiates a crime unless they were prescribed by a physician. During the last few decades, the most commonly abused opiate has been heroin. Because the sale of heroin has been and continues to be illegal in the United States, an illicit market of heroin dealers and traffickers has emerged, particularly in urban ghetto areas. Continuous pressure by law enforcement authorities has limited the supply of heroin and driven the price up to extreme levels. As a result, heroin users frequently resort to criminal activity to support their addiction. Heroin abuse coupled with poor quality control of heroin sold in the illicit market has resulted in injury and death for many abusers. Heroin abuse is currently considered to be an important cause of death in urban males between 15 and 35 years of age.

In recent years, the abuse of other opiates and opiate-like drugs has become widespread. Morphine and meperidine (Demerol) abuse has become more common, because of the availability of these drugs in health care institutions and physicians' offices. Of particular concern has been the increasing abuse of these drugs by physicians, nurses, pharmacists, and other health care professionals who have access to them. The use of codeine, particularly as an ingredient in cough medicines, continues to be a problem, especially in states that do not require a prescription for such products.

Pharmacology

All opiate and opiate-like drugs are capable of producing a variety of pharmacological effects (see Chapter 10). The nature and magnitude of the effects depend on the drug being used, its route of administration, and the client's history of use of the drug. Many of the most potent opiate compounds, particularly morphine and heroin, have little activity when administered orally. Methadone, Dilaudid, meperidine, and dextropropoxyphene, on the other hand, retain much of their narcotic activity when administered orally.

When an opiate or opiate-like compound is administered to an inexperienced, nontolerant user, the initial feeling may be quite unpleasant and may include profuse sweating and itching caused by the dilation of peripheral blood vessels. The user may also experience nausea and vomiting because of the opiate-induced stimulation of the vomiting control CNS center. After this initial unpleasant phase, the user may experience analgesia, partially the result of the reduction of anxiety and tension caused by the perception of pain. This may be accompanied by a feeling of euphoria, tranquility, mental clouding, and sleepiness. Opiates also tend to cause constriction of the eye pupils, respiratory depression, reduced body temperature, reduced gastric motility, and diminished propulsive activity of the small and large intestines.

With repeated use of opiates such as heroin and morphine, the user experiences fewer unpleasant effects. Each administration tends to produce a sense of drowsy relaxation, relief from worry and tension, and a feeling of detachment from all problems. With continued use, tolerance develops to the euphoric effects of the drug and the user must resort to higher doses and/or administration by subcutaneous (skin-popping) or intravenous (mainlining) injection. Intravenous injection of heroin produces an immediate feeling of warmth and a sensation of ecstasy, which has been compared to sexual orgasm and is sometimes termed a "rush" or "kick." This is followed by a profound lethargic state, which is considerably longer and deeper than that experienced with administration by other routes. With continued use, increasingly higher doses and more frequent administration are required for the user to experience an equivalent

response. This puts increasingly greater pressure on the abuser to devote more time and energy to supporting the addiction and may explain why many male heroin abusers resort to burglary and forgery to support their habit, with female abusers often turning to prostitution. Heroin abuse also has been associated with the development of a permanent Parkinson's disease-like syndrome.

Physical dependence on the opiates may be evident after only a few exposures to the drug. The abstinence syndrome produced varies with the drug, the dosage, and the dosage frequency. Abrupt withdrawal from the opiates (cold turkey) produces withdrawal symptoms including anxiety, depression, restlessness, insomnia, sweating, and irritability. In more severe episodes, nausea, vomiting, abdominal cramps, chills, and even convulsions may occur. Heroin or morphine withdrawal symptoms generally peak 36–48 hours after the last dose has been administered and then subside over the next 5–10 days. Abstinence syndrome to the opiates can be precipitated in minutes by the administration of narcotic antagonists, such as naloxone (Narcan), to opiate-dependent individuals.

Management of Opiate Dependence

Several methods may be employed in managing the opiate-dependent person. These include:

- detoxification
- methadone maintenance
- narcotic antagonist therapy
- abstinence, or drug-free, programs

Detoxification. Detoxification of the opiate abuser is the first step employed in managing opiate-dependent persons. This may be accomplished in several ways. In mild abstinence syndromes, only supportive care may be required. In more pronounced opiate withdrawal, methadone may be administered to the client. Methadone is a synthetic opiate-like compound eliminated more slowly than heroin. When administered orally, methadone prevents the opiate withdrawal syndrome but does not produce the euphoric effect of heroin or morphine. When administered to a heroin-dependent person in place of heroin and then gradually withdrawn over a period of weeks or months, abstinence symptoms tend to be relatively mild and tolerable as compared to heroin withdrawal.

Several other drugs have been used with some success in detoxifying opiate abusers. Some of these, such as chlordiazepoxide (Librium) or phenobarbital, are meant to reduce the client's anxiety and permit easier sleep. Clonidine (**Catapres**), an antihypertensive agent (see Chapter 31), has been shown to be effective in reducing the severity of withdrawal symptoms in opiate-dependent clients. It may produce hypotension in some clients, however.

As the detoxification phase of opiate dependence treatment is critical for the abuser, it is essential the client's treatment plan also include psychotherapy, family counseling, and social and rehabilitative therapy to increase the chance for successful treatment.

Methadone Maintenance. Another approach to managing the heroin-dependent client is to substitute methadone for heroin administration over an indefinite period. In such programs, methadone is administered orally, usually dissolved in a flavored drink, in doses high enough to prevent withdrawal symptoms, yet low enough to permit the client to function normally. Advocates of the use of methadone maintenance believe that such therapy reduces the client's desire for heroin and provides stability for the client who would otherwise engage in criminal activities or other socially unacceptable behavior. As clients using orally administered methadone do not experience euphoric effects, it is believed that the methadone-controlled client can engage in normal life pursuits.

Opponents of the methadone maintenance concept claim that the client receiving methadone is not actually cured, but is actually dependent on another opiate. In addition, clients on methadone maintenance must regularly visit a clinic to receive their medication and other forms of therapy. This is claimed by some to interfere with the clients' ability to engage in a normal lifestyle and exposes them to current and former abusers who may hamper their progress.

Several methods of improving methadone maintenance therapy are being investigated. One approach is the use of a methadone-like drug, acetylmethadol, which exhibits methadone-like effects but has a relatively long duration of action. Such a drug, if proven successful, would reduce the need for frequent visits by the client to the methadone clinic. Another approach being examined is the combining of methadone with the narcotic antagonist naloxone (Narcan). Such a combination would not alter the effects of methadone when used orally. If an attempt were made, however, to abuse the methadone by injecting a solution of the drug, the naloxone content of the mixture would produce immediate withdrawal symptoms.

Opiate Antagonist Therapy. The newest approach to the management of opiate-dependent clients is opiate antagonist therapy. Such therapy requires that the client voluntarily take regular doses of an opiate antagonist that blocks the euphoric effects of heroin or other opiates that the client might attempt to abuse in a "moment of weakness." The greatest drawback to such therapy has traditionally been the relatively short duration of action exhibited by available opiate antagonists (e.g. naloxone). More recently a long-acting opiate antagonist, naltrexone (Trexan), has been marketed. A single dose of naltrexone appears to block the effects of injected opiates for 48–72 hours and is, therefore, more likely to be used consistently by clients than drugs requiring more frequent administration.

Abstinence, or Drug-Free, Programs. A number of programs designed to treat the opiate abuser are based on total abstinence of the client from the use of all drugs, whether heroin, methadone, or an opiate antagonist. Such programs, which include Phoenix House, Narcotics Anonymous, Synanon, Project Return, and many others, are generally staffed, at least in part, by former drug abusers. Such programs usually attempt to rehabilitate abusers by helping them develop a more positive self-image and learn skills required to perform well in society without the use of drugs. Although many opiate abusers, particularly teenagers and young adults, have responded favorably to such programs, others have failed to respond well and have returned to opiate abuse.

CENTRAL NERVOUS SYSTEM DEPRESSANT ABUSE

Substances which depress the central nervous system are the most widely abused substances in the United States. The two major classes of these substances are:

- sedative-hypnotic/antianxiety agents
- alcohol

Sedative-Hypnotic/Antianxiety Abuse

Sedative-hypnotic/antianxiety agents include drugs such as the benzodiazepines, e.g., diazepam (Valium), chlordiazepoxide (Librium), and oxazepam (Serax) and the barbiturates, e.g., phenobarbital, **secobarbital** (**Seconal**), and pentobarbital (**Nembutal**). Such drugs are believed to be widely used because unlike the opiates, they are readily available by prescription. In the 1970s, many of the drugs in this category were among the most widely prescribed drugs in the United States. Today their popularity remains high, although they are not as frequently prescribed as in the past.

The abuse of a sedative-hypnotic/antianxiety drug frequently begins with a client's use of the drug as prescribed by a physician to control anxiety or insomnia. With inadequate monitoring by the prescriber and ready availability of the drug, the client may, for a variety of reasons, increase the dosage and/or frequency of administration. With such prolonged misuse, the client may develop a true dependence on the drug to the point where normal functioning is no longer possible without it. Such clients often attempt to obtain more of the drug through prescriptions from several physicians.

In most cases, the abuse of sedative-hypnotic/antianxiety drugs involves oral administration, although, in rare cases, the drugs may be dissolved in water and injected parenterally. In recent years, the hypnotic drugs have been most widely abused by teenagers and young adults, often in combination with alcohol, to produce a state of disinhibition and inebriation. Sedative or tranquilizer abuse has been most frequently associated with young and middle-aged women who may have begun using the drug while being treated for anxiety.

Pharmacology. When abused, sedative-hypnotic/antianxiety agents are capable of producing a broad spectrum of effects depending on the drug dosage, route, and frequency of administration, as well as the level of tolerance developed by the abuser. At normally prescribed doses, these drugs generally produce sedation, which may reduce anxiety and alertness. Higher doses tend to interfere with normal mental and motor function and may produce drowsiness, slurred speech, impaired judgment, lethargy, and incoordination, which may appear similar to alcohol intoxication. Even higher doses tend to further depress consciousness, as well as cardiac and respiratory function. Coma and death may eventually result from respiratory and circulatory failure. The combination of sedative-hypnotics with alcohol or opiates may result in acute poisoning at relatively moderate dosages.

Tolerance may develop with the repeated or prolonged use of sedative-hypnotic/antianxiety drugs. Clients who have developed such tolerance may consume relatively high doses of these agents without any apparent outward change in their behavior or appearance. When abusers exceed their tolerance threshold, however, severe CNS toxicity is likely to occur rapidly.

When the sedative-hypnotic/antianxiety drug abuser is abruptly withdrawn from these drugs, restlessness, anxiety, shaking, and weakness may begin to appear within about 12 hours. In some clients these symptoms may be accompanied by nausea, vomiting, *orthostatic hypotension*, tremors, and seizures. Withdrawal symptoms generally reach their peak within 2–3 days after the last dose and then gradually subside over the next 3–5 days. The withdrawal process may be considerably prolonged in clients who have abused barbiturates or benzodiazepines, e.g., phenobarbital, diazepam (Valium), or chlordiazepoxide (Librium), which have a relatively long half-life.

Treatment of Sedative-Hypnotic/Antianxiety Abuse. As in the treatment of opiate abusers, detoxification is generally the first goal of therapy for the sedative-hypnotic/antianxiety abuser. Because of the risk of agitation and seizure activity during the withdrawal process, a long-acting depressant drug in the same class as the one(s) abused may be administered. Drugs such as diazepam (Valium) or phenobarbital are widely used for this purpose. Initially, these long-acting drugs are administered in a dose that not only suppresses withdrawal symptoms, but actually produces a mild level of intoxication. Once stabilized on this drug, the client's daily dosage is gradually reduced over 10 days to 3 weeks, until the client is drug-free. Throughout this controlled withdrawal process, the client is monitored for the development of withdrawal symptoms. Unlike the opiate withdrawal process, complete sedative-hypnotic/antianxiety withdrawal, particularly after abuse of the long-acting benzodiazepines, may take weeks or months. During and after the withdrawal period, every effort must be made to provide the client with supportive care and counseling to increase the likelihood of successful therapy.

Alcohol Abuse

Alcohol (ethanol) is the oldest psychoactive drug known. It has been consumed for thousands of years as a beverage, medication, and element of religious ceremonies. In the United States, it is estimated that two out of three people drink alcoholic beverages and that ten million drink enough alcohol to interfere with their ability to function. Of these, an estimated six million are considered to be alcohol-dependent or suffering from alcoholism.

Defining alcoholism is a difficult task. The World Health Organization has defined "alcohol-type drug dependency" as existing in an individual "when the consumption of alcohol exceeds the limits that are accepted by his culture; if an individual consumes alcohol at times that are deemed inappropriate within that outline, or intake of alcohol becomes so great as to injure his health or impair his social relationships." The American Psychiatric Association has attempted to define alcohol abuse and alcoholism in biological terms. It has proposed that alcohol abuse be suspected when an individual shows evidence of psychological dependence on alcohol or a need for alcohol to continue daily functioning. Also associated with this definition are frequent episodes of intoxication, continuous intoxication, or both. In addition, these events must persist for at least a month to rule out the possibility that the episode is a transient event in the client's life. The association defines alcoholism as alcohol abuse with evidence of physiological addiction to alcohol. Addiction is characterized as an extreme degree of tolerance to alcohol and the development of physical withdrawal symptoms when alcohol consumption is abruptly discontinued.

The medical effects of alcohol abuse are widespread. They include:

- acute alcohol intoxication
- alcohol dependence
- acute alcohol withdrawal syndrome
- medical complications
- fetal alcohol syndrome

Collectively, such problems account for hundreds of millions of dollars in lost work time, lost productivity, and medical care costs. In addition, as alcoholism is associated with a higher incidence of automobile accidents, violent behavior, and disruption of the lives of the abuser and his/her family, the true cost of alcoholism is virtually impossible to determine.

Pharmacology. Alcohol (ethanol) is a colorless liquid with a distinctive odor. It is derived from the fermentation of carbohydrates found in fruits, grains, and other vegetative material.

Alcohol is rapidly and completely absorbed from the gastrointestinal tract when consumed by a fasting individual. Its absorption rate is reduced in the presence of food, the degree of reduction depending on the amount of alcohol consumed, as well as the type and quantity of food in the gastrointestinal tract. Because of its rapid absorption the effects of alcohol on the body are quickly apparent.

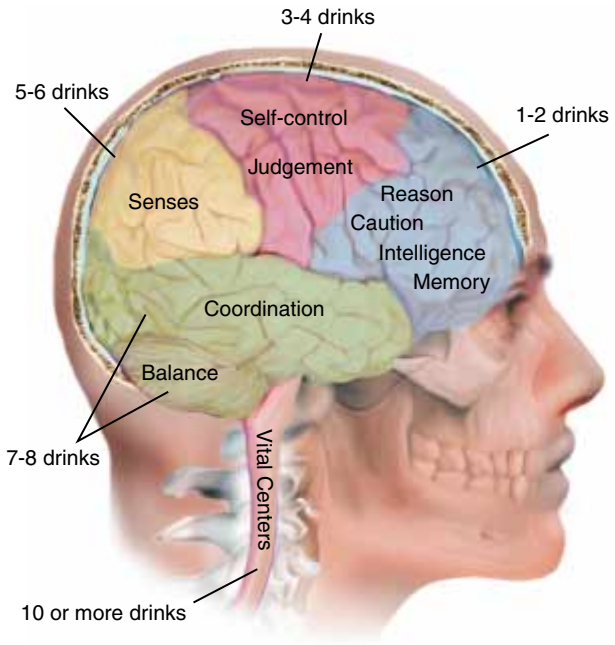

Figure 41–1 Effects of alcohol consumption on the brain.

The predominant pharmacological effect of alcohol is to *depress* the CNS (Figure 41–1). This is contrary to the mistaken belief that alcohol is a stimulant, a belief based on observation of the aggressive behavior displayed by some alcohol abusers. Such behavior is actually the result of depression of the brain areas that normally inhibit psychomotor activity. Alcohol's effects on the CNS are dependent on the level of alcohol in the blood. The blood alcohol concentration (BAC) is often expressed as milligrams (mg) of alcohol per 100 milliliters (mL) or one deciliter (dL) of blood or as milligrams percent (mg%). In a nontolerant individual, 30–50 mg/dL (0.02%–0.03%) of alcohol in the blood generally produces a state of relaxation and mood elevation that may be socially and/or medically beneficial for many people. Such levels do not produce significant impairment of judgment or motor coordination. At levels of 50–150 mg/dL (0.11%–0.12%) the alcohol abuser may experience progressively increasing levels of impairment of judgment, speech, motor coordination, balance, and reaction time. In most states, drivers with a BAC in this range are considered "impaired" or "intoxicated," depending on the precise alcohol level measured and may be subject to arrest. Blood alcohol concentrations in the range of 150–250 mg/dL tend to produce intoxication characterized by a progressive deterioration of higher cortical function. In some clients, the depressant action of alcohol becomes quite evident in this range and may be characterized by marked loss of coordination and impaired judgment. In the 250–400 mg/dL range, virtually all subjects will experience profound intoxication characterized by loss of motor function, uninhibited behavior, and loss of memory. Above a BAC of 400 mg/dL alcohol is likely to produce severe intoxication, which may be evident as a stuporous state or coma. Death may result from respiratory and/or cardiovascular failure. Table 41–1 summarizes the effects of various blood alcohol concentrations on the human body.

The precise effects that a given amount of alcohol will have on an individual is dependent not only on the alcohol concentration in the blood, but also on the client's level of tolerance and the ability of the body to metabolize and eliminate the consumed alcohol. Approximately 10% of the alcohol consumed is eliminated unchanged by the lungs and the kidneys. Portable devices (e.g., Breathalyzers) that measure the content of alcohol in expired breath are widely used by law enforcement agencies as a means of determining whether or not an individual is "under the influence" of alcohol. Although these devices may accurately determine the alcohol content of expired air, the assumption that such a measurement can be used to accurately predict blood alcohol concentration is questionable. Considerable biological variation in the ratio of alcohol in the blood and breath from person to person and even in the same person has been shown. Virtually all the consumed alcohol not eliminated unchanged by the lungs or kidneys is metabolized by the liver. The rate of alcohol metabolism by the liver is dependent on genetic factors, the condition of the liver, and the use of drugs that alter the liver's metabolizing capability. The rate may vary from person to person and in the same person at different times. It has been estimated that a 150-lb man will eliminate and metabolize approximately 9 g of ethanol per hour. This will result in a decrease in alcohol blood level of approximately 15 mg/dL/hr.

Continued use of high levels of alcohol results in physical dependence. Such dependence is believed to be related to the development of increased excitability of neurons in the body in response to the depressant effects of alcohol. When suddenly deprived of alcohol, withdrawal symptoms are likely to occur. The severity of these symptoms is dependent on the amount of alcohol which the abuser regularly consumed and on the duration of time over which alcohol was abused.

TABLE 41–1

Effects of Various Blood Alcohol Concentrations on the Human Body

BLOOD ALCOHOL CONCENTRATION	EFFECTS ON THE HUMAN BODY
0.02%–0.03%	Slight muscle relaxation and mood elevation.
0.05%–0.06%	Feeling of relaxation and warmth. Some increase of reaction time and decrease in fine muscle coordination.
0.08%–0.09%	Some impairment of balance, speech, vision, and hearing. Feeling of euphoria. Increased loss of muscle coordination.
0.11%–0.12%	Coordination, balance, judgment, vision, and speech distinctly impaired.
0.14%–0.15%	Gross impairment of mental and physical control.
0.20%	Loss of motor control. Requires assistance to move. Confused.
0.30%	Severely intoxicated. Little, if any, conscious control of mind or body. Blackouts likely.
0.40%	Unconscious. Threshold of comatose state.
0.50%	Deep comatose state. Death possible.
0.60%	Death from respiratory failure likely.

Early withdrawal symptoms may occur in some individuals within 6–8 hours after the last drink is consumed. These may consist of nausea, mild tremors, flushing, sweating, and mild disorientation. Hallucinations may be present in about 25% of those undergoing early alcohol withdrawal. Nightmares may also be evident during this period. Early withdrawal symptoms generally disappear after about 48–72 hours, although hallucinations may persist for longer periods. Generalized tonic-clonic seizures may occur in some clients during the first 12–48 hours after alcohol is withdrawn.

The most common manifestation of acute alcohol withdrawal syndrome is delirium tremens (DTs). This occurs in about 5% of all clients undergoing acute alcohol withdrawal symptoms and is characterized by confusion, disorientation, fever, tachycardia, sweating, hypertension and tremors. The syndrome generally appears within 2–5 days after alcohol has been withdrawn. Symptoms may persist for 1–6 days, after which they gradually subside. Throughout the alcohol withdrawal process, the client's symptoms are often successfully managed by the administration of CNS depressants other than alcohol. The benzodiazepines, particularly diazepam (Valium) or chlordiazepoxide (Librium), are often used. In addition, an anticonvulsant drug, such as phenytoin (Dilantin), may be employed to control seizure activity during the withdrawal process.

Treatment of Alcohol Abuse. The major objective in treating alcohol abuse is to achieve and maintain total abstinence in the abuser. This is based on the premise that, in most cases, alcohol consumption of any kind is likely to result in a return to alcohol abuse. The three most successful approaches to treating alcohol abuse are:

- counseling or psychotherapy
- membership and participation in organizations such as Alcoholics Anonymous (AA)
- use of disulfiram (Antabuse)

Counseling or psychotherapy for the alcohol abuser is generally aimed at achieving and maintaining abstinence and at providing the abuser with the ability to adjust to the psychological and social changes required to maintain abstinence. Alcoholics Anonymous (AA) and similar groups are organizations made up of former alcoholics that provide social support and acceptance for the alcoholic who is attempting to overcome alcohol abuse. Such groups have been shown to be extremely effective in preventing a return to alcohol abuse, particularly when the client is involved in other forms of therapy at the same time.

Disulfiram (Antabuse) is a drug voluntarily taken by the former alcohol abuser. It acts to interfere with the enzyme aldehyde dehydrogenase (Figure 41–2) and results in the accumulation of acetaldehyde in the blood whenever even small quantities of alcohol are consumed. The accumulation of acetaldehyde produces a variety of symptoms, collectively known as a "disulfiram reaction" or "Antabuse reaction" and characterized by flushing, headache, weakness, dizziness, nausea, and vomiting, within minutes after alcohol has been consumed. The success of disulfiram therapy is dependent on the client's commitment to use the drug regularly and to abstain from alcohol use.

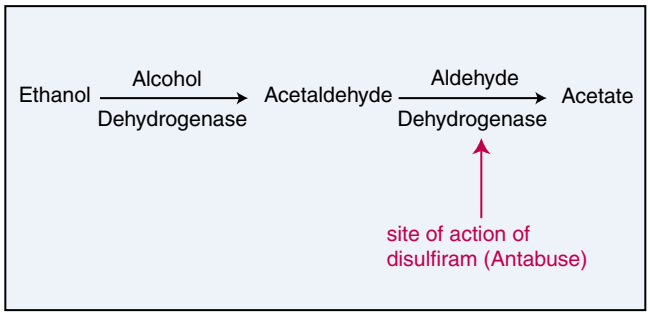

Figure 41–2 Pathway of ethanol (alcohol) metabolism. When disulfiram is used, the breakdown of acetaldehyde to acetate is inhibited, resulting in the accumulation of acetaldehyde to toxic levels.

CENTRAL NERVOUS SYSTEM STIMULANTS

Commonly abused CNS stimulants include the amphetamine and amphetamine-like drugs and cocaine. Collectively, the abuse of these agents has been a problem for several decades. In recent years, however, the abuse of cocaine has reached epidemic proportions in the United States.

Amphetamine and Amphetamine-Like Agents

Amphetamine and amphetamine-like agents such as **methylphenidate** (**Ritalin**) and **phenmetrazine** (**Preludin**) are agents used for many years to treat narcolepsy and hyperkinesis, as well as obesity. Such agents have also been widely abused because of their ability to produce CNS stimulation. Their effects include increased alertness and wakefulness, with diminished perception of fatigue. They may also suppress appetite and produce a euphoric state. Because of these properties, amphetamine and amphetamine-like drugs have been abused primarily by college students, truck drivers, and others who find the feeling of increased alertness desirable.

In addition to affecting the CNS, amphetamine and amphetamine-like agents also produce sympathomimetic effects (see Chapter 15). These may be evident as elevated blood pressure, cardiac palpitations, headache, and dry mouth, particularly when high doses are used. At one time the sympathomimetic properties of the amphetamines were utilized in nasal inhalant products to treat nasal congestion. Their use for this purpose ended abruptly when it was recognized that the amphetamines were being abused by some users.

In the past, most amphetamine abuse began with occasional use of the drugs by those wishing to increase alertness. With the development of amphetamine-like compounds that were marketed as appetite suppressants, many persons, particularly women, developed dependence secondary to their use of the drugs for weight reduction. More recently amphetamines, particularly methamphetamine, or "speed," has been used parenterally to get a "high." Abusers of this drug often do not sleep for days and develop a tolerance to the drug that necessitates increasingly higher doses to elicit the desired euphoric effect. With prolonged amphetamine use, some abusers develop a paranoid psychosis similar to acute paranoid schizophrenia. Such a response is characterized by hallucinations and potentially violent behavior. The phenothiazine antipsychotic agents (see Chapter 18) have been successfully employed in controlling a client during such episodes.

On abrupt discontinuation of amphetamines, the regular abuser may experience a withdrawal syndrome characterized by lethargy, depression, nightmares, increased appetite and prolonged (12–18 hour) sleep. During this period, the abuser may experience an intense craving for the use of amphetamines to counteract the feeling of lassitude and depression.

To curtail the use of amphetamine and amphetamine-like agents, the U.S. Food and Drug Administration has restricted the use of some products to the treatment of narcolepsy or childhood hyperkinesis. In addition, many of these drugs have been reclassified as Schedule II drugs by the federal and many state governments, thereby further restricting their availability and distribution.

Rehabilitation of the amphetamine abuser is generally based on abstinence from further drug use and in helping the abuser develop a social support system to minimize the likelihood of a return to drug use. The poorest prognosis exists for abusers who continue to experience personality disorders and/or psychotic episodes even after a period of drug abstinence.

Cocaine Abuse

A 1984 monograph issued by the National Institute on Drug Abuse (NIDA) stated that "cocaine is currently the drug of greatest national concern." It is estimated that the number of people in the United States who have tried cocaine at

least once decreased from more than 30 million in 1990 to 1.5 million in 1997. Alarm continues with the growing evidence that cocaine is no longer the drug of the rich, but is widely abused by people of widely varying ages and social classes. It is estimated that in 1990, 25%–30% of the teenage and young adult population in the United States had used the drug. In 1997, that figure had dropped to 0.7% of Americans 12 years old and older, according to the 1997 National Household Survey on Drug Abuse (NHSDA).

Cocaine is a substance found in the leaves of certain varieties of the coca shrub grown primarily in parts of South America. Leaves of this plant have been chewed by the people of the Andes mountains for more than 5,000 years. When extracted from coca leaves and purified, cocaine is a fine, white crystalline powder known by such street names as "snow," "crystal," "C," "white lady," and others. Prior to being sold to a user, cocaine is usually diluted with various powders, so that it is about 40% pure. Such diluents may include local anesthetics, such as procaine or benzocaine, or substances ranging from ascorbic acid (vitamin C) to quinine. Some of these adulterants have potent pharmacological actions of their own and have contributed to the development of severe toxicity or death in some users, particularly in those who were injecting the drug mixture directly into the bloodstream. Through illicit channels, a gram of the diluted cocaine powder costs the user $100 or more.

Cocaine is employed in medicine as a local anesthetic. Because it also has the ability to constrict blood vessels, it has been widely used for this purpose by ear, nose, and throat specialists, as mucous membranes in these areas are rich in blood vessels. Cocaine is generally applied to these areas as an aqueous solution.

When abused, cocaine powder is generally sniffed or inhaled (snorted) like tobacco snuff. By this route, cocaine is rapidly absorbed and reaches the brain within 3 minutes. In recent years, increasing numbers of abusers have turned to intravenous administration of the drug. Such administration generally carries cocaine to the brain within 30 seconds and produces an intense "rush" or euphoric state. Some users also engage in smoking, or "free-basing," of cocaine. This is the most rapid way to get cocaine to the brain and permits the user to experience the most intense "high." The use of free base cocaine, a form of cocaine that is rapidly absorbed through mucous membranes of the respiratory tract, has reached epidemic proportions in the United States. This form of cocaine, often referred to by its street names "crack" or "rock," produces more rapid physiological changes and dependence than other forms of cocaine.

Although cocaine shares the CNS stimulant effects produced by the amphetamines, its duration of effect is markedly shorter. Thus it requires more frequent administration to maintain a "high" and results in more rapid development of tolerance and dependence. When regularly sniffed or "snorted," cocaine tends to damage the nasal mucosa of the user and may eventually cause ulceration and perforation of the nasal septum. Compared to the use of amphetamines, cocaine use is more likely to induce seizures as well as cardiovascular and respiratory failure. It is particularly toxic to the new user. It may also produce toxic psychosis characterized by *paranoia* and violent behavior.

Treatment of the cocaine abuser is much the same as that of the amphetamine abuser, with abstinence and phenothiazine antipsychotic agents being generally useful. Residential and nonresidential treatment programs for cocaine abusers have emerged during the last few years. In addition, Cocaine Anonymous, a support group similar to Alcoholics Anonymous, has become popular, particularly for infrequent or moderate cocaine abusers.

CANNABIS ABUSE

Derivatives of the hemp plant *Cannabis sativa*, which include marijuana and hashish, are among the most widely abused drugs, next to alcohol, in the United States. It is estimated that one-half to two-thirds of all people 18–25 have used one or both of these drugs and that at least 35% of these are regular users. During the last two decades, the safety of **cannabis** use has been hotly debated. Although further study is required, it has become evident that cannabis derivatives may be detrimental to health. They have also, however, been shown to possess some medically useful properties, as well.

Marijuana is a substance derived from the leaves and flowering tops of the cannabis plant. Hashish is a resinous secretion of the plant's flowers. The active principle of each of these substances is tetrahydrocannabinol (THC), a psychoactive substance. Hashish contains approximately five to ten times more of this psychoactive agent than an equal weight of marijuana. Marijuana is generally

smoked in homemade cigarettes (joints), while hashish (hash) is generally smoked in small pipes. Either can be ingested orally although this is a less common form of use.

When smoked in moderation, marijuana or hashish produces a loss of time perception as well as alterations in visual, auditory, and taste perception. The user also experiences euphoria, relaxation, disorientation, ataxia, and drowsiness not unlike that which is experienced in the use of alcohol or the barbiturates. Motor performance may also be impaired while under the influence of these drugs. Driving performance is significantly impaired by THC intoxication. Cannabis derivatives are usually used in social groups. The level of euphoria and behavioral changes induced by the drug depend on the activities engaged in by the group, as well as the personality and expectations of the user. Higher doses of the cannabis derivatives tend to produce more pronounced perceptual changes and hallucinatory activity similar to those experienced in the use of LSD. *Dysphoria*, or depression, may also accompany such use.

Use of the cannabis derivatives may cause a variety of effects not directly associated with the desired euphoric effect. Their use tends to increase heart rate and may, therefore, adversely affect clients with coronary heart disease, hypertension, or cerebrovascular disease. Users may also experience decreased pulmonary function and a greater incidence of bronchitis, as well as reddening of the eyes and increased appetite. Some cannabis users may experience brief episodes of simple depression, acute panic, or acute psychosis, but it is unclear if such effects occur in users who were psychologically stable before administering the drug.

Several medically useful effects have been attributed to the smoking of marijuana. Of greatest interest is the finding that this agent may reduce the nausea experienced by clients undergoing cancer chemotherapy. It is likely that the U.S. Food and Drug Administration will permit the limited legal use of marijuana for this purpose in the near future. Marijuana has also been used experimentally to reduce intraocular pressure in glaucoma clients.

Tolerance to the effects of cannabis generally does not occur in clients who use the drug occasionally in social situations, although it has been shown to occur in persons who continue to use unusually large doses. Physical dependence does not appear to occur in cannabis users, nor does its use necessarily lead to heroin addiction or antisocial behavior.

PSYCHEDELIC AGENTS

Psychedelic drugs, or hallucinogens, are agents that produce alterations in perception, thought, mood, and behavior. They have been used for thousands of years, primarily as part of religious ceremonies. The most frequently abused psychedelic drugs in the United States are **lysergic acid diethylamide** (LSD) or "acid," **mescaline** (Mesc, Cactus) and **phencyclidine** (angel dust, PCP).

LSD is the most potent psychedelic agent known. Doses as low as 20–25 mcg are capable of producing psychological effects. In most cases LSD is administered orally, often absorbed in a cube of sugar. Within less than ½ hour after a dose of 200 mcg of LSD has been ingested, a central sympathomimetic response becomes evident. This may include tachycardia, increased blood pressure, hyperthermia, mydriasis, *piloerection*, and nausea. Perceptual changes may begin to be evident within an hour after administration. The client may perceive objects changing their shape and color. Sensory experiences may overlap, so that the client may "hear" a color or "taste" a sound, phenomena referred to as *synethesia*. Many users report that they experience unusual perception and clarity of thought while under the influence of LSD. Some may experience hallucinations. Mood changes may range from euphoria to depression and panic and may be related to the personality of the user and the environment in which the user is placed. In a pleasant, quiet setting, the user may experience a "good trip," while a "bad trip" or "bum trip" may be more likely if the user is in a threatening environment (e.g., a police station or hospital emergency room) or if the user is fearful of the effects of the drug.

Few serious, acute, adverse physical effects accompany the use of usual doses of LSD. The likelihood of long-term adverse physical effects from LSD use is still debated. There is evidence, however, that long-term LSD use may result in chromosome breakage, which could lead to birth defects in the offspring of LSD users. Perhaps of even greater concern are the adverse psychological effects that may occur in some users. Acute panic reactions experienced by some LSD users have led to accidents and suicide in some and prolonged psychological effects in others.

Clients who are to be treated during an LSD "trip" usually respond best to a quiet environment and reassurance from close friends or family members. Antipsychotic drugs, such as chlorpromazine (Thorazine) or haloperidol (Haldol), or antianxiety

agents, such as a benzodiazepine, have been used successfully in reducing a client's agitation.

