Drug Therapy in Nursing

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The authors, editors, and publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accordance with the current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new or infrequently employed drug.

Some drugs and medical devices presented in this publication have Food and Drug Administration (FDA) clearance for limited use in restricted research settings. It is the responsibility of the health care provider to ascertain the FDA status of each drug or device planned for use in his or her clinical practice.

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Preface

"How will I ever learn all of this?" and "Where do I begin?" are questions that nursing students frequently ask themselves and their faculty when beginning to study pharmacology. The subject is indeed vast for novices in the profession who lack the skills to organize drug information appropriately. Students feel overwhelmed by all of the isolated pieces of drug information they must learn. Consequently, they lose sight of "the forest for the trees."

Prototype Approach

For years, many pharmacology faculty have favored a prototype approach to teaching pharmacology. This method encourages identification of "the major trees" and facilitates recognition of "the forest." Use of a prototype, a drug that is representative of a class (or group) of drugs, helps students because it offers a systematic approach to grouping drug data, while beginning to recognize individual drug names. It gives students a "method" of learning and organizing large amounts of information. *Drug Therapy in Nursing, Third Edition,* is designed and written by faculty who themselves teach nursing pharmacology using the prototype approach. At last, nursing pharmacology faculty have a text that matches the way they teach. *Drug Therapy in Nursing, Third Edition,* is that text!

Clinical Judgment and Clinical Application

Drug Therapy in Nursing, Third Edition, is unique in that it presents a totally nursing-focused framework to support the teaching and learning of nursing pharmacology. Learning the pharmacology facts about different drug prototypes is only half of the knowledge nursing students need. Because they're learning to be nurses, they must understand how to apply this knowledge to patient care. Nurses must learn to think critically, evaluate information, and make decisions. However, this essential aspect of knowledge application has never been thoroughly addressed in nursing pharmacology texts. Frequently, students view *nursing application* of drug knowledge as less important than learning the hard drug facts. This thinking is fostered when the pharmacology textbooks they use present the nursing process after or apart from drug knowledge in a brief paragraph or chart. *Drug Therapy in Nursing, Third Edition,* fully integrates core drug knowledge with core patient information, appropriately stressing, as no other text does, the relationship between the two bodies of information.

As with all other factual, scientific, or medical information used by nurses, students must learn to integrate this knowledge into their practice and apply it to patient care. Applying drug information to patient care may overwhelm students because every patient is different, with different responses, positive or negative, to the same drug therapy. If the student sees each patient situation as an isolated case, learning is again hampered. This text provides a systematic framework for assessing and evaluating patient responses that change in accord with health, age, gender, lifestyle, and other factors. This important *patient focus* is strengthened by use of the nursing process framework. Pharmacologic facts are integrated into nursing, to help the student apply knowledge to practice, safely administer drugs, educate patients, and begin to make the journey from novice to expert.

Use of a Systematic Framework

The authors of *Drug Therapy in Nursing, Third Edition,* present a systematic framework for drug therapy with every prototype drug. The framework consists of two basic areas of information: first, core drug knowledge and core patient variables; and second, actions of the nurse using this knowledge.

Core Drug Knowledge highlights the important drug facts about a prototype drug. Core drug knowledge includes pharmacotherapeutics, pharmacokinetics, pharmacodynamics, contraindications and precautions, adverse effects, and drug interactions.

Core Patient Variables identify the major topics that should be assessed in every patient to determine special considerations that need to be taken into account when administering a drug to a patient. Core patient variables include health status; life span and gender; lifestyle, diet, and habits; environment; and culture and inherited traits. The text presents the relevant variables for each particular prototype.

The nurse uses knowledge about the drug and knowledge about the patient to maximize the therapeutic effect of the drug, minimize the adverse effects of the drug, or provide patient and family education. The authors of this text call what the nurse does with knowledge about the drug and the individual patient "nursing management of drug therapy."

Organization

Drug Therapy in Nursing, Third Edition, has twelve units. The first three units address the principles and process of nursing management of drug therapy, and the basics of core drug knowledge and patient-related variables. The next nine units present the nursing management of drugs affecting various body systems and disease states. The text concludes with eight appendices.

Unit 1, Foundations for Drug Therapy in Nursing, consists of three chapters. Chapter 1 explains the framework for the text and how this framework relates to the application of drug knowledge to clinical practice. **This is a crucial chapter for students to read so that they will best understand the content in the rest of the text.** The remaining chapters address basic pharmaceutical knowledge, drug development and its related safeguards, and drug delivery, and the modes of drug administration.

Unit 2, Core Drug Knowledge, includes two chapters that present the basics of pharmacology: pharmacotherapeutics, pharmacokinetics, and pharmacodynamics; and adverse effects and drug interactions.

Unit 3, Core Patient Variables, includes seven chapters that highlight information pertinent to patient assessment relevant to drug therapy. This is not an exhaustive list of every aspect that can be considered by these variables. The topics include life-span issues (children, pregnant or breast-feeding women, and older adults); lifestyle, diet, and habits issues (substance abuse, dietary considerations, and complementary medication use); environment (influences on drug therapy); and culture and inherited traits (considerations in drug therapy). The core patient variable of health status is not presented, as this includes all physiology, pathophysiology, disease states, and their related treatments.

Units 4 through 12 present drugs affecting the various body systems and drugs used to treat diseases and their symptoms.

The Appendices present essential information on diagnostic imaging agents, enzymes and débridement therapy, enteral and nutritional supplements, parenteral nutrition, immunizations and immunization schedules for the United States and Canada, drugs causing photosensitivity, drugs that interact with grapefruit juice, and drugs metabolized by the P450 system. Emphasis is given in the appendices to the nursing management of these drug therapies.

Pedagogy

- **Chapter Learning Objectives** identify key content within the chapter to help direct student learning.
- **Key Terms** identify terms that are key to understanding each chapter's contents.
- **Chapter Summaries** highlight the most important information presented in the chapter.
- **Questions for Study and Review** encourage the student to reflect on the important aspects of the chapter. Answers are provided in the back of the text.

New To This Edition

- More pathophysiology information relevant to drug therapy is included to assist with understanding and critical thinking.
- All chapters have been updated and include new drugs approved by the FDA.

- Black Box warnings from the FDA labels have been added to the discussion of each prototype when applicable.
- Safety alerts have been added to the Memory Chips to emphasize prevention of common medication errors.
- Separate chapters are included on drugs affecting fungal and viral infections, with revised expanded content.
- The chapter sequence has been reorganized to promote student comprehension and learning.

Key Features

- **Concept Maps** introduce the student to all drugs that will be mentioned in the chapter. Each map identifies the drug class, its prototype, and drugs in the class that are similar to or different than the prototype. Concept maps also refer the student to other chapters if related drugs are covered elsewhere.
- **Physiology Figures** illustrate physiologic processes relevant to the drug class and link drug actions to physiology.
- **Memory Chips** assist students in studying and preparing for clinical practice, providing a quick reference of key points for each prototype drug.
- **Focus on Research** boxes highlight current research in pharmacology. The implications for nursing practice are addressed for each article.
- **Community-Based Concerns** highlight nursing issues related to drug therapy carried out in patients' homes and communities.
- **Critical Thinking Scenarios** challenge students to develop critical thinking skills for applying pharmacology knowledge to patient care. Answers are provided for instructors on thePoint.
- **Drug Summary Tables** relate pharmacotherapeutics and general dosage data to pharmacokinetic parameters.
- **Drug Interaction Tables,** for every prototype drug, highlight known drug–drug and drug–food interactions. When diagnostic and laboratory test values are affected by drug use, this information is pointed out as well.

Teaching/Learning Package

These excellent ancillary materials make teaching and learning even easier!

Resources for Instructors

The following tools are available upon textbook adoption to instructors on thePoint: **http://thePoint.lww.com/aschenbrenner3e:**

- The **Test Generator** lets you generate new tests from a bank containing over 550 NCLEX-style questions to help you assess your students' understanding of the course material.
- **Lesson Plans** organize all ancillary resources by learning objective to assist in preparing your lessons.
- A sample **Syllabus** provides guidance for structuring your nursing pharmacology course.
- An **Image Bank** contains illustrations from the book in formats suitable for printing and incorporating into PowerPoint presentations and Internet sites.

In addition, an extensive collection of materials is provided for each book chapter:

- **Pre-Lecture Quizzes** are quick, knowledge-based assessments that allow you to check students' reading before you begin your instruction. Answers are also provided.
- **PowerPoint Presentations** provide an easy way for you to integrate the textbook with your students' classroom experience, either via slide shows or handouts. Multiple-choice and True/False questions are integrated into the presentations to promote class participation and allow instructors to use i-clicker technology.
- **Guided Lecture Notes** walk you through the chapters, objective by objective, and provide you with corresponding PowerPoint slide numbers.
- **Discussion Topics** (and suggested answers) can be used as conversation starters or in online discussion boards.

- **Assignments** (and suggested answers) include group, written, clinical, and web assignments.
- **Case Studies** for every drug chapter in the book are provided to help your students apply their knowledge to clinical scenarios.

Resources for Students

Valuable learning tools for students are available both on the free Student's Resource CD-ROM bound into this book and on thePoint:

- **NCLEX-Style Review Questions** for every chapter feature traditional and alternative-format NCLEX-style questions.
- **CONCEPTS** in action **ANIMATION** illustrating pharmacologic and pharmacokinetic mechanisms bring the text to life.
- **WATCH & LEARN** video clips demonstrate important concepts related to medication administration and preventing medication errors, teaching students habits for careful clinical practice.
- **Dosage Calculation Quizzes** provide review of dosage calculation concepts to further promote patient safety
- **Monographs** of the 100 most commonly prescribed drugs, a **Spanish–English Audio Glossary,** and an **NCLEX Alternate Item Format Tutorial** are also provided.

In addition to these resources, the following are also available exclusively on thePoint:

- **Drug Class Review Exercises,** based on the Concept Maps in the text, are interactive drag-and-drop exercises that allow students to place the drugs in their appropriate drug classes and hear the drug names pronounced.
- Additional **CONCEPTS** in action **ANIMATION** and **WATCH & LEARN** video clips related to physiology and pathophysiology concepts offer students additional tools for review.
- **Journal Articles,** corresponding to every book chapter, offer students access to current research available in Lippincott Williams & Wilkins journals.

Study Guide

Study Guide to Accompany Drug Therapy in Nursing, **Third Edition,** authored by Diane Aschenbrenner and Samantha Venable, has been carefully designed to complement the textbook. Information is reviewed according to the types of knowledge presented in each textbook chapter (e.g., key terms, physiology and pathophysiology, core drug knowledge, core patient variables, and nursing management). The *Study Guide* provides students further study and learning opportunities through various techniques, such as multiple-choice questions, matching, decision trees, and case studies, that encourage critical thinking and the application of knowledge. Students move through the levels of learning, beginning with knowledge of terms and acquisition of facts, and progressing to the application of knowledge in each chapter. Answers for all of the exercises are provided at the end of the study guide to assist students with independent study.

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CHAPTER 3

Drug Administration

Learning Objectives

At the completion of this chapter the student will:

1. Describe the three routes for administering drugs.
2. Differentiate systemic and local effects related to the various routes of drug administration.
3. Describe the variety of oral forms of enteral drugs.
4. Differentiate the three main methods of parenteral drug administration.
5. Describe the methods of topical administration.
6. Describe how the route of administration interacts with core drug knowledge.
7. Describe how the route of administration interacts with the core patient variables.
8. Describe nursing interventions to maximize therapeutic and minimize adverse effects based on drug administration route.

Key Terms

buccal
capsules
elixir
emulsion
enteral route
enteric coating
intra-arterial
intra-articular
intradermal
intramuscular
intrathecal
intravenous
intravenous piggyback
intravenous push
local effect
parenteral route
subcutaneous
sublingual
suspension
sustained release
syrup
systemic effect
tablet
topical route
troches

Drug therapy can be administered by several different routes or methods. These routes of administration require different preparations or forms of a drug. Most drugs are available from the drug manufacturer in multiple forms. The selection of the route and form is based on the interaction between core drug knowledge and core patient variables. In managing drug therapy, nurses use this information to assess patient needs, plan care, administer drugs, and evaluate the effectiveness of therapy. This chapter describes the different routes of drug administration, explains the different forms of drug preparations, and shows how the route and drug form interact with the core drug knowledge and the core patient variables.

DRUG ADMINISTRATION ROUTES: GENERAL CONSIDERATIONS

The three basic routes of drug administration are enteral, parenteral, and topical. (Some authorities place topical in the parenteral category.)

- The **enteral route** uses the gastrointestinal (GI) tract for the ingestion and absorption of drugs. The most common method of administering drugs through the enteral route is orally. The enteral route also includes drugs that are administered through a nasogastric (NG) or a gastrostomy (G) tube.
- The **parenteral route** avoids or circumvents the GI tract and is associated with all forms of injections: intramuscular (IM), subcutaneous (SC or SQ), and intravenous (IV). Less commonly used parenteral routes than IM, SC, and IV are intradermal (into the dermis), intrathecal (into the cerebrospinal fluid), intra-articular (into a joint), and intra-arterial (into an artery).
- The **topical route** is technically another parenteral route because it also bypasses the GI tract. Drugs administered topically are applied to the skin or mucous membranes, including those of the eyes, ears, nose, vagina, rectum, and lungs.