The use of other psychedelic drugs, such as mescaline or phencyclidine, often produces effects comparable to those seen with LSD use. The use of phencyclidine has, however, been associated with a greater incidence of violent and psychotic behavior and with acute physiological toxicity characterized by seizures, coma, and death.

"ECSTASY"

Methylenedioxymethamphetamine (**MDMA**) is the drug known as "Ecstasy," also referred to as "XTC," "X," "Adam," "the love drug," and described by users as "happiness in a pill." MDMA has both CNS stimulant and hallucinogenic properties. According to users, MDMA replaces anxiety and depression with feelings of pleasure and also acts as an antidepressant. It was developed in 1912 as an appetite suppressant and then became a recreational drug in the 1980s, when it was primarily used at urban dance and "rave" parties. Although classified as an illegal agent in 1985, according to the Partnership for a Drug-Free America, MDMA use has doubled among the teenage population since 1995 and that one in 10 adolescents have experimented with the drug.

Although users have created the reputation that MDMA is "safe," a recent (2000) study connected at least 40 deaths in Florida since 1997. In the past few years, more than 1,100 MDMA users have been seen in emergency departments throughout the USA.

When experiencing the "high" after taking MDMA, the user feels like he/she is "on top of the world, like nothing can go wrong while you're high." This, in itself, increases the risk-taking behavior characteristic of the adolescent years and adds to it the loss of logical thinking. MDMA causes dehydration, hyperthermia (body temperatures as high as 106°F), anxiety, and enhaustion. The increased body temperature causes brain damage and can lead to death. MDMA acts by causing the brain to release serotonin, a neurotransmitter that helps control mode. This release can cause depression and can impair thought and memory.

Unlike heroin and cocaine that must be injected or snorted, MDMA is supplied in pill form, making it easier to take. Also because its cost is approximately $20.00 per pill, it is seen as a less expensive alternative. As with any illicit chemical agents, most substances claimed to be the drug that are confiscated and tested are not "Ecstasy," but substitutes using PCP, hallucinogens, and other harmful chemicals.

An additional problem has been identified recently, with MDMA used in combination with LSD. Despite its profound effects on the mind, LSD causes relatively minor physical effects (pupillary dilation, appetite suppression, and tachycardia), even if the user is taking very high doses. However, when taken with MDMA, the user experiences increased loss of judgment, as well as the physical adverse effects on the body. This has increased the death rate associated with substance abuse.

TOBACCO

One of the major health problems in our society is the smoking of tobacco products. Cigarette smoking increased rapidly until 1964, when 52% of the men and 32% of the women 21 years and older smoked. In that year, the U.S. Surgeon General issued a warning about the health risks of smoking. In 1979, the Surgeon General issued a report that strongly linked cigarette smoking to heart disease, lung cancer, and other illnesses. Although the number of smokers has declined since 1979, the proportion of smokers who are teenagers and women has risen.

Cigarette smoke is a complex mixture of more than 3,000 chemical substances. Of these substances, the four most dangerous components of the smoke are:

- carbon monoxide
- nicotine
- tars
- smoke particles

Carbon monoxide is a poisonous gas that alters the nature of hemoglobin for blood to be less capable of carrying oxygen. Also, it has been shown to cause degenerative changes in blood vessels and to contribute to the development of heart disease and lung disorders.

Nicotine is a CNS stimulant and is partly responsible for the difficulty encountered by smokers in stopping their smoking habit. Because of its toxic nature, nicotine is believed to play an important role in causing myocardial infarction and peptic ulcer disease can be related to smoking.

Tars are complex chemical mixtures that contain carcinogens. They are believed to be one of the major causes of lung cancer related to smoking.

Smoke particles are minute solids carried to the lower respiratory tract by inhaling cigarette smoke. As many as 25% of the particles may be trapped on the moist, sticky, lining of the lungs. Prolonged accumulation of these particles interferes with respiratory cell function and gas exchange, causing the development of scar tissue. Both of these actions may contribute to the development of chronic respiratory diseases such as bronchitis and emphysema.

During the last decade, studies have indicated that cigarette smoking contributes significantly to the development of lung cancer, heart disease, chronic respiratory diseases, and peptic ulcer disease, also increasing the risk of miscarriage and premature birth in pregnant women who smoke. Also, children born of women who smoke during pregnancy have a higher risk of developing various disabilities during childhood.

In recent years, evidence has shown that not only are smokers at greater risk of developing a multitude of health problems, but also nonsmokers who inhale elements of the smoke in their environment, i.e., "second-hand" smoke, are at risk. This concern about such "second-hand" exposure has led to the passage of federal, state, and local laws and ordinances that prohibit smoking in public places, such as airplanes, schools, and restaurants. The federal government also requires that cigarette packages carry a health warning and has prohibited cigarette advertising from radio and television.

Clearly, health professionals have a dual responsibility with regard to cigarette smoking. First, they must be role models for the public in respect to the avoidance of tobacco products. Second, they have an obligation to educate the public about the health hazards of cigarette smoking and provide support for persons who wish to stop smoking.

Several methods have been employed in an attempt to help cigarette smokers "kick the habit." The most popular method is by the use of nicotine-containing transdermal patches or chewing gum. Clients who wish to use such systems must have the desire to completely stop smoking and should be enrolled in an organized smoking cessation program. Smokers who seem to benefit most from the use of such nicotine-containing products are those having a physical dependence to nicotine.

A number of transdermal nicotine patches are currently marketed in the U.S. (e.g., **Habitrol**, **Nicoderm**, **Nicotrol**, and **ProStep**). Although each has slightly different characteristics, they are administered in a similar manner. The patches are initially used as substitutes for cigarette use. Once the client has become accustomed to using only the patches, their use is gradually decreased so as to wean the user off nicotine. The entire period of nicotine substitution and gradual withdrawal should take about 8 to 12 weeks.

Transdermal nicotine patches may be irritating to the skin of some clients. If this becomes severe or persistent, the client should be advised to discontinue the use of the nicotine system and to contact their physician. When the used system is removed from the skin, it should be folded inward and returned to the pouch in which the new system was packaged. It should then be disposed of in a way that will prevent access by children or pets. Transdermal nicotine systems are sensitive to heat and should not be stored above 30°C (86°F). Once removed from its pouch, the system should be applied immediately to avoid losing strength.

Nicotine chewing gum (e.g. **Nicorette**) is also available. Clients who have stopped smoking may chew such chewing gum products whenever they have an urge to smoke. Once the client is totally reliant on the nicotine gum, it is slowly discontinued until one is totally weaned.

Clients using nicotine patches or gum should be monitored for toxic effects, such as nausea, vomiting, salivation, diarrhea, dizziness, or CNS stimulation. More serious adverse effects, including increased risk of myocardial infarction, acute angina attacks, and cardiac arrhythmias may occur in clients with a history of heart disease. In addition, nicotine-containing chewing gums have been placed into pregnancy category "X" by the FDA, with transdermal nicotine products placed into pregnancy category "D." This indicates imminent danger to the fetus when the nicotine product is used by a pregnant woman. All nicotine transdermal systems and chewing gum products include a client package insert (PPI) that clearly instructs the client and their family in the use and disposal of the systems. Clients and their families should be encouraged to read these information sources before and during the use of the systems.

Lobeline is a nicotine-like substance that has weaker pharmacological effects than nicotine but also has been employed in various products (e.g. **Bantron**, **Zyban**) to help break the cigarette habit.

Perhaps the safest and most effective means of breaking the smoking habit have been support groups such as Smoker's Anonymous and

Smokenders. These groups, patterned after support groups that have successfully helped alcoholics, enable the smoker to obtain the assistance and emotional support required to become free of the smoking habit.

The student and health professional are encouraged to contact the American Lung Association for further information about the dangers of smoking and how the habit can be overcome.

INHALANT ABUSE

The inhalation of volatile organic solvents has become a fairly common form of abuse among young children. Such solvents, usually found in model airplane glue and household cement, generally consist of toluene. Abuse of organic spot removers, gasoline, and fluorocarbon propellants from aerosol products has also been reported. The product to be abused is generally squeezed or emptied into a plastic bag and the vapors inhaled. The result is intoxication and dizziness similar to that produced by alcohol. Often the user appears drunk because of slurred speech and ataxia.

Although few abusers of volatile organic solvents suffer adverse effects from a single or occasional exposure, prolonged or regular abuse of such compounds is known to cause renal, hepatic and bone marrow damage, as well as cerebral degeneration. Organ failure and death may follow these events.

Table 41–2 summarizes the properties of some commonly abused substances.

APPLYING THE NURSING PROCESS

Nurses provide a variety of services to substance abusers and to the community. Among their roles are caring for clients in emergency settings, detoxification units, clinics, and other settings, providing educational programs to schools and community groups and counseling substance abusers in employee assistance programs. To function effectively in these roles, the nurse must have a thorough knowledge of the mechanisms of dependence and addiction and the actions of commonly abused drugs, a nonjudgmental attitude, and familiarity with agencies providing information about substance abuse and treatment services for substance abusers.

ASSESSMENT: SCREENING FOR SUBSTANCE ABUSE

Increasingly, nurses are responsible for primary care activities including completion of a history and physical examination. In such cases, it is important for the nurse to obtain a history of substance use and abuse as part of a review of symptoms. The client is questioned in a matter-of-fact manner about the use of various substances, beginning with commonly used substances such as coffee, cigarettes, and alcohol, then progressing to other drugs of abuse. Clients who are examined in greater detail include those with histories of repeated trauma, skin abscesses, poor nutrition and hygiene, and vague complaints of pain. Clients complaining of blackouts, insomnia, and nervousness and those requesting specific pain-relieving agents are also examined carefully.

A thorough physical examination is indicated in all cases of known or suspected drug abuse. The nurse looks for evidence of unsteady gait, slurred speech, jaundice, debilitation, and nasal ulceration. Intravenous drug users may have needle tracks on arms, legs, between the toes, under the tongue, and in the scrotal area. Piloerection, or gooseflesh, on the arms and trunk is symptomatic of opiate withdrawal. Persons smoking crack cocaine often have bilateral loss of eyebrow and eyelash hair, which results from the hot vapor produced when the crack cocaine is smoked. A urine sample is obtained for drug screening when there is suspicion of drug abuse. It has been suggested by experienced primary care practitioners that the client be confronted directly when evidence of drug abuse is found. Many clients will deny abuse, yet others will express relief. In all cases, the nurse should be nonjudgmental and show concern for the client's welfare. If the client expresses an interest in treating the abuse, referral is made to an appropriate treatment program for managing physical dependency and withdrawal and for rehabilitation.

Special attention should be given to assessment of pregnant women and the elderly. Substance abuse in pregnant women may result in fetal loss, malformation, or result in an infant

TABLE 41–2

Common Drugs and Symptoms of Abuse

TYPE OF DRUG	DRUG NAMES	STREET NAMES	METHODS OF USE	SYMPTOMS OF USE	HAZARDS OF USE
Marijuana/ Hashish	—	Pot, Grass, Reefer, Weed, Columbian, Hash, Hash Oil, Sinsemilla, Joint	Most often smoked; can also be swallowed in solid form	Sweet, burnt odor Neglect of appearance Loss of interest, motivation Possible weight loss	Impaired memory and perception Interference with psychological maturation Possible damage to lungs, heart, and reproduction and immune systems Psychological dependence
Alcohol	Ethanol	Booze, Hooch, Juice, Brew	Swallowed in liquid form	Impaired muscle coordination, judgment	Heart and liver damage Death from overdose Death from car accidents Addiction
Stimulants Drugs that stimulate the central nervous system *Includes look-alike drugs resembling amphetamines that contain caffeine and ephedrine	Amphetamines* Amphetamine Dextroamphetamine Methamphetamine	Speed, Uppers, Pep Pills, Bennies, Dexies, Meth, Crystal, Black Beauties, Ice	Swallowed in pill or capsule form, or injected into veins	Excess activity Irritability, nervousness Mood swings Needle marks	Loss of appetite Hallucinations, paranoia Convulsions, coma Brain damage Death from overdose
	Cocaine	Coke, Crack, Rock, Snow, Toot, White Lady	Most often inhaled (snorted); also injected or swallowed in powder form, smoked	Restlessness, anxiety Intense short-term high followed by dysphoria	Intense psychological dependence Sleeplessness, anxiety Nasal passage damage Lung damage Death from overdose
	Nicotine	Coffin Nail, Butt, Smoke	Smoked in cigarettes, cigars, and pipes, snuff, chewing tobacco	Smell of tobacco High carbon monoxide levels Stained teeth	Cancers of the lung, throat, mouth, esophagus Heart disease, emphysema
Depressants Drugs that depress the central nervous system	Barbiturates Pentobarbital Secobarbital Amobarbital	Barb, Downers, Yellow Jackets, Red Devils, Blue Devils	Swallowed in pill form or injected into veins	Drowsiness Confusion Impaired judgment, slurred speech Needle marks Constricted pupils	Infection Addiction, with severe withdrawal symptoms Loss of appetite Death from overdose Nausea
	Opiates Dilaudid Percodan Demerol Methadone	Many	Swallowed in pill or liquid form, injected	Drowsiness Lethargy	Addiction with severe withdrawal symptoms Loss of appetite Death from overdose

continues

TABLE 41–2 *continued*

TYPE OF DRUG	DRUG NAMES	STREET NAMES	METHODS OF USE	SYMPTOMS OF USE	HAZARDS OF USE
Depressants *continued*	Morphine, Heroin	Dreamer, Junk, Smack, Horse	Injected into veins, smoked	Needle marks	Addiction with severe withdrawal symptoms Loss of appetite Death from overdose
	Codeine	School Boy	Swallowed in pill or liquid form	—	
	Hypnotics Methaqualone	Quaaludes, Ludes, Sopors	Swallowed in pill form	Impaired judgment and performance Drowsiness Slurred speech	Death from overdose Injury or death from car accident Severe interaction with alcohol
Hallucinogens Drugs that alter perceptions of reality	PCP (Phencyclidine)	Angel Dust, Killer Weed, Supergrass, Hog, Peace Pill	Most often smoked; can also be inhaled (snorted), injected, or swallowed in tablets	Slurred speech, blurred vision, uncoordination Confusion, agitation Aggression	Anxiety, depression Impaired memory and perception Death from accidents Death from overdose
	LSD	Acid, Cubes, Purple Haze	Injected or swallowed in tablets, sugar cubes, edible papers, etc.	Dilated pupils, illusions, hallucinations, mood swings	Breaks from reality Emotional breakdown Flashback
	Mescaline	Mesc, Cactus	Usually ingested in their natural form		
	Psilocybin	Magic Mushrooms			
Inhalants Substances abused by sniffing	Gasoline Airplane Glue Paint Thinner Dry Cleaner Solution Fluorocarbons Aerosol	—	Inhaled or sniffed, often with use of paper or plastic bag or rag or direct aerosol	Poor motor coordination Impaired vision, memory and thought processes Abusive, violent behavior	High risk of sudden death Drastic weight loss Brain, liver, and bone marrow damage
	Nitrous Oxide	Laughing Gas, Whippets	Inhaled or sniffed by mask or cone	Lightheadedness	Death by anoxia Neuropathy, muscle weakness
	Nitrites Amyl Butyl	Poppers, Locker Room, Rush, Snappers	Inhaled or sniffed from gauze or ampules	Slowed thought Headache	Anemia, death by anoxia

Note: Taking drugs of any type during pregnancy can be hazardous.

KEY NURSING IMPLICATIONS 41–1

Screening for Substance Abuse

1. In primary care settings, routinely obtain a history of substance use and abuse.
2. Examine the client for evidence of substance abuse.
3. Discuss evidence of substance abuse with the client.

addicted to drugs who experiences problems in growth and development. To screen for drug use, the nursing history should request information about the prescription and over-the-counter drugs used during pregnancy. The nurse then asks whether the woman smoked cigarettes or marijuana during pregnancy and whether she consumed alcohol. Also, questions are asked about the use of heroin, cocaine, and other street or recreational drugs. For all drugs, the nurse should obtain information about amount and frequency of use and last time the drug was used.

Some older persons living in the community are at risk of alcohol abuse and may not be identified as alcohol abusers. In addition to persons who have abused alcohol before their later years, some older persons begin alcohol abuse late in life in response to loss and social isolation. The nurse should be aware of self-neglect, confusion, repeated falls, and social isolation as indicators or correlates of alcohol abuse. A complete assessment of older persons should include information on physical health, mental health, social functioning, economic functioning, and self-care capacity. Older persons who use alcohol may be at risk of adverse drug reactions resulting from interactions between alcohol and prescription or nonprescription drugs.

NURSING DIAGNOSES

Including but not limited to:

- Disturbed sensory perception related to effects of substance abuse
- Disturbed thought processes related to effects of substance abuse
- Ineffective individual coping related to life stressors
- Risk for injury related to effects of substance abuse
- Deficient knowledge related to risks associated with substance abuse

PLANNING/GOALS

- Client will not experience substance abuse.
- Client will use effective coping mechanisms when faced with life stressors.
- Client will verbalize and demonstrate understanding of risks associated with substance abuse.

IMPLEMENTATION: NURSING CARE FOR SUBSTANCE ABUSE

Sometimes the first contact between nurse and drug abuser occurs in an emergency situation. If the emergency occurs outside a health care setting, the nurse monitors vital signs and provides basic life support measures until the client can be transferred to an acute care setting. If the client is unconscious, the nurse attempts to determine what drug(s) the client took, in what amount, when, and by what route. It is also important to determine when the client last ate. Recent ingestion of food may slow the absorption of oral drugs, but it can also result in vomiting, with the potential for aspiration. If drugs and related administration equipment are found near the client, these should be sent to the emergency treatment setting with the client.

In the emergency department, the substance abuser who is unconscious is treated like any unconscious client. Attention is given to the client's ABCs—airway, breathing, and circulation. Vital signs are monitored and client safety is ensured by the use of siderails and close supervision. The client is never left unsupervised. The client's level of consciousness, movement, and verbalizations is monitored. The client will be examined thoroughly, and blood and urine samples will be obtained. Often a Foley catheter will be inserted and an intravenous infusion of normal saline will be begun. Intake and output records are kept. **Note:** Always report declining urinary output as this may indicate renal failure.

In some clients who have taken drugs orally, steps can be taken to prevent absorption of the drug(s). This could involve inducing emesis, if the client is conscious, or gastric lavage with the instillation of activated charcoal in the unconscious client. Forced diuresis by alkalinizing or acidifying the urine may be used as may peritoneal dialysis and chelating agents. If heroin use is suspected, naloxone will probably be

ordered for administration by IV push. When naloxone is given to clients who have taken opiates, an acute withdrawal syndrome can occur. The nurse observes the client for acute pulmonary edema, declining urinary output, and cardiac arrhythmias. Usually a cardiac monitor will be attached to the client.

Clients who are conscious, but experiencing effects of the drug(s) may be very anxious. They should be cared for in a quiet area and oriented to their surroundings. They will need a considerable amount of emotional support and should receive continual supervision. The nurse should encourage rest and provide reassurance that appropriate care is being provided.

To some extent, the treatment of the client is dictated by the drug that has been used. For example, if **PCP** or "crack" has been taken, the client may be easily agitated and become violent. Such clients are placed in quiet surroundings with minimal distractions. Assistance in performing procedures should be requested if the client becomes restless or violent. At high doses of PCP, clients may experience elevated temperature, loss of the gag and corneal reflexes, and hypertension. They must, therefore, be monitored carefully. Usually these clients are treated by forced diuresis and urine acidification to help promote drug excretion. As PCP is held in fat tissue and may be released after some passage of time, recovered clients are often instructed to drink 3–4 glasses of cranberry juice daily and to take 1–2 g of ascorbic acid to acidify the urine.

Clients who have taken diazepam (Valium) may be lethargic and sleepy. They may experience ataxia and must not be permitted to ambulate without supervision. Slurred speech, disorientation, and apprehension are also possible. Continually reassure the client to prevent panic.

If the client has taken a large dose of cocaine, particularly "crack," he/she may be restless and apprehensive and experience tremors, tics, and paranoia. Clients will often pick at their skin, clothes, and bedding as if ridding themselves of insects. Some clients experience seizures, which are often treated by the use of diazepam (Valium). When diazepam is used, watch the client for respiratory depression, hypotension, and rapid heart rate. If ventricular arrhythmias occur, they may be treated with drugs such as lidocaine (see Chapter 28). Intravenous propranolol (Inderal) may be given to decrease tachycardia, high blood pressure, and excessive CNS stimulation. See Chapter 28 for nursing actions related to the use of propranolol.

Clients who have ingested LSD often experience intensified and distorted perceptions and benefit from calm reassurance. Diazepam (Valium) or haloperidol (Haldol) may be given orally to calm the client. Persons who have taken excessive amounts of alcohol, especially chronic alcoholics, are often given thiamine intramuscularly to prevent an acute episode of *encephalopathy*.

All clients who have overdosed on drugs or who have experienced adverse reactions are retained in the hospital until their condition has stabilized. Often a complete physical workup is carried out, with special attention to identifying hepatitis, cirrhosis of the liver, systemic infection, and debilitation. The episode is reviewed with the client and appropriate treatment and social service options are discussed.

KEY NURSING IMPLICATIONS 41–2

Emergency Nursing Care

1. Try to determine the drug(s) taken, their amount, when, and by what route they were taken.
2. Determine when the client last ate.
3. Assure an unconscious client's airway, breathing, and circulation.
4. Monitor vital signs, level of consciousness, and verbalizations.
5. Protect the client's safety.
6. Report declining urinary output.
7. In clients who are conscious, orient the client to the surroundings and provide emotional support and supervision.

NURSING CARE DURING DETOXIFICATION

The role of the nurse in detoxification depends in part on the drug of abuse and the specific treatment program with which the client is involved. Initially, the client may require considerable physical care to ensure safety and promote comfort. Clients undergoing opiate detoxification, for example, often experience chills, which may be alleviated by the use of blankets, a heating pad, or warm beverage.

Clients being withdrawn from drugs such as diazepam (Valium) often experience hypotension and should not be permitted to ambulate without supervision. In general, nursing care is supportive and is planned to meet the changing needs of clients as they progress from admission through their rehabilitation programs.

The attitude of the nurse and other health care providers is an important factor in aiding a client's rehabilitation. The nurse maintains a nonjudgmental attitude and does not blame the clients for the discomfort they are experiencing. In addition, nurses must not become discouraged when they repeatedly see the same clients in detoxification and rehabilitation programs. It may be helpful to think of the client as similar to one with a chronic illness, such as diabetes mellitus, who will require continued care and support over an extended period.

TREATMENT OF SUBSTANCE ABUSE

The initial contact between the nurse and the client with a history of drug abuse may occur on a medical-surgical, psychiatric, emergency service, or detoxification unit. Usually clients are away from their usual environment, with its access to drugs and its supportive, drug-oriented culture. Nurses are responsible for providing physical care to drug-dependent persons during this initial hospitalization. They also administer drugs such as methadone or narcotic antagonists, function as members of therapeutic communities, and form therapeutic relationships with clients.

Caring for those with drug dependency requires understanding of the behavioral styles of drug abusers. These styles often include dependency on others, low self-esteem, a distorted view of their environment, and frequent use of manipulation in human relationships. Such behaviors make drug-dependent persons difficult and challenging to work with. Working effectively with such clients requires a team effort and consistency of staff behavior. If drug therapy is being used in the detoxification program, the client should know what drugs are being used and why. In addition, the client must know that a strict schedule will be followed in administering these drugs. Generally, drugs such as sleeping medications will not be ordered for client use. Compliance with the drug treatment program is usually accomplished by carefully controlling and monitoring the client's drug use. Nurses must be firm about the exclusion of illicit drugs from the hospital unit. This may involve excluding visitors, physically checking the client and immediate environment for drugs, and arranging supervision of the client on visits off the hospital unit.

Several nursing behaviors may be helpful in aiding clients to overcome their dependence. Such behaviors include a nonjudgmental and hopeful attitude by the nurse that the dependency can be overcome, engaging in mutual setting of goals and limits, and sharing of responsibility with the client. The client must not be allowed to continue dependency or to place the blame for failure of treatment on the staff. Clients must be assisted by all staff members in becoming increasingly independent and in assuming responsibility for maintaining a drug-free state.

In some cases, the problems associated with substance abuse are reinforced and sustained by the family of the person who abuses substances. Family members also may suffer distress and problems with self-esteem. It is often within the family that critical interventions must be made to rehabilitate someone who abuses substances. For these reasons, many persons working in substance abuse treatment believe that treatment must have a family focus. The first objective of working with families is to restore hope. Therapists and family counselors also support the family as they identify and deal with obstacles to recovery and as they learn that recovery is a prolonged process.

KEY NURSING IMPLICATIONS 41–3

Treatment of Substance Abuse

1. Consistency of staff behavior is necessary in working with substance abusers.
2. Exclude the client's drugs from the treatment unit.
3. Maintain a nonjudgmental, positive attitude.
4. Assist the client in becoming more independent and in taking responsibility for maintaining a drug-free state.
5. Treatment is often family-focused.

NURSING CARE PLAN

A Client with Substance Abuse Receiving Naloxone HCl (Narcan)

Roland Jordon, a 25-year-old, 6-foot, 140-pound male arrives in the emergency room at 2 am via medic transport. He was found sitting on a street corner. On arrival, his speech is slurred and he cannot be fully aroused. Track marks are visible on his arms and between fingers and toes. Roland arouses enough to say he had a "speedball" (a mixture of cocaine and heroin). He sounds congested, as if he has a cold. He is rolling about on the stretcher and moaning as the nurse attempts to start an IV. After much difficulty, an IV is inserted and a blood sample is sent for drug screen. He is then given naloxone hydrochloride (Narcan) 0.8 mg IV. He is shaking and appears anxious and wide-eyed, with greatly dilated pupils. He is now holding his abdomen and begging for something for pain. The cardiac monitor shows rapid sinus tachycardia with occasional premature ventricular contractions (PVCs). Arterial blood gases and a 12-lead EKG are ordered and oxygen is started via nasal cannula at 3 liters per minute. An IV of D5LR is started at 150 mL per hour. A urine sample is also sent for drug screen. Roland is admitted to a monitored bed with orders for diazepam (Valium) po 5 mg q4h. He is placed on blood and body fluid precautions and is observed for seizures. His skin is checked for abscesses and his nasal mucosa is checked for irritation.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Abdominal pain.	Acute pain related to drug withdrawal.	Client will have appropriate treatment that will help alleviate pain.	Client's pain is probably related to withdrawal. Keep client warm, position comfortably, give diazepam.	Client has relief of pain in 30 minutes.
Body weight. Appetite. Food patterns.	Imbalanced nutrition: less than body requirements related to anorexia and drug habit.	Client verbalizes and demonstrates selections of foods that will cease weight loss.	Provide client with plan for good nutrition. Encourage client to adopt better eating habits.	Client weighs within 10% of ideal body weight.
Anxious, nervous.	Ineffective individual coping related to dependence on drugs.	Client will identify alternative coping strategies.	Teach client how to problem solve. Ask client to provide alternate methods of handling concerns and to prioritize choices and select an alternative.	Client can identify coping methods, but has not yet adopted them or shown desire to control drug use.
Vital signs.	Risk for decreased cardiac output related to alterations in heart rate or rhythm conduction, secondary to effects of substances ingested.	Client maintains blood pressure and pulse rate within normal limits. Monitor shows normal sinus rhythm.	Use cardiac monitor to observe closely for rate and rhythm changes. Routinely monitor blood pressure. Watch for blood pressure drop that potentiates cardiac or respiratory arrest situation.	Client was in rapid sinus tachycardia on admission, but develops normal sinus rhythm over time.
Breathing and oxygenation.	Risk for ineffective breathing patterns related to effects of drugs.	Client maintains breathing pattern as evidenced by regular respiratory pattern, normal skin color, and arterial blood gases.	Maintain patent airway. Observe rate and depth of respirations. Assess oxygenation status and arterial blood gases. Provide oxygen. Ensure safety precautions when oxygen is in use. Ventilate mechanically as needed.	Client maintains adequate ventilation throughout hospitalization.

Identify drug used and when.	Risk for injury related to substance used.	Client will be kept free of injury.	Give antidote, naloxone (Narcan). Observe client for acute withdrawal as seen by pulmonary edema, declining urinary output, tachycardia, and cardiac arrhythmia. Implement seizure precautions. Record intake and output.	Client does not have cardiac arrest, respiratory depression, or seizure.
Skin lesions.	Risk for infection related to contaminated injection sites.	Client will not develop infection.	Assess skin carefully for areas of infection and clean well with povidone-iodine cleanser.	Client has no infected areas at this time.
Knowledge of blood and body fluid precautions and risk factors.	Risk for ineffective health maintenance related to unhealthy lifestyle.	Client will verbalize risk of hepatitis and AIDS from sharing needles and unprotected sex.	Instruct client about HIV and hepatitis transmission and methods of prevention. Encourage client to have HIV test.	Client is tested for HIV. Client adheres to blood and body fluid precautions.
Guilt, self-esteem.	Chronic low self-esteem related to feelings of powerlessness from inability to abstain from drug use.	Client will verbalize positive feelings about self.	Encourage client to identify his strengths and assist him in recognizing ways to use abilities to remain drug-free. Refer client to a rehabilitation unit, when medically stable.	Client is able to verbalize positive feelings.

IMPAIRED HEALTH CARE WORKERS

Attention has recently been focused on health care workers who abuse drugs. It is generally believed that the rate of drug dependency of nurses is approximately twice as great as that of the general population. One reason for this higher rate may be the continual exposure of nurses to drugs and opportunities to obtain them. Drug abuse in health care workers is costly to employers—for example, in lost supplies and lost work time. The abuse also threatens the quality of care provided to clients.

Dealing with impaired health care workers is a difficult task, in part because an entire work group not only one drug abuser may be involved. Other persons become involved as enablers; that is, they cover up for the person with a drug problem, allowing that person to continue nonproductive and often detrimental behaviors. It is important whenever drug abuse is suspected to document the performance of the individual. This may involve examination of personnel records for attendance and health information, reviewing incident reports and evaluating caregiving and decisionmaking. When the supervisor believes that a picture of drug abuse is emerging, the employee is asked to discuss his/her performance. Confronting the employee directly will often result in denial, unless overt behavior such as drug thefts or overdoses has been confirmed. The focus of the discussion, therefore, is usually on the individual's declining or unacceptable level of performance. Referral can be made to an employee assistance program, if one is available. Otherwise, referral to another source must be considered. It is suggested that attention also be given to helping the work group deal with their feelings about this situation and about their role as enablers.

Following the counseling session, whether the individual recognizes the problem and seeks assistance or not, standards are set for future behavior. The supervisor is supportive of the individual, but firm about expectations. In some cases, the worker is asked to sign a return-to-work contract. This contract lists specific behaviors expected of the individual, for example, abstaining from drug use and engaging in a treatment program. Most staff members will eventually improve their performance. For the small number who do not recognize a problem and/or improve performance, termination of employment is suggested. If it is warranted by documentation, the nurse can be prosecuted for drug theft or reported to the State Board of Nursing for violation of the Nurse Practice Act.

KEY NURSING IMPLICATIONS 41–4

Impaired Health Care Workers

1. The dependency of nurses on drugs is higher than in the general population.
2. Substance abuse is costly to employers and may compromise quality care.
3. The substance abuser must be counseled about declining performance and offered ways of dealing with the problem.
4. The substance abuser's work group may benefit from counseling.
5. Impaired nurses who refuse treatment and continue poor performance should be terminated and reported to the State Board of Nursing.

ESTABLISHING A DRUG-FREE WORKPLACE

It has been estimated that 65% of all work-related accidents are due to substance abuse. In responding to this problem, President Ronald Reagan, in September 1986, issued an executive order that all federal agencies introduce programs to assure a drug-free workplace. This order authorizes compulsory testing of new employees when there is reasonable suspicion of drug use. Although the executive order has been challenged as unconstitutional, many large companies have initiated urine testing of employees to detect illegal drugs. There is considerable controversy in the health professions about mandatory drug testing. Some practitioners see it as a violation of rights, placing a burden on all workers in the interests of a few. Others see it as part of a strategy of primary prevention. Because issues related to individual rights and public safety are involved, this is a controversy that will not be easily resolved.

SUBSTANCE ABUSE EDUCATION

Nurses, along with other health care professionals, have a responsibility to the community to provide information about substance abuse. Fulfilling this responsibility may involve providing information and counseling or referring clients, friends, and neighbors. It may also involve talking to school or community groups. To fulfill this responsibility, the nurse must keep up-to-date on common drug abuse problems and their treatment. Treatment resources vary depending on the region, and nurses should be familiar with those in their own communities. In addition, the following organizations may be able to provide literature about substance abuse or advice about appropriate referral for treatment.

1. American Council for Drug Education
   164 West 74th Street
   New York, NY 10023
   http://www.acde.org
2. National Clearinghouse for Drug and Alcohol Information
   P. O. Box 2345
   Rockville, MD 20847-2345
   (800) 729-6686
   (301) 468-6433 Fax
   http://www.health.org/govpubs/
3. National Center on Addiction and Substance Abuse at Columbia University
   633 Third Avenue, 19th Floor
   New York, NY 10017-6706
   (212) 841-5200
   (212) 956-8020 Fax
   http://www.casacolumbia.org/
4. Partnership for a Drug-Free America
   405 Lexington Avenue
   Suite 1601A
   New York, NY 10074
   1-888-5753115
   http://www.drugfreeamerica.org
5. Phoenix House Foundation, Inc.
   P. O. Box 333, Planetarium Station
   New York, NY 10123-0023
   webmaster@phoenixhouse.org
6. Alcoholics Anonymous
   475 Riverside Drive
   New York, NY 10115
   (212) 870-3400
   http://www.recovery.org/aa/

Web Sites

Teen Substance Abuse Resources:
http://www.focusas.com/SubstanceAbuse.html

International Substance Abuse and Addiction Coalition: *http://crc.iugm.org/isaac*

EVALUATION

- Client does not experience substance abuse.
- Client uses effective coping mechanisms when faced with life stressors.
- Client verbalizes and demonstrates understanding of risks associated with substance abuse.

HOME CARE/CLIENT TEACHING

1. Special attention should be paid to the substance use of pregnant women and elderly persons living in the community.
2. Persons who frequently experience minor trauma, problems in interpersonal relationships, fatigue, and insomnia should be screened for substance abuse.
3. Public education needs to start with school-age children and inform parents and children of the risks, potential health alterations, and legal implications of substance abuse.
4. Clients identified as substance abusers need to be informed of resources that provide help and support for substance addiction.
5. Clients need to be instructed concerning coping skills.
6. Client instruction should be presented nonjudgmentally and on the developmental level of the client.
7. Client education needs to include significant others of the client.

CASE STUDY

Franklin Jones, a 26-year-old male, comes to the emergency department of Hometown General complaining of severe headaches. After an initial assessment of vital signs, the physician examines the client and orders blood studies to screen for several possible causes of the headaches. The nurse who draws the blood notes that there are multiple needle tracks in the antecubital space of Mr. Jones's left arm. She asks Mr. Jones about the cause of these marks and he admits that he has recently started to use heroin "just for fun." He hastens to add that he is not addicted to the drug, but that he has used it with some friends for a couple of weeks, maybe 2 months. He tells the nurse that the real reason he has come to the hospital is that he shares the same needle and syringe with his friends, and he is afraid that he has hepatitis or AIDS. He refuses to say whether any of his friends currently have hepatitis, AIDS or other illnesses.

Questions for Discussion

1. What type of drug is heroin and what effects does it have on the body?
2. What sites are checked most often when the examiner is looking for evidence of intravenous drug use?
3. What types of referrals might be helpful to Mr. Jones?

CRITICAL THINKING EXERCISES

1. Obtain permission to visit a drug detoxification unit and observe the kinds of treatments being used and the staff-client interactions.
2. Attend an open meeting of Alcoholics Anonymous in your community.
3. Prepare a brief paper on a successful drug treatment program.
4. Plan a presentation designed for a community group on some aspect of substance abuse.
5. Prepare a brief class presentation on the development of AIDS in intravenous drug users.
6. Obtain literature from one or more of the resources suggested in this chapter and share it with your classmates.
7. Lead a class discussion on public health approaches to the treatment/control of intravenous drug use and HIV transmission, including needle exchange programs and legalization of currently illicit substances.

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Agents that Affect Immunity

42

OBJECTIVES

After studying this chapter, the student will be able to:

- Differentiate the drugs most often used to stimulate the immune system from those used to suppress the immune system
- Identify the major components of the immune system
- Identify the major side effects of drugs used to suppress the immune system
- Apply the nursing process for clients receiving drugs to stimulate the immune system
- Apply the nursing process for clients receiving drugs to suppress the immune system
- List the recommended childhood immunizations

FUNCTIONS OF THE IMMUNE SYSTEM

The immune system is responsible for recognizing and disposing of foreign material, such as bacteria, viruses, fungi, protozoa, worms, drugs, foods, or even transplanted organs, that enters the body. Resistance to invasion by a foreign organism or substance may be natural, inborn, and permanent or it may be acquired from the body's adaptation to the presence of a foreign substance.

Immunology is the study of the molecules, cells, and organs responsible for the recognition and disposal of foreign materials, how those materials interact, and how their action can be diminished or enhanced. Both natural and acquired immunity involve cellular and chemical components of the body. Cellular components involved in the immune process include mast cells, polymorphonuclear leukocytes (PMN), and macrophages. Mast cells are large tissue cells that release chemical substances to promote inflammation by increasing the permeability of blood vessels. This increased permeability permits cellular and chemical substances to easily enter the damaged or invaded area of the body. PMNs are "scavenger" white blood cells that contain granules with powerful antibacterial enzymes. Macrophages are large tissue cells responsible for removing damaged cells, bacteria, and other debris from the body.

Chemical components of the blood involved in the immune system include complement, lysozyme, interferons, interleukins, and other substances that still have not been completely identified. Complement comprises a series of enzymes that, when activated, produce inflammatory effects and lysis of bacteria. Lysozyme, an enzyme released by macrophages, attacks the cell walls of bacteria. Interferons and interleukins are discussed later in this chapter.

Acquired immunity is similar in action to that of T and B lymphocytes, small cells circulating through the blood, tissues, and lymphatic system. These cells police the body for foreign substances, or antigens, leading to a permanently altered response pattern and antibody formation. Antibodies are serum proteins that have an affinity for specific antigens. When an antibody meets such an antigen (e.g., a bacterial cell) it binds to the surface of the antigen and makes it more susceptible to destruction.

Although an effective immune system is essential for the body to prevent serious infection, the immune system also may be responsible for causing a variety of serious and debilitating conditions. For example, when some people are exposed to environmental agents (e.g., pollen, foods, or drugs) that are foreign to the body, their immune system may overreact. This may affect not only the substance that caused the reaction, but also the surrounding tissue. Such exaggerated reactions may result in an allergic or hypersensitivity response, which can be mild or life-threatening. Allergic responses to common environmental agents, such as dust or pollen, can sometimes be diminished by exposing the sensitive individual first to low and then to increasingly greater intradermal doses of an extract of the allergen. This may desensitize the individual to the allergen and reduce the likelihood of future, acute adverse responses to the allergen.

In some cases, an immune reaction may occur when the body rejects its own tissue, that is, exhibits an autoimmune response. This may result in conditions such as rheumatoid arthritis and systemic lupus erythematosus (SLE). The immune system also may be responsible for the body's rejection of organ grafts. Prevention of such rejection requires careful matching of the organ donor and recipient and the use of immunosuppressant drugs or techniques to suppress the body's immune system.

A normal immune response requires the successful interaction of many factors. When defects develop in some of these factors, the effectiveness of the immune system may diminish, resulting in increased susceptibility to infection. An impaired immune system may result from genetic defects or may be secondary to malnutrition, aging, or immunosuppressant drug use. During the past decade, the impact of human immunodeficiency virus (HIV) as the cause of acquired immunodeficiency syndrome (AIDS) has illustrated the harm that a compromised immune system can have on an individual's health.

AGENTS THAT PROVIDE ACTIVE OR PASSIVE IMMUNITY

The normal human immune system is capable of defending the body from invasion by most common infecting organisms by natural resistance, by stimulation of the body's adaptive responses, or by both. Unfortunately, natural and adaptive immune responses may not be completely effective. Immunization enhances or stimulates the body's own immune system to dramatically increase the body's resistance to certain infections.

Active immunization involves administering an antigen, usually as a vaccine, that has been diluted, weakened, or killed so it does not cause full disease symptoms. In a weakened or killed state, the antigen may stimulate the body's immune system to produce antibodies. This permits the body to effectively resist future exposures to the causative organism. This immunization is effective for long periods, but the full effect of the immunization may be delayed while the immune system responds. Passive immunity generally involves administering preformed antibodies, which may act more rapidly but have shorter duration of action.

Many vaccines are available to prevent or treat infectious diseases. Table 42–1 is a summary of agents that produce passive immunity, with Table 42–2 summarizing the products that produce active immunity. Table 42–3 describes products that prevent rabies in clients who have or have not been exposed to the rabies virus. Table 42–4 provides a recommended immunization schedule for infants and young children.

INTERFERONS AND INTERLEUKINS

Interferons and interleukins are low molecular weight proteins that regulate the extent and duration of the immune and inflammatory response. Their release by cells appears to be triggered by foreign molecules associated with an infection or abnormally growing cells. Many interferons and interleukins have been identified. Although some of these agents are currently employed in the treatment of various types of cancer (see Chapter 39), they also are studied for use in stimulating T-cell production, for promoting blood cell formation, and for treating several diseases having an inflammatory component.

TABLE 42–1

Agents Used in Providing Passive Immunity

Note: Obtain history of allergy before administering any agent affecting immunity.

Do not use agents beyond their expiration date.

Always administer these agents in a setting where life support equipment is available.

Epinephrine injection 1:1000 must be immediately available for the treatment of anaphylactic reactions.

Following the administration of these agents, observe client's response for 20 to 30 minutes before discharging client.

Update client's personal immunization records.

Refer to Table 42–2 for recommended childhood immunization schedule.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
A–1. Immune Serums				
cytomegalovirus (CMV) immune globulin intra venous, human	prevention of CMV in clients receiving kidney transplant	IV	50–150 mg/kg at intervals of every 2–4 weeks beginning at time of kidney transplant	Refer to cytomegalovirus discussion.
hepatitis B immune globulin (H-BIG, Hep-B-Gammagee, HyperHep)	provides passive immunity for persons exposed to hepatitis B virus	IM	0.06 mL/kg (usual adult dose 3–5 mL); administer as soon as possible after exposure (within 7 days) and repeat 28–30 days after exposure	Antibodies persist for 2 months or longer. Contraindicated in persons allergic to gamma globulin and those with anti-immunoglobulin A antibodies. Do not give intravenously. Skin tests to determine allergy are not used prior to injection. Local tenderness and stiffness of muscles at the injection site and occasionally low grade fever, erythema, urticaria, and angioedema may occur.
immune globulin intravenous (Gamimune-N, Sandoglobulin, Gammagard, etc.)	provides rapid increases in intravascular immunoglobulin levels in clients with immunodeficiency syndrome	IV	100–200 mg/kg once a month by IV infusion	Do not use a solution that has been frozen or if turbidity exists.
immune globulin, intramuscular, gamma globulin (Gamastan, Gammar)	prevention or modification of hepatitis A measles in susceptible contacts	IM	0.25–1.2 mL/kg	Administer the first dose within 6 days after exposure. Use of buttocks for injection is preferred.
	prevention of hepatitis A in exposed persons	IM	0.01 mL/lb 0.02–0.05 mL/lb for protection in endemic areas	Readminister every 6 months as long as risk exists.
	prevention of infection in clients with immunoglobulin deficiency	IM	Initially 1.3 mL/kg followed every 3–4 weeks by 0.66 mL/kg	Concurrent antibiotic therapy may be required.

continues

TABLE 42–1 *continued*

See **Note** at beginning of Table 42–1, page 845.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
immune globulin, intramuscular, gamma globulin *(continued)*	prevention of rubella	IM	0.55 mL/kg at time of exposure	May be useful for prevention of rubella in high risk groups, e.g., pregnant women during the first trimester.
lymphocyte immune globulin, antithymocyte globulin (Atgam)	management of allograft rejection in renal transplant clients	IV	*Adults:* 10–15 mg/kg/day for 14 days *Children:* 5–25 mg/kg/day for 14 days	Dilute in saline before infusing. Do not infuse a dose in less than 4 hours. Refrigerate for storage. DO NOT FREEZE. Should infuse using filter.
respiratory syncytial virus immune globulin (Respigam)	prevents serious respiratory tract infections caused by RSV in children <24 months with bronchopulmonary dysplasia	IV	*Children <24 mo.:* 750 mcg/kg (15 ml/kg); initially 1.5 ml/kg/hr for 1st 15 min. then increase to 3 ml/kg/hr for next 15 min. then 6 ml/kg/hr for rest of infusion	Monitor for fever, respiratory distress.
RHo(D) immune globulin (Gamulin Rh, HypRho-D, Rhesonativ, RhoGAM, etc.)	suppression of the immune response of nonsensitized Rho(D) negative, D^u negative persons who receive Rho(D) positive or D^u positive blood. Prevention of sensitization to the Rho(D) factor in Rh negative women who have ended a pregnancy with an Rh positive fetus or newborn, thus preventing hemolytic anemia of the fetus in a subsequent pregnancy	IM	1 or more 1 mL vials; administer within 72 hours after Rh-incompatible delivery, miscarriage, ectopic pregnancy, amniocentesis, and other abdominal trauma, abortion, or transfusion; for antepartum prophylaxis, 1 vial at 28 weeks gestation and 1 vial as above	This drug is not given to the infant, to Rho(D) positive or D^u positive persons, or to Rho(D) negative or D^u negative persons previously sensitized to the Rho(D) or D^u antigen. Before drug is given, laboratory analysis should confirm that mother is Rho(D) negative and D^u negative.
tetanus immune globulin (Hyper-Tet)	passive immunity in persons not actively immunized against tetanus or whose immunity status is unknown	IM	Prophylaxis *Adults and children:* 250 units	Provide thorough cleansing of wound. May be used concomitantly with antibiotics. May simultaneously administer tetanus toxoid at a different site.

continues

TABLE 42–1 *continued*

See **Note** at beginning of Table 42–1, page 845.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
varicella-zoster immune globulin (human)	passive immunization of susceptible immunodeficient children after exposure to varicella	IM	125–625 units depending on client weight *Clients 10 kg or less:* no more than 1.25 mL given at a single site *Clients over 10 kg:* no more than 2.5 mL given at a single site	Give deep IM. Obtain accurate client weight before administration.
A–2. Antitoxins and Antivenins				
antivenin (crotalidae) polyvalent	contains protective substances against the venoms of the crotalids (pit vipers) including rattlesnakes, cottonmouths, copperheads and moccasins	IM, IV	administer as soon as possible after bite; depending on the severity of envenomation, 1–15 or more vials containing 10 mL of serum may be administered	Immediately immobilize victim. Evaluate client for local and systemic response to bite. Larger doses are required for children. Need for subsequent doses is based on clinical response. Observe client carefully for pain, swelling, shortness of breath, weakness, faintness, and vomiting, which indicate that more antivenin may be needed. Antivenin should be used within a few hours after reconstitution. Client's blood should be typed and cross-matched as soon as possible after the bite, as the hemolysins in the venom may cause inaccurate results. Supportive therapy with corticosteroids, antibiotics and analgesics may be used. Opiates and barbiturates are used in small doses with caution.
antivenin (micrurus fulvius)	treatment of North American coral snake bites	IV	3–5 vials (30–50 mL) IV; up to 10 or more vials may be needed	Immediately immobilize victim. In clients not allergic to horse serum, dose is given slowly by injection into IV tubing or by adding to reservoir of IV drip of Sodium Chloride Injection, USP. The first 1–2 mL must be given slowly over 3–5 minutes while observing carefully for allergic reaction. Observe carefully for relapses indicating the need for additional antivenin.
black widow spider species antivenin Antivenin (Lactrodectus mactans)	treatment of black widow spider bites	IM, IV	*Adults and children:* 6,000 units of antivenin (contents of 1 vial–2.5 mL)	Treat promptly. Give dose in the anterolateral thigh to allow tourniquet application if a systemic reaction to dose occurs. IV administration (in 10–50 mL of saline solution) is preferred in children under 12, severe cases, and for those in shock. Use opiates and barbiturates carefully.

continues

TABLE 42–1 *continued*

See **Note** at beginning of Table 42–1, page 845.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
diphtheria antitoxin	prevention or treatment of diphtheria	IM, IV	Treatment: *Children and adults:* 20,000–120,000 units or more depending on site, severity and duration of infection	Use appropriate antimicrobial treatment. Begin active immunization with diphtheria toxoid. Whenever antitoxin is administered, epinephrine (1:1000) must be available for emergency use. Observe client for shock or anaphylaxis, usually occurring within 30 minutes of administration.
tetanus antitoxin	prevention and treatment of tetanus; used only when tetanus immune globulin is not available	IM, SC, IV	Prophylaxis: *Clients up to 25 kg:* 1,500 units IM or SC *Clients over 25 kg:* 3,000–5,000 units Treatment: 50,000–100,000 units (part of dose IV, part IM)	Prophylactic doses are given to persons who have had 2 or less injections of tetanus toxoid and who have tetanus prone injuries less than 24 hours old. Unimmunized persons should also receive tetanus toxoid at another injection site.

TABLE 42–2

Agents Used for Active Immunization

Note: Obtain history of allergy before administering any agent affecting immunity.
Do not use agents beyond their expiration date.
Always administer these agents in a setting where life support equipment is available.
Epinephrine injection 1:1000 must be immediately available for the treatment of anaphylactic reactions.
Following the administration of these agents, observe client's response for 20–30 minutes before discharging client.
Update client's personal immunization records.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
Bacterial Vaccines				
BCG vaccine (TICE BCG)	TB prophylaxis in persons with tuberculin negative skin tests exposed to TB	intradermal percutaneous	*Adults:* 0.1 mL *Infants less than 3 months of age:* 0.2–0.3 mL dropped on cleansed surface of the skin. Application site is then punctured with multiple-puncture disc.	Contraindicated in tuberculin-positive persons, those with fresh smallpox vaccinations, burn clients, and in those whose natural immunity is suppressed. Tuberculin testing should precede immunization. BCG is a live vaccine and must be treated carefully, along with equipment used to administer the dose. A number of local reactions, including prolonged ulceration, lymphadenitis, and granuloma formation, may occur.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
cholera vaccine	production of active immunization against cholera	SC, IM, intradermal	First or second dose Intradermal: 0.2 mL SC or IM: *6 months–4 years:* 0.2 mL; *5–10 years:* 0.3 mL; *Over 10 years:* 0.5 mL Booster Intradermal: 0.2 mL SC or IM: *6 months–4 years:* 0.2 mL; *5–10 years:* 0.3 mL; *Over 10 years:* 0.5 mL	Do not give during acute illness or infection or during any condition in which the immune response is depressed. Booster may be needed every 6 months to maintain effective immunity. Intradermal route may be used for persons 5 years of age and older. Minor reactions (e.g., pain, tenderness, erythema, fever) may occur. These usually subside within 24–48 hours.
hemophilus b conjugate vaccine (HibTITER, PedvaxHIB, ProHIBiT)	for immunization of children 2 months–6 years of age against diseases caused by *H. influenzae b.*	IM	0.5 mL	Do not administer if fever or active infection exists or if client is hypersensitive to thimerosal. Have epinephrine 1:1000 injection available for use if anaphylactoid reaction occurs. ProHIBiT is recommended only for children 15 months and older. Store at 2°–8°C (36°–46°F).
meningoloccal polysaccharide vaccine (Menomune–A/C/Y/W–135)	prophylaxis of meningitis in high-risk populations	SC	single dose 0.5 mL	Contraindicated in pregnant women and persons with an acute illness. Expected immune response may not be obtained in persons receiving immunosuppressant therapy. Reconstitute the vaccine using only the diluent supplied.
mixed respiratory vaccine (MRV)	desensitization to common bacterial organisms present in respiratory system	SC	Prophylactically: 0.05 mL initially; increase by 0.05–0.1 mL every 4–7 days; maximum dose 0.5–1 mL	Contraindicated in pregnant clients. Dosage is reduced or discontinued if client develops severe local reaction. Administer SC injection into the lateral aspect of the lower third of the upper arm.
plague vaccine	protection of persons living in areas where plague is endemic	IM	*Adults and children over 11:* 1 mL followed by 0.2 mL after 4 weeks and by 0.2 mL 6 months after the first dose; booster injections (0.2 mL) should be administered every 6 months to persons in known plague areas	Incidence and severity of reactions increase with repeated use of the vaccine. Avoid administration to persons with upper respiratory infections. May result in malaise, headache, local erythema, induration, fever, and lymphadenopathy.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
plague vaccine *(continued)*			*Children under 11:* *Under 1 year:* use 1/5 adult primary or booster dose *1–4 years:* use 2/5 adult dose *5–10 years:* use 3/5 adult dose	
pneumococcal vaccine, polyvalent (Pneumovax 23, Pnu-Imune 23)	protection against the most common types of pneumococci for high-risk persons, including those with a chronic illness, those in chronic care facilities, those convalescing from a severe illness, and those beyond 50 years of age	SC, IM	0.5 mL	Administration into the deltoid muscle or lateral midthigh is preferred. Contraindicated in pregnancy. Do not administer to persons on immunosuppressive therapy or those with active infections. Use caution in administering to persons who have had pneumonia within the past 3 years as they may have increased local and/or systemic reactions to the vaccine. Common adverse reactions include local erythema and soreness at injection site (for less than 48 hours) and low-grade fever. Prevnar does not require a booster; however both Pneumovax 23 and Pnu-Imune 23 do require a booster at 6 years.
staphage lysate (SPL-Serologic Types I and III)	treatment of staph infection or multiple organism infection with staph component	SC, intranasal, oral, topical	Initially 0.05–0.1 mL; increase incrementally to a maximum of 0.2–0.5 mL	Store in refrigerator. Not for use in children.
typhoid vaccine (Vivotif Berna Vaccine)	production of active immunization against typhoid for persons exposed to typhoid carriers and those traveling to areas where typhoid is endemic	SC, intradermal, oral	Primary immunization: *Adults and children over 10:* 2 doses of 0.5 mL each SC at interval of 4 or more weeks *Children less than 10:* 2 doses of 0.25 mL each SC at interval of 4 or more weeks *Adults and Children over 6:* Oral—one capsule on alternate days (e.g. on days 1, 3, 5, and 7) for four doses Booster immunization:	Do not administer to persons with active infections. Some degree of local and/or systemic response is common. These include erythema, induration and tenderness, malaise, headache, myalgia, and elevated temperature. Oral capsules should be taken approximately 1 hour before a meal with cold or lukewarm drink, not to exceed body temperature. Store oral capsules in a refrigerator (2°C–8°C).

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
typhoid vaccine (Vivotif Berna Vaccine) *(continued)*			*Adults and Children over 10:* 0.5 mL SC or 0.1 mL intradermally *Children 6 months to 10 years:* 0.25 mL SC or 0.1 mL intradermally	
Viral Vaccines				
hepatitis B vaccine (Heptavax-B, Recombivax HB, Engerix-B)	immunization against infection caused by hepatitis B virus	IM	*Adults and older children:* Initially: 1 mL 2 month: 1 mL 6 months after initial dose: 1 mL *Children (birth–10 years)* Initially: 0.5 mL 1 month: 0.5 mL 6 months after initial dose: 05 mL	Immunocompromised and dialysis clients should receive double the normal adult dose. Vaccination recommended for persons with high risk of infection with hepatitis B virus, e.g., health care providers, persons handling blood and blood products, morticians, homosexually active males, female prostitutes, prisoners, and users of illicit injectable drugs.
influenza virus vaccines (Influenza Virus, Trivalent, Types A & B; Fluogen; Fluzone, Flu-Shield, Fluvirin)	protection against strains of influenza viruses contained in vaccine and closely related strains; annual vaccination recommended for persons at increased risk of adverse consequences from lower respiratory tract infections (e.g., those with chronic respiratory diseases, kidney disease, diabetes mellitus, and immunosuppressed persons); also recommended for persons 65 and over and those at increased risk of exposure (e.g., those providing community services)	IM	*6 months–35 months:* 2 doses of 0.25 mL each given 4 weeks apart *3–12 years:* 2 doses of 0.5 mL each given 4 weeks apart *over 12:* 1 dose of 0.5 mL	Preferred site of injection is deltoid muscle or midlateral thigh. Do not routinely administer to persons hypersensitive to chicken eggs. Defer administration during acute respiratory infections and polio epidemics. Febrile reactions with convulsions may occur in children under 3 years. Local reactions (e.g., redness and induration at the injection site) may last for 1–2 days. Systemic symptoms (e.g., fever, malaise, myalgia) occur infrequently and are more common in children. Although uncommon, Guillian-Barré syndrome may occur.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
Japanese encephalitis virus vaccine (JE-VAX)	active immunization against Japanese encephalitis for persons over 1 year of age	SC	*Adults and children over 3:* 3 doses of 1.0 mL each given on days 0, 7, and 30 *Children (1–3):* 3 doses of 0.5 mL each given on days 0, 7, and 30	A booster dose of 1 mL (0.5 mL for children 1–3 years old) may be given after 2 years. Store vaccine at 2–8°C. Do not freeze.
Lyme disease vaccine (LYMErix)	recommended for persons 15–70 yrs who are at risk (those who live in or near tick-infested woods)	IM	30 mcg/0.5 ml dose given at 0, 1, and 12 mo. Second and third doses should be given prior to high risk time for tick infestation	Safety not established for children.
measles, mumps and rubella vaccine, live (M–M–R II)	simultaneous immunization against measles, mumps, and rubella in children from 15 months of age to puberty	SC	total volume of a single dose vial	See notes for measles, rubella, and mumps vaccines.
measles (rubeola) and rubella virus vaccine, live (M–R–Vax II)	simultaneous immunization against measles and rubella in children from 15 months to puberty	SC	total volume of a single dose vial	Preferred injection site is the outer aspect of the upper arm. See notes for measles (rubeola) virus vaccine and rubella virus vaccine. Prior to and following reconstitution, store at 2°–8°C. Protect from light. Discard if not used within 8 hours after reconstitution. Use only the diluent supplied.
measles (rubeola) virus vaccine, live, attenuated (Attenuvax)	active immunization of children 15 months of age or older against measles (rubeola); particularly indicated for institutionalized children and those who are malnourished or have chronic diseases; may also be used in adults when epidemic situations exist or where measles is not endemic	SC	1 dose of 1,000 $TCID_{50}$ (tissue culture infectious doses)	Preferred site of administration is the outer aspect of the upper arm. Contraindicated in persons hypersensitive to eggs, chicken, chicken feathers and neomycin. Also contraindicated in pregnant women, immunosuppressed persons, those with febrile illnesses or active untreated tuberculosis, and persons with blood dyscrasias or malignancies affecting the bone marrow or lymphatic system. Do not give within 1 month of immunizations, except monovalent or trivalent live oral polio virus vaccine, live rubella virus vaccine, and/or live mumps virus vaccine. Use caution in administering to children with a history of febrile convulsions, cerebral injury, or other conditions in which stress due to fever should be avoided.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
measles (rubeola) virus vaccine, live, attenuated (Attenuvax) *(continued)*				Defer vaccination for at least 3 months following transfusion of blood or plasma or administration of more than 0.02 mL/lb of human immune serum globulin. Adverse reactions commonly include moderate fever (38.4°–39.4°C) during the month following vaccination, and rash (appearing 5–12 days after vaccination). High fevers (over 39.6°C), reactions at the injection site, febrile convulsions, and central nervous system reactions (e.g., encephalitis) may occur. Use only the diluent supplied with the vial. Reconstitute immediately before using. Store reconstituted vaccine in a dark place at 2–8°C and discard if not used within 8 hours. Antibody levels have been shown to persist for 8 years.
mumps virus vaccine, live (Mumpsvax)	immunization against mumps in children 12 months or older	SC	total volume of a single dose vial	Contraindicated in persons hypersensitive to eggs, chicken, chicken feathers, or neomycin. Also contraindicated in persons with blood dyscrasias, leukemia, lymphomas or other malignancies affecting the bone marrow or lymphatic systems, immunosuppressed clients, pregnant women, or those with active infection. Epinephrine 1:1000 injection must be available for use if anaphylaxis occurs. Do not give less than 1 month before or after immunization with other live virus vaccine and/or live monovalent or polyvalent poliovirus vaccine. Defer vaccination for at least 3 months following transfusion of blood or plasma or administration of human immune serum globulin.
poliovirus vaccine, inactivated (IPOL, Poliovax)	active immunization against poliomyelitis	SC	3 doses of 1 mL each administered at 4–8 week intervals; a fourth dose of 1 mL should follow 6–12 months after the third dose	Vaccine of choice for immunization of persons with compromised immune systems. Defer administration in the presence of acute respiratory or other infections. Do not use vaccine unless it is completely free of particles and unless it is cherry red in color.
poliovirus vaccine live, oral, trivalent (Orimune Oral Suspension)	active immunization against poliomyelitis caused by types 1, 2 and 3 polioviruses	oral	Primary immunization *Infants:* 3 doses of 0.5 mL, first dose given at 8 weeks, second	Vaccine of choice for polio immunization. Contraindicated in the presence of acute and febrile illnesses. Also contraindicated in persons with leukemia, lymphoma or generalized malignancy, and in immunosuppressed persons.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
poliovirus vaccine live, oral, trivalent (Orimune Oral Suspension) *(continued)*			dose 6–8 weeks later, third dose 8–12 months after second dose *Children and adolescents:* 3 doses of 0.5 mL, first 2 doses given 6–8 weeks apart and third dose 8–12 months after second *Adults:* unimmunized adult at risk is treated like children and adolescents. Booster doses Entering school (4–6 years): for those who have received the primary immunization, give a single dose; unimmunized children should receive the primary series Increased risk: a single dose is used for previously immunized persons at risk	**Note:** Transmission of live, attenuated polioviruses from vaccinated persons to others not having intestinal resistance has been reported. Adverse reactions are rare. Paralytic disease in the person receiving the vaccine or those in close contact with such persons has rarely occurred (80 cases in 290,000,000 doses). For single-dose container, pull cap to remove, invert and squeeze to expel contents. Administer the entire contents of the tube directly into the mouth or give in 5 mL of distilled water or simple syrup, USP, mixing thoroughly. For multiple-dose container, administer each dose by dropping 2 drops into a disposable cup containing approximately 5 mL of distilled water or simple syrup, USP; or onto a sugar cube; or directly into the mouth, taking care not to contaminate the dropper. Use only the dropper supplied in the package. Unopened vials of vaccine in the liquid state may be used for up to 30 days if stored at 2°–8°C. Once opened, the vaccine must be kept refrigerated and used within 7 days.
rubella and mumps virus vaccine, live (Biavax II)	simultaneous immunization against rubella and mumps in children from 12 months of age to puberty	SC	total volume of a single dose vial	See notes for rubella virus vaccine and mumps virus vaccine.
rubella virus vaccine, live (Meruvax II)	indicated for immunization against rubella in children from 12 months of age to puberty; may also be used in preventing or controlling outbreaks of rubella in circumscribed populations	SC	total volume of a single dose vial	Contraindicated in pregnant women and women who may become pregnant within the following 3 months. Also contraindicated in persons hypersensitive to neomycin, those with febrile illnesses, immunosuppressed persons and those with blood dyscrasias, leukemia, lymphomas, or malignancies affecting the bone marrow or lymphatic systems. Epinephrine 1:1000 injection should be available for use if anaphylaxis occurs. Do not give less than 1 month before or after immunization with other live viruses, except live attenuated measles vaccine and/or live mumps vaccine.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
rubella virus vaccine, live (Meruvax II) *(continued)*				Vaccination should be deferred for at least 3 months following transfusion of blood or plasma or administration of human immune serum globulin. Adverse reactions are uncommon, but include lymphadenopathy, rash, malaise, sore throat, fever, headache, polyneuritis, temporary arthralgia (especially in women), local pain and erythema at the injection site, and moderate fever (38.4°–39.4°C). Mild fever may occur, although fever above 39.6°C is uncommon. Parotitis has occurred rarely. Preferred injection site is outer aspect of upper arm. Antibody levels have persisted for at least 10 years.
varicella vaccine (Varivax)	live attenuated vaccine for active immunization for healthy children over age 12 months and adults; effective immunization for chickenpox and shingles	SC	*Children (12 mo.–12 yrs.):* single dose of 0.5 ml *Adults:* 0.5 ml followed by 0.5 ml 4–8 weeks after first dose and, if needed, third dose 3 months after initial series	Contraindicated in persons who are immune compromised. Contraindicated in persons with active respiratory infections. Avoid salicylates for 6 weeks after vaccination to decrease risk of Reye's syndrome.
yellow fever vaccine (YF-Vax)	active immunization of travelers to countries requiring vaccination; for use in persons 6 months of age and older	SC	*Children and adults:* 0.5 mL	Contraindicated in hypersensitivity to egg and chick embryo protein. Avoid use in pregnant women. Administer 1 month before or after other live virus vaccines. Approximately 10% of clients develop fever or malaise following immunization. Rarely, encephalitis has developed in young infants. When preparing, use special diluent supplied, mix well and use within 1 hour of reconstitution. Revaccinate after 10 years.
Toxoids				
diphtheria and tetanus toxoids and whole cell pertussis vaccine, adsorbed (Diphtheria and Tetanus Toxoids and Pertussis Vaccine; Tri-Immunol; DTwP)	active immunization of infants over 2 months and children under 7 years of age against diphtheria, tetanus and pertussis	IM	Primary immunization Begin at 6 weeks–3 months or as soon thereafter as possible; 3 doses of 0.5 mL are given at 4 to 8 week intervals, with a fourth dose 1 year after the	DPT vaccine is not used for the treatment of tetanus, diphtheria, or whooping cough infections. Immunization should be deferred in clients more that 6 months old during an outbreak of poliomyelitis. Only well children should be injected. Children with cerebral damage should be immunized after 1 year of age using fractionated doses of single antigens.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
diphtheria and tetanus toxoids and whole cell pertussis vaccine, adsorbed *(continued)*			third Booster dose A booster of 0.5 mL is given at 4 to 6 years of age (preferably prior to school entry); thereafter, the recommended dose of diphtheria and tetanus toxoids, combined (for adult use) is used every 10 years	Children who have severe systemic reactions to the initial dose (e.g., temperature of 39.6°C, prolonged crying, coma, convulsions) should receive fractionated subsequent doses or no more injections. Defer immunization during short-term treatment with immunosuppressant agents. Adverse reactions include slight temperature elevation and mild local reactions. Chills and malaise occur infrequently and are generally mild. Cases of encephalopathy have occurred.
diphtheria and tetanus toxoids and acellular pertussis vaccine (Acel-Imune, Tripedia)	active immunization against diphtheria, tetanus, and pertussis as the 4th or 5th dose in children from 15 months to 7 years of age	IM	0.5 mL	Whole cell diphtheria, tetanus, and pertussis vaccine should be used for first 3 doses. Store vaccine at 2°–8°C. Do not freeze.
diphtheria and tetanus toxoids and whole cell pertussis and *Haemophilus influenzae* type B conjugate vaccines (Tetramune)	active immunization against diphtheria, tetanus, pertussis, and hemophilus b disease for children 2 months to 5 years of age	IM	0.5 mL	Store vaccine at 2°–8°C. Do not freeze.
diphtheria and tetanus toxoids, combined (Diphtheria and Tetanus Toxoids, Adsorbed [for pediatric use]; Diphtheria and Tetanus Toxoids, Adsorbed [for adult use])	active immunization against diphtheria and tetanus for use in infants and children when pertussis vaccination is contraindicated or used separately	IM	*Pediatric, adsorbed toxoids:* 2 doses of 0.5 mL given 4–8 weeks apart; a third dose of 0.5 mL given 6–12 months later and a booster dose of 0.5 mL on entry to school *Adult, adsorbed toxoids:* 2 doses of 0.5 mL each given 4–6 weeks apart followed by a dose of 0.5 mL given 6–12 months later; a booster dose of 0.5 mL is recommended every 10 years	See notes for diphtheria toxoid and tetanus toxoid.

continues

TABLE 42–2 *continued*

See **Note** at beginning of Table 42–2, page 848.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
diphtheria toxoid, adsorbed (pediatric)	active immunization against diphtheria in infants and children under 6 years of age	IM	Primary immunization: 2 injections of 0.5 mL given 6–8 weeks apart and a third dose of 0.5 mL 1 year later Routine booster: 1 dose of 0.5 mL given at 5–10 year intervals	Contraindicated during acute infection. Defer immunization in children receiving immunosuppressants. Do not use in the treatment of diphtheria infections. Use caution in administering to those with a history of neurological disorders or febrile convulsions. Mild to moderate local reactions, including redness, induration, and tenderness at the injection site, may occur. Systemic reactions have included transient fever, malaise, generalized aches, flushing, urticaria, pruritus, tachycardia, and hypotension, as well as neurological disorders. Shake well before withdrawing a dose.
tetanus toxoid (Tetanus Toxoid, Fluid; Tetanus Toxoid, Adsorbed)	active immunization against tetanus; recommended for all adults and children, particularly in persons sensitive to horses, cattle, or their products; those who have not received antitoxin or antiserum of animal origin, and those frequently exposed to injuries likely to be contaminated with tetanus organisms	IM (Tetanus Toxoid, Adsorbed) IM, SC (Tetanus Toxoid, Fluid)	Primary immunization: Tetanus Toxoid, Adsorbed: 2 injections of 0.5 mL given 4–8 weeks apart and a third injection 6–12 months after the second Tetanus Toxoid, Fluid: 3 injections of 0.5 mL 4–8 weeks apart and a fourth injection 6–12 months after the third Booster dose: 0.5 mL every 10 years	Preferred sites of injection are the vastus lateralis, deltoid, or gluteus muscles. Contraindicated in acute infection (except for emergency booster doses given following a wound) and during an outbreak of poliomyelitis. Not used for the treatment of tetanus infections or for immediate prophylaxis of unimmunized persons. Avoid using in immunosuppressed persons. Decrease the size of subsequent doses in infants with a history of febrile convulsions and those who develop moderate to severe systemic reactions following the first injection. Local reactions (erythema and induration) at the injection site are not uncommon. Application of heat or cold to the injection site may increase the severity of such reactions. Mild systemic reactions, including low-grade fever, chills, malaise, and general aches and pains, may occur, with severe reactions unusual.