Drugs are administered for their local or systemic effects. For example, most drugs applied topically to the skin or mucous membranes exert their effect at that site, which is a **local effect.** An example is corticosteroid cream applied to relieve the itch from a rash. However, certain drugs given topically are absorbed by the skin and distributed throughout the body systems to produce a **systemic effect.** Drugs given for a systemic effect by any route must be capable of being transported into the blood and distributed through the body to a location distant from the administration site. An example is the narcotic used for pain relief, fentanyl, which is imbedded in a transdermal patch and applied to the skin.

Drugs administered by a route other than the enteral route have the advantage of avoiding the first-pass metabolism in the liver. Drugs administered enterally are absorbed from the stomach and small intestine. However, they first pass through the liver, the primary organ for drug metabolism, before being distributed throughout the body. Drugs administered parenterally and even some topical drugs are transported directly into the blood, thereby bypassing the liver. (See Chapter 4 for a complete discussion of the first-pass effect and the processes of pharmacokinetics.)

ENTERAL ROUTE AND FORMS

WATCH & LEARN

The enteral route involves using the GI tract for the administration and absorption of drugs. Enteral drugs, particularly oral drugs, are manufactured and prepared in a variety of forms, including solid tablets and capsules and liquid elixirs and syrups. Because the oral route of administration is the most common enteral route, oral dosage forms are the most common preparations. They are convenient, economical, and easy to use.

Some oral drugs, such as antacids and laxatives, are given for their local effect in the GI tract, but most are given to achieve a systemic effect. In most cases, patients can reliably self-medicate with oral drug forms.

Oral Drug Forms

Tablets

A **tablet** is a solid dosage form that is prepared by compressing or molding a drug into various sizes and shapes. In many cases, tablets are scored; that is, designed to be easily broken at a point so that one half or one quarter of the dose may be given. Unless a tablet is scored, it should never be broken because doing so could result in inaccurate dosage.

The active ingredients in tablets are commonly mixed with lactose or other sugars, binding agents, or other inert materials to facilitate manufacturing and ensure stability of the preparation. When the patient swallows the tablet, esophageal peristalsis propels it to the stomach, where it dissolves and releases the drug into the gastric contents.

Drugs that are appropriate for use in tablet form have some limitations. First, the drug must be stable in gastric contents. Because gastric juices may be highly acidic, drugs that rapidly degrade in acid environments may not be administered as conventional tablets. An additional consideration is flavor because the tablet will begin to dissolve as soon as it is placed in the mouth. Drugs determined by the pharmaceutical company to be bitter, irritating, or unpleasant tasting are not usually manufactured in conventional tablet form because they would be accepted poorly by patients. These limitations can be overcome by using a special coating on the tablet.

An **enteric coating** is a wax-like layer that is used on some tablets. This layer resists the acid environment of the stomach but dissolves in areas in which the local pH is neutral or slightly alkaline (e.g., the small intestine). Enteric coatings may be used to protect acid-labile drugs, to provide a sustained-release dose, or to guard against local adverse effects from a drug. Other types of commonly used coatings include film or sugar. Both of these coatings are used to protect the patient from bitter or unpleasant-tasting drugs. These coatings do not impart any time-release characteristics.

Sustained-release (also called controlled-, timed-, extended-, or prolonged-release) tablets are formulated to release a drug slowly over an extended period, rather than rapidly like conventional tablets. Sustained release occurs by several methods:

- Layers of enteric coatings may be applied, and the drug is released in response to changes in the surrounding pH of the GI fluid.
- The tablet may be formulated to release the drug in a steady, controlled manner.
- The tablet may be formulated to release the drug in a series of pulsations.

In most cases, the total dose of drug in a sustained-release preparation is higher than that found in a regular tablet. The patient may safely take the higher dose because it is released in a controlled fashion, thereby preventing any adverse effects from overdosage.

Sublingual and Buccal Tablets

Sublingual and buccal preparations are tablet forms that are not used as often as oral tablets. These small, hard, compressed tablets are designed to dissolve rapidly in the vascular mucous membranes of the mouth. **Buccal** tablets are placed in the buccal pouch (between the cheek and gum), and **sublingual** tablets are placed under the tongue. Sublingual and buccal tablets must be relatively nonirritating, flavorless, and highly water soluble.

Because the buccal and sublingual areas are highly vascular, drugs are quickly absorbed into the bloodstream, and a rapid onset of drug effect occurs. At the same time, drugs administered in this way avoid the first-pass phenomenon because they are not ingested into the GI tract. Although these formulations typically are considered oral forms because they are placed in the mouth, most experts think of the sublingual and buccal forms as parenteral preparations because they are not absorbed in the GI tract. Others consider them a variation of the topical route.

Troches

Troches, also called pastilles or lozenges, are commonly used to achieve a local effect in the mouth or pharynx (throat). The drug is embedded in hard candy or another suitably flavored vehicle that the patient holds within the mouth, where it slowly dissolves. Antitussives, anti-infectives, local anesthetics, antihistamines, and analgesics are administered this way.

Capsules

Capsules are solid dosage forms in which the drug is usually encased in a shell of hard or soft gelatin. When the patient swallows the capsule, the drug is carried to the stomach, where the gelatin capsule quickly dissolves and releases the drug into the gastric contents. Because the active ingredients are enclosed in gelatin, foul-tasting drugs can be easily administered in capsules. Another advantage is that many patients find gelatin capsules easier to swallow than tablets. Unlike tablets, capsules cannot be easily divided or broken into equal pieces, so one disadvantage is that dosage may not be as flexible.

The most common capsules encase a powdered drug. Soft, elastic capsules are somewhat thicker and may be used to encase a drug paste, semiliquid, or liquid (provided the drug itself does not dissolve the capsule). In addition, the contents may be altered in one of several ways to produce a sustained-release dosage form as follows:

- Layers of enteric coatings may be applied to the drug particles, producing what is commonly known as microencapsulation. The drug is released in response to changes in the surrounding pH of the GI fluid. The rate of release is controlled by varying the thickness of the layers around the drug particles.
- The capsule may be formulated to release the drug in a steady, controlled manner from a matrix of drug encased in a slowly dissolving substance, such as wax.
- The drug is bound to ion-exchange resins, chemical compounds that form insoluble complexes within the capsule. Changes in the local environment, such as altered electrolyte content or pH, cause the drug to be released slowly from the resin matrix.

Like their tablet counterparts, sustained-release capsules may contain higher doses than those found in regular-release forms, but the patient may safely take the higher dose because the drug is released in a controlled fashion.

Syrups

A concentrated solution of sugar, such as sucrose, in water is known as a **syrup.** Most syrups that contain 65% or more sucrose are also resistant to mold, yeasts, and other microorganisms, and they have a reasonable shelf life with no need for refrigeration. Occasionally, sucrose may crystallize out of solution, clouding the syrup or giving it the appearance of particulate matter.

Elixirs

An **elixir** is a clear hydroalcoholic mixture that is usually sweetened or otherwise pleasantly flavored. Most elixirs contain ethanol and water, but glycerin, sorbitol, propylene glycol, flavoring agents, aspartase, and even syrups may also be found in elixirs. The alcohol content of elixirs varies greatly and can exceed 25%. Elixirs are stored at room temperature, and the alcohol content usually prevents the growth of any mold or other microorganisms. Elixirs should always be clear. Cloudiness indicates contamination.

Emulsions and Suspensions

Many drug preparations use mixtures of two chemically incompatible substances. These preparations may be administered orally. Rarely, they may be used topically.

An **emulsion** is created when two liquids that do not mix well are combined, and one liquid distributes uniformly through the other. Because these mixtures tend to separate rapidly, remember to shake the preparation well immediately before measuring a dose and to administer the dose soon after pouring and measuring. To enhance the stability of the mixture, an emulsifying agent is added. Most emulsions consist of a nonaqueous agent (oil or lipid phase) dispersed with an aqueous (water) agent. In general, nothing should be added to emulsions because additives may adversely affect the stability of the mixture.

A **suspension** is a drug preparation consisting of two agents: a finely divided solid dispersed within a liquid. The

stability of the preparation depends on the ability of the dispersing medium to wet the solid particles. Surface-active agents may be used.

Nasogastric or Gastrostomy Tube Forms

Patients who cannot swallow but who have a functioning GI tract may have an NG (nasogastric) or G (gastrostomy) tube in place. An NG tube is a soft, flexible tube that is advanced through a nostril and into the stomach for administering food, fluids, and drugs, usually for a short time. An NG tube presents a risk for aspiration from gastric reflux because the tube prevents the gastroesophageal sphincter from closing. A G tube is surgically inserted into the stomach for administering food, fluids, and drugs to patients who need long-term care. Providing drugs and foods through a G tube is preferred over an NG tube because the G tube method leaves the gastroesophageal sphincter intact. Regurgitation is less likely with a G tube than with an NG tube.

Drugs administered through a tube should be either liquid or crushed and in a liquid vehicle. A liquid drug form is preferred because research has shown that this form causes less clotting of tubes than crushed and dissolved drugs. However, if a liquid form is not available, the tablet may be crushed as long as it is not an enteric-coated or sustained-release preparation. Sustained-release or enteric-coated tablets are never crushed.

Nursing Management in Enteral Drug Administration

Core Drug Knowledge

Although the oral method of drug delivery is most common, not all drugs can be administered orally. Gastric acids and enzymes destroy many drugs; others simply may not be absorbed.

Absorption may begin in the stomach, but most absorption of orally administered drugs occurs in the small intestine. Food may interfere with the dissolution and absorption of certain drugs, especially enteric-coated drugs, because of the considerable variation in individual gastric emptying times and therefore in the length of time a drug spends in the stomach.

Assessment of Relevant Core Patient Variables

Health Status

A primary consideration for administering an oral drug is the patient's condition. Can the patient tolerate an oral drug? Patients who are vomiting, uncooperative, or unconscious or whose condition requires that they receive nothing by mouth (i.e., no oral food or fluid) are not suited for oral drug therapy. Alternate routes should be used. If the patient cannot swallow at all but has a working GI system, the drug may be given through an NG or a G tube. If patients can take oral drugs but have difficulty swallowing tablets, pills, and capsules, the drugs may be crushed and mixed in a few milliliters of water or liquid or in a tablespoon of jelly, applesauce, or pudding. Large volumes of fluid or food are avoided because the patient must consume the full volume to receive the full drug dose. Alternately, a liquid drug form may be substituted. Sublingual drugs may be administered even to unconscious patients because these drug forms are so rapidly absorbed by the vasculature.

Life Span and Gender

The high sugar content of syrups can mask unpleasant drug flavors, making syrups useful vehicles for administering drugs orally to both adults and children. Because they usually contain little or no alcohol, syrups are especially good vehicles for drugs administered to children. Because of the potentially high alcohol content, elixirs are usually not used in children or in adults who should avoid ethanol.

Environment

Oral drug forms are easily self-administered by patients and can be used in home environments and acute or long-term care settings.

Planning and Intervention

Maximizing Therapeutic Effects

Capsules with sustained-release pellets in them can be opened and the pellets sprinkled on food or mixed with a liquid; the patient must eat or drink all the food or fluid.

Because emulsions and suspensions have a tendency to separate, they should be shaken well immediately before measuring a dose and then administered promptly.

Drugs administered through an NG or a G tube are instilled slowly without excessive force. Some may be allowed to flow in by gravity. The tube is flushed with 10 to 30 mL of water before and after drug administration to ensure that the patient receives the full dose and to maintain the patency of the tube.

Minimizing Adverse Effects

Drugs that have enteric coatings and drugs in sustained-release form should never be chewed, crushed, or broken. Doing so increases the risk for adverse effects, including toxicity, because a higher dosage of the drug is available all at once.

Repeated doses of sucrose-containing syrups may increase the risk for gingivitis or dental caries. Good oral hygiene should accompany the use of syrups. Also, patients with diabetes may need to monitor their glucose levels closely if they are receiving large doses of drugs in syrups.

Before administering drugs through an NG or G tube, the tube is assessed for proper placement. In addition, the head of the patient's bed is elevated to help prevent aspiration from reflux. If the patient is also receiving tube feedings, the nurse reviews information on the specific drug because some drugs are not absorbed well with tube-feeding formulas. When a tube-fed patient needs such a drug, the feeding must be shut off for a time both before and after drug administration.

To ensure safety, the nurse must closely follow the cardinal rules of drug administration (Box 3.1). Historically, these rules have been known as the Five Rights, but recently some authors have added a sixth right: documentation. To administer a drug at the "right time" using the "right route," the nurse must be able to read and interpret the medication order correctly. Standard abbreviations are frequently used in medication orders. The nurse must know these abbreviations (Table 3.1). To administer the "right dose," dosage calculation is often necessary. The most accurate method for doing

BOX 3.1 Six Rights of Drug Administration

In managing drug therapy safely and effectively, the nurse must heed the six rights of drug administration:

right	Patient
right	Drug
right	Time
right	Dose
right	Route
right	Documentation

TABLE 3.2 Measurement Equivalents

Metric	Household
5 milliliters	1 teaspoon
15 milliliters	1 tablespoon
30 milliliters	2 tablespoons or 1 ounce
500 milliliters	1 pint
1,000 milliliters or 1 liter	1 quart or 2 pints
1 kilogram or 1,000 grams	2.2 pounds

dosage calculations is to use a calculator. Any drug dosage calculation book contains all of the necessary specific information. Many institutions require that all drug calculations be confirmed by two nurses before drug administration to prevent drug errors. Information about calculating pediatric doses is provided in Chapter 6. Occasionally, the nurse may need to convert the unit of measurement for the drug to another unit of measurement (Table 3.2). Errors in listing the correct medications for a patient frequently occur as the patient moves between environments, such as from an intensive care unit to a general unit, or from the hospital to an extended care facility. For information on reducing errors related to changing environments, see Chapter 11.