IMMUNOSUPPRESSANT AGENTS

Immunosuppressants are drugs that suppress the immunological system of the body. They are primarily used to prevent organ rejection in kidney, liver, heart, and other organ transplants. Their mechanism of action is obscure, although their use is associated with suppression of T-lymphocytes, cells believed to play an important role in the immunological process. The immunosuppressant drugs are generally used in combination with corticosteroids (see Chapter 12) to improve their efficacy.

Azathioprine (Imuran)

Azathioprine is a chemical derivative of **6-mercaptopurine**, an antimetabolite used in treating certain forms of cancer (see Chapter 39). It shares many of the properties of its parent compound

TABLE 42–3

Agents Used in the Prophylaxis of Rabies

Note: Obtain a history of allergy before administering these agents.
Do not use these agents beyond their expiration date.
Ensure that epinephrine 1:1000 is immediately available for the treatment of anaphylactic reactions.
Following administration, observe the client's response for 20 to 30 minutes before discharging client.
Update client's personal immunization records.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
antirabies serum, equine origin	rabies prophylaxis	IM and wound infiltration	Single dose of 1,000 IU/55 lbs; up to ½ of dose should be infiltrated into tissue around the wound whenever feasible. Give in conjunction with Rabies Vaccine	Administer only once and at a site other than site of rabies vaccine injection. Intradermal or conjunctival test for hypersensitivity conducted before administration. Not recommended for persons allergic to horses and horse serum and those with multiple allergies.
rabies immune globulin, human (Hyperab, Imogam)	passive protection against rabies after exposure	IM and wound infiltration	Single administration of 20 IU/kg or 9 IU/lb of body weight at the time of the first vaccine dose; up to ½ the dose should be used to infiltrate the wound and the rest given IM	Used in conjunction with rabies vaccine of duck embryo origin. Contraindicated in persons known to be allergic to gamma globulin or thimerosal. Dose is not repeated to avoid interfering with action of the vaccine. Soreness at the injection site and slight temperature elevation may occur.
rabies vaccine, human diploid cell cultures (Imovax Rabies Vaccine, Imovax Rabies I.D. vaccine)	preexposure treatment of persons at risk of contact with rabid animals postexposure treatment of persons suspected of exposure to rabies	IM, intradermal (ID)	Preexposure: 3 injections of 1 mL administered on day 0, day 7 and either on day 21 or 28 Postexposure: 5 doses of 1 mL on days 0, 3, 7, 14 and 28; rabies immune globulin should also be given on day 0	Boosters may be advisable every 2 years for persons working with live rabies virus in research laboratories. Imovax may alternatively be administered intradermally in 3 doses of 0.1 mL each on days 0, 7 and 28 instead of IM regimen.

and is, in fact, converted within the body to 6-mercaptopurine. The adverse effects of azathioprine are similar to those of its parent compound and include severe bone marrow depression, nausea, and vomiting, as well as carcinogenicity. Its use must therefore be carefully monitored and appropriate measures instituted if signs of adverse effects develop.

Azathioprine may be administered intravenously or orally. Initially, it is administered intravenously in a dose of 3 to 5 mg/kg/day beginning on the day of transplantation or 1–3 days before the transplant is performed. In the postoperative period, the oral form is substituted for the IV form. A maintenance dose of 1–3 mg/kg/day may then be administered. Allopurinol (Zyloprim), a drug for reducing uric acid levels in the blood (see Chapter 13), has been shown to decrease the hepatic metabolism of azathioprine. In clients receiving both drugs simultaneously, it is, therefore, necessary to reduce the dose of azathioprine to approximately ⅓ to ¼ of the normal dose.

Cyclosporine (Sandimmune)

Cyclosporine is considered one of the most effective immunosuppressant agents and has probably been responsible for the dramatic advances made in transplant surgery during the last few years. Its use is, however, associated with an assortment of serious side effects, which include nephrotoxicity, tremor, hirsutism, hypertension, and gum *hyperplasia*. Cyclosporine must therefore be used with caution in clients receiving other nephrotoxic drugs (e.g., aminoglycoside antimicrobial agents).

Cyclosporine is generally administered intravenously at an initial dose of 15 mg/kg/day and is usually given 4–12 hours before transplantation. Postoperatively, this dose is administered orally for 1 to 2 weeks and then tapered by 5% per week, until a maintenance dose of 5 to 10 mg/kg/day is reached. Cyclosporine oral solution may be mixed with milk, chocolate milk, or orange juice just before administration to improve its palatability. After the cyclosporine-containing liquid has been given, the drinking container (preferably made of glass) is rinsed with more liquid, which is then given to the client, to ensure that the entire dose has been consumed. In clients unable to take cyclosporine oral solution, the IV form may be used at ⅓ the oral dose.

Tacrolimus (Prograf FK 506)

Tacrolimus is an immunosuppressant drug that prolongs the survival of the host and transplanted grafts in clients who have received liver, kidney, heart, bone marrow, small bowel and pancreas, lung and trachea, skin, cornea, and limb transplants. It appears to act by inhibiting T-lymphocyte activation. Adverse effects associated with tacrolimus use include headache, tremor, insomnia, diarrhea, nausea, hypertension, and renal dysfunction. An initial dose of 0.05 to 0.1 mg/kg/day of tacrolimus is administered by IV infusion beginning no sooner than 6 hours after transplantation. Concommitant administration of corticosteroids is helpful. Once the client can tolerate oral therapy (usually within 2–3 days) tacrolimus administration is continued with 0.04–0.2 mg/kg/day administered in 2 divided daily doses every 12 hours.

Muromonab-CD3 (Orthoclone OKT3)

Monoclonal antibodies are antibodies that work specifically against an antigen such as a virus. As they are specifically attracted to a single antigen, they may be used alone or may be chemically coupled with drugs or radioisotopes to target the treatment of a specific disorder. These agents are the closest to being a "magic bullet" that will attack a pathogenic organism or cancerous tumor without affecting healthy tissue. **Muromonab-CD3** is a monoclonal antibody to the antigen of human T cells that functions as an immunosuppressant. It is used in the treatment of acute *allograft* rejection in renal transplant clients. It is administered as an IV bolus in less than 1 minute in a dose of 5 mg/day for 10–14 days.

Common adverse effects with muromonab-CD3 therapy are fever, chills, dyspnea, chest pain, nausea, and vomiting. Clients receiving this agent are also more susceptible to infections caused by viruses and bacteria.

Basiliximab (Simulect)

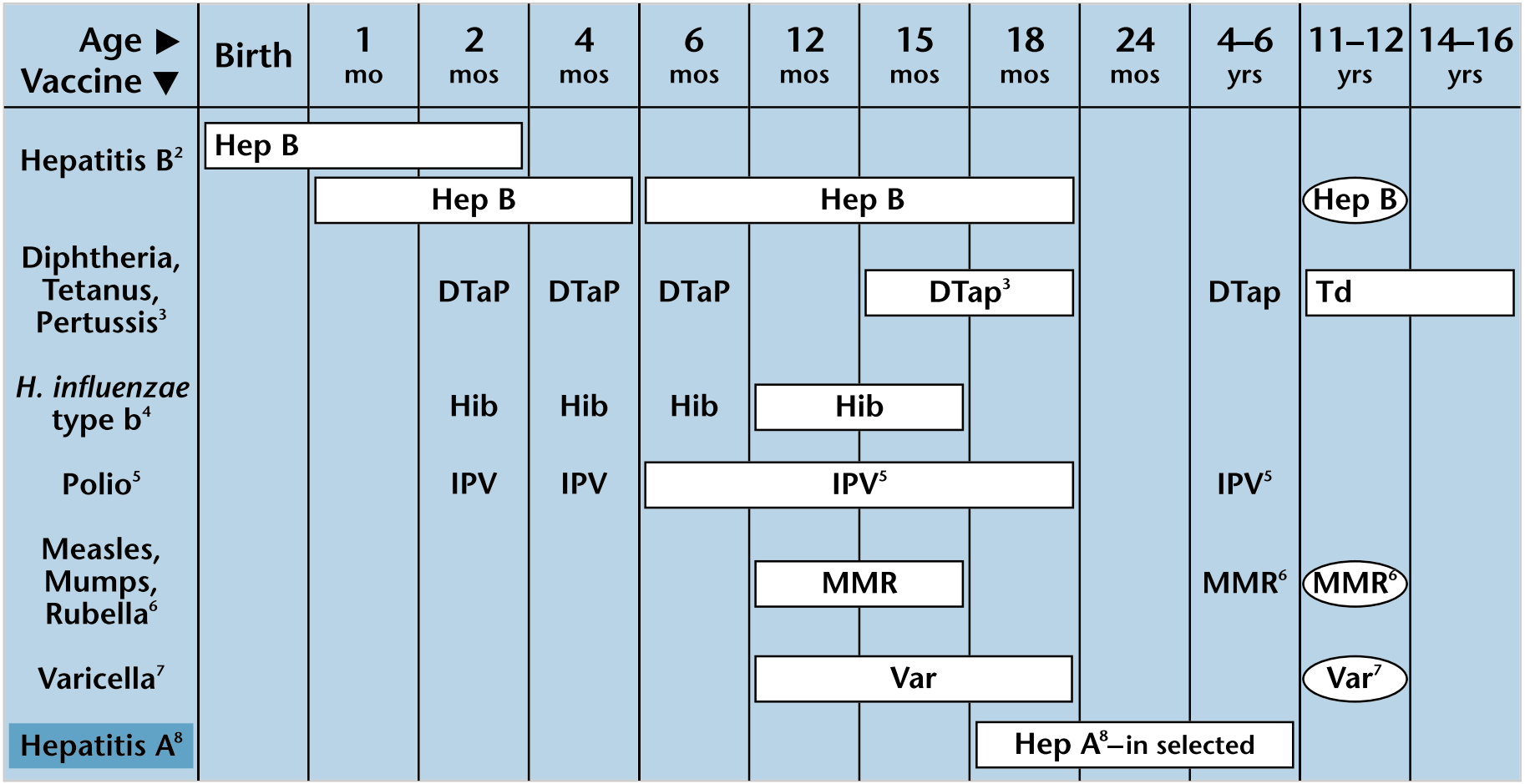
Basiliximab is one of the newer immunosuppressant agents. It is a monoclonal antibody used to prevent acute rejection adults and children 2 and older following renal transplantation. It acts by binding to and blocking interleukin-2 receptor sites on activated T-cells. It is designed to be used as part of a immunosuppressant regimen that includes cyclosporine and corticosteroids. Because its action does not suppress the entire immune system, basiliximab does not appear to create a major risk of infection. The most commonly experienced adverse effects associated with basiliximab in adults have been associated with gastrointestinal irritation, including abdominal pain, constipation, and diarrhea. In children, however, fever and urinary tract infections have been the most frequently seen adverse effects. Some clients have experienced potassium imbalances, including hyper- and hypokalemia. As a result, potassium serum levels should be monitored. Most adverse effects are treated symptomatically.

The initial dose of basiliximab is administered intravenously within 2 hours prior to the transplant with a second dose to be given 4 days following the transplant. For adults, the recommended dose is 20 mg; for children up to 15 years old, the recommended dose is 12 mg/m^2, each up to a maximum of 20 mg. Basiliximab should be reconstituted in 5 ml of sterile water and this is then diluted in 50 ml of 0.9% normal saline or 5% dextrose solutions and is administered over 20 to 30 minutes via a peripheral or central venous access.

TABLE 42–4

Recommended Childhood Immunization Schedule
United States, January–December 2000 *U.S. Centers for Disease Control*

Note: Vaccines are listed under routinely recommended ages. [Bars] indicate range of recommended ages for immunization. Any dose not given at the recommended age should be given as a "catch-up" immunization at any subsequent visit when indicated and feasible. (Ovals) indicate vaccines to be given if previously recommended doses were missed or given earlier than the recommended minimum age.



Approved by the Advisory Committee on Immunization Practices (ACIP), the American Academy of Pediatrics (AAP), and the American Academy of Family Physicians (AAFP).

On October 22, 1999, the Advisory Committee on Immunization Practices (ACIP) recommended that Rotashield® (RRV-TV), the only U.S.-licensed rotavirus vaccine, no longer be used in the United States (MMWR, Volume 48, Number 43, Nov. 5, 1999). Parents should be reassured that their children who received rotavirus vaccine before July are not at increased risk for intussusception now.

[1]This schedule indicates the recommended ages for routine administration of currently licensed childhood vaccines as of 11/1/99. Additional vaccines may be licensed and recommended during the year. Licensed combination vaccines may be used whenever any components of the combination are indicated and its other components are not contraindicated. Providers should consult the manufacturers' package inserts for detailed recommendations.

[2]**Infants born to HBsAg-negative mothers** should receive the 1st dose of hepatitis B (Hep B) vaccine by age 2 months. The 2nd dose should be at least one month after the 1st dose. The 3rd dose should be administered at least 4 months after the 1st dose and at least 2 months after the 2nd dose, but not before 6 months of age for infants.
Infants born to HBsAg-positive mothers should receive hepatitis B vaccine and 0.5 mL hepatitis B immune globulin (HBIG) within 12 hours of birth at separate sites. The 2nd dose is recommended at 1–2 months of age and the 3rd dose at 6 months of age.
Infants born to mothers whose HBsAg status is unknown should receive hepatitis B vaccine within 12 hours of birth. Maternal blood should be drawn at the time of delivery to determine the mother's HBsAg status; if the HBsAg test is positive, the infant should receive HBIG as soon as possible (no later than 1 week of age).
All children and adolescents (through 18 years of age) who have not been immunized against hepatitis B may begin the series during any visit. Special efforts should be made to immunize children who were born in or whose parents were born in areas of the world with moderate or high endemicity of hepatitis B virus infection.

[3]The 4th dose of DTaP (diphtheria and tetanus toxoids and acellular pertussis vaccine) may be administered as early as 12 months of age, provided 6 months have elapsed since the 3rd dose and the child is unlikely to return at age 15–18 months. Td (tetanus and diphtheria toxoids) is recommended at 11–12 years of age if at least 5 years have elapse since the last dose of DTP, DTaP or DT. Subsequent routine Td boosters are recommended every 10 years.

[4]Three *Haemophilus influenzae* type b (Hib) conjugate vaccines are licensed for infant use. If PRP-OMP (PedvaxHIB® or ComVax® [Merck]) is administered at 2 and 4 months of age, a dose at 6 months is not required. Because clinical studies in infants have demonstrated that using some combination products may induce a lower immune response to the Hib vaccine component, DTaP/Hib combination products should not be used for primary immunization in infants at 2, 4 or 6 months of age, unless FDA-approved for these ages.

[5]To eliminate the risk of vaccine-associated paralytic polio (VAPP), an all-IPV schedule is now recommended for routine childhood polio vaccination in the United States. All children should receive four doses of IPV at 2 months, 4 months, 6–18 months, and 4–6 years. OPV (if available) may be used only for the following special circumstances:

1. Mass vaccination campaigns to control outbreaks of paralytic polio.
2. Unvaccinated children who will be traveling in <4 weeks to areas where polio is endemic or epidemic.
3. Children of parents who do not accept the recommended number of vaccine injections. These children may receive OPV only for the third or fourth dose or both; in this situation, health-care providers should administer OPV only after discussing the risk for VAPP with parents or caregivers.
4. During the transition to an all-IPV schedule, recommendations for the use of remaining OPV supplies in physicians' offices and clinics have been issued by the American Academy of Pediatrics (see *Pediatrics*, December 1999).

[6]The 2nd dose of measles, mumps, and rubella (MMR) vaccine is recommended routinely at 4–6 years of age but may be administered during any visit, provided at least 4 weeks have elapsed since receipt of the 1st dose and that both doses are administered beginning at or after 12 months of age. Those who have not previously received the second dose should complete the schedule by the 11–12 year old visit.

[7]Varicella (Var) vaccine is recommended at any visit on or after the first birthday for susceptible children, i.e. those who lack a reliable history of chickenpox (as judged by a health care provider) and who have not been immunized. Susceptible persons 13 years of age or older should receive 2 doses, given at least 4 weeks apart.

[8]Hepatitis A (Hep A) is shaded to indicate its recommended use in selected states and/or regions; consult your local public health authority. (Also see *MMWR* Oct. 01, 1999/48(RR12); 1–37).

Mycophenolate Mofetil HCl (CellCept)

Mycophenolate mofetil HCl is used prophylactically to prevent rejection in clients receiving allogenic kidney or heart transplants in adult clients. Its safety and efficacy in children has not be established and is, therefore, not approved for used in pediatric clients. It acts by inhibiting both B and T lymphocytes and is used in combination with cyclosporine and corticosteroids in an immunosuppressant regimen. The most common adverse effects associated with **CellCept** range from gastrointestinal irritation (diarrhea and vomiting) to hematologic effects of leukopenia, thrombosis, and phlebitis. Serious adverse effects such as GI hemorrhage, severe neutropenia, and fatal infections occur rarely (<2%–3%).

The recommended doses differ for renal and heart transplants. For renal transplants, the standard dose is 1 gram administered twice daily intravenously, whereas for clients following heart transplant, the dosage is 1.5 grams infused twice daily. Each 500 mg is reconstituted in 15 ml of 5% dextrose solution and then each 500 mg is further diluted in 70 ml of 5% dextrose infused over a minimum of 2 hours.

Daclizumab (Zenapax)

Daclizumab is a recombinant monoclonal antibody produced by recombinant DNA that acts as an antagonist to interleukin-2, inhibiting the mediated activation of lymphocytes by interleukin-2. It is used prophylactically to prevent acute organ rejection in clients receiving renal transplants. Most of the adverse effects seen in clients receiving daclizumab are primarily in association with concurrent use of immunosuppressants, including azathioprine, cyclosporine, mycophenolate mofetil, and corticosteroids. The adverse effects of gastrointestinal irritation, bleeding, infection, pulmonary, and cardiac irregularities, do not appear to increase in frequency or severity from daclizumab. Most side effects are treated symptomatically.

Daclizumab has been FDA approved for use only in adults only at this time. The recommended dose is 1mg/kg administered intravenously as an infusion for a total of 5 doses. Following the initial dose, the other 4 doses are administered at 14-day intervals. Each dose is diluted in 50 ml of 0.9% saline and infused over 15 minutes.

Sirolimus (Rapamune)

As with many of the newer immunosuppressants, **sirolimus** is used in conjunction with cyclosporine and corticosteroids. It is indicated for the prevention of acute organ rejection in clients following allogenic renal transplantation. It inhibits T-cell activation and proliferation. Adverse effects of this agent include bone marrow suppression, insomnia, hyperlipidemia, tremors, and joint pain.

Sirolimus is administered orally to adults and children 13 years old and older (and weighing over 40 kg) as a 6 mg loading dose followed by a 2 mg daily maintenance dose. In adults and children weighing less than 40 kg, the loading dose is $3mg/m^2$ and the daily maintenance dose 1 mg/m^2.

Lymphocyte Immune Globulin (Atgam, Anti-Thymocyte Globulin)

Lymphocyte immune globulin reduces the number of lymphocytes dependent on the thymus and contains small concentrations of antibodies against other blood elements. It is used in the management of clients receiving allogenic renal transplantation. It is also indicated for clients with severe aplastic anemia who are not candidates for bone marrow transplantation. Although, many of the same adverse effects associated with other immunosuppressant agents occur with the use of lymphocyte immune globulin, it rarely results in severe lymphopenia.

This agent is administered intravenously and the usual dose for prevention of organ rejection is 10–15 mg/kg daily for 14 days. It is usually administered concurrently with azathioprine and corticosteroids. The pediatric dose ranges from 5 to 25 mg/kg daily. Lymphocyte immune globulin should be administered into a vascular shunt, an atrioventricular fistula, or a "high-flow" central venous access using a 0.2–1-micron filter. Each daily dose should be infused over a minimum of 4 hours.

Cytomegalovirus Immune Globulin (CMV-IGIV, Cytogam)

One of the most common infections associated with transplanted organs in the past has been cytomegalovirus (CMV). **Cytomegalovirus immune globulin** was developed to raise the antibody titer of this virus to sufficient levels to attenuate and reduce the incidence of potentially serious CMV

infections. This agent is indicated for clients following kidney, heart, liver, lung, and pancreas transplantation. Most adverse effects are associated with the rate of intravenous infusion of this agent. They include back pain, chills, fever, hypotension, nausea, vomiting, and muscle cramps. With the onset of any of these adverse effects, the infusion should be decreased immediately and may require temporarily discontinuing the infusion.

The recommended dose of cytomegalovirus immune globulin varies depending on the organ transplanted, although the timing of the administrations of this medication and the initial dose do not differ. Within 72 hours following the transplant, this agent must be administered and the usual dose is 150 mg/kg in a single intravenous infusion. Following this initial dose in the renal transplant client, a dose of 100 mg/kg are administered at 2, 4, 6, and 8 weeks after the transplant. The dose then decreases to 50 mg/kg infused at 12 and 16 weeks post-transplant. Following heart, lung, liver, or pancreas transplant, the initial dosing of cytomegalovirus immune globulin is 150 mg/kg. However, the succeeding doses, although given at the same intervals as following a renal transplant, are based on 150 mg/kg for the 2-, 4-, 6-, and 8-week doses and then decreased to 100 mg/kg for the doses administered at 12 and 16 weeks following the transplant.

Antineoplastics

Both cyclophosphamide and methotrexate are used as immunosuppressant agents in doses smaller than those when these agents are used as antineoplastics. Refer to Chapter 39 for adverse effects and nursing implications associated with the use of these agents.

APPLYING THE NURSING PROCESS

CLIENTS RECEIVING AGENTS TO ENHANCE THE IMMUNE SYSTEM

Many of the clients receiving drugs to enhance the immune system are healthy and are receiving these drugs to bolster immunity against specific diseases or antigens. Some of these clients, however, are ill and receiving agents that provide passive immunity. Nursing assessment and planning and implementing nursing care must be modified to meet the needs of these two groups of individuals.

Assessment

Nursing assessment of persons seeking immunizations includes a review of past immunizations, often available in the medical records and the person's response to such immunizations. Also, it includes taking a history of personal and family allergy, particularly to chickens, feathers, horses, and neomycin. It is useful to obtain a brief health history to determine if the person has or has had a medical condition that may contraindicate the use of a particular agent. Information for specific agents is contained in the nursing implications section of Tables 42–1, 42–2, and 42–3. Generally, the person's vital signs, particularly temperature, are assessed before administration of vaccines. Vaccination, particularly with agents containing live viruses, is avoided in persons with febrile illness, in the immunocompromised client, and for children with diarrhea. The nurse inquires whether women of childbearing age are pregnant, as vaccines containing live viruses are not given during pregnancy. Some clients, especially those with a history of allergy, are given skin tests before administering a vaccine. Often, the nurse is responsible for administering and reading these tests.

Following vaccine administration, nursing assessment focuses on observing the client's reaction. Persons who have received vaccines are usually detained for 20 to 30 minutes following administration, so they can be observed for adverse reactions. In particular, the nurse assesses the client for difficulty in breathing and other indications of anaphylaxis.

Some persons receiving immune globulin are already ill and an attempt is made to provide antibodies to prevent or treat illness. Nursing assessment includes obtaining vital signs and body weight, as dosage may be based on weight. Also, the nurse assesses the client's general condition, including nutritional state and fluid and electrolyte balance.

Nursing Diagnoses

Including but not limited to:

- Ineffective protection, immune related to disease process
- Risk for injury related to adverse effects of medication regimen
- Deficient knowledge related to disease process and medication regimen

Planning/Goals

- Client will experience enhanced immune system as evidenced by laboratory values and reduction in number of infections.
- Client will not experience adverse effects associated with immune enhancers.
- Client will verbalize and demonstrate understanding of disease process and importance of compliance with medication regimen.

Implementation

Special procedures in preparing vaccines for administration and in giving these drugs are contained in the nursing implications column of Tables 42–1, 42–2, and 42–3. The nurse must consult the manufacturer's instructions before administering vaccines and must also ensure that the preparation is not outdated. **Note:** When these drugs are administered, emergency, equipment including epinephrine 1:1000 must be available for life support, in case an anaphylactic reaction occurs.

Most injectable vaccines are administered to adults and older children in the deltoid muscle. Infants and small children usually receive vaccines in the vastus lateralis muscle. (See Chapters 3 and 5 regarding administration sites.) Large volumes of drugs that enhance the immune system, such as immunoglobulins, may be given intramuscularly in the gluteal muscles to adults or may be administered intravenously, particularly to infants and young children. When intravenous infusion is used, observe the client for fever, chills, difficulty in breathing, headache, backache, and restlessness. Monitor vital signs and observe the infusion site hourly for redness and swelling. Observe fluid and electrolyte balance, especially in low birth weight infants.

Recordkeeping is an important part of nursing care for clients receiving vaccines. The Vaccine Injury Compensation Act of 1988 requires that a written record be kept of the manufacturer, lot number, and expiration date of the vaccine, date of administration, and signature and title of the person administering the vaccine. Severe reactions to vaccines must be reported to the Food and Drug Administration on a form available from the state health department. It is also important to keep medical records and personal immunization records updated.

Parents of young children who have received vaccines are advised to use acetaminophen to treat slight elevations in temperature and discomfort. Higher temperature elevations and other adverse reactions should be reported to health care personnel. Parents must be advised to call the physician if the behaviors or

KEY NURSING IMPLICATIONS 42–1

Agents that Enhance the Immune System

1. Before administering these drugs, obtain a history of allergy, medical conditions, and response to past immunizations.
2. Determine if the client is pregnant, immunocompromised, febrile, or experiencing diarrhea. Live vaccines, in particular, are not administered under these circumstances.
3. Follow the manufacturer's directions about storage, preparation, and administration of vaccines. Do not use outdated medications.
4. Always have emergency equipment, including epinephrine, available if needed.
5. Most vaccines are given in the deltoid muscle in adults and older children and in the vastus lateralis in infants and young children. Exceptions do occur, so check the order and manufacturer's directions carefully.
6. Following vaccine administration, observe the person for 20 to 30 minutes to ensure that no immediate adverse reaction has occurred.
7. Clients receiving interferons are assessed for severe fatigue, fever, chills, tachycardia, gastrointestinal upset, and blood profile changes. Those clients receiving interleukins are monitored for fluid retention, dyspnea, fatigue, and anemia.
8. Keep appropriate and current written records of all vaccines administered.

signs of adverse reaction occur. These include a temperature of 105°F or greater, prolonged crying (5–6 hours), seizure, or high-pitched, shrill crying. Special precautions are taken when administering subsequent doses of vaccine to infants who have experienced such severe reactions to a vaccine dose.

Interferons and interleukins are used to enhance the body's immune system, particularly in cancer clients. Local administration of these agents has not been associated with significant side effects, but clients receiving them intravenously must be monitored carefully. Clients receiving interferons are assessed for severe fatigue, and nursing measures are used to conserve the client's energy. Vital signs are monitored, as fever, chills, and tachycardia may develop. Some clients experience gastrointestinal disturbances, such as nausea, anorexia, and diarrhea. Changes in blood values may occur, and the nurse monitors laboratory studies for low white blood cell and low thrombocyte counts. Measures to protect the client from infection and trauma are taken if these alterations in blood values occur.

Clients receiving interleukins frequently experience fluid retention and also may develop dyspnea, fatigue, and anemia. Nursing assessment is focused on monitoring body weight and blood pressure and assessing the client for edema.

Evaluation

- Client experiences enhanced immune system as evidenced by white blood cell count, red blood cell count, and platelet counts within normal limits and reduction in number of infections.
- Client does not experience adverse effects associated with immune enhancers.
- Client verbalizes and demonstrates understanding of disease process and importance of compliance with medication regimen.

CLIENTS RECEIVING AGENTS TO SUPPRESS THE IMMUNE SYSTEM

Clients receiving drugs to suppress the immune system may have an autoimmune disease or may be waiting for a bone marrow or organ transplantation. Many clients require sophisticated, intensive nursing care. References about nursing care given to clients with particular health problems are at the end of the text. The following discussion primarily focuses on nursing care related to administering immunosuppressant drugs and monitoring the effects.

Assessment

In caring for clients receiving immunosuppressant drugs, the most important aspect of assessment is the early recognition of infection. Clients must be routinely and carefully assessed for infection before and after drug administration. Vital signs are routinely monitored with particular attention to body temperature. The client's weight is monitored for changes due to anorexia or fluid retention. A complete assessment includes reviewing the body's systems. The skin should be intact and mucous membranes should be moist without evidence of lesions. The client's respiratory system is assessed for normal breath sounds or presence of abnormal sounds, cough, or purulent or bloody secretions. The nurse assesses the client for diarrhea and the presence of vaginal or urinary tract infections. Headache, tremor, confusion, and lethargy may indicate central nervous system (CNS) toxicity related to the use of immunosuppressants. The integumentary system may also be affected by the use of these drugs with acne, hirsutism, brittle nails, and alopecia. Also, it is important to determine if the client is pregnant, as these drugs are not commonly used during pregnancy.

Laboratory tests are monitored, including culture and sensitivity studies on body fluids, white blood cell counts (abnormal counts of less than 1,500 mm^3 or more than 14,000 mm^3 are reported), neutrophil counts (less than 500 mm^3 are reported), and sometimes T-cell assays or ratios. In addition, the effectiveness of drug therapy may be monitored by specific antibody titers or biopsy of the transplanted organ. Ongoing assessment of the person's psychosocial status is important in planning nursing care for these clients.

Nursing Diagnoses

Including but not limited to:

- Ineffective protection, immune related to immunosuppressant therapy
- Risk for injury related to adverse effects of immunosuppressant therapy
- Deficient knowledge related to disease process and medication regimen

Planning/Goals

- Client will not experience organ rejection following transplantation.
- Client will not experience adverse effects associated with immunosuppressant therapy.
- Client will verbalize and demonstrate understanding of importance of compliance with medication regimen.

Implementation

Prevention of infection is a primary nursing function in caring for any client receiving immunosuppressants. The nurse must ensure a clean environment, isolation of the client from persons currently infected, support for the person's natural barriers to infection, and aseptic technique in administering medications and conducting other nursing procedures. The client should be encouraged to adopt positive health habits, such as eating a well-balanced, nutritious diet and obtaining sufficient rest.

In general, live vaccines are contraindicated while clients or household contacts are taking immunosuppressants. Their use could lead to disease rather than immunity when the immune system is depressed. Clients should be instructed to contact the prescriber of the immunosuppressant before receiving immunizations or beginning therapy with other medications.

Specific nursing actions related to azathioprine use include monitoring intake and output and body weight. Clients are observed for indications of hepatic or renal dysfunction. Jaundice or low urinary output must be reported to the physician. Monitoring treatment also includes observations of positive response to the drug, such as improved functioning in persons with rheumatoid arthritis.

As noted earlier, when given orally cyclosporine may be mixed with milk or orange juice. Oral doses are measured with a dropper and then diluted. When given intravenously, it is administered slowly over 2–6 hours. During this time, the client's blood pressure and pulse are monitored. Blood studies routinely monitored include complete blood count, white blood cell differential, and platelet count. All clients receiving cyclosporine are assessed for jaundice; fever; fatigue; bleeding from the gums, gastrointestinal, or urinary tract; and declining urinary output. As gum hyperplasia may occur, the nurse routinely assesses the mouth and gums. Clients are instructed to use good oral hygiene, including regular flossing of teeth.

Muromonab-CD3 solution is prepared for intravenous administration by drawing it into the syringe through a 0.2 or 0.22 μm filter, which is then discarded and a needle is attached to the syringe. This drug is given by bolus injection and is not infused with any other drug. As significant temperature elevations can occur with the first

KEY NURSING IMPLICATIONS 42–2

Agents that Suppress the Immune System

1. Assess vital signs and weight and observe the client for indications of infection.
2. Prevention of infection is an important nursing goal.
3. Clients receiving immunosuppressants should not receive vaccines containing live viruses.
4. In clients taking azathioprine, monitor intake and output and body weight. Report jaundice or low urinary output.
5. Oral doses of cyclosporine can be mixed with milk, chocolate milk, or orange juice. Oral doses are measured with a dropper and then diluted.
6. Assess clients receiving cyclosporine for jaundice, fever, fatigue, and bleeding tendencies.
7. Clients taking cyclosporine are instructed to use good oral hygiene to minimize gum hyperplasia.
8. Muromonab-CD3 is given by bolus injection and not infused with other drugs.
9. Febrile reactions frequently occur with the first two doses of muromonab-CD3. These are treated by use of a cooling blanket. Generally this drug is withheld if the client's temperature goes above 100°F.
10. A careful history of allergy must be taken in all persons scheduled to receive antithymocyte or antilymphocyte preparations.
11. Assess clients receiving antithymocyte or antilymphocyte preparations for fever, malaise, gastrointestinal upset, pulmonary edema, changes in blood pressure, and tachycardia. Serum sickness may occur up to 14 days following administration.
12. Follow-up is important in persons receiving immunosuppressant drugs to monitor the effectiveness of treatment and to assist in prompt detection of the late effects of this therapy.

NURSING CARE PLAN

A Client Receiving Muromonab-CD3 (Orthoclone OKT3) Following Heart Transplantation

David Hertz, a 49-year-old welder, has just received a heart transplant after waiting for 9 months. He is recovering well from surgery. On the second postoperative day, his physician orders muromonab-CD3 intravenously to prevent transplant rejection. He is scheduled to receive 5 mg of muromonab-CD3 daily for 14 days. Before the first dose, Mr. Hertz is premedicated with hydrocortisone 500 mg by IV push, acetaminophen (Tylenol) 650 mg p.o., diphenhydramine hydrochloride (Benadryl) 25 mg p.o., and ranitidine (Zantac) 50 mg by IV push.

ASSESSMENT	NURSING DIAGNOSIS	PLANNING/GOALS	IMPLEMENTATION	EVALUATION
Body temperature.	Risk for imbalanced in body temperature, hyperthermia due to drug response.	Client will not experience elevation in body temperature above 101°F.	Monitor temperature. Ensure client receives acetaminophen 30 minutes before muromonab-CD3. Have cooling blanket available for use.	Client's temperature reaches 100°F but gradually decreases over 4 hours.
Vital signs, skin and mucous membrane integrity, gas exchange, urinary excretion, condition of surgical incision.	Risk for infection related to an invasive procedure and immunosuppression.	Client is free of infection, evidenced by normal body temperature and lack of purulent drainage at surgical site.	Observe client for indications of infection (purulent drainage at surgical site, elevated temperature, urinary burning, productive cough, and skin or mucous membrane lesions). Use aseptic technique for invasive procedures and dressing changes. Protect client from exposure to those with infection.	Client remains free of infection. Wound heals slowly but without evidence of infection.
Comfort, sleep patterns, pain on a scale of 0 to 10.	Acute pain related to tissue and trauma secondary to surgery.	Client expresses relief from pain and is able to sleep.	Ensure pain medication is given on a routine basis. Position client for comfort and provide back care.	Client is able to sleep without pain.
Intake and output, blood pressure.	Risk excess for fluid volume secondary to use of muromonab-CD3.	Client experiences minimal excess fluid retention.	Routinely assess intake and output and blood pressure. Report indications of fluid retention to the physician.	Client does not experience fluid volume excess.
Knowledge regarding procedure.	Deficient knowledge (transplant procedure and post-transplant recovery).	Client and family will have basic information about the procedure and post-transplant treatment.	Before procedure assess what physician has told client and family about the procedure and recovery period. Answer questions and reinforce information provided. When administering medication inform client what you are doing and what medication is expected to accomplish.	Client and family do not express concern about the number of medications being received in the post-operative period.

two doses, it is important to assess vital signs and to use a cooling blanket if the temperature rises above 103°F (39.4°C). Generally, subsequent doses of the drug are withheld if the temperature goes above 100°F. Immediately following the first two doses, check the vital signs every 15 minutes for the first 2 hours, then every 30 minutes for 2 hours, then every hour until stable. As fluid retention may develop, the client is assessed and daily measurement of intake and output, body weight, and blood pressure is performed.

Several antithymocyte or antilymphocyte preparations are used for immune system suppression following organ or tissue transplantation. It is important the nurse take a careful history of allergy to identify persons allergic to specific products derived from horses, rabbits, or other animals. Specific protocols often guide the use of these drugs, including instructions on premedication with analgesics, antipyretics, histamine receptor antagonists, and corticosteroids, as well as instructions for site preparation and drug administration. Before these drugs are administered, baseline measurement of vital signs is obtained and vital signs are carefully monitored after administration. Clients are assessed for fever, malaise, gastrointestinal upset, pulmonary edema, blood pressure changes, and tachycardia. Blood studies to monitor the client for low white blood cell counts are done. Serum sickness, evidenced by pain in the extremities and joints and skin rash, may occur up to 14 days following administration of these drugs.

Some clients receiving immunosuppressant drugs also may be receiving corticosteroids. Refer to Chapter 12 for a discussion of nursing care related to corticosteroid use. All clients receiving immunosuppressant drugs are instructed about the importance of follow-up visits to the physician and for laboratory studies. These follow-up visits are important for the treatment of the current health problem and because immunosuppressant drugs have been associated with various cancers years after their use has been discontinued. General instruction in hygiene is given, including instructions for oral hygiene, skin care, and hygiene following elimination.

Evaluation

- Client does not experience organ rejection following transplantation.
- Client does not experience adverse effects associated with immunosuppression.
- Client verbalizes and demonstrates understanding of and importance of compliance with immunosuppression regimen and importance of reporting symptoms of adverse effects associated with this regimen.

HOME CARE/CLIENT TEACHING

1. Advise parents to use acetaminophen to treat minor temperature elevations and discomfort experienced by infants and young children following immunizations.
2. Parents of children receiving immunizations should be informed to report any temperature elevations that don't respond to acetaminophen, temperatures greater than 100°F and/or other adverse reactions to their health care provider immediately.
3. Assist families to keep immunization records for all family members.
4. Clients receiving interferons and interleukins to boost the immune system should be be instructed to monitor their weight and report any symptoms of fluid overload to their health care provider.
5. Discuss the prevention of infection at home for persons on immunosuppressant therapy. Include information on general hygienic practices, avoiding shared eating utensils and glassware, use of separate linens, importance of handwashing, and isolation from persons with known communicable diseases.
6. Clients receiving immunosuppressant therapy should be instructed to report signs and symptoms to their health care provider immediately and should receive instructions concerning how to take their temperatures and to monitor their temperature daily.
7. Clients receiving cyclosporine are instructed to use good oral hygience to prevent gum hyperplasia and to mix the medication with milk or orange juice.
8. Clients receiving immunosuppressants should advised to inform any physician, dentist, and/or dental hygienist that they are taking immunosuppressants.
9. Clients taking any agents affecting the immune system should be encouraged to keep all follow-up appointments with their health care provider.

CASE STUDY

John Edwards is a 33-year-old mathematician who has had rheumatoid arthritis since he was 21. For the last 10 years he has been taking 30 grains of aspirin and 10 milligrams of prednisone daily. On his most recent visit to the rheumatologist, he was instructed to add the following drugs to his regimen:

- methotrexate (Mexate) 20 mg weekly
- azathioprine (**Imuran**) 50 mg OD

He is advised to avoid drinking alcoholic beverages and is scheduled to return to the physician in 4 weeks. In addition, a liver biopsy is scheduled in 6 months.

Questions for Discussion

1. Why is an immunosuppressant drug (azathioprine) used in the treatment of rheumatoid arthritis?
2. What are the major side effects of azathioprine that Mr. Edwards should be advised about?
3. Why has the physician advised Mr. Edwards not to drink alcoholic beverages and scheduled him for a liver biopsy?
4. What advice should the nurse give Mr. Edwards about his increased susceptibility to infection?

CRITICAL THINKING EXERCISES

1. Prepare a report describing the precautions taken to prevent infection before and after bone marrow transplantation.
2. Prepare a brief assessment form to be used before administering immunizations.
3. Present a case study of a client undergoing organ transplantation with a focus on the drugs affecting the immune system that are administered before and after the procedure.
4. Prepare a report on the issues involved in obtaining universal immunization of children in your country or some other country.
5. Prepare a report about research on the late effects (carcinogenicity) of immunosuppressant drugs.
6. Prepare a class for new parents about childhood immunizations.
7. Compile a list of suggested immunizations for travel to various countries.
8. Describe to your classmates what is known about the immune system and AIDS.

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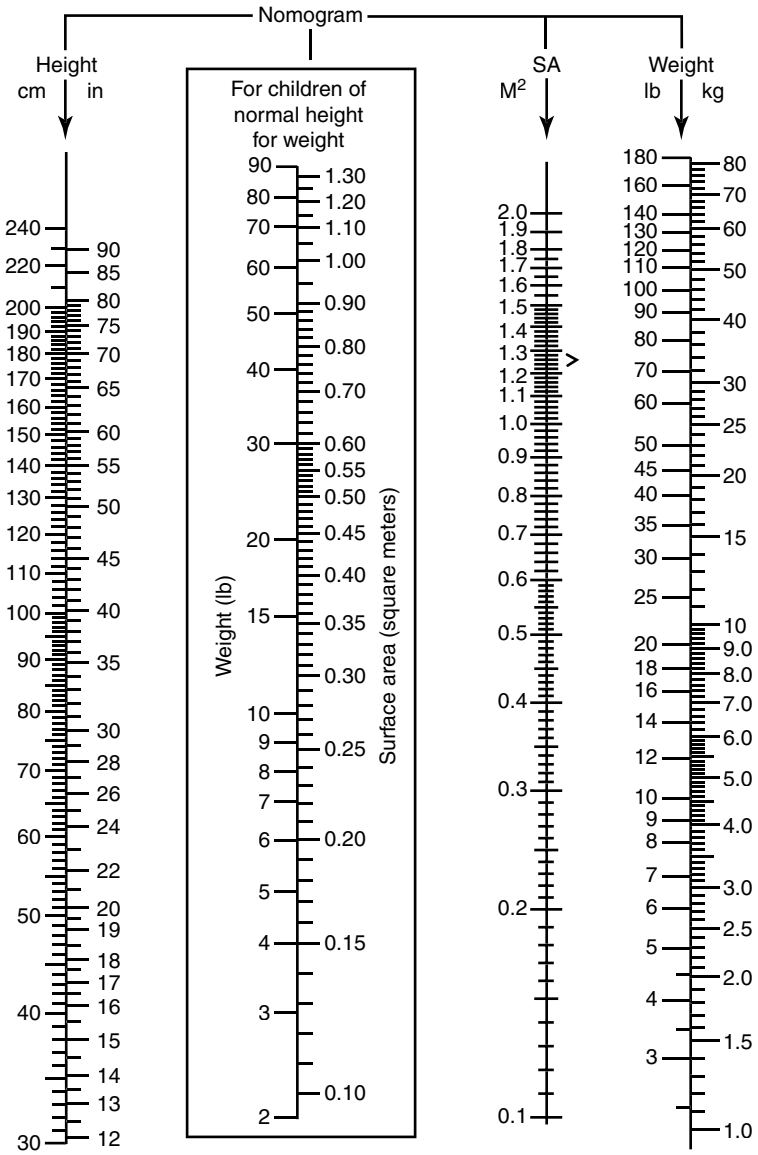
Appendices

APPENDIX 1
NOMOGRAMS FOR CHILDREN AND ADULTS

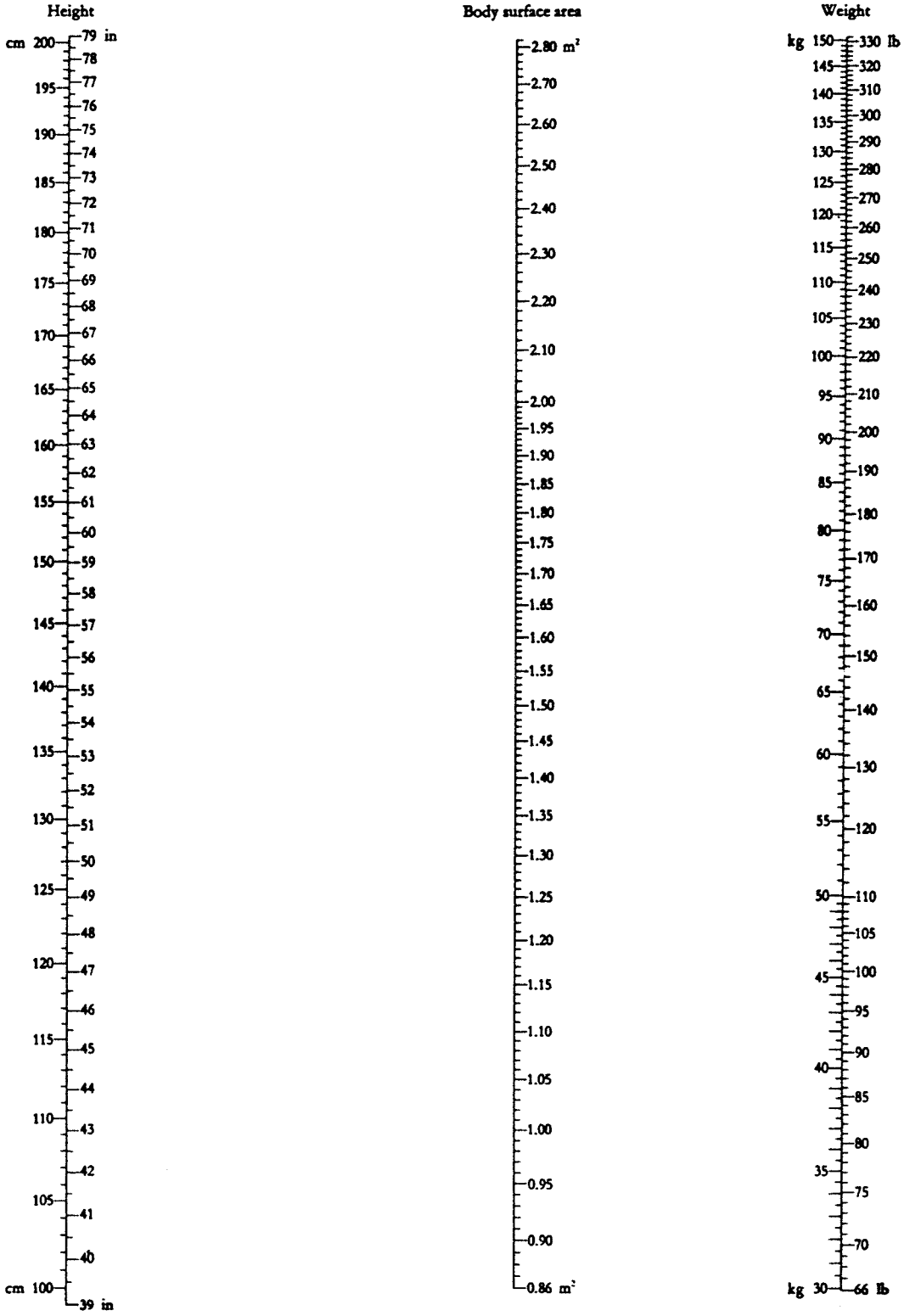
A nomogram is a chart that permits the estimation of body surface area (BSA) from a client's height and weight. Different charts are needed for children and adults. To find the BSA for your client, record the client's weight on the weight scale by placing a dot at the appropriate spot. Do the same for the client's height on the height chart. Using a ruler, draw a straight line between the two dots. Where the line crosses the body surface area graph, read the client's BSA.

Body Surface Area of Children



Body Surface Area of Adults

Nomogram for determination of body surface area from height and weight



From the formula of Du Bois and Du Bois, *Arch. intern. Med.*, 17, 863 (1916): $S = W^{0.425} \times H^{0.725} \times 71.84$, or $\log S = \log W \times 0.425 + \log H \times 0.725 + 1.8564$ (S = body surface in cm², W = weight in kg, H = height in cm)

APPENDIX 2
DIAGNOSTIC AGENTS

TABLE A.

Biological In Vivo Diagnostic Agents

Note: With the administration of all biologicals, epinephrine 1:1000 and life support equipment must be available for use in case of anaphylaxis.

Virtually all biological in vivo diagnostic agents should be stored in a refrigerator, but never frozen.

Consult the manufacturer's product insert for specific information about storage and use.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
coccidioidin	aids in the diagnosis of coccidioidomycosis and the differential diagnosis of this disease from histoplasmosis, sarcoidosis, and similar problems	intradermal	Usual test dose: 0.1 mL of 1:100 dilution	A positive reaction consists of induration of 5 mm or more. Readings are necessary at 24 and 48 hours, with the reaction usually maximal at 36 hours. A positive test indicates contact with the fungus at some time in the past. Store at 2°–8°C.
histoplasmin	aids in the diagnosis of histoplasmosis and the differential diagnosis of this disease from coccidioidomycosis, sarcoidosis, and other mycotic or bacterial infections	intradermal	Usual test dose: 0.1 mL	Hypersensitivity (urticaria, shortness of breath, and excessive perspiration) may occur. If serological studies are indicated, they should be drawn before 96 hours, as titers may rise after this period. Read reaction 48–72 hours after test. A positive reaction consists of induration of 5 mm or more.
mumps skin test antigen	determines skin sensitivity to mumps antigen; particularly helpful in identifying persons who should be protected against the disease	intradermal	Usual test dose: 0.1 mL	Persons sensitive to chickens and their eggs and feathers should not be tested. Avoid using in persons allergic to thimerosal. Read reaction in 24–48 hours. Sensitivity and probable immunity are indicated by an area of erythema of 1.5 cm or more in diameter.
skin test antigens, multiple	for detection of nonresponsiveness to antigens	percutaneous	Application of 8 skin test antigens simultaneously using preloaded applicator	Skin testing should only be performed on individuals over 17. Store at 2°–8°C.
tuberculin tests	skin tests used as an aid in diagnosing tuberculosis	intradermal		Positive reaction indicates that client has had TB infection; it does not indicate current active infection. Further diagnostic procedures are necessary to confirm presence of TB. Do not administer to known positive reactors because of severity of reactions. Avoid subcutaneous injection.

continues

TABLE A. ***continued***

See note at beginning of table.

NAME	USE	ROUTE(S)	DOSE/FREQUENCY	NURSING IMPLICATIONS
a. tuberculin purified protein derivative —Mantoux	(PPD)	intradermal	Initial test dose: 5 toxin units (TU) Test in sensitized persons: 1TU	Preferred test sites are flexor or dorsal surfaces of forearm about 4 inches below elbow. Read test 48–72 hours after administration. Record (in millimeters) the area of induration. It is measured transversely to long axis of arm. Positive reaction: 10 mm or more of induration. Doubtful reaction: 5–9 mm. Negative: less than 5 mm.
b. tuberculin PPD multiple puncture device	—	multiple skin puncture	—	Each unit consists of a cylindrical plastic holder bearing 4 stainless steel tines. The tines are coated with tuberculin PPD. The units are standardized to give reactions equivalent to 5TU of PPD.

TABLE B.

In Vitro Diagnostic Agents

TEST	USE
Acetone Test	See Ketone Test
Albumin Tests	Detection of protein in urine
Bacteriuria Tests	Detection of bacteria or nitrite in urine
Bilirubin Test	Detection of Bilirubin in urine
Blood Urea Nitrogen Test	Estimation of urea nitrogen in whole blood
Candida Test	Culture test for vaginal candida
Chlamydia Trachomatis Tests	Detection of *Chlamydia trachomatis* in client specimens
Color Allergy Screening Test	Determination of Immunoglobulin E in serum
Gastrointestinal Tests	Recovery of upper GI fluid without need for gastric intubation
Glucose Blood Tests	Measurement of glucose in blood
Glucose Urine Tests	Detection of glucose in urine
Gonorrhea Tests	Detection of *Neisseria gonorrhoeae*
Ketone Tests	Detection of ketones in urine or serum
Lung Cell Tests	Detection of precancerous lung cells
Mononucleosis Tests	Diagnosis of infectious mononucleosis
Occult Blood Screening Tests	Detection of occult blood in urine, feces, or gastric contents
Ovulation Tests	Prediction of ovulation time
Phenylketonuria Test	Test for phenylketonuria
pH Test	Determination of pH of urine
Pregnancy Tests (Home)	Detection of pregnancy
Pregnancy Tests (Office)	Detection of pregancy
Pseudomonas Test	Detection of *Pseudomonas aeruginosa* in exudate or urine
Rheumatoid Factor Test	Detection of rheumatoid factor in blood
Sickle Cell Test	Detection of hemoglobin S
Staphylococcus Test	Detection of *Staphylococcus aureus* in exudate
Streptococci Tests	Detection of streptococci from throat or nasopharyngeal swabs
Taste Function Test	Measurement of taste function or dysfunction
Toxoplasmosis Test	Detection of *Toxoplasma gondii* antibodies in serum
Trichomonas Test	Culture test for *Trichomonas vaginalis* from urethra or vagina
Virus Tests	Detection of HIV-1 in serum or plasma
Virus Test	Detection of antibody to Human T-Lymphotropic Virus Type I in serum or plasma
Virus Test	Confirmation of specimens found to be positive to antibody to HTLV III
Virus Tests	Identification and typing of herpes simplex virus
Virus Test	Detection of human antibody to HIV-1
Virus Test	Detection of rotavirus in feces
Virus Tests	Detection of rubella virus antibody in serum or recalcified plasma
Virus Test	Immunoassay for IgG antibody to rubella virus in serum

APPENDIX 3
APPROXIMATE NORMAL VALUES

TABLE A.

Blood Values

ITEM	VALUE
ammonia	80–110 mcg/dL (lower in children)
calcium	8.5–10.5 mg/dL (slightly higher in children)
chloride	98–106 mEq/dL
cholesterol	150–200 mg/dL
creatinine	0.6–1.2 mg/dL
fatty acids, total	190–420 mg/dL
glucose	75–115 mg/dL (ADA recommendation)
iodine, protein bound	3.5–8.0 mcg/dL
iron	50–150 mcg/dL (higher values in males)
lipids, total	450–1000 mg/dL
magnesium	1.5–2.5 mEq/L
pH	7.35–7.45
phosphorous (inorganic)	3.0–4.5 mg/dL (higher in infants under 1 year)
potassium	3.5–5.0 mEq/L
protein, total albumin globulin	6–8 g/dL 4–5 g/dL 2–3 g/dL
sodium	135–145 mEq/L
triglycerides	40–150 mg/dL
urea nitrogen (BUN)	6–18 mg/dL
uric acid	3–7 mg/dL

TABLE B.

Hematologic Values

ITEM	VALUE
erythrocyte sedimentation rate	1–15 mm/hour (males) 1–20 mm/hour (females)
hematocrit	41%–53% (males) 36%–46% (females)
hemoglobin	13–18 g/dL (males) 12–16 g/dL (females)
leukocyte count (WBC)	4,500–11,000/mm^3
partial thromboplastin time (PTT)	25–35 seconds
platelets	150,000–450,000
prothrombin time	11–15 seconds
red blood cell count	children 2–14: 3.9–5.3 million/mm^3 adult males: 4.5–5.5 million/mm^3 adult females: 4.0–5.0 million/mm^3
red cell corpuscular values:	
mean corpuscular volume (MCV)	80–94 $microns^3$
mean corpuscular hemoglobin (MCH)	31–36 g/dL RBC
mean corpuscular hemoglobin concentration (MCHC)	33%–38%
reticulocyte count	0.5%–1.5% of red cells

TABLE C.

Celsius–Fahrenheit Equivalents
Clinical Range

CELSIUS	FAHRENHEIT
36.0	96.8
36.5	97.7
37.0	98.6
37.5	99.5
38.0	100.4
38.5	101.3
39.0	102.0
39.5	103.1
40.0	104.0
40.5	104.9
41.0	105.8
41.5	106.7
42.0	107.6

Directions: To convert degrees Fahrenheit to degrees Celsius, subtract 32, then multiply by 5⁄9.
To convert degrees Celsius to degrees Fahrenheit, multiply by 9⁄5, then add 32.

APPENDIX 4
TOXICOLOGY OVERVIEW

Accidents are the leading cause of injury and death in children between the ages of 1 and 15 in the United States. Among all accidents each year, poisonings account for an estimated five million injuries and five thousand deaths for all ages nationwide. As a cause of death, poisonings are surpassed only by motor vehicle accidents, drownings, and burns. It has been estimated that poisoning at all ages is responsible for 9% of all ambulance transport, 10% of all hospital emergency visits, and 5% of all hospital inpatient admissions in the nation annually.

In many cases of poisoning in children, parents have contributed to the injury. Parents often fail to store hazardous household substances (e.g., bleach and furniture polish) in a safe place or they leave prescription drugs or common household remedies, such as aspirin, in the sight and reach of young children. It is evident that prevention is of utmost importance in controlling poisoning and that health care providers assume major responsibility for assisting parents in safeguarding their home. Specifically, parents need to be strongly encouraged to:

- keep all drugs, pesticides, and potentially hazardous household chemicals out of the sight and reach of children and stored away from food
- avoid storage of potentially toxic substances in food containers
- keep all dangerous substances in the home stored in a securely locked cabinet
- avoid telling children that medicine is candy as a means of encouraging them to take medication
- purchase potentially hazardous substances only in packages or containers fitted with child-resistant safety closures

Although prevention efforts should be continuously aimed at the public, such efforts are often best focused during national Poison Prevention Week, which is observed during the third week of March each year.

Toxicology

Toxicology is a branch of pharmacology that deals with the study of poisons. A poison is a chemical substance that can cause death or injury in relatively low concentrations. Some poisons (e.g., cyanide and carbon monoxide) interfere with the transport and/or utilization of oxygen by body tissues. This results in rapid deterioration of function of major physiological systems of the body and, if not quickly and effectively treated, results in permanent injury or death. Other poisons (e.g., lead and mercury) tend to cause injury to the body relatively slowly and only after they have accumulated to toxic concentrations as a result of the client's repeated exposure to the toxin.

Poisons are often classified according to the organ they primarily affect. Those primarily affecting the kidneys are known as nephrotoxins. Those that affect the liver are known as hepatotoxins and those acting on the nervous system are known as neurotoxins.

Table A provides specific antidotes for toxic substances, with Table B providing guidelines for the care of persons exposed to a poison.

TABLE A.

Specific Antidotes

TOXIC SUBSTANCE	ANTIDOTE(S)
acetaminophen	acetylcysteine (Mucomyst)
benzodiazepines	flumazenil (Romazicon)
cyanide	amyl nitrite sodium thiosulfate
cholinergic agents	atropine
iron	deferoxamine mesylate (Desferal Mesylate)
digoxin	digoxin immune FAB (Digibind)
arsenic	dimercaprol (BAL in Oil)
gold	dimercaprol
mercury	dimercaprol
lead	edetate calcium disodium (Calcium Disodium Versenate) succimer (Chemet) dimercaprol cuprimine succimer
calcium, digitalis	edetate disodium (Endrate, Sodium Versenate)
ifosfamide	mesna (Mesnex)
insulin	glucagon
folic acid antagonists (e.g., methotrexate)	leucovorin calcium
narcotics (opiates)	naloxone HCl (Narcan) nalmefene HCl (Revex)
agents with anticholinergic activity (e.g., tricyclic antidepressants)	physostigmine salicylate (Antilirium)
agents with anti-cholinesterase activity (e.g., organophosphate insecticides)	pralidoxime chloride PAM (Protopam Chloride)
heparin	protamine sulfate
warfarin	vitamin K

TABLE B.

Toxicology: Guidelines

SITUATION	PRINCIPLES AND INTERVENTIONS
Treatment of Acute Poisonings	Rapid and appropriate treatment is essential when a poisoning occurs. All health care professionals, as well as the public, should be aware of the location and telephone number of the nearest poison control centers. Such centers are found in major U.S. metropolitan areas. They are frequently located in or just adjacent to a hospital emergency room and are generally staffed by physicians, pharmacists, and nurses. Poison control centers generally have a variety of information resources available and laboratories enabling their staff to rapidly determine the chemical constituents of nearly any commercial product, as well as the appropriate treatment strategy to use in any type of poisoning. Poison control centers also frequently maintain statistical records of poisoning in their region and initiate and/or coordinate poison prevention programs in their community.
Ingested Poisons	When a poisoning occurs, it is often from intentional or accidental ingestion of a household product or a drug. Treatment of such an ingestion is usually determined by the nature of the substance taken. It is therefore essential that an ingested poison be identified as quickly as possible and that some attempt be made to estimate the amount ingested and the time elapsed since the ingestion took place. Removal of an ingested poison that is noncorrosive is often a major priority in treating such a client to reduce the likelihood of serious systemic effects. Unless contraindicated, emesis should be induced as quickly as possible by the administration of an emetic such as syrup of ipecac. In children, a dose of 15 mL (1 tablespoon) is generally employed. In adults, a dose of 30 mL (2 tablespoons, or 1 fluid ounce) is usually given. This dose is generally followed immediately by the administration of 1 to 2 glasses of a noncarbonated fluid to increase the rate of onset of the emetic action. If the ipecac syrup dose does not result in emesis within 20 minutes, a second dose of the emetic may be administered. No more than 2 doses of ipecac syrup should be administered to a client during a single poisoning episode because the components of ipecac may, themselves, produce toxic effects. Ipecac syrup is readily available without a prescription in containers containing 30 mL (1 oz) of the drug. All parents of young children should be strongly urged to have ipecac syrup available in the home for such poisoning emergencies. In the absence of ipecac syrup, mechanical induction of emesis can be attempted, although this technique is rarely as effective as the use of ipecac syrup. Another method of reducing the potential systemic toxicity of an ingested poison is to move it through the gastrointestinal tract more quickly to decrease absorption of the toxin into the bloodstream. This can be accomplished by administering a potent laxative, such as magnesium sulfate (Epsom salts) or sodium sulfate. These agents cause fluid to be drawn into the GI tract, thereby permitting the toxin to be diluted, as well as eliminated more rapidly in the stool. If a significant amount of toxic substance has already entered the client's blood, other techniques may be used to increase the rate of removal of the substance from the body. These may include dialysis, the use of diuretics to promote the urinary excretion of the toxin and/or its chemical byproducts, or the use of specific antidotes that counteract the toxic effects of the poison (Table A). Throughout treatment of a poisoning caused by the ingestion of a toxic substance, supportive therapy must be provided for the client. This includes the establishment and/or maintenance of an adequate airway, circulatory function and fluid and electrolyte levels, as well as monitoring of all vital signs. Parents should be advised to call a local or regional poison control center or hospital emergency room before attempting to provide treatment for an acute toxic ingestion.

continues

TABLE B. ***continued***

SITUATION	PRINCIPLES AND INTERVENTIONS
Ingested Poisons *(continued)*	Emesis should generally not be induced if the client is comatose or if a corrosive substance (e.g., a strong acid or alkali) or a petroleum distillate (e.g., gasoline or some furniture polishes) has been ingested. In such cases, the induction of emesis could reexpose the esophagus, throat, and oral cavity to the substance and/or promote aspiration of the toxic substance into the respiratory tract. If vomiting cannot be induced or is contraindicated, gastric lavage may be performed. This may be accompanied by the administration of activated charcoal (1–2 tablespoons in 8 oz of water). This substance is a finely divided powder with a large surface area onto which toxic substances may be absorbed or bound. **Note:** Activated charcoal should not be administered at or near the time that a dose of ipecac syrup is administered, as the charcoal will interfere with the emetic action of the ipecac.
Inhaled Poisons	Many inhaled substances may cause injury. Most of these are gases that may produce their toxic action by interfering with oxygen utilization of the entire body (e.g., as with a toxic exposure to carbon monoxide) or by causing localized irritation and damage to the respiratory tract (e.g., as with an exposure to chlorine gas). Even relatively inert gases such as nitrogen, if present in sufficient concentration in the environment, may cause toxicity by simple displacement of oxygen in the inspired air and subsequent suffocation of the client. Treatment of acute poisoning caused by the inhalation of a gaseous toxin is generally performed by allowing the client access to clean air and oxygen or by providing artificial respiration until normal respiration can again be sustained. Secondary treatment could include the administration of systemic antimicrobial agents to reduce the likelihood of infection of the respiratory tract and/or the use of anti-inflammatory corticosteroids to reduce severity of the inflammatory response of the respiratory tract to the toxin. In some cases, inhaled toxic substances may actually be very fine solids or "dusts," such as coal dust, cotton dust, or asbestos fibers. Such poisoning is often manifested as respiratory impairment after sustained exposure has taken place (perhaps over many years) and is often seen in clients who have been exposed to the dust as part of their occupation. The use of protective devices (e.g., dust masks) by workers, as well as more careful environmental control at the workplace has reduced the incidence of such poisoning.
Ocular Contamination	Contamination of the eye(s) with a toxic substance can rapidly result in permanent loss of ocular function if not treated promptly. Such contamination is usually best treated by flushing the affected eye(s) with copious amounts of water as soon as possible after the contamination has occurred. Such irrigation should continue for 5 to 20 minutes, depending on the nature of the contaminant. Once this has been accomplished, further therapy is generally aimed at repairing ocular damage and at preventing infection in the injured eye(s).
External Contamination	Contact of the skin with environmental chemicals may cause injury to the skin and underlying tissue. It also may subject the client to systemic toxicity from passage of the toxic substance through the skin and into the blood. When such contamination has occurred, removal of the substance and contaminated clothing from the skin surface is of utmost importance. The skin is generally decontaminated by repeated washing of the contaminated area with a detergent/water solution. This is followed by appropriate treatment aimed at minimizing localized tissue damage, as well as systemic effects of absorbed toxin.