PARENTERAL ROUTE

The parenteral route is associated with all forms of drugs administered by a syringe, needle, or catheter. The three most commonly used parenteral routes are intramuscular, subcutaneous, and intravenous.

TABLE 3.1 Abbreviations Related to Medication Administration

Abbreviation	Meaning
a.c.	before meals
p.c.	after meals
qam	every morning
bid	twice a day
tid	three times a day (usually limited to hours awake)
qid	four times a day (usually limited to hours awake)
q4h	every four hours
q6h	every six hours
qh	every hour
prn	as needed
ad lib	as desired
IM	intramuscularly
IV	intravenously
SQ or SC	subcutaneously
PO	by mouth
SL	sublingually
OD	right eye
OS	left eye
OU	both eyes
STAT	immediately

Intramuscular Administration

WATCH & LEARN

The **intramuscular** (IM) technique involves injecting drugs into certain muscles. This method requires specific knowledge of anatomy and aseptic technique. Because muscles have a good blood supply, drugs that are injected into a muscle move directly into the bloodstream without having to be broken down and absorbed, as oral drugs processed by the GI tract must be. Thus, the onset of action with intramuscular injections is faster than with oral administration. Similarly, because muscles have more blood vessels than subcutaneous tissue, the onset of action after IM injection occurs more rapidly than after subcutaneous injection.

Drugs such as oils or irritating chemicals can be administered intramuscularly in solutions or suspensions. Many injectable drugs are dry powders and must be reconstituted before administration, possibly requiring a specific amount of diluent. Thin and watery solutions given intramuscularly move promptly into the blood vessels. Because suspensions or drugs with an oil base are thicker or more viscous than water-based solutions, they do not move as quickly into the blood vessels. With these oil-based suspensions, a deposit of the drug is formed within the muscle that is slowly released into the bloodstream.

The most common sites for IM injection are the ventrogluteal, deltoid rectus femoris, and vastus lateralis muscles (Figure 3.1). Site selection is based on characteristics of the drug, such as viscosity, and characteristics of the patient, such as age and size. While the dorsogluteal site was used frequently in the past, injection in the dorsogluteal site carries a risk for damaging the sciatic nerve if the injection site is not located properly. Many experts and nursing fundamental texts no longer recommend using this site, and some state that it should be used only as a last resort. Consult your nursing practice textbooks for more information on the specific techniques used for administering intramuscular injections.

Subcutaneous Administration

WATCH & LEARN

Subcutaneous (SC) drugs are administered under the skin into fat and connective tissue. These drugs must be highly

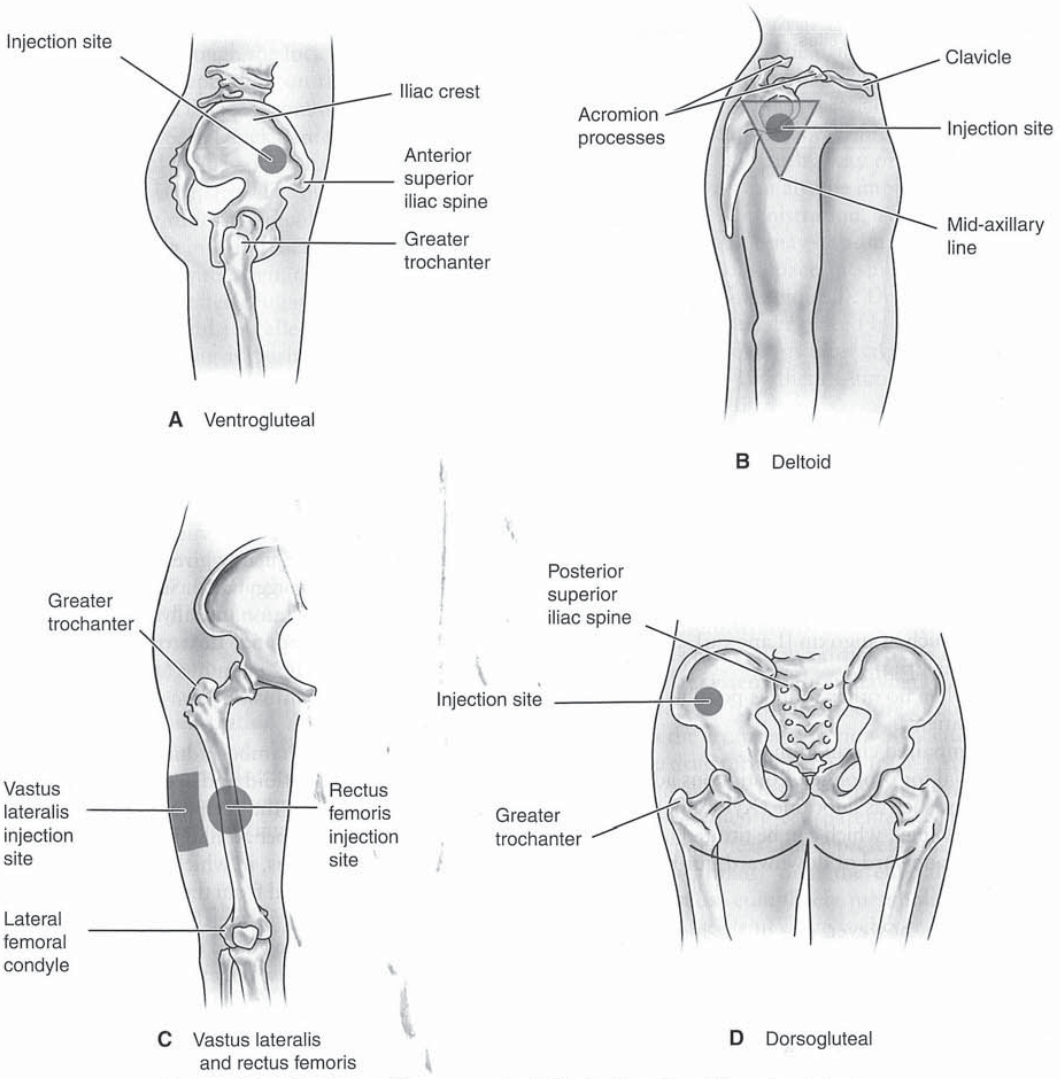

FIGURE 3.1 Anatomic landmarks and intramuscular (IM) injection sites: (**A**) ventrogluteal; (**B**) deltoid; (**C**) vastus lateralis and rectus femoris; (**D**) dorsogluteal (site of last resort; use should be limited).

soluble, low volume (less than 2 mL in a good-sized adult), and nonirritating (to prevent tissue damage, tissue necrosis, and sterile abscess formation). Distribution of the drug is through the capillaries and is less rapid than by the IM route. Distribution slows if the patient has inadequate peripheral circulation or if the drug is administered into scar tissue, which is avascular; onset will therefore be delayed.

The SC route may be used for vaccines, insulin, heparin, and narcotics. The sites used for this route are the upper, lateral arm; anterior thigh; abdomen; and midback above the scapula (although this last is infrequently utilized) (Figure 3.2). The size of the individual determines the angle of injection. Refer to nursing practice textbooks to review SC injection techniques.

Intravenous Administration

WATCH & LEARN

The **intravenous** technique administers a drug directly into the bloodstream, bypassing the need for absorption from the GI tract or transportation from other parts of the body, such as muscle or subcutaneous tissue. IV administration ensures prompt, sometimes immediate, onset of action and eliminates the uncertainty associated with varied absorption rates from other routes. The IV route is advantageous in that it

- Has immediate effect (e.g., nitroprusside for a patient in hypertensive crisis).
- Allows administration of a large volume of drug (e.g., with certain antibiotics, such as cefoxitin).

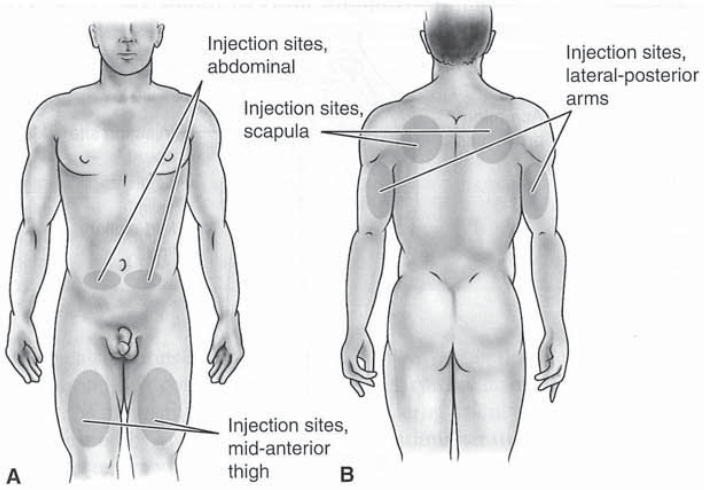

FIGURE 3.2 Subcutaneous (SC) injection sites: (**A**) anterior view: abdominal, mid-anterior thigh; (**B**) posterior view: scapula (infrequently used), lateral-posterior arms.

- Avoids tissue irritation or injury resulting from IM or SC administration (e.g., with chemotherapeutic drugs, vasopressors such as norepinephrine [Levophed], or cardiac glycosides such as digoxin [Lanoxin], because the blood buffers the drug).
- Is acceptable when no other route is possible (e.g., in an unconscious patient).
- Circumvents impaired circulation.
- Has the potential for prolonged, continuous administration of solutions, such as lidocaine (Xylocaine) or aminophylline (Truphylline), which can be titrated (adjusted in small increments upward or downward) for the desired effect.

The IV route is also, however, one of the most dangerous routes. Once the drug is given, it cannot be retrieved, nor can its distribution through the body be slowed or stopped.

Peripheral Drug Delivery

WATCH & LEARN

A peripheral vascular access device, usually an angiocatheter or a butterfly set, is placed to give drugs intravenously. IV drug solutions may be run through tubing into the access device, either continually or intermittently.

Prescribed drugs may be given by continuous IV infusion to maintain a certain blood level of the drug. They are ordered either in volume (milliliters [mL]) per hour or strength (milligrams [mg], micrograms [mcg], or units [U]) per hour. Aminophylline, lidocaine, and heparin are examples of drugs that are given continuously to achieve maximum therapeutic effect.

IV drugs may also be given intermittently. When the patient receives continuous IV fluids and is also receiving intermittent IV drug therapy, the drug is given through a secondary IV tubing or through a volumetric dose chamber administration set, also called a metered-dose infusion set. When a secondary IV tubing is used to administer an IV drug, the tubing is added to the main line tubing, usually at a Y port. Adding secondary tubing is called "piggybacking" because the tubing with the drug rides on top of the primary fluid tubing. Antibiotics are frequently given intermittently by **intravenous piggyback** (IV piggyback). Such drugs are diluted in a small volume of IV solution (usually 50 to 100 mL of sterile normal saline solution or 5% dextrose in water for an adult) and infused over 30 to 90 minutes (according to the specific drug). The main IV infusion then resumes at the original preset rate.

Volumetric-dose chamber administration sets connect to the main bag of IV fluid and are connected to IV tubing that in turn attaches to the peripheral venous access device. Volumetric-dose chamber administration sets can be used to run continuous infusions, in which fluid leaves the chamber and is replaced with fluid from the IV bag, or they can infuse only what is currently inside the chamber until manually refilled. When drugs are added to the chamber for infusion, the set is adjusted to infuse only what is in the chamber. When the drug is infused, the set may be returned to a continuous infusion, or refilled with only the main IV solution. These sets are primarily used when fluid restrictions are important, such as with pediatric, elderly, or critically ill patients.

Certain IV drugs, whether given by piggyback or through a metered-dose infusion set, may be incompatible with an existing continuous IV infusion. If this situation arises, the tubing should be flushed with 10 mL of an appropriate solution (usually sterile normal saline) before and after administration of the drug.

If intravenous drugs are prescribed intermittently, and other fluids are not running constantly, the access device is capped to prevent blood from coming out and bacteria from entering the body. This cap may be permanently attached to a small extension tubing set. This tubing is secured to the peripheral device. An access device equipped this way is called "locked," or the patient is said to have a "lock" in place.

Drug infusion locks are used for patients who require intermittent IV drugs but do not need continuous IV fluid administration. As with piggybacks, the drug is usually diluted in 50 to 100 mL of solution. When the drug infusion is complete, the tubing is disconnected from the lock, allowing the patient increased ease of movement. The lock is kept patent

(open, without blood clotting occurring), with small volumes of either normal saline (0.9% sodium chloride) solution or heparin pushed through the lock on a routine basis, usually every 8 hours. Depending on the solution that is used for flushing, the lock device is commonly called a saline lock or a heparin lock. Saline locks are flushed with 0.5 to 2 mL of sterile normal saline solution. Heparin locks are flushed with 10 to 100 U heparin. The nurse should be familiar with established institution protocols regarding the exact method for flushing drug infusion locks.

Direct administration into a vein or an established drug infusion lock of a concentrated drug in a very small amount of solution (usually 1 to 2 mL) is called an **intravenous push** (IVP or IV push). The drug is pushed into the vein very slowly over at least 1 minute. The exact amount of time depends on the drug and the dose. Drugs given by IVP may be used for intermittent dosing or for treating emergencies, such as cardiac arrest.

Central Access

Certain patients may require IV access for a prolonged time, or they may not be able to have peripheral vascular access devices inserted. Devices used for these patients include single or multilumen central venous catheters and implantable venous access ports. A central venous catheter is inserted by the health care provider into a vein (jugular or subclavian) near the heart. The catheter may have as many as three lumens to allow the administration of various solutions and drugs. Peripherally inserted central lines (PICs) or peripherally inserted midlines can be inserted by nurses specifically skilled in the technique. These also may be multilumen lines, and drugs may be delivered continuously, intermittently, or by IVP.