APPENDIX 5
COMMON DRUG AND FOOD INTERACTIONS

A drug interaction exists when the effects of one drug are modified by the effects of another drug administered before, during or after the first drug. Drugs may interact not only with other drugs but also with dietary components. Although many hundreds of possible drug interactions have been identified, the following are considered to be of greatest clinical significance. They are listed alphabetically. The student is referred to *2001 PDR Nurse's Drug Handbook* for more information about common drug and food interactions.

TABLE A.

Clinically Significant Drug and/or Food Interactions

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
ACE Inhibitors	Aspirin	Decreases effect of ACE inhibitors
Acetaminophen	Carbamazepine	Increases acetaminophen breakdown; increases risk of hepatotoxicity
	Oral contraceptives	Decrease acetaminophen effects
Amiodarone HCl	Beta-adrenergic blockers	Increase bradycardia and hypotension
	Cimetidine	Increases serum drug levels of Amiodarone HCl
	Rifampin	Decreases serum levels of Amiodarone HCl
Aminoglycosides	Penicillins	Decrease aminoglycoside effects
	Ticarcillin sodium	Avoid mixing in intravenous fluids because of acid-base interaction
Anticholinergics (Cholinergic blocking agents)	Amantadine	Increases anticholinergic effects
	Antacids	Decrease absorption of anticholinergics
	Antihistamines	Increase anticholinergic side effects
	Benzodiazepines	Increase anticholinergic side effects
	Corticosteroids	Increase intraocular pressure
	Digoxin	Increases anticholinergic effects
	Haloperidol	Increases intraocular pressure
	Levadopa	Decreases anticholinergic effects
	MAO inhibitors	Increase anticholinergic effects
	Nitrates/Nitrites	Increase anticholinergic effects
	Procainamide	Increases anticholinergic effects
	Quinidine	Increases anticholinergic effects
Anticoagulants (oral)	Aspirin	Increases effects of anticoagulants by decreasing plasma protein binding
	Cephalosporins	Increased hypoprothrombinemia
	Oral contraceptives	Decrease anticoagulant effects
	Thyroid preparations	Increase anticoagulant effects
Warfarin	Amiodarone	Increases warfarin effect
	Carbamazepine	Decreases warfarin effect
	Erythromycin	Increases warfarin effect
	Fluoroquinolones	Increase warfarin effect
	Phenobarbital	Increases warfarin effect
	Tamoxifen	Increases warfarin effect

continues

TABLE A. *continued*

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Antidepressants	Oral contraceptives	Decrease antidepressant effects
Antidiabetic drugs	Alcohol	Possible antibuse-like syndrome
	Anticoagulants	Increase hypoglycemic action
	Corticosteroids	Decrease hypoglycemic effects
	Estrogens	Decrease hypoglycemic effects
	Fluconazole	Increases hypoglycemic effects
	Ginseng	Increases hypoglycemic effects
	Histamine-2 antagonists	Increase hypoglycemic effects
	Hydantion anticonvulsants	Decrease hypoglycemic effects
	Isoniazid	Decreases hypoglycemic effects
	MAO inhibitors	Increase hypoglycemic effects
	NSAIDs	Increase hypoglycemic effects
	Phenothiazines	Decrease hypoglycemic effects
	Salicylates	Increase hypoglycemic effects
	Sulmonamides	Increase hypoglycemic effects
	Sympathomimetics	Decrease hypoglycemic effects
	Thiazide diuretics	Decrease hypoglycemic effects
	Thyroid hormones	Increases hyperglycemia
	Tricyclic antidepressants	Increase hypoglycemic effects
Antihypertensives	Garlic	Increases antihypertensive effects
Antipsychotic agents (Phenothiazines)	Alcohol	Potentiates action of phenothiazines
	Aluminum-based antacids	Decrease absorption of phenothiazines in GI tract
	Anticholinergics	Decrease antipsychotic effects and increase anticholinergic effects
	Lithium	Increases extrapyramidal effects
	MAO inhibitors	Increase phenothiazine effects
	Milk thistle	Helps prevent liver damage
	Propranolol	Increases drug levels of both drugs
Aspirin (Salicylates)	Acetazolamide	Increased CNS toxicity of aspirin; avoid concomitant use
	Alcohol, ethyl	Increases risk of GI bleeding associated with use of aspirin
	Ammonium chloride	Increases effects of aspirin
	Antacids	Decrease salicylate levels due to increased rate of renal excretion
	Ascorbic acid (vitamin C)	Increases effects of aspirin
	Charcoal, activated	Decreases absorption of aspirin
	Corticosteroids	Ulcerogenic; may decrease blood salicylate levels
	Furosemide	Increases risk of aspirin toxicity by decreasing excretion of aspirin
	Garlic	Increases aspirin's antiplatelet action
	Ginkgo biloba	Increases platelet aggregation
	Ginseng	Decreases aspirin's platelet aggregation
	Nizatidine	Increases serum levels of aspirin
	Sodium bicarbonate	Decreases effects of aspirin

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Atenolol	Anticholinergics	Increase effects of atenolol
Benzodiazepines	Antacids	Decrease absorption of benzodiazepines
	Cimetidine	Increases benzodiazepine effects
	Erythromycin	Increases benzodiazepine effects
	Isoniazid	Increases benzodiazepine effects
	Ketoconazole	Increases benzodiazepine effects
	Opiates	Additive CNS effects
	Oral contraceptives	Increase benzodiazepine effects
	Propranolol	Increases benzodiazepine effects
	Rifampin	Decreases benzodiazepine effects
	Theophylline	Decreases benzodiazepine effects
	Valporic acid	Increases benzodiazepine effects
Beta-adrenergic blocking agents	Anesthetic agents	Increase depression of myocardium
	Anticholinergic agents	Antagonize beta-adrenergic blocking agent-induced bradycardia
	Aspirin	Decreases action of beta-adrenergic blocking agents by inhibiting prostaglandin.
	Chlorpromazine	Increases effects of beta-adrenergic blocking agents
	Cimetidine	Increases effects of beta-adrenergic blocking agents
	Clonidine	Increases severity of rebound hypertension
	Epinephrine	Increases blood pressure
	Furosemide	Increases effects of beta-adrenergic blocking agents
	Indomethacin	Decreases effects of beta-adrenergic blocking agents
	Lidocaine	Increases effects of beta-adrenergic blocking agents
	NSAIDs	Decrease effects of beta-adrenergic blocking agents
	Oral contraceptives	Increase effects of beta-adrenergic blocking agents
	Phenobarbital	Decreases effects of beta-adrenergic blocking agents
	Phenothiazines	Increase effects of both drugs
	Phenytoin	Increases depression of myocardium
	Rifampin	Decreases effects of beta-adrenergic blocking agents
	Sympathomimetics	Antagonize effects of beta-adrenergic blocking agents
	Thyroid hormones	Decrease effects of beta-adrenergic blocking agents
	Tricyclic antidepressants	Decrease effects of beta-adrenergic blocking agents
Calcium channel blockers (CCB)	Amiodarone HCl	Increases risk of hypotension and with verapamil or diltiazem increases risk of AV block
	Beta-adrenergic blockers	Depression of myocardial contractility and AV node transmission
	Cimetidine	Increases effects of CCBs
	Fentanyl	Severe hypotensive crisis
	Ranitidine	Increases effects of CCBs
Carbamazepine	Charcoal	Decreases carbamazepine effect
	Cimetadine	Increases carbamazepine effect
	Erythromycin	Increases carbamazepine effect
	Grapefruit juice	Increases peak drug levels

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Carbamazepine *(continued)*	Isoniazid	Increases carbamazepine effect
	Lithium	Increases CNS toxicity
	Macrolide antibiotics	Increase carbamazepine effect
	Phenobarbital	Decreases carbamazepine effect
	Phenytoin	Decreases carbamazepine effect
	Primidone	Decreases carbamazepine effect
	Verapamil	Increases carbamazepine effect
Cephalosporins	Alcohol	Anabuse type responses
	Aminoglycosides	Increase risk of nephrotoxicity
	Antacids	Decrease effects of cefaclor, cefdinir, and cefpodozime
	Colistin	Increases risk of nephrotoxicity
	Furosemide	Increases risk of nephrotoxicity
	Probenecid	Increases effects of cephalosporins
	Vancomycin	Increases risk of nephrotoxicity
Ciprofloxacin	Aluminum and magnesium hydroxides	Reduce ciprofloxacin absorption
	Iron supplements	Reduce ciprofloxacin absorption
	Sucralfate	Reduces ciprofloxacin absorption
Clonidine	Propranolol	Rapid clonidine discontinuation can cause hypertensive crisis
Corticosteroids	Multiple drug interactions, including but not limited to:	
	Anabolic steroids	Increase risk of edema
	Antacids	Decrease corticosteroid effects
	Antibiotics	May lead to serious infections
	Anticholinergics	Increase intraocular pressure and aggravate glaucoma
	Asparaginase	Increases hypoglycemic risk
	Barbiturates	Decrease corticosteroid effects
	Cyclosporine	Increases effects of both drugs
	Estrogen	Increases anti-inflammatory effects
	Ginseng	Increases corticosteroid effects; do not use together
	Heparin	Increases risk of GI ulcers
	Immunosuppressants	Increase risk of infection
	Indomethacin	Increases risk of GI ulcers
	Licorice	Increases corticosteroid drug levels
	NSAIDs	Increase risk of GI ulcers
	Phenytoin	Decreases corticosteroid effects
	Rifampin	Decreases corticosteroid effects
	Salicylates	Increase risk of GI ulcers
	Thyroid hormones	Increase tissue demands for corticosteroids
	Vitamin A	Used locally antagonizes impaired wound healing associated with corticosteroids

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Cyclophosphamide	Allopurinol	Increases antineoplastic activity
Cyclosporine	Amiodarone HCl	Increases plasma drug levels and increases creatinine potentiating risk of nephrotoxicity
	Barbiturates	Decrease cyclosporine levels
	Ciprofloxacin, erythromycin, ketoconazole	Increase risk of nephrotoxicity associated with cyclosporine
	Rifampin	Decreases cyclosporine levels
Digoxin	Amiodarone HCl	Increases digoxin levels
	Antacids	Decrease digoxin levels; administer at least 1.5 hours before antacids
	Anticholinergics	Increase digoxin absorption
	Captopril	Increases digoxin levels
	Corticosteroids	Increased risk of digoxin toxicity
	Cyclosporine	Increased risk of digoxin toxicity
	Diazepam	Increased risk of digoxin toxicity
	Digoxin-immune fab	Antagonist for digoxin toxicity
	Erythromycin	Increased risk of digoxin toxicity
	Furosemide	Increased risk of digoxin toxicity due to potassium excretion
	Ibuprofen	Increased risk of digoxin toxicity
	Insulin	Use with caution due to effects on potassium levels
	Kaolin	Decreases digoxin levels
	Metoclopramide	Decreases digoxin levels
	Prozocin	Increases digoxin toxicity
	Quinidine	Increases digoxin toxicity
	Rifampin	Decreases digoxin levels
	Tetracyclines	Increase digoxin toxicity
	Verapamil	Increases digoxin toxicity
Diuretics	Anticholinergics	Increase thiazide effects
	Calcium salts	Risk of hypercalcemia
	Corticosteroids	Enhance potassium loss
	Indomethacin	Decreases diuretic effects
	NSAIDs	Decrease drug effects
	Sulfonamides	Increase diuretic effects
Potassium-sparing	Potassium supplements	Hyperkalemia
Doxycycline	Carbamazepine	Decreases doxycycline effect
	Phenobarbital	Decreases doxycycline effect
	Phenytoin	Decreases doxycycline effect
Estrogen	Barbiturates	Decrease estrogen effects
	Rifampin	Decreases estrogen effects
Fluoroquinolones	Antacids	Decrease antibiotic effects
	Anticoagulants	Increase antibiotic effects
	Antineoplastics	Decrease serum levels of fluoroquinolones

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Fluoroquinolones *(continued)*	Cimetidine	Decreases elimination of fluoroquinolones
	Didanosine	Decreases serum drug levels of fluoroquinolones
	Probenecid	Increases serum drug levels of fluoroquinolones
	Sucralfate	Decreases serum drug levels of fluoroquinolones
	Zinc salts	Decrease serum drug levels of fluoroquinolones
Haloperidol	Carbamazepine	Decreases haloperidol effect
Heparin	Aspirin	Due to increased platelet aggregation by aspirin, concomitant use may increase risk of bleeding.
	Dipyridamole	Increases risk of bleeding
	Garlic	Increases antiplatelet effect
	Ginger	Increases antiplatelet effects
	NSAIDs	Increase risk of bleeding
Hypoglycemics (oral)	Aspirin	Increases hypoglycemic action
Insulin		Refer to oral antidiabetics in this table
	Alcohol	Increases hypoglycemic effect and risk of insulin shock
	Anabolic steroids	Increase hypoglycemic effects
	Beta-adrenergic blockers	Prolong hypoglycemic effects
	Propranolol	Inhibits rebound of serum glucose after insulin-induced hypoglycemic
	Tetracyclines	Increase hypoglycemic effects
	Thyroid preparations	Decrease hypoglycemic effect
Isoniazid	Corticosteroids	Decrease isoiazid effects
Ketoconazole	Rifampin	Decreases ketoconazole levels
Leucovorin	Sulfamethoxazole-trimethoprim	Competes for same receptor sites as leucovorin (methotrexate rescue), causing decreased effectiveness of leucovorin and increased methotrexate toxicity
Lidocaine or **Procainamide**	Cimetidine	Increased risk of lidocaine or procainamide toxicity due to decreased clearance
Lithium	ACE Inhibitors	Increase lithium toxicity
	Anorexic agents	Increase lithium toxicity
	Caffeine	Decreases lithium effectiveness
	Fluoxetine	Increases lithium toxicity
	Iodides	Concurrent use may cause hypothyroid effects
	Methyldopa	Increases lithium toxicity
	Metronidazole	Increases lithium toxicity
	NSAIDs	Increase lithium toxicity
	Tetracyclines	Increase lithium toxicity
	Theophylline	Decreases lithium effectiveness
	Thiazide diuretics	Increase lithium toxicity
	Verapamil	Decreases lithium effectivness

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
MAO inhibitors	Meperidine	Can cause deep coma or death
	Sympathomimetics	Increased risk of hypertensive crisis
Methotrexate	Amiodarone HCl	Impairs drug metabolism
	Aspirin	Increases methotrexate levels
	Leucovorin	Competes at cellular sites to decrease methotrexate levels and prevent methotrexate toxicity
	Probenecid	Increases risk of methotrexate toxicity
	Sulfamethoxazole-trimethoprim	When used concurrently may cause folate deficiency
Narcotic Analgesics	Tricyclic antidepressants	Increase risk of respiratory depression
Neuromuscular Blocking agents	Aminoglycosides	Increase muscle relaxation
	Amphotericin	Increases muscle relaxation
	Carbamazepine	Decreases duration of muscular relaxation
	Clindamycin	Increases muscle relaxation
	Colistin	Increases muscle relaxation
	Corticosteroids	Increase muscle relaxation
	Hydantoins	Decrease duration of muscular relaxation
	Lithium	Increases muscle relaxation
	Magnesium	Increases muscle relaxation
	Narcotic analgesics	Increase risk of respiratory depression
	Nitrates	Increase muscle relaxation
	Phenothiazines	Increase muscle relaxation
	Pipercillin	Increases muscle relaxation
	Procainamide	Increases muscle relaxation
	Quinidine	Increases muscle relaxation
	Ranitidine	Significant decrease in muscle relaxation
	Theophylline	Reverses muscle relaxation
	Thiazide diuretics	Increases muscle relaxation
	Verapamil	Increases muscle relaxation
Nifedipine	Cimetidine	May cause up to an 80% increase in nifedipine blood levels, which can result in hypotensive crisis
Nitroglycerin	Aspirin	In combination may cause hypotension
NSAIDs	Aspirin	May decrease serum levels of NSAIDs
	Gingko biloba	Increases platelet aggregation
	Loop diuretics	Decrease NSAIDs effects
	Phenobarbital	Decreases NSAIDs effects
	Probenecid	Increases NSAIDs effects
	Sulfonamides	Increase NSAIDs effects
Oral contraceptives	Penicillins	Decrease contraceptive effects
	Phenobarbital	Decreases contraceptive effects
	Phenytoin	Decreases contraceptive effects
	Protease inhibitors	Decrease contraceptive effects
	Rifampin	Decreases contraceptive effects
	Tetracyclines	Decrease contraceptive effects

continues

TABLE A. *continued*

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Penicillins	Antacids	Decrease penicillin effects
	Aspirin	Increases penicillin effects
	Erythromycins	Decrease penicillin effects
	Tetracyclines	Decrease penicillin effects
Phenytoin	Amiodarone HCl	Increases phenytoin levels
	Aspirin	Increases phenytoin levels
	Cimetidine	Increases phenytoin levels
	Fluconazole, Omeprazole	Increases phenytoin levels
	Folic acid	Decreases antiseizure action in doses greater than 5 mg/day
	Isonizid	Increases phenytoin levels
	Nifedipine	Increases phenytoin levels
	Phenothiazines	May increase or decrease phenytoin levels
	Rifampin	Increases phenytoin levels
	Valporic acid	Increases phenytoin levels
Propranolol	Indomethacin	Decreases propranolol effects
	Nicotine	Decreases propranolol serum levels
Pyridoxine	Isoniazid	Decreases pyridoxine levels; use pyridoxine supplements
	Levodopa	Pyridoxine decreases levodopa levels
Quinidine	Amiodarone	Increases risk of quinidine toxicity
	Verapamil	Increases risk of quinidine toxicity
Quinolone antibiotics	Tricyclic antidepressants	Increase risk of life-threatening cardiac dysrhythmias
Spironalactone	Aspirin	Decreases diuretic effect
Sulfonamides	Anticoagulants	Increase sulfonamide effects
	Aspirin	Increases sulfonamide effects
	Diuretics, thiazide	Increased risk of thrombocytopenia
	Indomethacin	Increases sulfonamide effects
	Phenytoin	Increases sulfonamide effects
	Probenecid	Increases sulfonamide effects
Sympathomimetics	Beta-adrenergic blockers	Inhibit adrenergic stimulation
	Libirum	Decreases pressor effects
	MAO inhibitors	Potentiate sympathomimetic effects
	Sodium bicarbonate	Increases sympathomimetic effects
	Thyroxine	Enhances sympathomimetic effects
	Tricyclic antidepressants	Risk of hypertension and cardiac dysrhythmias
Tetracyclines	Aluminum salts	Decrease tetracycline effects
	Antacids	Decrease tetracycline effects
	Calcium salts	Decrease tetracycline effects
	Cimetidine	Decreases tetracycline effects
	Furosemide	Increases risk of nephrotoxicity
	Iron preparations	Decrease tetracycline effects

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Tetracyclines *(continued)*	Lithium	May increase or decrease tetracycline effects
	Magnesium salts	Decrease tetracycline effects
	Sodium bicarbonate	Decreases tetracycline effects
	Zinc	Decreases tetracycline effects
Theophylline	Allopurinol	Increases theophylline levels
	Amiodarone HCl	Increases theophylline levels
	Barbiturates	Decrease theophylline levels
	Beta-adrenergic blockers	Reverse effects of theophylline
	Caffeine	Increases theophylline levels
	Cimetidine	Increases theophylline levels
	Ciprofloxacin	Increases theophylline levels
	Corticosteroids	Increase theophylline effects
	Disulfiram	Increases theophylline levels
	Erythromycin	Increases theophylline levels
	Nicotine	Decreases theophylline levels
	Phenytoin	Decreases theophylline levels
	Propranolol	Increases theophylline levels
	Rifampin	Decreases theophylline levels
	Verapamil	Increases theophylline levels
Thyroid hormones	Estrogens	Decrease thyroid effects
	Phenytoin	Increases thyroid effects
	Salicylates	Decrease thyroid effects by competing with thyroid-binding sites on proteins
	Soy	Decreases absorption of thyroid hormones so space at least 2 hours apart
Trazodone	Fluoxetine	Increases risk of trazodone toxicity
Tricyclic antidepressants (TCA)	Carbamazepine	Decreases TCA effects
	Clonidine	Risk of hypertensive crisis
	Epinephrine	Increases effects of epinephrine
	Estrogens	Depending on the dose, may increase or decrease effects of TCA
	Haloperidol	Increases effects of TCA
	Histamine-2 antagonists	Increase anticholinergic effects of TCA
	MAO inhibitors	Increase risk of TCA toxicity
	Phenothiazines	Increase anticholinergic effects and decrease TCA levels
	Thyroid hormones	Increase TCA effects
	Tobacco	Decreases serum TCA levels
	Valporic acid	Increases TCA plasma levels
Valporic acid	Aspirin	Increases valporic acid levels
	Carbamazepine	Decreases valporic acid effects
	Erythromycin, clarithromycin, azithromycin	Increase valporic acid levels

continues

TABLE A. ***continued***

DRUG OR CLASSIFICATION	INTERACTING DRUG/FOOD	NATURE OF INTERACTION
Vasopressin	Carbamazepine	Increases vasopressin effects
Zidovudine	Probenecid	Increases zidovudine levels and increases risk of toxicity
	Rifampin	Decreases zidovudine levels

Food digestion improves the metabolism of the drugs:
Cefuroxime (Ceftin)
Hydralazine (Apresoline)
Ketoconazole (Nizoral)
Metoprolol (Lopressor)
Propranolol (Inderal)
Spironolactone (Aldactone)
Ticlopidine (Ticlid)

From *2001 PDR Nurse's Drug Handbook,* by G. R. Spratto and A. L. Woods, 2001. Albany, NY: Delmar Thomson Learning.

APPENDIX 6
SPANISH AND FRENCH TRANSLATIONS OF COMMON MEDICATION INSTRUCTIONS

Providing meaningful instructions to clients who do not speak English is frequently a source of difficulty for the health professional. The translations provided are intended to permit the nurse to prepare written or verbal medication instructions for clients who speak Spanish or French. To best use this appendix, the nurse should:

1. locate the appropriate type of instruction to be provided from Section A.
2. add the appropriate numbers from Section B to the space(s) provided in the instruction.
3. add, if required, any suffix(es) and/or statement(s) from Section C that would complete the instruction.

Section A: Instructions

_____	tablet(s)	_____	times daily	_____	(English)
_____	pastilla(s)	_____	veces cotidiano	_____	(Spanish)
_____	comprimé(s)	_____	fois quotidien	_____	(French)
_____	capsule(s)	_____	times daily	_____	(English)
_____	capsula(s)	_____	veces cotidiano	_____	(Spanish)
_____	capsule(s)	_____	fois quotidien	_____	(French)
_____	teaspoonful(s)	_____	times daily	_____	(English)
_____	cucharadita(s)	_____	veces cotidiano	_____	(Spanish)
_____	petite(s) cuillerée(s)	_____	fois quotidien	_____	(French)
_____	tablespoonful(s)	_____	times daily	_____	(English)
_____	cucharada(s)	_____	veces cotidiano	_____	(Spanish)
_____	grande(s) cuillerée(s)	_____	fois quotidien	_____	(French)
_____	drop(s)	_____	times daily	_____	(English)
_____	gota(s)	_____	veces cotidiano	_____	(Spanish)
_____	goutte(s)	_____	fois quotidien	_____	(French)
_____	suppository	_____	times daily	_____	(English)
_____	supositorio	_____	veces cotidiano	_____	(Spanish)
_____	suppositoire	_____	fois quotidien	_____	(French)
_____	Apply to the skin	_____	times daily	_____	(English)
_____	Aplicar a la piel	_____	veces cotidiano	_____	(Spanish)
_____	Appliquer à la peau	_____	fois quotidien	_____	(French)

Section B: Numbers

	Spanish	French
one	uno, una, un	un, une
two	dos	deux
three	tres	trois
four	cuatro	quatre
five	cinco	cinq
six	seis	six
eight	ocho	huit
twelve	doce	douze

Section C: When and How

When	Spanish	French
every hour	cada hora	chaque heure
every two hours	cada dos horas	toutes les deux heures
every three hours	cada tres horas	toutes les trois heures
every four hours	cada cuatro horas	toutes les quatre heures
every six hours	cada seis horas	toutes les six heures
every eight hours	cada ocho horas	toutes les huit heures
every twelve hours	cada doce horas	toutes les douze heures
before meals	ante comer	avant les repas
after meals	después comer	après les repas
before breakfast	ante desayuno	avant le petit déjeuner
after breakfast	después desayuno	après le petit déjeuner
before lunch	ante almuerzo	avant le déjeuner
after lunch	después almuerzo	après le déjeuner
before dinner	ante cena	avant le dîner
after dinner	después cena	après le dîner
at night	por la noche	le soir
in the morning	por la mañana	le matin
at bedtime	al dormir	à l'heure du coucher

How	Spanish	French
with meals	con la comida	avec les repas
with milk	con leche	avec du lait
with food	con la comida	avec de l'aliment
with antacid	con antacid	avec de l'antacide
in the right eye	en el ojo derecho	dans l'oeil droit
in the left eye	en el ojo izquierdo	dans l'oeil gauche
in both eyes	en los dos ojos	dans les deux yeux
in the right ear	en la oreja derecha	dans l'oreille droite
in the left ear	en la oreja izquierda	dans l'oreille gauche
in both ears	en las dos orejas	dans les deux oreilles
into the nostrils	en las narices	dans les narines
into the rectum	en el recto	dans le rectum
into the vagina	en la vagina	dans le vagin
chew	mascar	mâcher
do not chew	no mascar	ne mâchez pas
avoid sunlight	evitar sol	éviter la lumière du soleil
avoid alcohol	evitar alcohol	èviter l'alcohol
shake well	agitar bien	agiter bien
for external use	por uso externo	pour usage extérieur
keep refrigerated	tenga en refrigerador	garder réfrigére

APPENDIX 7
ABBREVIATIONS COMMONLY FOUND IN DRUG ORDERS

Note: Abbreviation may be written in uppercase or lowercase letters and with or without periods

a	before	fl, fld	fluid
aa	of each	g	gram
a.c.	before meals	gr	grain
a. d., A. D.	right ear	gtt	drop(s)
ad	to, up to	h	hour
ad lib	freely as desired	h. s.	at bedtime, at hour of sleep
AM	before noon	IM	intramuscular
aq	aqueous (water)	inj.	by injection
a. s., A. S.	left ear	I. U.	International Units
A. S. A.	aspirin (acetylsalicylic acid)	IV	intravenous
a. u., A. U.	each ear	IVPB	intravenous "piggyback"
b. i. d., bid	twice a day	kg	kilogram
buc	inside the cheek	Ⓛ	left
c	with	L	liter
caps	capsule	L A	long acting
cc	cubic centimeter	lb, #	pound
cm	centimeter	mcg	microgram
comp	compound	mEq	milliequivalents
d	day	mg	milligram
D/C, dc	discontinue	mixt	mixture
dil	dilute	ml, mL	milliliter
dl, dL	deciliter	Noct	at night
D^5W	5% dextrose in water	non rep	do not repeat
DS	double strength	NPO	nothing by mouth
EC	enteric coated	N. R.	do not refill
elix	elixir	NS, N/S	normal saline (0.9% sodium chloride)
et	and	o. d.	every day, once a day
ext	extract	O. D.	right eye

os	mouth
O. S.	left eye
OTC	over-the-counter
O. U.	each eye, both eyes
oz	ounce
p	after
p. c.	after meals
per	by, through
PM	after noon
p. o.	by mouth
prn	as occasion arises, as needed or requested
pt	pint
q	every
q a. m., QM	every morning
q. d.	every day
q. h.	every hour
q.i.d., qid	four times a day
q#h (e.g., q4h)	every # hours
QNS	quantity not sufficient
q. o. d.	every other day
QS	quantity sufficient, as much as necessary
qt	quart
Ⓡ	right
R, PR	by rectum
Rx	treatment, prescription
s	without
ss	one-half
SC, SQ, subq	subcutaneous
SL, subl	sublingual
sol	solution
sos	if necessary
sp	spirit
SR	sustained release
S. Sig.	write (on the label)
stat	immediately
syr	syrup
supp	suppository
T, Tbs, tbsp	tablespoon
t, tsp	teaspoon
tab	tablet
t. i. d., tid	three times a day
tinct, tr	tincture
TO	telephone order
U	unit
u.d., ut dict	as directed
ung	ointment
U.S.P	United States Pharmacopeia
vag	vaginal
VO	verbal order
x	times, multiply
x	except

Glossary

absence seizure – formerly referred to as petit mal seizures, which are characterized by staring and client's lack of self-awareness of the seizure event

absorption – movement of drug particles from the gastrointestinal tract into body fluids

abstinence syndrome – physiological response to the removal of a drug for which an individual has developed a dependence; characterized by sweating, restlessness, diarrhea

acetylcholine – neurotransmitter at cholinergic synapse in the central, parasympathetic, and sympathetic nervous systems

acidosis – state characterized by an actual or relative decrease in the alkali in body fluids in proportion to the content of acid

acid rebound – return to an acid condition

acquired bacterial resistance – resistance due to prior use of antibiotic

acquired immunodeficiency syndrome (AIDS) – an epidemic transmissible retroviral disease due to infection by the human immunodeficiency virus (HIV)

acrocyanosis – bluish coloring in the extremities due to oxygen decrease

acromegaly – chronic disease caused by excessive secretion of growth hormone in adults. It is characterized by enlargement of the hands and feet and of the bones of the head and chest.

actin – a protein that combines with myosin to form actomyosin, the contractible constitutent of voluntary muscle

actinic keratosis – premalignant lesion caused by excessive exposure to sunlight or ultraviolet rays

active absorption – the movement by a cell membrane of particles against a concentrated gradient

active immunity – resistance to disease acquired by contact with an antigen

acuity – measure of the power of the eye to distinguish or recognize block letters. Normal acuity is 20/20.

acute – having rapid onset; sharp, severe

adenocarcinoma – malignant tumor of glandular epithelium and connective tissue

adenoma – tumor of glandular epithelium and connective tissue

addiction – person's loss of control over use of a chemical substance and a strong compulsion to obtain and use the substance

adrenal cortex – outer part of the adrenal glands; it produces a variety of sex hormones and hormonal products having glucocorticoid and/or mineralocorticoid activity

adrenergic – pertaining to the sympathetic nervous system

adrenergic blocking agents – drugs that antagonize the secretion of epinephrine and norepinephrine from sympathetic terminal neurons

adrenergic receptors – receptors of epinephrine and norepinephrine

adrenocortrophic hormone (ACTH) – hormone released in response to the corticotrpin-releasing factor from the hypothalmus

adrenocortical – pertaining to the adrenal cortex

adverse effect – negative action resulting from the pharmacological action of a drug, among other factors

aerobic – living only in the presence of oxygen

affective disorder – emotional or mental dysfunction marked by mood disturbance

afterload – the arterial resistance against which the left ventricle must eject its volume during contraction

agammaglobulinemia – condition characterized by a low level of gammaglobulin and antibodies in the blood. It is associated with frequent infections

aggregation – clumping of cells

agonist – drug capable of combining with receptors to initiate drug actions

agranulocytosis – an acute condition in which the white blood cell count is extremely low and symptoms of neutropenia are pronounced

AIDS – See acquired immunodeficiency syndrome

akathisia – a subjective feeling of restlessness resulting in an inability to sit still

aldosterone – mineralocorticosteroid hormone secreted by the adrenal gland, regulates potassium, sodium, chloride, and bicarbonate by increasing sodium reabsorption in the kidneys

alkalosis – abnormally high alkali reserve (bicarbonate) of the blood and other body fluids that may produce an increase in the pH of the blood

allergen – substance causing a specific hypersensitivity reaction in an individual

allergic reaction – hypersensitive response of the client's immunological system in the presence of a drug

allergic rhinitis – inflammation of the nasal mucous membranes caused by allergy (e.g., hay fever)

allograft – tissue or organ taken from a human cadaver intended for use in a human client

alopecia – baldness or loss of hair

alpha-adrenergic – sympathetic nervous system receptor sites in the smooth muscle of the blood vessels, gastrointestinal tract, and genitourinary tract that produce vasoconstriction when stimulated by adrenergic drugs

alveoli – air cells, or cavities, in the lungs

alveolitis – inflammation of the alveoli or saclike dilations in the ducts of the lungs

amblyopia – diminished vision without structural abnormality of the eye

ambulation – walking

amphetamine – drug group of central nervous system stimulants that act on the brainstem

ampule – a small glass container that can be sealed and sterilized; usually containing medication for injection

anaerobic – able to live without oxygen

analgesia – loss of sensibility to pain, especially pain relief without loss of consciousness

analgesic – agent that produces analgesia or pain relief

analog – two or more chemical compounds with similar structures that differ in some significant way—for example, in their function

anaphylactic shock – circulatory collapse resulting from extreme sensitivity to a foreign protein or other substance

anaphylaxis – unusual or exaggerated reaction to foreign protein or other substance; a hypersensitivity. Sometimes used interchangeably with anaphylactic shock.

androgens – natural and synthetic steroids responsible for presence of primary and secondary male sex characteristics

anemia – condition in which there is a reduction in the number of circulating red blood cells

anesthesia – loss of feeling or sensation. This includes drug-induced loss of sensation in a body part or the entire body.

angina pectoris – substernal pain or sense of constriction often radiating into the neck or arms. It is produced from insufficient blood supply to the myocardium to meet its oxygen demands at the time of pain.

angiocardiography – X-ray examination of the great vessels and the chambers of the heart following intravenous injection of a radiopaque dye

angioedema – allergic disorder, with transient circumscribed edematous swellings of the skin, subcutaneous tissues, and mucous membranes

angiography – X-ray examination of blood vessels or lymph vessels following injection of a radiopaque dye

anion – ion with a negative charge

anorexia – lack or loss of appetite for food

antacids – agents that neutralize hydrochloric acid and pepsin activity in the stomach

antagonist – agent that resists or opposes the action of another agent

antecubital – at the inner bend of the elbow; site used for peripherally inserted central catheter (PICC) or peripheral intravenous access

anterograde – moving frontward

antianginal – agents that cause vasodilation (especially venous), resulting in a decreased amount of blood returning to the heart and decreased cardiac workload

antibiotic – chemical substance derived from molds or bacteria inhibiting the growth of or destroying bacteria and other microorganisms

anticholinergic – agent with action antagonistic to the action of parasympathetic or other cholinergic nerve fibers

anticoagulant – agent preventing blood coagulation or clotting

antiemetic – drug that controls nausea and vomiting

antigen – substance that can stimulate a specific immune response

antihistamine – agent that neutralizes or antagonizes the action of histamine. Frequently used in the treatment of allergy.

antihypertensive – agent used to treat high blood pressure

anti-inflammatory – reducing inflammation without directly antagonizing the causative agent. An agent that reduces inflammation.

antimetabolite – agent that alters or block a specific metabolic step essential for the normal functioning of a cell

antimicrobials – agents used to inhibit the growth of or kill bacteria or other microorganisms including viruses, fungi, protozoa

antineoplastic – agents used in treating new abnormal tissue growth, primarily malignant tissue

antipruritic – agent preventing or relieving itching

antipyretic – agent used to reduce fever

antiseptic – an agent that kills or inhibits the growth microorganisms

antitoxin – antibody produced as a response against a toxin, particularly a toxin produced by bacteria

antitussive – agent that relieves or prevents cough

antivenin – active principle in a serum against a snake bite or insect bite

anxiety – feeling of apprehension, uncertainty, and/or fear

anxiolytic – agent used to reduce nervousness, excitability, and irritability (anxiety)

aortography – X-ray examination of the aorta

apical – pertaining to the apex of any structure; apical pulse is the pulse measured over the apex of the heart

aplastic anemia – condition in which the number of red blood cells is less than normal because of defective development or regeneration of cells

apnea – absence of respiration

apocrine gland – sweat gland found only in hairy areas, such as the axilla

APTT – activated partial thromboplastin time – laboratory test used to monitor bleeding times on clients receiving heparin

aqueous – prepared in water

arrhythmia – irregularity or loss of rhythm, particularly an irregularity of heartbeat

arteriography – X-ray examination of arteries following injection of a radiopaque dye

arteriosclerosis obliterans – slow narrowing of the arteries, with degeneration of the intima and thrombosis leading to complete occlusion and infarction or gangrene

arthrography – X-ray examination of a joint following injection of air, oxygen, or a contrast dye into the joint space

ascites – abnormal accumulation of fluid in the peritoneal cavity

asepsis – condition in which living pathogenic organisms are absent

aspiration – the act of breathing fluid or a foreign body into the airways

assessment – first step of the nursing process, involving collection of both subjective and objective data, analysis of the data, and development of nursing diagnoses

asthma – a respiratory condition characterized by paroxysmal attacks of dyspnea, or difficult respiration, on expiration

astringent – agent that causes contraction of tissues, arrests secretions or controls bleeding

ataxia – loss of control over voluntary movements, particularly walking

atherosclerosis – condition characterized by thickening of the inner lining of large and medium-sized arteries and deposition of lipids and calcium within the vessels

atonic seizure – seizure involving collapsing and falling, which after about 10 seconds resolves itself with client able to rise and ambulate without assistance

atony – lack of muscle tone

atopic – pertaining to the tendency of some persons to develop immediate hypersensitivity states, such as asthma or hay fever

atrial fibrillation – common cardiac rhythm disorder in which the atria undergo a continuous process of incoordinated multifocal activity

atrial flutter – rapid, irregular contractions of the atria independent of the sinoatrial node. The atrial rate is usually about 300 beats per minute.

atrophy – wasting away of a tissue or organ; a condition of general malnutrition, with wasting of body tissues

auditory – related to sense or organs of hearing

auscultate – to examine by listening to body sounds, especially through a stethoscope

autoimmune – condition of immunological responses against the organism producing agents that attack itself

autoinoculation – spread of a virus from a lesion on one part of the body, by contact with another part of the body

autoinoculation – inoculation by use of organisms obtained from another part of a client's body

automaticity – the property of automatic (without conscious control), repetitive activity. The activity of the sinoatrial node of the heart is an example.

autonomic ganglion – group of nerve cells, especially outside the central nervous system, that is involved in regulation of the activity of body parts not under voluntary control

autonomic nervous system – branch of the nervous system that works without conscious control

bactericide – substance causing the death of bacteria

bacteriostatic – inhibiting or retarding the growth of bacteria

bacteriuria – presence of bacteria in the urine

basal metabolic rate – rate of metabolism and potential elimination of drug, based on the speed of metabolism in the body at rest; BMR

beta-adrenergic – sympathetic nervous system receptor sites located in the heart muscle that control contractility

beta blocker – agents that block action of epinephrine and at beta-adrenergic receptors on cells of effector organs; $beta_1$ receptors in the myocardium and $beta_2$ receptors in the bronchioles and vascular smooth muscle

bevel - the angular pointed tip of a needle

biliary – relating to bile

biliary colic – intense pain in the upper right quadrant of the abdomen, often the result of an impacted gallstone

bioassay – method for determining the concentration of substances such as drugs and hormones. It involves controlled observation of the effect of a substance upon living animals or tissues and comparison of this effect with an international standard.

bioavailability – absorption efficiency of a drug

bioequivalent – resulting in the same degree of bioavailability

biogenic amines – a group of chemical substances with similar chemical structure capable of altering cerebral and vascular function. Agents in this group include epinephrine, dopamine, serotonin, etc.

bipolar affective disorder – mental health problem involving mood changes, with both mania and depression

blepharitis – inflammation of the eyelids

body surface area – the amount of body surface relative to height and weight used to calculate fluid and drug administration; expressed in meter squared; BSA

bolus – a mass, as in a volume of medication, intended for intravenous injection over a short period of time

bradyarrhythmia – slow, abnormal cardiac rhythm

bradycardia – slowness of heartbeat, usually defined as less than 60 beats per minute in adults

bradykinin – polypeptide (chain of amino acids) formed in blood by proteolysis (protein breakdown). It stimulates visceral smooth muscle and relaxes vascular smooth muscle, producing vasodilation and increasing capillary permeability.

brand name – name of a drug given by the pharmaceutical company that patented the agent; is patented with the U.S. Patent Office and approved by the U.S. Food and Drug Administration (FDA); same as trade name

broad-spectrum antibiotic – antimicrobial effective against both gram-positive and gram-negative organisms; usually used when causative microorganism has not been identified by culture and sensitivity testing

bronchodilator – agent causing an increase in the caliber of a bronchus or air passages of the lungs

bronchospasm – spasmodic narrowing of the lumen of a bronchus

buccal – fleshy inner lining of the cheek; used to administer selected drugs for rapid absorption through oral membranes; administered by placing medication between gums and cheek

bulbourethral glands – Cowper's glands; two small glands located adjacent to the urethra in males

bulimia – eating disorder characterized by overeating followed by purging (vomiting, taking laxatives, etc.)

bursa – closed sac lined with a membrane and containing fluid. These are found in areas of the body subject to friction.

bursitis – inflammation of a bursa

calcitonin – hormone produced by the thyroid gland that helps regulate serum calcium levels

calcium channel blocker – drug that blocks the movement of calcium ions through specific ion pathways (channels) of the cardiac and smooth muscle cells

cannabis abuse – misuse or addiction to derivatives of the hemp plant *Cannabis sativa*

cannula – tube inserted into a body cavity to permit drainage of fluid or oxygenation (see tracheostomy)

capillary proliferation – reproduction or multiplication of the minute blood vessels that connect the arterioles and venules

carbonic anhydrase – enzyme that contains zinc and is found in red blood cells. It controls the amount of carbon dioxide in the blood and its rate of excretion in the lungs.

carcinogenic – causing cancer

carcinoma – malignant epithelial tumor that spreads locally and, if unchecked, throughout the body

cardiac glycoside – naturally occurring substance consisting of sugars and nonsugars that has a stimulating effect on the heart, e.g., digitalis

cardiotonic – old term for cardiac glycosides; agent used to alter the tone of the cardiac muscle

catabolic – related to the breaking down of complex chemical compounds into simpler ones. This is often accompanied by the liberation of energy.

catecholamines – a group of chemically related compounds having a sympathomimetic action, e.g., epinephrine and norepinephrine

catheter – a small tube inserted into a vein to administer fluids or medications

cations – positively charged ions

caustics – substances that cause burning or corrosion and may destroy living tissue

cauterize – to apply an agent (heat or chemical) that produces scarring or burning of the skin or tissues. It is useful for destroying tissue, especially diseased tissue, and for stopping bleeding.

ceiling effect – doses that, even if increased, produce no additional clinical results, but can lead to toxic effects; thiazide diuretics and NSAIDs are examples of drugs that have a ceiling effect, whereas opiates do not have a ceiling effect.

cell-cycle nonspecific – drugs that act during any phase of the cell cycle

cell-cycle specific – drugs that act on specific phases of the cell cycle

cerebral palsy – a motor function disorder caused by a permanent nonprogressive brain defect or lesion present at birth or shortly after

chelating agent – a substance that binds with a metal ion

chemical name – describes the chemical make up of an agent

chemotherapy – treatment of a health problem with medications; usually used in conjunction with antineoplastic agents

cholangiography – X-ray examination of the gallbladder and bile ducts

cholecystography – X-ray examination of the gallbladder

cholestatic hepatitis – inflammation of the liver produced by an arrest in the flow of bile

cholinergic – pertaining to the parasympathetic portion of the autonomic nervous system

cholinesterase – enzyme that separates acetylcholine into acetic acid and choline

chronotropic – influencing the heart rate by altering the rate of impulse formation in the SA mode; may have either a positive or negative effect

chrysotherapy – gold therapy used to reduce the progression of rheumatoid arthritis

cinchonism – syndrome often accompanying regular use of quinine. It may include ringing in the ears, dizziness, headache, GI distress, and visual disturbances.

circumoral – around the mouth

climacteric – menopause. In males, this term refers to a decline in sexual power.

clonic – characterized by repetitive muscular contraction induced by stretching

coccidioidomycosis – fungal infection caused by *Coccidioides immitis*

code designation – the chemical name of a drug during its early development

coenzyme – substance necessary for the action or that enhances the action of an enzyme

colitis – inflammation of the colon or bowel

collagen – main supportive protein of skin, tendon, bone, cartilage, and connective tissue

collagen disease – a group of disorders of collagen tissues associated with rheumatic signs and symptoms. Examples include rheumatoid arthritis, scleroderma, and lupus erythematosus.

communicable – capable of being transmitted from one person to another

complex partial seizure – psychomotor or temporal lobe seizure, usually beginning with a blank stare followed by random activity

conjunctival sac – pouch made by pulling down the lower lid of the eye

conjunctivitis – inflammation of the conjunctiva or mucous membrane lining the eyelids

continuous subcutaneous insulin infusion – called insulin pumps, needle is placed in the underlying tissue of the abdomen and is attached to the pump via tubing, this provides a constant amount of insulin continuously, thus more closely mimicking healthy pancreatic function

contraceptive – agent used for the prevention of conception either by creating a barrier or as an oral, patch, or injectable agent containing estrogen, progestin, or a combination that acts to inhibit ovulation

controlled substance – drug subject to strict laws defining how it is to be prescribed, distributed, and stored. Such drugs are classified into five groups (Schedules) according to their ability to be abused. Examples of controlled substances include codeine, meperidine, barbiturates, amphetamines, etc.

convulsive threshold – amount of stimulation needed to produce a convulsive seizure

Coombs' positive – presence of globulin antibodies in red blood cells. It indicates sensitized red blood cells in hemolytic anemias.

corpus luteum – temporary ovarian structure that forms about the time of ovulation and is responsible for the secretion of progesterone during the last 2 weeks of the menstrual cycle

corticosteroid – substance of steroidal structure produced by the cortex of the adrenal gland. Examples are cortisone and corticosterone.

cross-sensitivity – hypersensitivity to an antibiotic, including other agents in the same or related chemical class

cross-tolerance – reduced effect of a substance resulting from repeated use of a chemically related substance

crystalluria – presence of crystals in the urine

cummulative effect – occurs when a drug's metabolism or excretion occurs more slowly than the rate at which it is administered; creates the potential for toxic serum levels of the drug

curettage – treatment with a curette (i.e., a scraper in a spoon shape). It is frequently used in diagnosis and treatment of uterine problems. Suction curettage employs an instrument using suction to pick up tissue that has been scraped off of the wall of an organ.

Cushing's effect – increased circulating cortisol from the adrenal cortex; associated with Cushing's syndrome, which has such symptoms as painful edema of the face and interscalpular area (Buffalo humps), abdominal distention, generalized weakness, and amenorrhea

CVAD – central venous access device

CVC – central venous catheter; intravenous catheter leading into the superior vena cava

cyanosis – bluish tint to the skin or nailbeds as a result of diminished oxygen from the bloodstream to the site; usually indicating hypoxia

cystic fibrosis – fibrocystic disease of the pancreas

cystitis – inflammation of the bladder. Most frequently used to refer to infection of the urinary bladder.

cystography – X-ray examination of the urinary bladder following instillation of radiopaque dye through either a cystoscope or a urethral catheter

cystoscopy – examination of the interior of the urinary bladder with a lighted instrument called a cystoscope

cystourethrography – X-ray examination of the urinary bladder and urethra following injection of a radiopaque dye

dander – minute scales from hair, skin or feathers which may act as allergens

DEA – Drug Enforcement Agency

deciliter (dL) – 100 milliliters or 0.1 liter

decompensation – condition in which an organ that was previously meeting the body's demands fails to meet its demands

decongestant – drug used to reduce the swelling or congestion of the nasal membranes

decubitus – ulcer or bedsore

delirium – condition of extreme mental and, often, motor excitement. Often involves confused and unconnected ideas, illusions, and hallucinations.

delusion – false belief that cannot be changed by an argument or reason

denature – to destroy the usual nature of a substance that causes a loss of unique or specific characteristics

depot – drug in a form that is only slowly absorbable, placed into the body's tissues to exert a continuous and prolonged action

dermatitis – inflammation of the skin

desensitization – administration of a graded series of doses of an antigen in order to stimulate antibody production and thereby decrease hypersensitivity reactions

diabetes insipidus – disease characterized by polydipsia and polyuria. It results from a deficiency of vasopressin.

diabetes mellitus – metabolic disorder characterized by faulty carbohydrate, fat and protein metabolism.

diabetic ketoacidosis – uncontrolled diabetes mellitus, which results in the body's burning fat and protein instead of carbohydrates. This produces acid waste products (ketones) that accumulate in the body tissues.

diabetogenic – causing diabetes or caused by diabetes

dialysis – process of separating soluble crystalloid substances (e.g., drugs) in the blood from colloids by diffusion across a semipermeable membrane

digitalization – administering digitalis on a dosage schedule to produce a therapeutic concentration of the cardiac glycosides

diluent – an agent that decreases the concentration of another agent

diplopia – double vision

discography – X-ray examination of the disc of a joint following injection of a radiopaque dye

discoid lupus erythematosus – a collagen disease characterized by coin-shaped lesions on the skin

disinfectant – an agent that rapidly destroys pathogenic microorganisms and thereby prevents infection, used only on external inanimate objects

dissecting aneurysm – localized dilatation of the walls of a blood vessel in which there is a splitting of the media, usually of the aorta and, finally, a rupture either outward through the vessel or inward into the lumen

distal tubule – portion of the nephron that leads from the ascending loop of Henle into the collecting ducts

distribution – process by which a drug becomes available to body tissues and cells

diuresis – excretion of urine, particularly an excessive quantity of urine

diuretic – agent that increases the volume of urine

diverticulitis – inflammation of a diverticulum or small pocket in the colon wall

dopamine – neurotransmitter found in the central nervous system that is a precursor of norepinephrine and epinephrine

douche – current of fluid directed into a body cavity, for example, into the vagina; to direct a current of fluid into a body cavity

dromotropic – pertaining to the fibers that influence electroconduction of the heart

drug dependence – can be either physical and/or psychological; when the body and mind become accustomed to the drug being in the system

drug interaction – interference of a drug with the effect of another drug, nutrient, or laboratory test. Conversely, a drug interaction is possible if a food interferes with the action of a drug.

drug tolerance – occurs when a client develops a resistance to the effects of an agent

dyscrasia – a developmental disorder, usually of the blood

dysentery – disease characterized by frequent watery stools, often with blood and mucous and associated with pain, fever, dehydration, and spasm of the anal sphincter

dyskinesia – impaired voluntary motion producing movements that are incomplete or only partial

dysmenorrhea – difficult and painful menstruation

dysphoria – restlessness; feeling of being ill at ease

dyspnea – difficult respiration; a subjective feeling of distress when the increased need for pulmonary ventilation becomes conscious

dysrhythmia – defective heart rhythm

dystonia – lack of tonicity in body tissues

dysuria – difficulty urinating

ecchymotic – marked by ecchymosis, or a swollen livid or black and blue spot in the skin caused by effusion of blood into the tissue

eccrine gland – excretory gland found in the skin; e.g., eccrine sweat gland

eclampsia – convulsions associated with acute toxemia of pregnancy

ectopic pacemaker – abnormal focus in the heart that takes over the function of the sinoatrial node in initiating cardiac contraction

edema – accumulation of an excessive amount of fluid

effervescence – bubbling, sparkling; giving off gas bubbles

efficacy – the ability to produce a wished-for response

electroencephalography – use of a special instrument to register the brain's electrical activity

electrolytes – electrically charged particles; substances capable of conducting electrical currents when dissolved in water; either positively or negatively charged

elemental – in chemistry, a substance that cannot be broken down into any simpler form by ordinary chemical processes; referring to the elements found in the periodic table of elements

elixir – solution containing a solvent mixture of alcohol and water, as well as other components

embolism – sudden blocking of a blood vessel, usually an artery, by a blood clot, clump of bacteria, or other foreign body

embolus (pl., emboli) – foreign body, such as a blood clot or bubble of air, that is impacted within a blood vessel

emesis – vomiting or the matter that is vomited

emetic – substance causing vomiting

emetogenic – able to produce vomiting

emphysema – chronic respiratory condition in which the alveoli of the lungs are dilated

emulsion – a preparation of two liquids, usually oil and water, in which fine droplets of one are dispersed throughout the other

encephalitis – inflammation of the brain

encephalopathy – general term used to refer to any disease of the brain

endemic – a disease constantly present in an affected community. These diseases may become epidemic when some factor upsets the equilibrium.

endobronchial – related to the smaller bronchi of the lung

endocrine – secreting internally; a gland that produces internal secretions or hormones

endometriosis – presence of endometrial tissue, i.e., the lining of the uterus, outside of the uterine cavity

endometrium – mucous membrane lining the uterus

endoplasmic reticulum – an extensive network of membrane-enclosed tubules in the cytoplasm of cells that functions in the synthesis of protein and lipids and in the transport of these materials within the cell

endoscopic – a procedure that uses an illuminated optic instrument to visualize the interior of a body cavity or organ

endovenomation – injection of a venom into the body. Such a substance is a poison excreted by some animals, such as insects or snakes. It is generally transmitted by a bite or sting.

enteric-coated (ec) – special coating applied to tablets or capsules that prevents release and absorption of contents until the small intestine is reached

enteritis – inflammation of the mucous membranes of the intestine, generally the small intestine

enuresis – involuntary discharge of urine from the urinary bladder after the age at which bladder control should have been established; bed-wetting

eosinophils – white blood cells easily stained by eosin dye

epidural anesthesia – regional loss of sensation produced by injection of an anesthetic agent into the extradural space

epidural space – situated upon or outside the toughest outer membrane (dura) covering the brain and spinal cord

epilepsy – a chronic disorder characterized by attacks of brain dysfunction usually associated with some alteration of consciousness (seizure)

epiphyseal – relating to the epiphysis or secondary bone-forming center attached to a bone. After some years the epiphysis becomes a part of the calcified bone.

epiphysis – secondary bone-forming center attached to a bone

erectile dysfunction – inability to establish or sustain an erection for sexual intercourse

erythema – redness of the skin or inflammation

erythroblastosis fetalis – a hemolytic disease of newborn infants that most often results from the development of anti-Rh antibodies in an Rh-negative mother to the Rh-positive factor in the fetal blood

erythropoietin – substance secreted by the kidneys that stimulates red blood cell production

eschar – a dry scab — for example, a scab that forms on an area of skin that has been burned

esophageal reflux – flow of acid from the stomach into the esophagus

estrogen – female sex hormone produced by the ovaries and placenta

eunuchoidism – condition in which the testes are present, but the sex hormone secretion is inadequate or lacking. This results in a eunuchoid appearance and impairment of sexual functioning.

euphoria – feeling of well-being that may be exaggerated and not necessarily well founded

euphoric – characterized by euphoria

eustachian tube – passage connecting the tympanic cavity of the ear with the nasopharynx. It functions to equalize pressures on either side of the tympanic membrane (eardrum).

euthyroid – normal function of the thyroid gland

evaluation – fifth phase of the nursing process; determining the effectiveness of care in attaining goals and outcome criteria established in care plan

exacerbation – increase in the severity of a sign, symptom, or disease

excoriate – to create a raw surface from abrasion or scraping of skin or mucous membrane

exfoliative dermatitis – skin disorder marked by profuse scaling

exocrine – gland that secretes regulatory substances through a duct

expectorant – drug aiding in the removal of bronchial secretions

extrapyramidal – outside of the pyramidal tracts of the nervous system — that is, tracts not entering into the pyramids of the medulla

extravasation – exudation or escape of fluid from a vessel into the surrounding tissues

exudative – marked by exudation; i.e., fluid that seeps into a cavity or tissues

FDA – Food and Drug Administration

febrile seizure – seizure activity experienced by children in the presence of a temperature elevation sufficient to stimulate excessive electrical brain activity

fibrillation – quivering or spontaneous contraction of single muscle cell; usually associated with cardiac dysrrhythmias; ventricular fibrillation, atrial fibrillation

fibrinolytic – able to dissolve fibrin; an agent with this ability

fibrocystic – cystic lesions situated within fibrous connective tissue

field block – type of regional anesthesia in which the anesthetic agent is used to create walls of anesthesia encircling an operative site

first-line drugs – agents considered to be most effective for treating a specific health alteration

flaccid – flabby, soft, or relaxed

flora – bacterial content of a portion of the body; e.g., the content of the lumen of the intestine

focal – related or belonging to a focus or localized area

fungicide – substance causing the death of fungi

fungistatic – substance arresting the growth of fungi

ganglion – a cluster of nerve cell bodies

gastroenteritis – inflammation of the mucous membranes of the stomach and intestine

gastroparesis – a degree of paralysis of the stomach; commonly seen in diabetic ketoacidosis

gastrostomy – opening into the stomach

gauge – diameter of the lumen of the needle; the larger the gauge, the smaller the lumen

general anesthesia – state of unconsciousness produced by an anesthetic agent. This state is associated with absence of pain sensation and with muscle relaxation.

generalized tonic-clonic seizure – hyperelectric charging of neurons in both hemispheres of the brain involving loss of consciousness, falling, jerking movements of the extremities, changes in breathing pattern, and possible loss of bowel and bladder control

generic name – name of a drug as designated by the U.S. Adopted Names (USAN) Council of the federal government

germicide – general term used to describe agents capable of destroying microorganisms

glaucoma – disease of the eye characterized by increased intraocular pressure due to restricted outflow of aqueous humor. This may produce degeneration of the optic disc, with loss of vision.

glomerular – relating to or belonging to the glomerulus of the kidney

glomerulus (kidney) – one of many tufts of capillaries lying within Bowman's capsule, whose function it is to filter waste products from the blood

glucocorticoid – a substance that elevates the concentration of glycogen and blood sugar; secreted from the adrenal cortex

gluconeogenesis – formation of glucose from noncarbohydrates (protein and fat)

glycogenolysis – breakdown of glycogen in tissue, including its conversion into glucose

glycosuria – presence of an abnormal amount of sugar, generally glucose, in the urine. This is one of the signs of diabetes mellitus.

goals – based on assessment data analysis and nursing diagnoses; identification of outcome criteria and stated in such a way as to include (1) client-centered, realistic outcome (2) measurable and observable criteria

gonioscopy – diagnostic eye test using an instrument (gonioscope) to inspect the angle of the anterior chamber of the eye and to visualize ocular movements and rotation

gout – inherited metabolic disorder characterized by an elevated blood uric acid level, recurrent acute arthritis, and deposition of urate crystals in tissues, especially connective tissue

Graafian follicle – small cavity, or recess, in the ovary that matures during a menstrual cycle and releases an ovum

gram-negative – bacterium that fails to retain the stain using the Gram's method. Examples are *E. coli*, *N. gonorrhea*, and *P. aeruginosa*.

gram-positive – bacterium that retains the stain using the Gram's method. Examples are *M. tuberculosis*, *S. aureus*, and *S. hemolyticus*.

granuloma – tumor composed of granulation tissue (connective tissue and blood vessels)

gravid – pregnant

Guillain-Barré syndrome – acute infective polyneuritis resulting in an ascending paralysis

gynecologic(al) – pertaining to diseases peculiar to women, primarily those of the reproductive tract

gynecomastia – excessive development of mammary glands in the male

habituation – pattern of repeated substance use in which a person feels better when using a particular substance than when not using it

half-life – time interval required for elimination processes to reduce the concentration of a drug in the body by one-half

hallucination – subjective perception (sound, smell, etc.) manifest in the absence of an actual stimulus

hematocrit – volume of corpuscles or cells in a sample of blood. Normal is 42%–50% for males and 40%–48% for females.

hematological – relating to the blood or blood-forming tissue

hematoma – swelling composed of accumulated blood. It is often the result of injury or of a blood disease, such as leukemia.

hematuria – presence of blood in the urine

hemoconcentration – concentration of the blood by loss of water and electrolytes; this results in an increase in viscosity and a slowing of circulation

hemolysin – substance capable of damaging the wall of red blood cells, thereby allowing leakage of hemoglobin

hemolytic anemia – anemia resulting when the lifespan of red blood cells is shortened

hemoperitoneum – blood in the abdominal cavity lined by the peritoneal membrane

hemophilia – inherited blood disorder characterized by hemorrhages due to a blood coagulation defect

hemoptysis – expectoration of blood

hemorrhagic cystitis – inflammation of the bladder causing potentially life-threatening bleeding from the bladder wall caused by the use of certain antineoplastic agents

heparin lock – intravenous adaptor designed for the intermittent intravenous administration of drugs, particularly through a central venous access; CVAD

hepatic – related to or belonging to the liver

hepatitis – inflammation of the liver

hepatotoxicity – damage or destruction of liver cells

hirsutism – excessive hairiness; often referring to a condition in females where hair grows in places it is normally absent from in females, but present in males (e.g., face and chin)

histamine – amine occurring in all animal and vegetable tissues. It is a stimulator of gastric secretion, a dilator of capillaries, and a constrictor of bronchial smooth muscle.

histamine receptor antagonist – agent that blocks H_2 receptors of the parietal cells in the stomach, thus decreasing gastric acid.

histoplasmosis – highly infectious disease due to *Histoplasma capsulatum*, that primarily affects the lungs

Hodgkin's disease – painless, progressive enlargement of the lymph nodes, spleen, and lymphoid tissues

holistic nursing approach – an approach to a client in which the client is viewed as a physiobiologicpsychosocial being

hospice – model for quality, compassionate care at end-of-life, with focus on pain management and emotional and spiritual support of clients and families

hydantoins – class of anticonvulsants

hyperaldosteronism – excess secretion of aldosterone, a steroid produced by the adrenal cortex to regulate sodium and potassium balance in the body

hypercalcemia – elevated serum calcium level (about 10.5 mg/dL in adults and slightly higher in children)

hypercalcinuria – excess of calcium in the urine

hyperchlorhydria – excessive secretion of hydrochloric acid by the stomach

hyperfibrinolysis – excessive decomposition or dissolution of fibrin by action of the enzyme fibrinolysin

hyperglycemia – excessive amount of sugar in the blood; an elevation of blood glucose (normal fasting glucose is 80–120 mg/dL)

hyperkalemia – excess level of potassium in the blood (normal serum potassium is 3.6–5.5 mEq/L)

hyperkeratotic – hypertrophied horny layer of epidermis

hyperkinesis – abnormally increased motor activity, often associated with attention deficit hyperactivity disorder in children.

hypermetabolic – increased metabolism, i.e., increase in the chemical processes essential for life

hypernatremia – excess of sodium in the blood; a serum sodium level in excess of 145 mEq/L

hyperplasia – an increase in the number of cells

hypertensive crisis – presence of an extremely high blood pressure (e.g., 240/150 mm/Hg) accompanied by clinical features indicating extreme danger to major organs and life, e.g., severe headache, seizures, massive bleeding (from nose or kidney), or left ventricular failure

hyperthermia - fever

hyperthyroidism – excessive activity of the thyroid gland

hypertonic – saline solution of strength above physiological or normal saline; solution with an osmotic pressure greater than that of an isotonic solution

hypertrophy – increase in the number or size of the cells composing a tissue with a resulting increase in the function of that tissue

hyperuricemia – excess of uric acid in the blood (normal is 2.0–7.8 mg/dL)

hypnotic – agents that produce a diminished responsiveness, as well as sleep

hypocalcemia – deficient level of serum calcium (below 8.5 mg/dL)

hypochloremia – abnormally low level of chloride ions in the circulating blood

hypogammaglobulinemia, also called **agammaglobulinemia** – condition in which there is low level of gammaglobulin and antibodies in the blood

hypoglycemia – abnormally low glucose content in the blood, generally less than 60 mg/dL

hypokalemia – subnormal level of potassium in the blood (i.e., less than 3.5 mEq/L)

hypomagnesemia – a subnormal level of magnesium in the blood (i.e., less than 1.5 mEq/L)

hyponatremia – electrolyte imbalance occurring when the concentration of sodium in the extracellular fluid falls below 135 mEq/liter

hypoparathyroidism – underactivity of the parathyroid glands, leading to a subnormal concentration of serum calcium and to signs of tetany

hypoperfusion – deficiency of blood passing through an organ or body part

hypophosphatemia – deficient level of serum phosphorus (normal is 3.0–4.5 mg/dL, slightly higher in infants under 1 year)

hypoprothrombinemia - condition in which there is a deficiency of prothrombin in the blood resulting in hemorrhage

hypotension – blood pressure below the normal range for the client's level of growth and development

hypothalamic-pituitary-adrenal system – parts of the body participating in the production and regulation of many hormones produced by the endocrine system

hypothalamus – a portion of the brain responsible for regulation of body temperature and secretion of endocrine glands

hypothermia – body temperature below 37°C, especially low temperature induced as a means of decreasing tissue metabolism and need for oxygen

hypothyroidism – underactivity of the thyroid gland

hypoxia – inadequate tissue oxygenation for normal tissue functioning

hysterosalpingography – X-ray examination of the uterus and fallopian tubes following injection of radiopaque dye

iatrogenic – resulting from the activity of physicians; said of any adverse condition in a client resulting from treatment by a physician or surgeon

IDDM – insulin-dependent diabetes mellitus

idiopathic – without a known cause

idiosyncratic drug reaction – abnormal reactivity to a drug caused by a genetic difference between reactive individuals and nonreactive persons

ileum – lower three-fifths of the small intestine

ileus – mechanical obstruction of the bowel

illicit agents – agents/drugs that are not legal in the U.S.

immune serum - any serum (fluid remaining after whole blood or plasma has been allowed to clot) used in the treatment of bacterial or viral diseases. These are usually prepared in animals by extensive immunization with the causative organism or its products, but may also be obtained from an animal or person naturally infected and recovered from the infection.

impaction – substances pressed so tightly together as to be immovable, for example fecal material that cannot be expelled

implementation – fourth stage of the nursing process; involves performing nursing actions focused on meeting established goals

incisor – one of the four front biting teeth characterized by a chisel-shaped crown and a single root and lying anterior to the canine teeth in the arch

incontinence – inability to prevent discharge of bodily excretions, especially urine or feces

induration – hardening of a tissue or organ because of pathological changes

infantile seizure – seizure seen in children between the ages of 3 months and 2 years characterized by clusters of jerking movements and head and knee flexion

infection – a health alteration caused by microorganisms that results in inflammation

infiltration – the process of intravenous fluids escaping into surrounding tissues due to displacement of the intravenous catheter outside of the vein

infiltration anesthesia – regional anesthesia produced by injection of an anesthetic immediately adjacent to the area where loss of sensation is desired

inflammation – response to tissue injury/trauma or infection involving protective mechanisms by which the body attempts to neutralize and destroy invading agents at a damaged site and to establish conditions for repairing tissue damage

inhaler – a device for the administration of medication by inhalation

innervate – to supply nerve action to a body part or organ

inotropic – increase or decrease the force of myocardial contractions

instillation – slow administration of a liquid drop-by-drop into a cavity

insulin – hormone secreted by the islets of Langerhans of the pancreas in response to increase in serum blood sugar

interferons – a family of naturally occurring proteins that regulate cell growth that affect the immune system

intermittent claudication – syndrome in which a person experiences severe pain, tension, and weakness in the legs after walking for a certain distance. Symptoms increase with further walking and are alleviated by rest.

internuncial neuron – a neuron that serves as a link between two other neurons

intra-arterial – into an artery

intra-articular – within the cavity of a joint

intracardiac – into the heart

intractable seizure – term used to describe seizure activity that does not respond to traditional pharmacologic anticonvulsant therapy

intradermal – intracutaneous or within the structure of the skin

intralesional – into a lesion

intramuscular – within the substance of a muscle

intrathecal – within a sheath, especially into the spinal column

intratracheal – inside or inserted into the trachea or windpipe

intravenous – within a vein or into a vein

intrinsic factor – enzyme in gastric juice that reacts with extrinsic factor (vitamin B_{12}) to form a factor essential for the production of red blood cells by the bone marrow

iodism – pathologic condition caused by long-term administration of iodine or its compounds. It is characterized by frontal headache, excessive salivation, skin eruptions, and glandular disorders.

ion exchange resin – synthetic ionizable resin that may be exchanged for other ions of similar charge in solution

ions – atoms or groups of atoms carrying an electrical charge (either positive or negative)

iridectomy – surgical removal of a portion of the iris

irrigation – rinsing of a cavity or wound with a fluid

irritable bowel syndrome (irritable colon syndrome) – common benign condition of the colon characterized by pain, constipation and/or diarrhea. In some clients, the condition may be characterized by intermittent or continuous diarrhea with little or no pain. Heredity, emotional stress, and a history of previous gastrointestinal disease may contribute to the development of this disorder.

ischemia – insufficient blood supply to a part of the body, usually as a result of disease of the blood vessels supplying the body part

isotonic – of equal tension or tonicity; solutions that exert equal osmotic pressures

IVAD – intravenous access device

jaundice – yellow staining of the skin, sclera, and mucous membranes due to deposition of bile pigment

Jennerian vesicle – small rounded blister formed by accumulation of fluid in the epidermis following smallpox vaccination

keratitis – inflammation of the cornea of the eye

keratinized – horny characteristic of skin

keratoconjunctivitis – inflammation of the cornea and the mucous membrane lining the eyelid

keratolytic – pertaining to the separation or peeling of the horny layer of the epidermis; an agent which produces this action

ketoacidosis – a variety of metabolic acidosis produced by the accumulation of ketones. It usually results from uncontrolled diabetes mellitus.

ketones – breakdown products of metabolism, often acidic in nature. These substances, including acetone, may accumulate in body fluids in clients with diabetic acidosis.

kilocalorie – amount of heat needed to raise 1 kilogram of water 1° Celsius; a large calorie

laceration – a tear or torn wound

lacrimation – the secretion and flow of tears

laparoscopy – examination of the peritoneal cavity with a lighted instrument called a laparoscope

laryngeal edema – swelling of the internal structures of the neck that leads to difficulty breathing by causing airway obstruction

laryngospasm – spasmodic closure of the larynx

lassitude – weariness, exhaustion, lack of energy

legend drug – drug required by federal law to be distributed only if it has been prescribed by an authorized practitioner. The manufacturer's label for such a drug must bear the legend, or statement, "Caution—Federal Law Prohibits Dispensing Without Prescription."