An implantable vascular access port (VAP) is surgically implanted under the skin with the distal end inserted into a large central vein. A special needle (a Huber needle) is used to suffuse the drug into the port. These ports are used for intermittent infusions of, for example, antineoplastic drugs. Use of a VAP requires advanced skills and expertise on the part of the nurse.

Other Parenteral Delivery Routes

Other parenteral routes are the intradermal, intra-articular, intra-arterial, and intrathecal routes. These routes of parenteral administration are not as common as the IM, SC, and IV routes.

Intradermal injections are made into the dermis just below the epidermis. This technique is used primarily for local anesthesia and for sensitivity tests, such as allergy and tuberculin tests. A small needle (25- or 27-gauge) and small-volume syringes (less than 1 mL) are used for intradermal injections. The most common sites for intradermal injections are the medial forearm and the back over the scapula because the skin is thinner there.

An **intra-articular** injection is performed only by a skilled practitioner and involves injecting a drug into a joint. Corticosteroids are typically administered by intra-articular injection to relieve pain in an acutely inflamed joint. The effect is local. Nurses do not commonly administer medications by this route.

Intra-arterial drug administration requires a surgeon to insert a catheter into an artery leading directly to the targeted treatment area. The drug is delivered under positive pressure through the catheter. The positive pressure overcomes the pressure within the arterial system. For example, powerful undiluted chemotherapeutic agents can be delivered directly to a tumor by way of the artery that feeds it. Intra-arterial ports can also be implanted by a surgeon.

In **intrathecal** administration, a drug is delivered into the cerebrospinal fluid. It may be administered directly into the spinal subarachnoid space (a spinal) or outside the subarachnoid space (an epidural). Drugs are introduced into these areas by a catheter placed by specially trained health care providers. The drugs most commonly administered by this route are local anesthetics, antibiotics, and radiographic contrast media. This route is commonly used to deliver an anesthetic during labor and delivery. Pain relief can also be achieved with drugs given via this route by the nurse or by the patient using a patient-controlled analgesia device.

Nursing Management in Parenteral Drug Administration

Parenteral administration may be selected for a variety of reasons. This route allows drugs to be distributed directly to the vascular system without having to be absorbed by the GI tract and sent to the liver before circulating. This route also avoids the erratic absorption associated with the movement of the drug through the GI tract. Drugs that are highly metabolized by the first-pass mechanism can be given in smaller doses when given parenterally rather than orally because the parenteral route presents more drug to the vascular system initially than the enteral route does. Some drugs are almost completely metabolized during the first pass, so the parenteral route is chosen exclusively for these drugs. Moreover, drugs that are rapidly destroyed by GI secretions can be given parenterally to promote their effectiveness. Parenteral routes may also be necessary because of the GI irritant nature of the drug. Drugs administered by the parenteral routes have a faster onset of action than those administered orally or topically.

Assessment of Relevant Core Patient Variables

Health Status

A parenteral route may be chosen because the patient cannot tolerate oral drugs, cannot swallow, or has a condition that warrants resting the GI tract or keeping it empty. Muscle mass must be sufficient for the volume of a drug given intramuscularly. The gluteal muscle mass can deteriorate if the person does not walk (e.g., because of paralysis), and in such cases it should be avoided as a site for IM injections. The patient's veins must be able to accept a venous access device if drugs are to be given intravenously. When peripheral access devices cannot be inserted, central venous access devices may be used.

Life Span and Gender

Infants have small muscle mass. The largest muscle mass at birth is the vastus lateralis, which is the preferred site for IM injections in infants, although the rectus femoris may also be used. The deltoid is never used for IM injections in infants.

The gluteal muscles develop with walking and usually are not used for injections until the child has been walking for 1 year.

Elderly people have decreased muscle mass overall and decreased tissue elasticity, which may result in drugs oozing from injection sites. Muscle mass must be determined before IM injections.

Lifestyle, Diet, and Habits

Parenteral forms of drugs are more expensive than oral forms. Parenteral administration requires specialized skills, equipment, and education. Placing IV access devices into peripheral veins may be difficult in patients who are IV substance abusers.

Environment

Patients, particularly diabetic patients who receive insulin, can be taught to give themselves SC injections at home. The techniques for IM injections can also be taught to patients and their families for home use, although this practice is not as common. IV administration of drugs usually occurs in an acute or a long-term care setting; however, it can also be performed in the home setting with a home health nurse administering the drug therapy.

Planning and Intervention

Maximizing Therapeutic Effects

Selecting the appropriate-sized syringe and needle is key to administering an IM or SC injection. Selection is based on the patient, the type of required injection, the administration site, and characteristics of the drug (how viscous, how irritating, and how much volume).

A continuous IV drug infusion should be monitored to ensure that therapeutic blood levels are achieved and that drug therapy is effective. After administration of an intermittent IV drug, the lock must be flushed to maintain patency. If heparin is used to keep the lock patent, flushing the lock is usually necessary before drug infusion with sterile normal saline solution, and then again after the infusion before flushing with the heparin. Flushing is necessary because many drugs are incompatible with heparin.

Minimizing Adverse Effects

To minimize adverse effects and drug errors, the nurse follows the six rights of drug administration when administering parenteral drug therapy. To prevent infections, the drug, all parts of the syringe that have come into contact with the drug, and the shaft of the needle that enters the patient's body must be sterile. Meticulous administration technique is necessary because most parenteral drugs enter the bloodstream readily, quickly spreading any organisms introduced with the injection.

Site selection is important because incorrect placement of the needle may damage blood vessels or nerves. Knowledge of the muscles, visible or palpable anatomic landmarks, and location of major nerves and blood vessels in the underlying tissue is an absolute necessity for safe administration.

The oils and irritating chemicals found in the solutions or suspensions of some parenteral drugs may be dangerous if given intravenously. Care must be taken by careful site selection and aspiration before injection to prevent inadvertently administering an IM drug into a blood vessel.

To prevent bacterial growth, reconstituted drugs usually require refrigeration if they are not completely used after dilution. The reconstituted drug container must be labeled with the patient's name, dilution date, and volume and type of diluent used.

When administering drugs that are very irritating to the tissues, the nurse may use an injection technique known as the Z-track method to prevent the drug from seeping up from the muscle into the subcutaneous tissue. Subcutaneous tissue is displaced to one side before inserting the needle into the muscle. The drug is then injected, the needle is withdrawn, and the subcutaneous tissue is allowed to go back into place. Consult your nursing practice texts for more detailed information.

Patients receiving drugs such as aminophylline, dopamine, and heparin by continuous IV infusion must be closely monitored. These drugs have powerful effects on the body, and their adverse effects can be serious or life threatening. The rate at which such drugs are administered should be regulated carefully by using an IV pump or controller. Because the drug enters the bloodstream directly, blood levels of the drug can rise above desired therapeutic levels quickly. Blood levels, therefore, should be closely monitored.

CRITICAL THINKING SCENARIO

Choosing the Right Drug Administration Site

Georgia Govans, 79 years old, is admitted with osteomyelitis of the hip, a severe infection, after a recent repair of a hip fracture. She has a temperature of 101°F (38.3°C) on admission and a history of severe peripheral vascular disease.

1. Which route will most likely be chosen to administer antibiotics to this patient?
2. Select and support a choice of drug delivery method based on the patient's history and her drug requirements.

TOPICAL ROUTE AND FORMS

The topical route of drug administration involves applying drug preparations to the skin or mucous membranes, including the eyes, ears, nose, rectum, vagina, and lungs. The primary advantage is that topical drugs usually act locally, although some can have systemic effects. A disadvantage of topical drugs is that most are intended for only one specific site. For example, ophthalmic drugs are used only in the eyes, and dermatologic drugs are used only on the skin. Drugs that can be administered in topical forms include antibiotics, antiseptics, antifungals, anti-inflammatory agents, antipyretics, vasodilators, hormones, antismoking agents, analgesics, antiemetics, and débriding agents.

The most common and widely used topical agents are applied to the skin. Dermatologic preparations come in several forms: lotions, creams, liquids, ointments, and emollients. Emollients are applied liberally to dry skin. Most drugs

applied to the intact skin have primarily local effects because little drug is absorbed through the outer epidermis. Absorption increases under the following circumstances:

- The skin is abraded or denuded.
- The drug is added to a specific solvent because only lipid-soluble substances are absorbed through the intact skin.
- The medicated skin is covered by an occlusive dressing (e.g., in treatment for psoriasis).

Most dermatologic drugs are applied in a thin layer or in a measured amount (topical nitroglycerin is applied in inches). Single-dose, adhesive-backed drug applications, called transcutaneous or transdermal drug delivery systems, are currently available. Some examples of the transdermal drug delivery route include nitroglycerin (Nitro-Dur) for patients with coronary artery disease, scopolamine (Transderm-Scop) for patients who suffer from motion sickness, and fentanyl (Duragesic) for patients with severe pain. Although this drug form can be expensive, its ability to avoid first-pass effects is an advantage. The transdermal system is convenient and usually requires less frequent application than other forms.

Drugs administered to the eye take the form of drops or ointments that are applied to the rim of the lower lid. Drugs administered in the ear are in the form of drops. Drugs administered through the rectum are either in suppositories (waxy, bullet-shaped systems that dissolve in the body from body heat) or ointments. Drugs administered into the vagina are in the form of suppositories, creams, foams, liquids, or tablets (moistened before insertion to promote dissolving inside the body).

Drugs given into the nose are in liquid sprays, drops, or aerosol preparations. Inhalers, another form of aerosolized therapy, are used for respiratory conditions and have an effect on the lungs but are inhaled through mouth breathing. Patients should shake the inhaler well, exhale fully, and then inhale while pushing down on the inhaler to activate it. They should breathe in the puff of drug and hold the breath for several seconds before exhaling. The timing of this technique is difficult for many patients. The use of a spacer, which acts as a reservoir for the drug, is helpful for many patients. The patient activates the inhaler, and the drug enters the spacer. The patient then breathes in from the spacer. If multiple puffs of the inhaler are ordered, the patient should wait 1 to 2 minutes between puffs. The inhaler and the patient's mouth should be rinsed after drug administration.

Nursing Management in Topical Drug Administration

Assessment of Relevant Core Patient Variables

For the most part, assessment involves inspecting the skin for integrity. If the skin is not intact, aseptic technique becomes an important factor in infection control.

Planning and Intervention

To maximize therapeutic effects and minimize adverse effects, the nurse should wear gloves or use an applicator when administering dermatologic drugs, to avoid infecting the patient and to protect his or her own skin from the drug. If the skin is broken, the nurse needs to use sterile technique when applying a dermatologic drug to prevent introducing bacteria and other organisms into the body. If an adverse effect occurs with drugs given by a transdermal system, removing the patch usually relieves the symptoms.

To ensure safety when administering all forms of topical drugs, the nurse must again observe the six rights of drug administration (see Box 3.1).

Chapter Summary

- The three routes of drug administration are enteral, parenteral, and topical.
- The drug route may produce systemic effects, local effects, or both.
- Oral drugs may be available in sustained-release or enteric-coated form to delay onset of action of the drug.
- Food, fluids, and other drugs may alter the absorption of enteric drugs.
- The parenteral route avoids the GI tract and the irregularities of absorption, including the first-pass effect. The most common methods of parenteral drug administration are the IM, SC, and IV routes.
- Onset of drug action is more rapid with the parenteral than with the enteral route.
- Patient characteristics (age, weight, muscle mass) and drug characteristics (volume, viscosity, irritability) are considered when selecting a site for IM drug administration.
- Administration of IV drugs may be through continuous drip, intermittent infusion, or IVP methods into peripheral or central venous access devices.
- Topical drugs include those that are applied to the skin and mucous membranes of the eyes, ears, nose, rectum, and vagina.

Questions For Study and Review

1. Which route of drug administration is most frequently used?
2. What is the advantage of an enteric-coated tablet?
3. Why might a parenteral route of a drug be prescribed instead of an enteral route?
4. Which parenteral technique poses the greatest risk for rapid drug toxicity to a patient?

Need More Help?

Chapter 3 of the Study Guide to Accompany *Drug Therapy in Nursing,* 3rd Edition, contains NCLEX-style questions and other learning activities to reinforce your understanding of the concepts presented in this chapter. For additional information or to purchase the study guide, visit thePoint: **http://thepoint.lww.com/aschenbrenner3e**

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Core Patient Variables

6 Life Span: Children

Learning Objectives

At the completion of this chapter the student will:

1. Identify key areas of core drug knowledge for children that differ from those for adults.
2. Explain why calculating drug dosages for children is different from calculating dosages for adults.
3. Describe methods for calculating dosages for children of different ages.
4. Identify key core patient variables for children and explain how they differ from those for adults when considering drug therapy.
5. Discuss key developmental variables for each of the pediatric age groups (infant, toddler, preschooler, school-aged, and adolescent) that affect how the nurse administers drug therapy.
6. Propose some common nursing diagnoses related to drug therapy in children.
7. Describe key nursing interventions to promote maximal therapeutic effects and minimal adverse effects during pediatric drug therapy.
8. Identify key points to include in educating patients and families about pediatric drug therapy.

Key Terms

body surface area

kernicterus

nomogram

pediatric patient

play therapy

When implementing pediatric drug therapy, the nurse must remember that children are different from adults in many ways. Although some drugs and administration routes are similar in adults and children, the nursing management of drug therapy varies greatly. For example, physiologic differences in children and the child's immature body systems, greater fluid composition, and smaller size all affect the core drug knowledge. These differences can exaggerate or diminish the pediatric patient's response to drug therapy, making some drug actions and outcomes less predictable in the child than in the adult.

Additionally, in children, core patient variables differ from those in adult patients and from child to child because of the differences across the developmental stages of childhood. The **pediatric patient** is usually defined as younger than 16 years and weighing less than 50 kilograms.

This chapter focuses on core drug knowledge that is relevant and unique to pediatric patients and on core patient variables that emphasize children's needs according to developmental changes. Special issues in managing pediatric drug therapy are explored, including maximizing therapeutic effects, minimizing adverse effects, and educating patients and families.

Nursing Management of the Pediatric Patient

Core Drug Knowledge Related to Children

Pharmacotherapeutics

Therapeutic indications and effects for many drugs are similar for children and adults. Not all drugs that are labeled as safe for adults, however, have been labeled as safe for children, partly because not all drugs have been adequately tested in clinical trials on pediatric patients. Historically, it was considered unethical to enroll children in randomized, controlled drug studies. Because drugs in development were not tested on children, they were not labeled as approved for use in children. As a result, pediatricians must often prescribe medications for off-label uses in children. An off-label use is when a drug is used for a purpose not clearly stated on its label but the prescriber has reason to believe the drug will produce the desired therapeutic effect (see Chapter 4 for a complete discussion of off-label use of drugs). An estimated 75% of drugs regularly prescribed to children in the United States have never been labeled for use in any pediatric population. Additionally, the 10 most frequently prescribed drugs for outpatient use in children either carry disclaimers on their labels about their use in children, or have labels that lack adequate information about drug dosing or adverse effects in children (FDA website, 2006).

Compounding this problem of off-label uses was a lack of financial incentives for drug manufacturers to retest drugs already on the market to obtain approval for use in children. In recent years, however, the thinking has changed so that it is now considered unethical to *exclude* children from drug studies and not to include child-specific prescribing information on labels for drugs used in children. To meet this need, the United States Congress passed the Best Pharmaceuticals for Children Act in 2001. This act provides several avenues for drugs already on the market to be tested in clinical drug trials in children. Labeling changes are occurring based on findings from these new studies. At the end of 2005 a milestone of 100 drugs had been tested for use in children and relabeled. The list of the drugs that have been studied for use in children and the summaries of medical and clinical pharmacology reviews are available on the FDA website (*http://www.fda.gov/cder/pediatric/Summaryreview.htm*). The Best Pharmaceuticals for Children Act will continue until October 2007, at which time the United States Congress will need to renew it (Aschenbrenner, 2006).

Until all drugs have been tested and labeled for use in children, nurses need to be aware that off-label use will occur. When a drug is prescribed off-label, the full therapeutic and adverse effects, as well as appropriate dosing, may be unknown.

Even when a drug has the same labeled therapeutic uses in adult and children, a major difference is the appropriate drug dosage for different age groups. Committing drug dosages to memory is difficult and unnecessary because child weights vary considerably. Unlike most adult drug dosages, almost all pediatric drug dosages are based on the weight of the child in kilograms. Dosage is usually specified in milligrams of drug per kilogram of body weight (mg/kg).

When a child dose is not specified, it can be determined from the adult dose based on the body surface area of the child. The **body surface area** is the external surface of the body expressed in square meters. The ratio of body surface area to weight is inversely proportional to length; therefore, the infant or young child who is shorter and weighs less than the adult has relatively greater surface area than would be expected from the weight. Body surface area is calculated using a standard formula, found in Box 6.1.

Body surface area can also be determined by using a nomogram (Figure 6.1). A **nomogram** is a chart or a graph that shows relationships between numerical variables. A representative nomogram used to estimate body surface area in children may have several columns of calibrated measures representing height, surface area, and weight. Body surface area is calculated by drawing a line across the columns to connect the patient's height with the patient's weight. The point at which the line intersects the central surface area column is the patient's *estimated* body surface area. Using a nomogram is less accurate than using the formula to determine body surface area.

Once body surface area is determined, the dosage can be computed using the formula in Box 6.1. A child's drug dosage may also be determined by comparing the child's weight to the recommended dose per kilograms of weight. Administering the correct drug dosage is crucial in pediatric drug therapy. The child's small and immature body systems make overdosages potentially lethal. Drugs with high potential for toxicity, such as anticancer drugs, are more likely to have their dosage determined by body surface area than by only the weight of the child.

Pharmacodynamics

A drug's mechanism of action is the same in all individuals at all ages. However, what distinguishes individual responses is the ability of the organ systems to function fully and appropriately. In very young children, immature organ systems have less than optimal functioning, which may necessi-

BOX 6.1 Calculating Pediatric Drug Dosages

Body Surface Area Method

Step 1. Determine the body surface area (BSA) of the child. It is measured in meters squared. A standard formula is used. Computations should be made with a calculator.

$$BSA = \sqrt{\frac{\text{Weight in kg} \times \text{Height in cm}}{3{,}600}}$$

Example: Child weighs 10 kg and is 45 cm tall

1. Multiply weight in kilograms by height in centimeters.

$$BSA = \frac{10 \times 45}{3{,}600}$$

2. Divide product by 3,600.

$$= \frac{450}{3{,}600}$$

3. Enter square root sign on calculator.

$$= \sqrt{0.125}$$

4. Round the BSA to the nearest hundredth.

$$= 0.35 \text{ m}^2$$

Step 2. Determine dose using the computed BSA and this formula:

$$\frac{\text{Child's BSA}}{1.7 \text{m}^2 (\text{average adult BSA})} \times \text{Usual adult dose} = \text{Child's dose}$$

Example: Child's BSA = 0.35 m², and usual adult dose is 100 mg.

$$= \frac{0.35 \text{ m}^2}{1.7 \text{ m}^2} \times 100$$

$$= 20.588\ (20.59) \text{ mg is child's dose.}$$

Body Weight Method

Usual dose (in mg): 1 kg :: needed dose (in mg): weight of child in kg, solve for the needed dose

Example:

Usual dose is 10 mg/1 kg and child weighs 18 kg

$$10 \text{ mg} : 1 \text{ kg} :: \chi \text{ mg} : 18 \text{ kg}\ \chi = 180 \text{ mg}$$

tate increasing or decreasing drug doses to prevent toxicity and to achieve a therapeutic drug level.

Pharmacokinetics

A child's age, growth, and maturation can affect how the body absorbs, distributes, metabolizes, and excretes a drug. By understanding how drugs affect pediatric patients differently from adult patients, the nurse can help maximize the therapeutic effects of a drug and minimize adverse effects. Dosages must often be lowered to account for immature or impaired body systems in neonates and infants.

Absorption

Absorption of a drug depends on various factors. In the pediatric patient, age, disease process, dosage form, route of administration, and foods and drugs present in the child's body have an effect on drug absorption.

The infant's gastrointestinal (GI) tract is less acidic and thus has a higher pH than that of an adult. Moreover, a premature infant's immature GI tract secretes less acid than the full-term newborn's or older child's. As the GI tract matures, the gastric pH decreases and the GI tract becomes more acidic, reaching adult values at approximately 1 year of age. These differences in pH affect drug absorption. For example, a drug such as digoxin is very well absorbed in an acidic environment. Therefore, less digoxin would be absorbed from the premature infant's GI tract than from the older child's or adult's GI tract.

Route of administration also affects absorption. Drugs administered intramuscularly (IM) or subcutaneously (SC) are affected by age. For example, the rate of absorption may be decreased in the infant or child because of erratic blood flow from the immature peripheral circulation. The neonate's blood flow is particularly slow and erratic. Conversely, increased absorption of topical drugs is common in pediatric patients, especially infants. Compared with adults, infants and children have a greater body surface area. The infant's skin exhibits greater permeability as well. An increased body surface area combined with increased permeability result in increased absorption of topical agents, which may result in adverse effects that usually do not occur in the adult patient.

Distribution

In a pediatric patient, drug distribution processes can differ from those in an adult because of differences in body water and fat, immature liver function, and an immature blood–brain barrier.

Differences in Body Water and Fat. Compared with adults, children, especially infants, have a higher concentration of water in their bodies and a lower concentration of fat. Newborns have the greatest proportional water content, followed by infants, children, and then adults (Table 6.1). Because infants and children have a greater proportion of body water, water-soluble drugs are diluted to a greater degree, and for this reason, it is important to assess the amount of water in

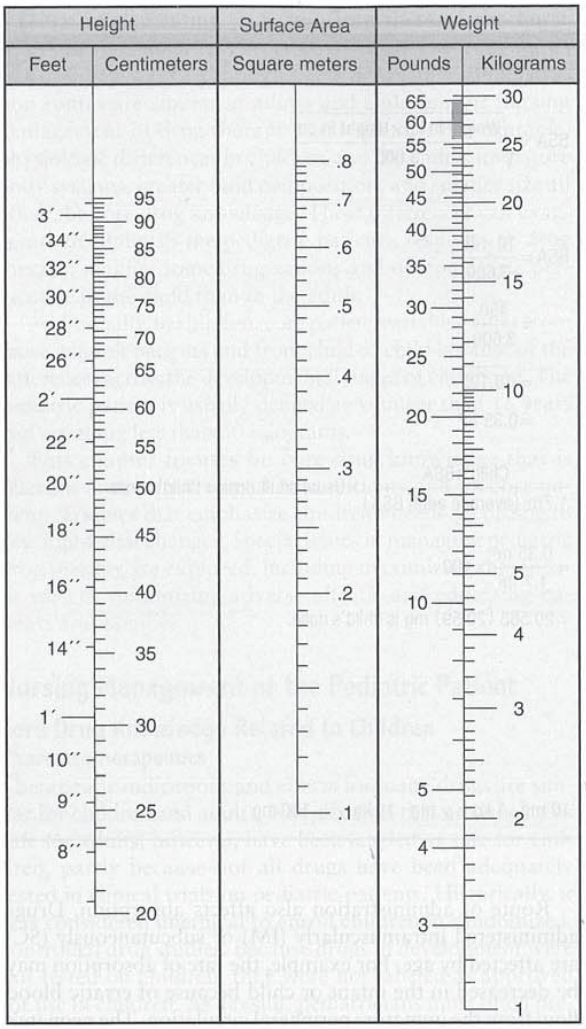

FIGURE 6.1 A pediatric nomogram is a device for estimating body surface area in children. To use it, draw a line from the child's height to the child's weight. The point at which this line intersects the surface area in the middle is the child's estimated body surface area.

the body of an infant or child before administering water-soluble drugs. The drug moves to areas of water throughout the body, not just in the blood, resulting in lower concentrations of the drug in the blood. With drugs such as gentamicin, proportionately increased dosages may be required to achieve or maintain therapeutic levels.

To a lesser degree, fat-soluble drugs are affected by the proportionately lower fat in the infant and child. Fat distribution increases with age; thus, fat-soluble drugs are distributed to a greater degree in the adult. Because fat-soluble drugs are not widely distributed in the infant's or child's body, greater blood concentrations may result, leading to toxicity.

Immature Liver Function. In the infant and especially in the neonate, immature liver function affects drug distribution. The neonate's immature liver produces fewer plasma proteins, especially albumin; acidic drugs bind strongly to albumin. Pharmacologic effects of drugs result from unbound (i.e., free) drug. In the neonate and infant, more free drug is available because less drug is bound to plasma proteins. The result is increased blood levels of drugs, which in turn can cause greater adverse effects and toxicity in infants. Drug binding to serum proteins reaches adult levels by 6 months of age.

TABLE 6.1 Proportional Water Content Across the Life Span

Age	Percentage of Body Water
Newborn	75%–85%
Infant	Approximately 85%
One year old	65%
Two years old	60%
Adult	50%–60%

Multiple drugs administered to an infant may compete for the same binding sites, resulting in higher blood concentrations of both drugs or of the drug with less affinity for the binding site. Other naturally occurring substances in the body can also compete for fewer binding sites in the pediatric patient. For example, bilirubin, which may increase during the neonatal period, binds with plasma proteins. When a sulfonamide is administered to the neonate who has an increased bilirubin level, it competes with bilirubin for binding sites, leaving more bilirubin free in the blood. Rarely, the bilirubin level can increase to a dangerous level, resulting in bilirubin accumulation in the central nervous system (CNS), a life-threatening condition called **kernicterus.**

Immature Blood–Brain Barrier. The blood–brain barrier prevents drugs in the general circulation from passing to the circulation of the brain, thereby protecting the brain from toxic substances. At birth, the blood–brain barrier is not fully developed. Therefore, newborns are particularly vulnerable to CNS toxicity. In the newborn, the effect of drugs that act on the CNS (e.g., phenobarbital and morphine) is intensified. In addition, infants experience exaggerated CNS responses to other drugs targeted for other body systems.

Metabolism

The liver metabolizes most drugs. However, the immaturity of the neonatal and infant liver results in decreased or incomplete metabolism of many drugs, which may necessitate lower drug dosages or an increased interval between doses to achieve appropriate blood levels. In children with liver disease, drug metabolism is further complicated by the liver's inability to detoxify drugs. A child with an immature liver or compromised liver function is at risk for drug toxicity.

Drugs requiring oxidation for metabolism are frequently more rapidly metabolized in children than in adults because children have a faster resting respiratory rate. These drugs include phenobarbital, phenytoin, and the methylxanthines (e.g., theophylline and caffeine). With these types of drugs,

children may require higher dosages or more frequent administration schedules than adults do to maintain therapeutic blood levels.