Lennox-Gastaut syndrome – a form of epilepsy that generally appears in preschool-age children. It may be characterized by atypical absence attacks, head nodding, and tonic seizures during sleep.

lethargy – drowsiness; a state of unconsciousness from which a person can be aroused, but is associated with relapses

leukemia – an acute or chronic disease characterized by rapid and abnormal proliferation of white blood cells

leukocytes – any white blood cells

leukopenia – reduction in the number of white blood cells in the blood; fewer than 5,000 white blood cells/mm^3

libido – sexual desire

limbic system – set of neural structures in the midbrain that are activated during emotional arousal and motivate behavior

lingual – pertaining to the tongue

lipodystrophy – a disorder of fat metabolism

lipolysis – chemical breakdown of fat

lupus erythematosus – inflammatory condition characterized by a rash and widespread internal pathology

lymphadenitis – inflammation of the lymph glands

lymphadenopathy – any pathological condition of lymph nodes

lymphocytes – white blood cells formed in lymphoid tissue. They represent approximately 22%–28% of the white cells in circulating blood.

lymphography – X-ray examination of the regional lymphatic vessels following injection of a radiopaque dye

macrophage – phagocytic cells derived from monocytes that function in cytoxic, antigen, and inflammatory responses

maintenance dose – amount of a drug necessary to maintain the physiological status quo

malabsorption syndrome – state resulting from impaired absorption of nutrients from the small bowel

malaise – vague feeling of bodily discomfort

malignant hyperthermia – an unexpected fever occurring while a person is anesthetized or when exposed to intensive exercise or other stressors

manic – pertaining to mania or a mental disorder characterized by excitement

manic-depressive – mental disorder in which excitement and mania alternate with periods of depression; also known as bipolar affective disorder

MAO inhibitors – agents used as antidepressants and antihypertensives that block the action of monoamine oxidase, causing an increase in catecholamine and serotonin levels in the brain

mast cells – type of connective tissue cell found in the mucous membrane of the small intestine. They are believed to manufacture and store histamine and heparin.

mastocytosis – neoplastic mast cells that manifest as urticaria pigmentosis

meconium – the first intestinal discharge of a newborn infant. It is greenish in color and consists of epithelial cells, mucus, and bile.

medical asepsis – measures used to prevent transfer of pathogenic organisms from one person to another

medulla (oblongata) – the portion of the brainstem responsible for controlling life-supporting reflexes such as breathing, gagging, and swallowing

megaloblastic anemia – anemia in which the red blood cells are enlarged

meningitis – inflammation of the membranes of the brain or spinal cord

metabolic acidosis – increase of hydrogen ions (H^+) in the body fluids arising from excess production of H^+, failure of normal elimination by the kidneys, or excessive administration of acids

metabolic alkalosis – decrease in the hydrogen (H^+) ion concentration of the body tissues due to administration of alkalis that combine with H^+ ions or increased elimination of H^+ ions from the gastrointestinal tract or kidneys

metabolism – process of energy and material transformation in all living cells; the sum of all physical and chemical changes that take place within a microorganism

metabolite - any product of metabolism

metatarsophalangeal – the articulation between the metatarsal bones and the phalanges of the foot

methemoglobinemia – the presence of a form of hemoglobin in the blood in which the iron component has been oxidized so it cannot carry oxygen. This results in cyanosis.

microbial – pertaining to or caused by minute living organisms known as microbes

microorganism – microscopic organism, such as, bacteria, viruses, fungi, protozoa, rickettsiae, and spirochetes

microsomal enzymes – enzymes found primarily in the liver that are involved in the biotransformation (metabolism) of many drugs

minerals – naturally occurring inorganic elements or compounds necessary for body functions

miosis – contraction of the pupil of the eye

miotic – agent that causes contraction of the pupil of the eye, e.g., pilocarpine

monocytes – relatively large mononuclear white blood cells that constitute 3%–7% of the white cells in circulating blood

mucosa – mucous membrane

multiple sclerosis – a progressive central nervous system disease characterized by degeneration of the myelin sheath of nerves

muscarinic – acetylcholine receptors that lie on the postganglionic portion of the parasympathetic nervous system

muscle relaxant – agents used to relieve muscle spasms and pain

myalgia – painful condition of muscle(s)

myasthenia gravis – syndrome of progressive muscular weakness marked by progressive paralysis of muscles without sensory disturbances or atrophy

mydriasis – dilation of the pupil of the eye

mydriatic – any drug causing dilation of the eye's pupil

myelography – X-ray examination of the spinal cord and subarachnoid space following injection of radiopaque contrast medium into the subarachnoid space

myocardial infarction – wedge-shaped area of dead cardiac tissue, with or without hemorrhage, produced by obstruction of a coronary artery; MI

myoclonic seizure – seizure causing the client to exhibit sudden, brief, massive jerking motion of the muscles that may involve the entire body or parts of the body

myopathy – an abnormal condition of skeletal muscle characterized by muscle weakness, wasting, and changes within muscles

myopia – short sight; failure to distinguish objects at a distance

myosin – protein that combines with actin to form actomyosin, the contractible constituent of voluntary muscle

narcolepsy – condition characterized by the periodic uncontrollable tendency to fall asleep

narcotic – drug producing narcosis (stupor or insensibility)

narcotic agonist – a narcotic analgesic used to treat moderate to severe pain

narcotic antagonist – agent used to reverse the respiratory depression associated with Schedule II narcotics

nasogastric – usually refers to a tube that is inserted into one of the nares and extends down into the stomach; may be used for decompression, lavage, or gavage.

nebulize – reduce to a fine spray

nebulizer – atomizer or device used for breaking up a liquid into a fine spray

necrosis – death of a group of cells

negative feedback mechanism – stimulation or release of a hormone or hormone-releasing factor produced by a deficiency in the circulating level of the hormone; e.g., stimulation of thyroid-stimulating hormone by the hypothalamus in response to a low level of thyroid hormone in the bloodstream

negative nitrogen balance – situation in which the excretion of nitrogen by the body exceeds its intake

neonatal – pertaining to newborn; usually refers to the first month of life

neoplastic – pertaining to or characterized by neoplasia or abnormal tissue growth

nephritis – a disease of the kidneys characterized by inflammation and abnormal functioning

nephron – the functioning unit of the kidney that filters the blood

nephrotoxicity – damage or destruction of kidney cells

nerve block – type of regional anesthesia in which the anesthetic agent is injected close to the nerves whose conduction is to be temporarily interrupted

neuritis – inflammation of a nerve or nerves usually associated with a degenerative process

neuroleptic – agents that suppress spontaneous movements and complex behavior, but do not alter spinal reflexes

neuromuscular blockade – agents that facilitate surgery by reducing muscle movement and/or permit used of lower anesthetic agents, prevent muscle spasm of the larnyx in clients who require endotracheal intubation, aid in the treatment of tetanus, facilitate electroconvulsive therapy (ECT) by reducing excessive muscular contractions

neuropathy – any disease of the nervous system, also used to denote nonspecific lesions or disturbances in the peripheral nervous system

neurotoxicity – a deleterious effect on nervous tissue

neurotransmitters – substances that excite or inhibit a target cell

neutropenia – reduction in the number of white blood cells produced by the bone marrow

neutrophil – mature blood cell formed in the bone marrow. It represents 54%–65% of the total number of white blood cells. It is stainable by neutral dyes.

nicotinic – acetylcholine receptors located at the ganglia of the sympathetic and parasympathetic systems

nomogram – representation by graphs, diagrams, or charts of the relationship between variables

nonproprietary name – see generic name

norepinephrine (noradrenaline) – a catecholamine neurohormone produced in the sympathetic postganglionic fibers and in the adrenal medulla. It functions as a vasoconstrictor.

nosocomial infection – infection acquired in a hospital or other health care setting

nuchal – pertaining to the neck

nursing diagnosis – statement identifying client problems or needs; established after analyzing client data; core of the statement established by North American Nursing Diagnosis Association (NANDA)

oculogyric crisis – acute onset of rotation of the eyeballs not under voluntary control

onset of action – begins when the drug enters the plasma

ophthalmopathy – any eye disease

opiate – any preparation of opium derived from the unripe seeds of *Papaver somniferum* or *album*. Most opiates are used as analgesics and can cause physical and psychological dependence with prolonged use.

opiod analgesics – controlled substances derived from opium and used for pain control

oral hypoglycemic – agent used to stimulate secretion of insulin

organic psychosis – severe mental illness attributed to an organic disease of the brain

orthostatic hypotension – drop in blood pressure associated with assuming a standing position

orthostatic hypotension – drop in blood pressure occurring when a person arises from a recumbent position

osmotic – pertaining to the passage of fluids and solutions through a membrane or other porous substance

osseous – concerning bones

osteoarthritis – degenerative joint disease

osteomalacia – adult rickets; softening of the bones due to deficiency of vitamin D

osteoporosis – reduction in the quantity of bone

OTC – over-the-counter; refers to drugs not requiring a prescription

otitis media – inflammation of the middle ear

ototoxicity – a deleterious effect on the eighth cranial nerve or upon the organs of hearing and balance

oxidize – to combine or cause to combine with oxygen

oxytocic – agent that hastens childbirth, e.g., oxytocin

Paget's disease – a disease of bones leading to their deformation

pain threshold – level of stimulus necessary to produce pain

pain tolerance – the amount of pain an individual can withstand without disrupting normal function and without requiring analgesic treatment

palliative – serving to ease pain or the severity of a disease; a treatment which alleviates, but does not cure

pallor – paleness of the skin

palpitation – a forcible pulsation of the heart felt by the client. It is often rapid and/or irregular.

pancreatitis – inflammation of the pancreas

para – referring to the number of live children a woman has delivered

paradoxical – alternating or seemingly contradictory

paradoxical reaction – a response opposite to that which is expected

paranoia – mental disorder characterized by delusional ideas, particularly those of persecution

parasympathetic nervous system – part of the autonomic nervous system that regulates the nerve ending's secretion of acetylcholine

parenteral – by some means other than through the intestinal tract; e.g., administration of medications into a muscle, vein, or subcutaneous tissue

paresthesia – abnormal spontaneous sensation; e.g., burning, numbness, or tingling

parietal cells – cells lining the wall of any body cavity

parotitis – inflammation of the parotid or salivary glands

paroxysmal tachycardia – fast heart rate due to rapid succession of impulses arising from an ectopic focus

partial thromboplastin time (PTT) – clotting factor monitored when administering heparin; 25–40 seconds or within 5 seconds of control

passive immunity – resistance to disease that is obtained as a result of the transfer of some immune mechanism (e.g., serum-containing antibodies) from another animal

patient-controlled analgesia – intravenous administration of analgesia via a control pump controlled by the client within prescribed parameters

pathogenic – causing disease or able to cause disease

PDR – Physicians Desk Reference; an annual reference containing pharmacologic data supplied by pharmaceutical companies

peak drug action – occurs when the drug reaches its highest serum concentration

peak plasma level – highest concentration of a substance in the blood plasma

percutaneous – inserted through the skin

percutaneous transluminal coronary angioplasty (PTCA) – a procedure in which a balloon-tipped catheter is used to dilate a narrowed coronary artery to increase the blood flow to the heart muscle

pericardial – pertaining to the sac surrounding the heart

peripheral vasodilator – drugs that increase the diameter of the vessels in the extremities, causing increased blood flow

perivascular – tissues or area surrounding a blood vessel

permeability – ability to permit the passage of substances

petit mal – a mild epileptic seizure with momentary loss of consciousness usually occurring in children; does not involve motor activity; newer term is absence seizure

phagocyte – any cell that ingests microorganisms and foreign particles (e.g., monocytes and polymorphonuclear leukocytes)

phagocytize – ingestion of microorganisms and foreign particles by a cell

pharmacodynamics – study of the biochemical and physiological effects of drugs; study of drug mechanism action

pharmacognosy – study of drugs derived from herbal and other natural sources; by studying the compositions of natural substances and how the body reacts to them, this field provides better knowledge for developing synthetic versions.

pharmacokinetics – study of the absorption, distribution, biotransformation (metabolism), and excretion of drugs; each of these factors is related to the concentration of the drug and/or its chemical by-products in various body sites, as well as the time required for these drug concentrations to develop and/or change.

pharmacology – study of history, sources, physical, and chemical properties of drugs; also includes how drugs affect living systems

pharmacotherapeutics – study of how drugs may best be used in the treatment of illnesses; study of which drug would be most or least appropriate to use for a specific disease, what dose would be required, etc.

pharyngeal – belonging to or related to the pharynx or voicebox

pharyngitis – inflammation of the pharynx or foregut that extends from the base of the skull to the beginning of the esophagus

phenylketones – phenylpyruvic acid and other breakdown products of phenylalanine (an essential amino acid) metabolism

phlebitis – inflammation of a vein

photophobia – intolerance or abnormal sensitivity to light

photosensitivity – sensitivity to light

physical dependence – a state in which one or more physiological functions of the body become dependent on the presence of a particular chemical substance in the body

psychological dependence – compulsive need to experience the effect(s) produced by a chemical substance

piloerection – elevation of body hair; gooseflesh

placebo – inactive substance given to a person for its suggestive effects, to please a person. Placebos are also inactive substances identical in appearance to a drug being tested experimentally.

placebo effect – positive response of an individual to a placebo

placental barrier – epithelial layer of the placenta that prevents the mingling of fetal and maternal blood

planning – third phase of the nursing process; involves the setting of goals and outcome criteria

plasminogen – substance derived from plasma capable of dissolving fibrinogen, fibrin, and other substances associated with the blood-clotting process

platelet – small blood cell that, when damaged, liberates thromboplastin, which is essential for blood clotting

pneumothorax – the presence of air or gas in the pleural cavity

polydipsia – excessive degree of thirst

polyneuritis – inflammation of many nerves

polypharmacy – use of multiple medications

polyuria – increase in the amount of urine excreted

portal circulation – the blood supply to the spleen, pancreas, gallbladder, liver, and part of the gut

positive chronotropic effect – drug effect that increases the heart rate

positive dromotropic effect – drug effect that increases atrioventricular and sinoatrial node conduction in the heart

positive inotropic effect – drug effect that increase contractility of the heart

postpartum – period following childbirth or delivery

postsynaptic – pertaining to the area on the distal side of a nerve junction or synapse

postural drainage – changing a client's posture to enlist the aid of gravity in draining secretions from the lungs

postural hypotension – drop in blood pressure associated with assuming an upright position; also known as orthostatic hypotension

potassium-sparing diuretic – diuretics that promotes retention of potassium; may lead to hyperkalemia

potentiate – combined action of drugs greater than the effects of each used alone

pre-eclampsia – condition arising in pregnancy as a precursor of eclampsia. It is characterized by edema, hypertension and protein in the urine.

preload – the volume of blood in the ventricle end of diastole

pressor – substance which raises blood pressure

PRN – *pro re nata*, meaning "as circumstances may require" or "according to need"

prodromal – pertaining to the initial stage of disease

prodrug – a newly developed group of chemicals that exhibit pharmocokinetic activity after being metabolized

prophylactic – preventing disease; agent such as a vaccine that prevents disease

prophylaxis – preventive treatment

prostaglandins – substances in many tissues that cause strong contractions of smooth muscle and dilation of certain vascular beds

prostate gland – gland that surrounds the neck of the urinary bladder in males

prostatic hypertrophy – increase in size of the prostate gland in males. This may result in complete or partial urinary retention.

proteinuria – presence of protein in the urine

proteolytic – related to the decomposition of protein

prothrombin time – clotting factor measurement monitored when using warfarin; 11–15 seconds

protocol – a description of steps to be used in conducting an experiment

protozoal – pertaining to one-celled animals that reproduce by fission and may cause diseases such as amebic dysentary and *trichomonas vaginalis*

pruritic dermatoses – inflammatory skin conditions associated with itching

pruritus – itching

pseudomembranous colitis – inflammatory condition of the colon with membranous plaque formation

pseudomonas – gram-negative bacteria

pseudoseizure – current term used to describe seizure-like body movements (without conscious client motivation) frequently client is unable to remember episode, but there is no electrical brain evidence of a seizure. This used to be termed "hysterical seizure"; usually reflects an underlying psychosocial cause.

psoriasis – skin condition characterized by the eruption of discrete reddish lesions covered by profuse silvery scales. These lesions are most common on the elbows, knees, scalp, and trunk.

psychochological dependence – intense desire for a drug

psychomotor retardation – slowing down of the motor effects of mental activity

psychosis – severe mental or emotional illness

ptosis – prolapse of an organ or part; drooping of the upper eyelid

purulent – associated with the formation of pus

putrefaction – decomposition or rotting; decomposition of organic tissues brought about by enzymes and resulting in the production of foul-smelling compounds or products

pyelography – X-ray examination of kidney pelvis

pyogenic – forming pus

pyrogenic – inducing or causing fever

radial – belonging or referring to the radius of the forearm

Raynaud's disease – condition in which intermittent pallor and cyanosis of the extremities is precipitated by a unique sensation of coldness

Raynaud's phenomenon – intermittent occurrences of pallor followed by cyanosis, which is then followed by redness of the fingers and toes before a return to normal; occurs with exposure to cold or emotional stress that causes vasopastic responses in the peripheral vessels

RDA – recommended daily allowance established by the National Academy of Science Board of Nutrition

receptor site – a biological structure; e.g., a cell protein, enzyme, etc. with a particular affinity for a drug or toxin

recumbent – lying down, or reclining

redman's syndrome – reflects an adverse reaction to vancomycin in which the client develops a deep red color in the face and neck that indicates the potential for the client to develop nephrotoxicity

regional anesthesia – the production of insensitivity of a part of the body by interrupting the sensory nerve conduction from that region of the body

renal – relating to the kidneys

renal colic – severe pain caused by the impaction or passage of a stone in the ureter or renal pelvis

renin-angiotensin system – physiological mechanism involving a proteolytic enzyme (renin) secreted by the juxtaglomerular cells that catalyses the conversion of angiotensinogen to angiotensin I, which is subsequently converted to angiotensin II. This latter substance is responsible for causing the release of aldosterone. The outcome of this operation is an increase in blood pressure.

resorption – loss or removal of a substance through absorption

reticulocyte – young red blood cell with a network of precipitated basophilic substance; occurs during the process of active blood regeneration

retinopathy – any disease condition of the retina or inner lining of the eyeball

retrograde – backwards; e.g., in a retrograde pyelogram, dye is injected upward into the kidney pelvis, which is opposite to the direction in which urine usually flows

retroperitoneal – located behind the peritoneum, or lining, of the abdominal cavity

retrovirus – a virus that begins with RNA to form DNA and then uses DNA as a template to make new RNA to form a new virus. This is the reverse of the pattern used by other life forms.

Reye's syndrome – a life-threatening condition in children that may follow a milder illness. This syndrome may be precipitated by treatment of an acute respiratory infection with aspirin.

Rh – complex system of erythrocyte antigens. There are two major groups—Rh-positive (majority of the population) and Rh-negative.

rheumatoid arthritis – chronic disease usually involving more than one joint, characterized by inflammatory changes in the synovial membranes and by atrophy of bones. May produce deformity and loss of function.

rickets – disturbance of calcium and phosphorus metabolism occurring in growing children from vitamin D deficiency. It results in retarded development and softening of the bones.

right client – essential component of the rights of safe medication administration based on correct identification of medication recipient

right documentation – essential component of the rights of safe medication administration that involves the accurate recording of medication administration, including client response

right dose – essential component of the rights of safe medication administration based on making sure the ordered dose to be administered is safe for the client and is the dose administered

right drug – essential component of the rights of safe medication administration that involves making sure the correct medication is ordered and administered

right route – essential component of the rights of safe medication administration that involves making sure the route ordered is safe and that the route ordered is administered

right time – essential component of the rights of safe medication administration based on assuring that the medication is administered at the correct time

right to refuse – essential component of the rights of safe medication administration that involves assuring that the client's right to refuse is preserved; this usually involves a lack of knowledge on the part of the client and requires client education

SASH – saline-administer drug-saline-heparin; procedure for intravenous administration of a medication into a heparin IVAD; if IVAD is a saline lock, no heparin is administered

schizophrenia – most common type of psychosis, in which there is an impaired sense of reality

sclerotic – hardening of tissues often associated with inflammation

SDF – standard drip factor; number of drops required to deliver 1 ml established by the manufacturer of the intravenous tubing

sebaceous gland – small gland, usually associated with hair follicles, that secretes a fatty substance known as sebum

second-line drug – drug that is less effective in the treatment of a health problem; may be used if a client has resistance or allergy to a first-line agent

sedative – agents that produce a diminished responsiveness to stimuli without producing sleep

seizure – involuntary focal or generalized muscle contractions associated with increased neuron firing

seminal vesicles – two small pouches located between the bladder and rectum; they secrete a fluid that becomes part of semen

sepsis – presence of disease-producing (pathogenic) organisms or their toxins in the blood or tissues

serotonin – vasoconstrictor liberated by blood platelets and found in relatively high concentrations in some parts of the central nervous system. It inhibits secretion and stimulates smooth muscle.

sickle-cell anemia – a severe anemia in which the red blood cells are crescent-shaped because of abnormal hemoglobin. It is inherited, most often found in black persons.

side effects – actions other than intended therapeutic effects resulting from the pharmacological action of a drug

simple partial seizure – seizure that usually begins in one area, such as the arm, leg or face, with the individual remaining awake and aware

slough – to cast off dead tissue

solar keratosis – senile keratosis associated with excessive exposure to the sun

solute – a solid that is dissolved in a fluid (solvent)

solvent – a liquid holding another substance (solute) in solution

spacer – device to improve the delivery of medication from a metered-dose inhaler

spasmolytic – agent that arrests or stops spasms

spasticity – hypertonicity of muscles characterized by rigidity and increased reflexes

spermatogenesis – formation and development of spermatozoa or male germ cells

sphincter – ringlike band of muscle fibers that constricts a passage or closes an orifice

spinal anesthesia – regional loss of sensation produced by injection of a local anesthetic into the subarachnoid space around the spinal cord

spirochete – a group of slender, spiral-shaped nonflagellated bacteria

splenoportography – X-ray examination of the splenic and portal veins by injection of a radiopaque dye into the spleen

spondylitis – inflammation of the spine

spores – inactive or resistant form of certain species of bacteria; also the reproductive element of a lower organism, such as a fungus

stasis – stagnation of blood or other fluid

stasis pneumonia – inflammatory condition of lung tissue associated with inactivity and resulting from an accumulation of secretions within the lungs

status asthmaticus – severe, continuous asthma attack that may result in exhaustion

status epilepticus – a condition in which one major attack of epilepsy follows another with little or no break

stepped-care approach – various levels of treatment for hypertension

sterilization – complete destruction of microorganisms by agents such as heat or chemical compounds; rendering an indivdual incapable of reproduction

stimulant – drug that promotes increased activity in body tissues or organs

stomatitis – inflammation of the mucous membranes of the mouth

subarachnoid space – area beneath the arachnoid membrane covering the brain and spinal cord

subcutaneous – beneath the skin or hypodermis

sublingual – beneath the tongue

substance abuse – socially unacceptable use of drugs or other chemical substances for nontherapeutic purposes

substance dependence – a state in which a person has difficulty functioning unless under the influence of a drug or other chemical substance

substance misuse – the improper use of drugs and/or other chemical substances that have been prescribed or acquired for a legitimate therapeutic or other nonrecreational purpose

supine – lying on one's back with the face upward; opposite of prone position

superinfection – a new infection added to an existing one; the sudden growth of an organism different from original organism in a wound or body part

suppository – a semisolid substance (medication) designed to be inserted into the vagina (local action) or rectum (systemic absorption), where the substance melts at body temperature and is absorbed

surfactant – agent that lowers surface tension; notably in the lungs, it is a phopholipid substance necessary to control the surface tension of air-liquid emulsion in the lungs

suspension – liquid dosage forms that contain solid drug particles suspended in a suitable liquid medium

sympathetic nervous system – large part of the autonomic nervous system; ganglia, nerves, and plexuses that supply the involuntary muscles of the heart, smooth muscles, and glands

sympatholytic – inhibiting or opposing adrenergic nerve function

sympathomimetic – adrenergic or producing an effect similar to that obtained by stimulation of the sympathetic nervous system

synapse – gap between two neurons or between a neuron and a tissue receptor

syncope – transient loss of consciousness due to inadequate cerebral blood flow; fainting

synergistic – effect of the use of two or more agents that produce a pharmacological response greater than what would be expected by individual effects of each agent

synesthesia – experiencing a sensation in one area of the body due to stimulation in another area; condition in which stimulation of one sense produces sensation in a different sense, as when sound produces a sensation of color

syringe pump – electronic device used for intravenous infusion of small volumes of medications

syrup – concentrated solution of sugar and water typically used to make liquid medication more palatable

systemic – related to the entire organism rather than any of its individual parts; affecting the body as a whole

tablets – solid form of a drug; does not melt at body temperature, but is broken down by digestive enzymes or absorbed through the buccal or sublingual membranes

tachyarrhythmia – a rapid, abnormal cardiac rhythm

tachycardia – rapid beating of the heart, usually defined as heart rate in excess of 100 beats per minute in adults

tardive dyskinesia – dyskinesia or movement disorder that takes time to develop. It is a serious side effect associated with long-term use of antipsychotic medication.

teratogenic – causing physical defects or abnormal development of a fetus in utero

testosterone – the primary natural male sex hormone that in its metabolized form, is responsible for most androgenous effects

tetany – condition caused by a decrease in serum calcium level. It is characterized by a hyperexcitability of the neuromuscular system.

therapeutic index – range of drug dose that produces therapeutic effects

therapeutic range – concentration of drug between the minimum level and toxic level

thrombocytopenia – decrease in the number of blood platelets

thromboembolism – blood clot producing embolism or sudden blocking of a blood vessel

thromboembolus – thrombosis producing embolism or sudden blocking of a blood vessel

thrombolytic – agents that dissolve a thrombus (blood clot)

thrombophlebitis – blood clot preceded by inflammation of the vein wall

thrombosis – intravascular coagulation with the formation of a clot within a blood vessel

thrombus – blood clot formed in and remaining in the blood vessel or the heart

thyroid stimulating hormone – hormone secreted by the pituitary as a result of decreased thyroid hormones; stimulate the release of triiodothyronine (T_3) and thryroxine (T_4) from the thyroid gland

thyroid storm – acute overproduction of thyroid hormone that can result in death, if not properly treated

thyrotoxicosis – toxic condition resulting from hyperactivity of the thyroid gland; Graves' disease

tic douloureux – paroxysmal trigeminal neuralgia, with severe pain limited to the distribution of the trigeminal nerve; trigeminal neuralgia

tics – coordinated repetitive movements usually involving a number of muscles. These commonly involve the face and shoulders.

tincture – solution that contains alcohol as the primary solvent

tinea – fungal infection usually affecting the scalp, nails, and/or skin; most common of these infections is ringworm

tinnitus – ringing in the ears

titer – quantity of a substance required to produce a reaction with a given volume of another substance

tocolysis – inhibition of uterine contractions

tolerance – capacity for enduring large quantities of substances (drugs, food, or toxic substances) without negative effects; reduced effect from the use of a substance resulting from its repeated use

tomography – X-ray technique that shows the body one layer at a time

tonic – in a state of partial and continuous contraction

tonometer – instrument used for measuring tension—for example, intraocular tension

tonometry – the measurement of tension

tophi – urate deposits in body tissues

topical – pertaining to a particular spot or locale—e.g., the application of a drug to skin

topical anesthesia – loss of sensation produced by application of a local anesthetic directly to the area involved

torticollis – condition in which the head is drawn to one side and rotated so that the chin points to the opposite side

total parenteral nutrition – parenteral hyperalimentation or the intravenous infusion of hypertonic solutions containing glucose, amino acids, and other substances, such as vitamins and minerals

toxemia – condition of generalized ill health resulting from soluble toxins entering into the blood

toxic effects – effects caused by drugs that can result in poisonous injury to a client

toxicity – quality of being poisonous

toxicology – study of poisons and poisonings

toxoid – material resulting from the treatment of toxin that inactivates toxic properties while retaining antigenic properties

tracheostomy – surgical creation of an opening into the trachea for insertion of a tube to facilitate the exchange of air or the evacuation of secretions

trade name – see **brand name**

translumbar – pertaining to passage into the subarachnoid space at the lumbar region of the spinal cord. This area is often used to withdraw spinal fluid as part of a lumbar puncture procedure.

transmission – mechanism of spread in the cycle of an infection

trigeminal neuralgia – pain in the distribution of one or more of the sensory divisions of the fifth cranial nerve; tic douloureux

triglyceride – a chemical combination of glycerol with three fatty acids. Most animal and vegetable fats are triglycerides.

troche – solid tablets consisting primarily of medicine powder, sugar, and mucilage designed to be used by placing in the mouth and allowed to slowly dissolve

trough level – lowest plasma concentration of a drug—measures the rate at which the substance is excreted

turbidity – cloudiness; loss of transparency due to sediment or insoluble matter

turgor – swollen or congested, producing a feeling of fullness

ulcerative colitis – severe ulcerative inflammation of the colon characterized by fever, anemia, and the passage of blood, mucus, and pus in the stool

ulcerogenic – ulcer-producing

unit dose – system of packaging medication for a single dose

urethritis – inflammation of the urethra

uricosuric – tending to increase the excretion of uric acid

urinary analgesics – drugs used to relieve pain, burning, frequency associated with urinary tract infections and/or bladder spasms

urinary antiseptics – drugs that act to reduce and prevent the growth of bacteria in the renal tubules and bladder

urinary antispasmodics – drugs used to reduce bladder spasms

urinary stimulants – drugs used to increase the tone of the urinary bladder

urography – X-ray examination of the urinary tract

urticaria – hives resulting from a hypersensitivity response

USP/NF – United States Pharmacopedia/National Formulary; current federal source of drug standards

uveitis – inflammation of all or part of the uveal tract of the eye, including the iris, ciliary body, and choroid

Valsalva maneuver – muscular contraction of the chest, abdomen, and diaphragm in forced contraction against a closed glottis, as in bearing down during defecation

varices – enlarged and tortuous vessels

vas deferens – the excretory duct of the testes that leads from the epididymis to the prostatic portion of the urethra

vasoconstriction – narrowing of the blood vessels

vasodilation – dilation or increase in the caliber of a blood vessel

vasomotor – causing dilation or constriction of blood vessels; denotes nerves which have this action

vasopastic – characterized by vasospasms

vasopressor – agent that raises blood pressure, particularly such an agent administered intravenously

venipuncture – puncture into a vein for the purpose of obtaining blood specimens or for initiating intravenous access

venography – X-ray examination of veins following injection of a radiopaque dye

venous pooling – collection of blood in the veins of the body

ventricular fibrillation – cardiac rhythm disorder in which a continuing incoordinated multifocal activity of the ventricles occurs. It results in cardiac arrest and is, therefore, a life-threatening arrhythmia.

vermicidal – capable of killing worms, particularly intestinal worms

vertigo – sensation of whirling (disorientation) either of ones self or of external objects

vesicant – drug capable of destroying tissue; usually related to an intravenous drug that infiltrates or extravasates into the tissues surrounding the vein

vial – a small glass solution container with a self-sealing rubber stopper

virilization – development of male secondary sexual characteristics, especially in a female

vitamins – essential substances found in foods and needed for health and life; vitamins are classified as fat-soluble or water-soluble; A, D, E, K are examples of fat-soluble vitamins; B-complex and C are examples of water-soluble vitamins.

visual field – that portion of space in which objects are visible at the same time without movement of the eyes

wetting agent – surface-active compound that acts as a detergent and promotes the wetting of a surface by water

xerostomia – dry mouth

zonule – (zonule of Zinn) — delicate membrane running from the ciliary body to the capsule of the lens of the eye and forming suspensory ligaments

Z-track – injection method to administer irritating medications deep intramuscularly that prevents the medication from leaking into subcutaneous tissues

Index

A page number followed by a *t* references a table
A page number followed by an *i* references other non-text materials

System Requirements for Delmar's Gameshell Practice Software
Basic system requirements are:
• Microsoft "Windows" 95 or better
• 486 Mhz CPU (Pentium recommended)
• 16 MB or more of RAM Double-spin CD-ROM drive 10 MB or more free hard drive space
• 256 color display or better

Set-Up Instructions for Delmar's Gameshell Practice Software
1. Insert disk into CD ROM player
2. From the Start Menu, choose RUN
3. In the Open text box, enter d: setup.exe then click the OK button.(Substitute the letter of your CD ROM drive for d:)
4. Follow the installation prompts from there.

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