Excretion

Most drugs are eliminated from the body through the urine. Drug elimination requires a functioning renal system, and its effectiveness depends on glomerular filtration rate, tubular reabsorption, and maturity of the renal system. In children with impaired renal function, drug dosages should be altered to achieve and maintain therapeutic drug levels.

The neonate, especially the preterm infant, has immature kidneys, and renal excretion of drugs is slow. Drug dosages and therapeutic drug levels must therefore be monitored closely to prevent toxicity. In addition, the reduced glomerular filtration rate and decreased tubular secretion and reabsorption during the first 6 months of life extend the half-life of many drugs (e.g., penicillins, sulfonamides, and cephalosporins). Drugs with a narrow margin between effective and toxic doses must be administered at longer dosage intervals to prevent toxicity. At about 3 months of age, the infant's kidneys can concentrate urine at the adult level, but urinary excretion remains low until the child is about 30 months old, when the kidneys become functionally mature.

A few drugs are excreted through the biliary tree into the intestinal tract. Biliary blood flow is decreased during the first few days of life, during which careful monitoring of drug levels and signs and symptoms of toxicity is imperative.

Contraindications and Precautions

As stated above, most drugs prescribed to children are prescribed off-label and have never been clinically tested for efficacy, unique pharmacokinetics, or adverse effects in children. Off-label usage therefore requires cautious administration and careful, frequent assessments of the child. Some drugs are known to be dangerous in children and are labeled as such; these drugs are contraindicated. The core drug knowledge must be determined for each drug before the drug can be administered to a child.

Adverse Effects and Drug Interactions

Adverse effects of some drugs are more severe and more likely to occur in children because of the immature body systems of children. Newborns and young children may experience serious adverse effects either from direct administration of a drug or through their mother's use of a medication. In a review of adverse effects in infants and children younger than 2 years that were reported to the United States Food and Drug Administration (FDA) between 1997 and 2000, approximately 3.5% of the adverse effects accounted for half of the reported deaths in children. About one fourth of the total adverse effects reported were related to exposure from the mother during pregnancy, delivery, or lactation (Moore et al., 2002).

Other adverse effects on body systems occur only at specific phases of development. For example, tetracycline administered to a child between the ages of 4 months and 8 years will stain the permanent teeth. Glucocorticoids given to a child of any age will suppress growth if the child has not matured to full adult size. Drug receptor sensitivity varies with age; it may be increased or decreased for certain drugs. This variability may promote adverse effects and may necessitate lower or higher drug dosages than would normally be expected (see Chapter 5).

Drug interactions in children are similar to those occurring in adults.

Assessment of Core Patient Variables Related to Children

Health Status

A child's disease process can affect absorption of drugs from the GI tract. Diarrhea, for example, decreases intestinal transit time and therefore decreases the time available for drug absorption. Children with hepatic or renal disease cannot metabolize or excrete drugs as easily as other children and are more prone to adverse effects from drugs. As with adults, any chronic disease or condition may alter the effects of certain drugs and must be seriously considered in drug therapy.

Life Span

Always consider the developmental stage of the pediatric patient. In planning appropriate drug administration methods, explain the treatment and enlist the child's cooperation. If doing so is not possible, seek appropriate assistance to administer the drug therapy safely. Developmental considerations are especially important when communicating with the child. To elicit cooperation and obtain necessary information, communication must be at an appropriate level of understanding for the child. The following are age-appropriate considerations in administering drugs to infants and children. Box 6.2 provides more information regarding pediatric drug routes.

Infants (Birth to 12 Months)

Some infants with a well-developed sucking reflex may willingly swallow a pleasant-tasting liquid drug through a bottle nipple. Other babies may spit out oral medicine, making it difficult to administer a full dose. Administer infant drops by gently squeezing the child's cheeks to open the mouth, and then placing the drops in the buccal pouch to ensure they will be swallowed. Drugs may be given to infants in rectal suppository form if necessary. However, to avoid expulsion of the suppository before the drug is absorbed, you may need to hold the child's buttocks together for a short time.

If the IM route must be used, choose the smallest gauge of needle appropriate for the drug. The preferred injection site for infants and children up to age 3 years is the vastus lateralis. This muscle is on the side of the thigh in the upper outer quadrant of the area between the greater trochanter and the knee. The vastus lateralis has few nerves and blood vessels and forms the largest muscle mass in this age group.

Normally, a ⅜-inch needle is used for the vastus lateralis in infants; if one is not available, a needle no larger than

CRITICAL THINKING SCENARIO

Calling on Core Drug Knowledge for Children

You are caring for a premature newborn in the nursery. The newborn is receiving intravenous antibiotic therapy to treat an infection. Which specific aspects of core drug knowledge do you think will most help you anticipate any adverse effects of drug therapy?

BOX 6.2 Special Precautions for Pediatric Drug Routes

One way to promote a good outcome when administering drug therapy is to call on your knowledge of normal growth and development in children and your knowledge of safe administration techniques for specific routes.

Oral Route

- Drug volume should not exceed that which can be swallowed by a very small mouth. The drug dose should be mixed in a small amount of liquid so all of the dose is taken.
- Avoid adding a drug dose to formula. The infant may refuse future feedings because of the foul taste.
- Balance dosage schedules with feeding schedules. Consider whether the drug should be given with meals or on an empty stomach. Check for the possibility of a food-drug interaction.

Intramuscular Route

- Assess whether a less painful route is possible.
- If the IM route is unavoidable, apply a topical, local anesthetic, such as a lidocaine and prilocaine combination (EMLA cream), to numb the injection site.
- Locate anatomic landmarks and boundaries of injection sites.
- Evaluate muscle mass, skin condition, and potential complications related to the child's diagnosis.
- Rotate injection sites as needed, and use appropriate equipment and techniques.
- Seek help to hold the child still while administering the IM injection.

Intravenous Route

- Minimize initial pain on starting the IV by applying a topical anesthetic.
- Check the IV insertion site hourly for infiltration in infants and children.
- Monitor fluid status for signs of overload (risk is greatest in neonates and young infants because of their immature kidney function).
- Control the IV infusion rate by using volumetric pumps and microdrip calibrated chambers.
- Supply no more than 1 hour's worth of fluid when administering a continuous IV drip with an infusion pump (in case the pump malfunctions).
- Engage the lock feature on a volumetric pump to prevent unauthorized changes in the drop rate.

⅝ inch should be used. With the longer needle, modify the angle of injection from the usual 90 degrees to 45 degrees toward the frontal plane of the knee. The 45-degree angle ensures that the needle does not traverse the blood vessel.

The rectus femoris is another possible injection site. This muscle is located near the vastus lateralis but is anterior mid-thigh; inject the needle at a 90-degree angle at this site.

In infants, neither the deltoid nor the dorsogluteal muscle site is used because the muscle masses are too small and undeveloped. The ventrogluteal muscle site, which is large at birth, is not recommended for use in infants because problems encountered in positioning the child make it difficult to locate the muscle site accurately.

Drugs may be administered intravenously to the infant through a peripheral site. These intravenous (IV) sites differ from those used for adults. Ideally, select a site that is easy to access and that poses the least risk to the patient. In the neonate and infant, the scalp's many superficial veins offer easy access. The superficial temporal vein just in front of the pinna of the ear and the metopic vein in the middle of the forehead are relatively easy to find and are less risky for patients (Figure 6.2). Other suitable IV sites for infants and older children include the vessels in the nondominant hand, forearm, upper arm, feet, and antecubital fossa. Distal IV sites are used first and are moved proximally as necessary. The feet also provide good IV sites and are used in infants.

Toddlers (13 Months to 3 Years)

Toddlers can swallow liquid forms of drugs, and older toddlers can chew oral drugs. Because toddlers experience anxiety when separated from their parents, having a parent nearby usually helps the child's cooperation during drug therapy. Attempt to elicit cooperation from the toddler but be prepared for the toddler to resist. A toddler's resistance may be associated with a past experience, such as unpleasantly flavored drugs or a painful injection.

Toddlers are also likely to be anxious or uncooperative during administration of rectal suppositories because of their experiences with toilet training and sphincter control. Toddlers have vivid imaginations but limited understanding of how the body works. A common fear is that important body contents will leak out from an injection site. As with infants, the vastus lateralis and rectus femoris remain the IM injection sites of choice for toddlers.

When IV drug therapy is necessary for toddlers, the scalp veins are still appropriate and can be used up to age 18 months. By this time, hair follicles mature and skin layers thicken, making IV access more difficult. Although the scalp provides excellent IV access, it is not the first choice because of the anxiety it causes parents. Parents feel uneasy

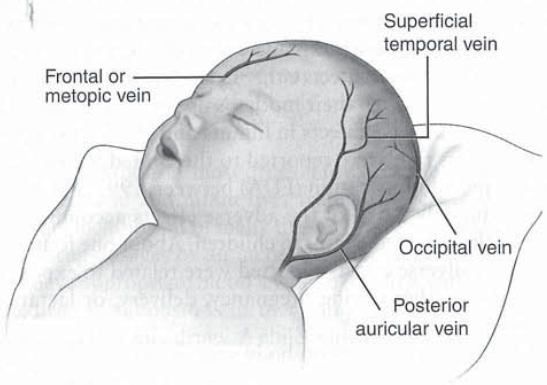

FIGURE 6.2 The scalp is an excellent site for intravenous (IV) therapy in the neonate and infant. The superficial temporal vein and the metopic vein in the central forehead are the preferred sites because they are easy to find and reasonably safe.

because of the scalp's close proximity to the brain and because the area must be shaved at the IV site. If a scalp vein must be used and the site shaved, ask the parents whether they would like to save the hair, and collect it for them if desired. Saving their child's hair makes the procedure less distressing to some parents. For toddlers, as for infants, other peripheral IV sites are also used. If possible, try to avoid using the foot so as not to impede the toddler's mobility or cause undue frustration. The foot veins are used, however, in children who need to be immobile.

Preschoolers (3 to 5 Years)

Preschoolers are often uncooperative during drug administration. Strategies for enlisting cooperation include offering choices (e.g., between liquid medicines or chewable tablets) when feasible. Heightened awareness and the fear of punishment or body mutilation in this age group may influence the child's perception of and cooperation with drug therapy. Nurses (and parents) should always reassure preschoolers that the drug is to help them feel better and keep them healthy.

When an IM injection must be given, the use of topical anesthetic creams (e.g., EMLA) to numb the site reduces pain in preschoolers during the injection. Several sites may be used for IM injections in preschoolers, most commonly the vastus lateralis, rectus femoris, and ventrogluteal sites. The ventrogluteal site is free of major nerves and blood vessels and is characterized by deep muscle mass. It is located above the greater trochanter between the anterior superior iliac spine and the posterior iliac crest. The drug is injected into the gluteus medius muscle, which is in the ventrogluteal site. Injection in the gluteus medius is less painful than injection in the vastus lateralis.

The dorsogluteal site can be used if necessary but only in children who have been walking for at least 1 year, because the gluteus maximus muscle at this site is developed by walking. By 3 years (with the exception of developmentally delayed children), almost all preschoolers have been walking for at least 1 year. Locate the dorsogluteal site by drawing an imaginary line from the head of the femur to the posterior superior iliac spine. Then deliver the injection into the gluteus maximus at the upper outer portion above the line. *The dorsogluteal site should be used only as a last resort because of potential damage to the sciatic nerve if the site is not chosen with precision.* Some authorities believe the site should be not used at all. When IV drug therapy is necessary, peripheral sites are selected for the preschooler. Scalp veins are no longer used.

School-aged Children (6 to 12 Years)

The school-aged child is often very cooperative. As with the preschooler, offer choices to help the school-aged patient exercise control. The school-aged child's greatest fears of drug therapy are usually related to negative past experiences. School-aged children can tolerate warning of drug therapy without becoming fearful and anxious. The school-aged child takes pride in accomplishments such as receiving an injection without incident.

Oral drugs may still be provided in liquid form or chewable tablets. Many school-aged children can also swallow pills. Generally, if rectal drug forms must be used, the school-aged child will feel embarrassment. School-aged and older children, like adults, must be ensured privacy at all times throughout the procedure.

The ventrogluteal site is recommended for an IM injection in the school-aged child, but the vastus lateralis and rectus femoris sites may also be used in this age group. The dorsogluteal site is again possible, as a last resort. Although it is not the preferred administration site, the deltoid muscle may also be used for small volumes of drugs (0.5 mL) or vaccines. This site is often considered less painful than the ventrogluteal site.

Adolescents (13 to 16 Years)

An adolescent's ability to cooperate is highly developed and much like an adult's. Offer adolescents control whenever possible and let them make choices. Also offer support and encouragement without treating adolescents like children. Adolescents are more likely to cooperate and participate in drug therapy when they have a complete understanding of the treatment regimen. Adolescents are particularly sensitive about their bodies and their independence. Therefore, privacy and control are important issues to consider when administering drug therapy to this age group.

Routes of administration are similar to those for adults. Oral forms of drug therapy include tablets or pills. Suppositories can be used, but the adolescent is likely to be embarrassed. IM injection sites are usually the same as for adults unless the adolescent is particularly small. Careful examination is necessary to ensure that adequate muscle mass is available for IM injection. Site selection for IV therapy in adolescents is the same as for adults. The dorsogluteal site remains a last choice.

Lifestyle, Diet, and Habits

The infant's primary food intake is milk and formula. These substances decrease acidity and thus increase gastric pH. Drug absorption is usually affected by pH levels; therefore, food and drug interactions are a primary concern when administering oral drug therapy to infants.

In school-aged children and adolescents, assess for the use and abuse of substances such as caffeine, alcohol, tobacco, and street drugs. During drug therapy, these substances cause the same complications in children as in adults. Adolescence is a time of experimentation, which may include experimentation with legal and illegal substances. Preadolescents may also experiment with these substances. Try to elicit this information from all school-aged or adolescent patients throughout drug therapy because potential adverse effects or interactions of these substances may cause serious complications. Regardless of the patient's age and appearance, never assume that the child does or does not use or abuse certain substances. Pose questions regarding substance use in the health assessment interview in a nonjudgmental, matter-of-fact manner.

Question the parent regarding the use of herbal therapy. Use of alternative therapies has become common, and their use is frequently not reported to the primary care provider. Patients and their families often do not consider these therapies "medications" or may not realize how they can interact

with prescribed drug therapy. One study in a pediatric emergency department found that 45% of parents had administered an herbal therapy to their child. The most frequently reported herbal therapies were aloe plant/juice, echinacea, and sweet oil. Of the children who received herbal therapies, 27% had received three or more types within the last year. Most of the parents did not know if the herbal products had any adverse effects or if they could interact with prescribed medication. Less than half of the parents had discussed the use of herbs with their child's primary care provider (Lanski et al., 2003).

Also consider the economic circumstances of the patient and family. Are the parents concerned about paying for the child's drug therapy? Are insurance and other resources available?

Environment

Children may receive drug therapy in any setting, although some types of drugs may be administered primarily in one setting or another, just as in the adult population. Children receiving drug therapy at home need to have a parent or guardian responsible for ensuring that the child receives the prescribed therapy. General considerations about the home need to be assessed just as they are assessed for adults. Does the home have electricity, a refrigerator, and indoor plumbing?

An important additional question to ask of the parent or caretaker is whether the home has a safe place to store prescription and nonprescription drugs away from children. Childhood ingestion of drugs is a serious concern because many drugs have serious adverse effects or may cause poisoning in children. Unintentional ingestion of over-the-counter drugs is a serious problem and is related to several factors, such as absent or inadequate child-resistant packaging, lack of understanding by the parent or caregiver about the toxicity of the over-the-counter drug, and carelessness by parents or caregivers in the use and storage of the over-the-counter drug.

Culture and Inherited Traits

The family's beliefs greatly affect a child's attitude and adherence to the therapeutic regimen. Questions and assessment concerns to consider include the following:

- Does the child's cultural background suggest suspicions about or taboos against drug therapy?
- Do health practices in the child's family rely on other forms of healing, such as using herbal or natural medicines, acupuncture, prayer, or mysticism?
- Do family religious beliefs directly conflict with the use of drug therapy?

The child's cultural background and heritage must be considered quite seriously when planning drug therapy (see Chapter 12).

Nursing Diagnoses and Outcomes

Nursing diagnoses and outcomes related to specific drug therapy for children are much the same as they are for adults. However, many drug therapies are burdensome for families to maintain, present special concerns, or pose risks to a child's normal growth and development. Common nursing diagnoses and outcomes may include the following:

- Delayed Growth and Development
  Desired outcome: *The patient will achieve normal growth and development during drug therapy.*
- Ineffective Family Therapeutic Regimen Management
  Desired outcome: Family members will master effective management strategies of the patient's drug regimen.
- Caregiver Role Strain
  Desired outcome: *The patient and family will develop effective coping skills to avoid, reduce, or relieve stress on family caregivers.*

Planning and Intervention

Maximizing Therapeutic Effects

Administering drugs safely and effectively to children requires an understanding of pediatric anatomy and physiology, the patient's developmental and cognitive levels, and the child's diagnosis and prognosis. Use this knowledge to select appropriate drug administration sites, equipment, and administration techniques.

Oral Drug Therapy

Although usually not painful, administration of oral medications can be traumatic, especially when the drug flavor is foul and the child protests. Many pediatric drugs come in liquid form and are drawn up into a syringe (without a needle) for accurate measurement. The drug can then be transferred to a medicine cup for older, cooperative children who prefer this way of receiving the drug.

If the patient cannot swallow pills, some pills can be crushed and dissolved in a liquid or soft food (such as applesauce, gelatin, or ice cream) that masks the flavor of the drug. Dilute the drug in the smallest amount of liquid or food possible to ensure that the child receives the full dose and does not leave any in the residue. Another method of masking bad-tasting drugs for children is to offer a flavored ice pop or ice chips to help numb the taste buds and promote cooperation.

Work carefully with the child to ensure that all of the drug is taken. If the child drools or spits out some of the drug, calculate the amount of drug lost. If the total is considerable, report the estimated amount lost to the prescriber and obtain an order for a replacement dose. For drugs that pose a high risk for toxicity, another dose is unlikely to be ordered. For example, when digoxin (which slows the heart) is given to children with congestive heart failure, an overdose can be lethal.

Parenteral Drug Therapy

To ensure accurate parenteral drug delivery, choose age-appropriate equipment. For example, the length and gauge of a needle must be suited to the child's age and growth level. A needle that is too long for the child's size delivers a drug into the muscle rather than into the subcutaneous tissue, thereby speeding the rate of absorption.

When offering a child choices for the sake of gaining his or her cooperation during drug administration, present only those choices that truly exist. For example, do not ask a preschooler if he or she would like to take medicine now if the child does not really have the choice to refuse. Instead,

ask which drug the child wants to take first or how many bandages the child would like to apply after an injection.

Rectal Drug Therapy

Always give the patient and family a full explanation of the need to administer a drug rectally and ask the child to attempt to retain the drug for as long as possible. As always, take into consideration the developmental level of the child with the rectal administration of drugs. To allow time for the drug to be absorbed, dissuade young children from going to the bathroom and encourage them to participate in a quiet activity. Older children and adolescents need to have their privacy maintained during the administration of rectal suppositories.

Minimizing Adverse Effects

Preventing Medication Errors

Medication errors are the most common type of error in the medical care of children. Most of these errors can be prevented through appropriate actions by the individual healthcare providers (physician, pharmacist, and nurse) and by health care systems, such as hospitals. Medication errors in children are more likely to be life threatening than medication errors in adults, even though their rate of occurrence is similar. Children are more at risk because they have not physiologically matured. Immature liver or renal function, for example, can increase the circulating level of a drug beyond what would be expected in adults. The younger the child, the less likely the body organs function maximally, so infants and premature infants are at the highest risk of serious adverse effects from drug therapy and medication errors. Hughes and Edgerton's (2005) research review identifies the children most likely to be involved in a medication error. These include children:

- Younger than two years old
- In intensive care units, especially neonatal intensive care units
- In Emergency Departments between the hours of 4 AM and 8 AM or on weekends, with the highest risk for those children who are seriously ill
- Who are receiving chemotherapy
- Who are receiving IV medication
- Whose weight was not documented

Pediatric medication errors are most likely to occur in the prescribing phase and the administration phase of drug therapy. As mentioned previously, many drugs are not specifically labeled for use in children. Therefore, the efficacy, correct dose, and possible adverse effects may not be known for the drug when used in pediatric patient populations, and medication errors may result. Incorrect dosage is the most common error. When determining a drug dosage, remember that muscle mass, body water, fat content, gastric pH levels, and liver function vary greatly from the child to the adult. These variations affect the pharmacokinetics of the drug and must be considered when determining the correct dosage. Overdosage of many drugs can cause serious or even fatal effects in children. Also remember that the pediatric drug dosage is not merely a reduced adult dosage; rather, it is calculated by specific equations adjusted to the child's weight and body surface area (see Box 6.1). It is important to be proficient at using these mathematical formulas in computing the correct dose.

Of all the problems that may contribute to an incorrect dose, the most common involve errors in math during dosage calculation. Dosage calculation can involve several steps, and a mathematical error can occur at each step. Because a pediatric dose is calculated as a percentage of an adult dose, the computed pediatric dose often includes a decimal point. Misplacement of the decimal point results in a ten-fold error: either too much drug (ten times as much), or too little drug (one tenth of what it should be). *Ten-fold errors are the most common dosing error in children.* Because infants and young children require extremely small doses due to their size and immature body systems, a dose that is ten times too large may be lethal. Because mathematical computation of a drug dose is common in pediatric dosing but rare with adults, children are most likely to incur a ten-fold medication error. In addition to misplaced decimal points, errors in computing can also lead to serious medication errors. Most of the problems in dosage calculation are related to the following:

- Inability to identify the correct mathematical calculation or sequence of calculations to perform to obtain the correct answer
- Poor math skills related to using fractions, percentages, decimals, and ratios
- Infrequent use of calculation formulas
- Inexperience in applying dosage calculation formulas to actual clinical practice (Hughes & Edgerton, 2005)

Even when the pediatric drug dose is calculated correctly, it may be an incorrect dose for a particular child based on the child's illness or current physiologic state. For example, drug calculations for premature newborns (those born at less than 30 weeks' gestation) must consider not only their current weight, but also physiologic characteristics found in this age group: lower gastrointestinal motility, higher levels of extracellular body water, lower total body fat, and decreased plasma protein binding. Because of these factors, premature newborns require much smaller doses than if only weight or body surface area were considered. Children who weigh between 40 and 50 kg (the cutoff size for a pediatric patient) may in some cases be eligible for adult doses; the standardized pediatric dose conversion formulas may be less useful for these patients (Hughes & Edgerton, 2005).

Strategies to reduce the incidence of medication errors in children require efforts from both the individual health care provider and the health care system. These strategies include:

- *Always weigh the child before administering any medication.* Since most pediatric dosage is based on the weight of the child, it is not safe to give any medication without knowing the child's accurate weight. Documenting the patient's weight in kilograms, not pounds, should be standard procedure throughout the institution. Reweigh the child as indicated by disease or physical condition if the weight is likely to change (e.g., a child with cancer may lose weight due to his disease process or from an adverse effect of drug therapy). (Hughes and Edgerton, 2005; U.S. Pharmacopeia, 2003; American Academy of Pediatrics Guideline, 2003).

- *Standardize as much as possible throughout a health care system.* Standardized medication order sheets should include entry spaces for weight, age, and allergies. Standardized concentrations of high-risk drugs administered by IV infusion, such as opioids, heparin, insulin, potassium, and chemotherapy, should be used whenever possible as these prevent computation errors. Avoid use of nonapproved abbreviations and the apothecary system of measurement, as these are likely to be misinterpreted and cause errors. Standardization of equipment, such as scales and infusion pumps, will prevent errors between units or services. See Box 6.3 for research on this topic (Hughes & Edgerton, 2005; U.S. Pharmacopeia, 2003; American Academy of Pediatrics (AAP) Guideline, 2003; Kozer, Scolnik, et al., 2005; Coco, King & Slattery, 2005; White, Veltri & Fackler, 2005; and Larsen, Parker, et al., 2005).
- *Use computerized drug order entry systems where possible.* These systems help prevent medication errors made by misinterpreting illegible handwriting. These systems also can compute the correct dose based on built-in algorithms as well as built-in safety checks to confirm appropriateness of ordered drug dosages (U.S. Pharmacopeia, 2003 and AAP Guideline, 2003).
- *Use reliable drug information sources to determine the recommended dose.* If the drug label does not include a recommended pediatric dose, a computerized pharmacology database or current printed drug information references may be used. Although many nursing drug references give dosage ranges for children as well as adults, they usually do not include dosages specific to preterm and full-term neonates. When administering drugs to these patients, use a pediatric drug guide that gives ranges of pediatric dosages in mg/kg of body weight or by dose for all children.
- *Double-check each calculated dose for accuracy.* It is recommended that the pharmacist check the dose, even if it was ordered via a computer order entry system. As the nurse is the last person involved in drug delivery, the nurse is the last person to find a potential drug calculation error as well as the last person who might make an error. The nurse is responsible for ensuring the accuracy of a prescribed drug dose before it is administered. For safety, even when drug doses were previously computed by the physician, pharmacist, or both, *always double-check dosage calculations before administering any dose to a child.* Certain hospital protocols may require two nurses to independently double-check a dose prior to administration of medications that pose a high risk of injury to the child, such as chemotherapy, anticoagulants, insulin, or opioids. Inservice programs can be provided to ensure that all health care professionals are capable of accurately performing pediatric dosage calculation (Hughes & Edgerton, 2005; U.S. Pharmacopeia, 2003; AAP Guideline, 2003).
- *Measure and deliver oral medications via oral syringes only, never via syringes used to administer parenteral injections.* This precaution prevents oral medications from accidentally being given by the wrong route (U.S. Pharmacopeia, 2003).
- *Involve the family in drug administration.* Families of children need to be aware of the drug therapy that is

FOCUS ON RESEARCH BOX 6.3

Standardization and Technology Decrease Medication Errors

Larsen, G. Y., Parker, H. B., Cash, J., O'Connell, M., & Grant, M. C. (2005). Standard drug concentrations and smart-pump technology reduce continuous-medication–infusion errors in pediatric patients. *Pediatrics, 116*(1), e21–25.

The Study

A comparison of infusion therapy medication errors was undertaken before and after a university-affiliated tertiary pediatric hospital made three major changes related to the administration of medications by continuous intravenous infusions. Data were gathered from two calendar years, 2002 and 2003. The changes that were made were adoption of standard drug concentrations for infusions, the use of new "smart" syringe infusion pumps (containing computer software that includes specific drug information and policies and procedures related to administering that particular drug), and a revision of the medication label applied by the in-house pharmacy. The number of reported errors dropped by 73% overall, with an absolute risk reduction from 3.1 to 0.8 errors per 1,000 doses of medication administered. Preparation errors that occurred in the pharmacy decreased from 0.66 to 0.16 errors per 1,000 doses prepared. The number of 10-fold errors in dosage (due to a misplaced decimal point) decreased from 0.41 to 0.08 errors per 1,000 doses administered.

Nursing Implications

Medications that require a continuous intravenous infusion are frequently drugs with potentially serious adverse effects. If an incorrect dose is administered, the risk for injury is magnified significantly. Children are especially at risk of drug overdosage, as they have a much smaller body weight and surface area than adults. Additionally, determining the proper dosage for a child is often more complex than for an adult, as the dose needs to be computed based on the child's weight or body surface area. To do this, a multistep drug dosage calculation problem may be required. System-wide changes need to occur in hospitals and other settings to help minimize the risk of human errors creating a medication error. While standardization of drug concentrations does limit some of the choices of volume and rate for drug administration, standardization has been shown to decrease the errors which can occur in ordering, preparing, and administering medications in numerous settings and with various drug therapies. Combining standardized drug concentrations with the newest infusion pump technology continues to decrease the incidence of medication errors. Nurses need to be involved in product evaluation and in safety committees to help decrease the incidence of medication errors in their facilities.

prescribed for the child. By being knowledgeable about the indication, dose, and frequency of medication administration, families become active partners with the rest of the health care team in preventing medication errors (Hughes & Edgerton, 2005).

- *Communicate the drug therapy plan clearly when different nurses will be caring for the patient.* Medication errors are most likely to occur at points of transition such as at shift change or in patient transitions between units or from the hospital to another institution or to home (Hughes & Edgerton, 2005). (See Chapter 11 for more information.)

Nurses are viewed by all members of the health care team as having primary responsibility for ensuring patient safety (Cook et al., 2004). Thus, you are essential in decreasing the incidence of pediatric medication errors. Nurses have a responsibility to do two things. The first is to incorporate the above recommendations into daily practice. The second is to participate in hospital-wide safety committees to help institute system-wide recommendations.

While many of the serious adverse effects and medication errors in pediatric patients occur in acute care settings, many also occur in the home setting. See the discussion under Patient and Family Education for more information on preventing these types of errors.

Reducing Psychological Stress and Anxiety

Some adverse effects in pediatric drug therapy involve psychological distress of the child or parent. Consider age-related emotional needs when selecting appropriate communication techniques to help allay anxiety and negative, stress-provoking feelings regarding drug therapy. For school-aged children and adolescents, address feelings and discuss and answer questions as simply and honestly as possible.

Although infants do not converse, they do communicate nonverbally. Parents are helpful in providing a history of the infant's experiences, behaviors, and schedule, and they can also provide an interpretation of the infant's nonverbal cues. Infants are very much in tune with their parents and can sense their feelings. If the parents are anxious, the infant is likely to be anxious as well. Therefore, offer parents reassurance and full explanations regarding procedures and rationales. During therapy, the parents may comfort the infant by maintaining eye contact, gently stroking the head, or talking in soothing tones. Parents are not asked to restrain the infant but should be at hand to comfort the child. After drug therapy is administered, they should cuddle and comfort the child.

Because toddlers need to view drug therapy as positively as possible, they should be comforted and praised after receiving a drug regardless of whether they were cooperative or uncooperative. Whatever their behavior, they should never be referred to as a "bad boy" or "bad girl." Toddlers take pride in their accomplishments, and positive feedback and praise enhance their sense of self-esteem.

Play therapy is useful for reducing a child's anxiety and promoting understanding of drug therapy. To familiarize the child with an administration procedure, encourage role-playing with dolls and appropriate medical equipment. During role-playing, further encourage the child to express any feelings of anxiety or anger.

For preschoolers and school-aged children, take care to explore the child's experiences with the health care system. These experiences strongly influence the behavior of these children, which, like the behavior of toddlers, are accepted without value judgments. Similarly, take advantage of opportunities to provide positive feedback and avoid negativity.

Providing Patient and Family Education

A crucial step in administering pediatric drug therapy is educating the child, the parents, and other family members or caregivers. Providing honest and detailed explanations and rationales helps reassure those caring for the child. Patient and family education is especially important if drug therapy continues when the child returns home. Many pediatric medication errors occur unintentionally in the home setting because the parent does not adequately understand the drug, its effects, and the best manner to dose the drug. Include the child in drug education and provide age-appropriate explanations. Children have a right to appropriate information regarding any medicine they take. Including children in drug education, starting at an early age, helps them to grow into the role of informed consumers. The position paper *Ten Guiding Principles for Teaching Children and Adolescents About Medicines* issued by the United States Pharmacopeia encourages educating children about drug therapy. Additional resources for teaching children about medications, including guidelines for creating age-appropriate teaching materials, are also available from the United States Pharmacopeia.

Education for infant patients is directed solely toward the parent. Medication errors can result in serious adverse effects in infants. One research study of the epidemiology of medication errors in infants found that almost half of the cases reported to a regional poison control center resulted from an incorrectly measured dose, double-dosing (from multiple caregivers each providing a dose), administration of doses too closely together, or administration of the drug by the wrong route. The same study also determined that 8% of the medication errors resulted from a ten-fold error in calculating the dose. Other errors were related to pharmacy mistakes and the wrong medication given. Parents need to be taught specific drug information, including the name of the drug, what it is for, how it works, its adverse effects, and the exact dose for the child. This information should be provided in writing. Parents should be taught exactly how to measure and administer the medication to their infant. Teach the parent to use a measured-oral-dosing syringe, and have the parent demonstrate dosing with the equipment (Coco et al., 2005).

For toddlers, fully explain the rationale for drug therapy and type of administration in private, away from the toddler. Give toddlers a very brief, straightforward, honest explanation immediately before they receive drug therapy and especially before an invasive procedure. The information is supplied just before a procedure so that little time is left for their fears and anxiety to escalate.

Preschoolers require simple explanations. They often understand more than they can articulate. The information

on the drug therapy should be accurate but brief. Giving preschoolers a simple description of the medication administration procedure and calmly informing them—for example, telling them that they might feel a momentary "pinch" or "stick"—is generally sufficient to prepare them. For preschoolers, just as for toddlers, supply the information immediately before a procedure so that there is little time for their fears and anxiety to escalate. Parents or primary caregivers are usually permitted to be with the child during the procedure.

The school-aged child can understand somewhat more in-depth explanations and will ask many specific questions regarding drug therapy. Answers and explanations are honest and as detailed as necessary for the patient and parents. Information is provided on what the child wants to know, not just what the health care provider believes the child should know.

Adolescents are treated like adults with regard to full explanations and rationale for drug therapy. Invite adolescents to be involved in these discussions and encourage them to ask questions and express their feelings. Stress the importance of therapeutic adherence because adolescents are at the age when they assume more responsibility for their own health and well-being. Many adolescents take responsibility for scheduling and administering their own drug therapy.

At a minimum, include the following in initial education for school-aged children, adolescents, and parents:

- Generic and trade names of drugs
- Rationale for drug therapy
- Description of the intended therapeutic drug effect
- Route by which drug will be administered
- Schedule and duration of administration
- Potential adverse effects
- Special drug-related precautions or restrictions (e.g., relating to exercise or diet)

In addition, educate as many family members or other caregivers as possible. Doing so promotes accurate and safe drug administration to the child at home and ensures that sources of information about the child's drug history are easily found, especially in an emergency.

School-aged children and adolescents typically require instruction in proper techniques for self-administering drug therapy. For example, children with diabetes need to learn how to select injection sites and administer injections. Children with asthma need instruction in using respiratory inhalers. Other patients may need instruction in how to mix, shake, or otherwise prepare drugs before measuring the dose.

Give parents and pediatric patients as much opportunity to practice drug administration techniques as possible while you observe and offer feedback. For example, techniques are re-evaluated frequently during admissions to the hospital or at scheduled medical visits, because problems related to poor technique frequently arise. Providing parents with a dosing spoon or syringe with a line marked at the correct dose and asking them to again demonstrate how they measure the dose is an effective technique for teaching how to measure a dose properly. Spoken instructions on administering the drug are much less effective.

Emphasize to parents and children the importance of administering a drug at the appropriate times and continuing therapy for the full course of treatment. Sometimes, parents stop administering a drug once the child no longer exhibits signs or symptoms of an illness, which is especially true if the child protests or has difficulty taking the drug. Stress that interrupting drug therapy before treatment is completed may cause problems such as recurrence of an infection or development of a drug-resistant infection.

The importance of education and health promotion in pediatric drug therapy cannot be overemphasized. Preventing illness and injury helps eliminate the need for many types of drug therapy and the subsequent risk for adverse effects (Box 6.4).

BOX 6.4
COMMUNITY-BASED CONCERNS

Health Education to Minimize Drug Therapy Use and Adverse Effects in Children

- Involve the child in education about drug therapy at an age-appropriate level.
- Explain the role of childhood immunizations in maintaining health, the need to follow the recommended schedule of immunizations, the importance of receiving all recommended immunizations, and the potential adverse effects that may follow the immunization.
- Show the family and child how to perform frequent, thorough hand washing. Explain how this practice prevents the spread of infections, including cold and influenza viruses.
- Teach families the importance of the regular use of sunscreen with children to prevent sunburn resulting from drug-induced photosensitivity and to protect them against skin cancer later in life.
- Caution families to avoid accidental overdosage and poisonings by keeping all drugs (prescription and over-the-counter products) out of the reach of children, insisting on childproof caps for drug containers, and installing child-resistant latches on cupboards where drugs and other dangerous products are stored. Instruct family members never to describe drugs as "candy."
- Help patients and families develop hygienic practices that will prevent or minimize transmitting parasitic infections by fecal–oral contamination (from not washing hands after using the toilet or touching soiled diapers) or by sharing hairbrushes or hats contaminated by lice.
- Demonstrate how to use car seats appropriately for children of different ages and sizes to prevent injury in car accidents.

Ongoing Assessment and Evaluation

Nursing management of drug therapy in a child is considered effective when the developmental needs of the patient have been met, the care has involved the family, and the drug has achieved its therapeutic effect without adverse effect to the child. Children who are receiving drug therapy for chronic conditions need to be reassessed frequently and evaluated during regular yearly pediatric checkups to ensure that they are safely adhering to prescribed drug therapy, self-administering drug therapy as indicated, and growing and developing normally while undergoing drug therapy.

Chapter Summary

- Children are different from adults both physically and emotionally, and these differences seriously affect the planning of safe and effective drug therapy.
- Most drugs have not been tested for efficacy or safety in children and thus are prescribed off-label to children. Additional monitoring for adverse effects from drug therapy is necessary when drugs are used off-label.
- A child's age, growth, and development are crucial considerations in relating core drug knowledge with core patient variables in drug therapy.
- A child's age, weight, body surface area, water content, and fat content must be considered when determining the proper dose of a drug. Drug dosage is calculated for each child, using mathematical formulas. Most drug dosages are calculated based on the child's weight. No medication should be administered unless the current weight is documented on the chart.
- Pediatric dosages must be accurate because even small errors can cause adverse effects, toxicity, or death. A misplaced decimal point results in a ten-fold dosing error. This is the most common dosage calculation error occurring in children. The nurse independently verifies all dosage calculations made by other health care providers prior to administering each dose.
- To maximize the therapeutic effect of any drug, the nurse must ensure that all of the appropriate dose is administered by the desired route.
- Many of the adverse effects of drug therapy can be avoided or minimized by ensuring that the child receives the appropriate drug dosage calculated specifically for him or her. Nurses should have access to a pediatric drug reference, guide, or electronic data base that gives the pediatric ranges for drug doses, including those for preterm and full-term neonates.
- In addition to determining the correct dose for a child, pediatric medication errors can be prevented by standardizing as much as possible within a hospital setting, using computerized order entry whenever possible, using the appropriate administration equipment, involving the family in medication administration, and carefully communicating the drug therapy plan at points of transition in care.
- One of the adverse effects in pediatric drug administration is psychological distress in the child or parent. The nurse who uses knowledge of age-related emotional needs and communication techniques can greatly help relieve this emotional distress and enhance compliance with drug therapy.
- Patient and family education regarding drug therapy should include information needed to help the child take the drug safely and effectively. Teaching involves giving honest and straightforward explanations about drug therapy, answering questions, allaying patient and family anxiety, and emphasizing the importance of drug compliance. Parents should be taught how to measure a correct dose at home and how to use the appropriate measuring/dosing tool.

Questions For Study and Review

1. How does the neonate's and infant's liver function affect drug distribution?
2. What is body surface area? How is body surface area utilized in pediatric drug therapy?
3. What dose adjustment might be expected when a water-soluble drug is given to an infant?
4. Are all drugs that are safe for adults also safe for children?
5. A three-year-old child is hospitalized and is to receive amoxicillin, an antibiotic. The recommended dose is 25 mg/kg/day in divided doses every 12 hours. The child weighs 20 kg. What is the correct dose that should be administered every 12 hours? What should you do to prevent the most common pediatric medication error when administering the amoxicillin?
6. What is the appropriate site of an IM injection for an infant?
7. Why is it important to assess the preschooler's or school-aged child's past experience with health care providers and drug therapy? Why is patient and family education important with pediatric patients?

Need More Help?

Chapter 6 of the Study Guide to Accompany *Drug Therapy in Nursing,* 3rd Edition, contains NCLEX-style questions and other learning activities to reinforce your understanding of the concepts presented in this chapter. For additional information or to purchase the study guide, visit thePoint: **http://thepoint.lww.com/aschenbrenner3e**

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