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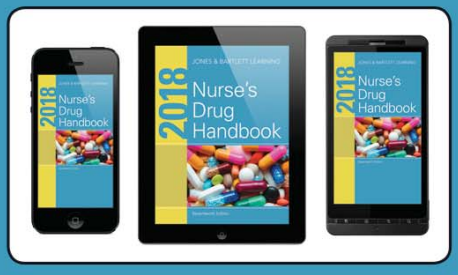
2018

Nurse's Drug Handbook

Seventeenth Edition



Mobile Apps Available!

See back cover for details!

Mechanism-of-Action Illustrations

Drugs with illustrated mechanisms of action	Drugs with similar mechanisms of action
enoxacin	alatrofloxacin mesylate, cinoxacin, ciprofloxacin, gatifloxacin, levofloxacin, lomefloxacin hydrochloride, moxifloxacin hydrochloride, nalidixic acid, norfloxacin, ofloxacin, sparfloxacin, trovafloxacin mesylate
etanercept	infliximab
exenatide	none
ezetimibe	none
famotidine	cimetidine, nizatidine, ranitidine hydrochloride
hydrochlorothiazide	chlorothiazide, chlorothiazide sodium, chlorthalidone, indapamide, metolazone
ipratropium bromide	none
isosorbide dinitrate, isosorbide mononitrate	nitroglycerin
lanthanum carbonate	sevelamer hydrochloride
levodopa	none
linezolid	none
memantine hydrochloride	none
milrinone lactate	inamrinone (formerly amrinone lactate)
nateglinide	repaglinide
olmesartan medoxomil	irbesartan, losartan potassium, valsartan
omeprazole	esomeprazole magnesium, lansoprazole, pantoprazole sodium, rabeprazole sodium
orlistat	none
palonosetron hydrochloride	alosetron, dolasetron, granisetron, ondansetron
phenelzine sulfate	isocarboxazid, tranylcypromine sulfate

(continued)

Mechanism-of-Action Illustrations

Drugs with illustrated mechanisms of action	Drugs with similar mechanisms of action
remifentanil hydrochloride	codeine phosphate, codeine sulfate, fentanyl citrate, fentanyl transdermal, fentanyl transmucosal, hydrocodone bitartrate and acetaminophen, hydrocodone and ibuprofen, hydromorphone hydrochloride, levomethadyl acetate hydrochloride, levorphanol tartrate, meperidine hydrochloride, methadone hydrochloride, morphine sulfate, oxycodone and acetaminophen, oxycodone hydrochloride, oxymorphone hydrochloride, propoxyphene hydrochloride
reserpine	guanadrel sulfate, guanethidine monosulfate
spironolactone	none
tacrine hydrochloride	donepezil hydrochloride, galantamine hydrobromide, rivastigmine tartrate
teriparatide	none
tubocurarine chloride	atracurium besylate
vasopressin	desmopressin acetate, lypressin
ziconotide	none

2018 Nurse's Drug Handbook

The Drug Reference That Gives You More!

Now the authoritative Jones & Bartlett Learning ***2018 Nurse's Drug Handbook*** goes wherever you do with an affordably priced app for Android, iPhone, and iPad.

- Accurate index of all generic, trade, and alternate drug names for quick reference with timely facts on hundreds of drugs from A–Z
- No-nonsense style that speaks your language in terms you use every day
- Mechanism-of-action illustrations show how drugs work at the cellular, tissue, or organ levels

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LEARNING

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ISBN: 978-1-284-12134-6

Production Credits
VP, Product Management: David D. Cella
Director of Product Management: Amanda Martin
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Senior Vendor Manager: Sara Kelly
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Product Fulfillment Manager: Wendy Kilborn
Composition and Project Management: S4Carlisle Publishing Services
Cover Design: Kristin E. Parker
Rights & Media Specialist: Wes DeShano
Media Development Editor: Troy Liston
Cover Image: © ajt/Shutterstock
Printing and Binding: Edwards Brothers Malloy
Cover Printing: Edwards Brothers Malloy

6048

Printed in the United States of America
21 20 19 18 17 10 9 8 7 6 5 4 3 2 1

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How to Use This Book

Jones & Bartlett Learning *Nurse's Drug Handbook* gives you what today's nurses and nursing students need: accurate, concise, and reliable drug facts. This book emphasizes the vital information you need to know before, during, and after drug administration. The information is presented in easy-to-understand language and organized alphabetically, so you can find what you need quickly.

What's Special

In addition to the drug information you expect to find in each entry (see "Drug Entries" for details), the *Nurse's Drug Handbook* boasts these special features:

- **A new design** makes it easy to find the most need-to-know drug information, such as indications, dosages, dosage adjustments, and warnings.
- **A new size** makes the *Nurse's Drug Handbook* easier and more convenient to carry and use. But even though the book is now smaller and more convenient to carry, this new edition contains more drug information than ever. We made the book smaller and better without taking anything out.
- **Practical trim size** allows the book to open flat so you can find the information you need without wrestling with a book that wants to close. You can hold the book in one hand, see complete pages at a glance, and use your other hand to document or perform other activities.
- **Introductory material** reviews essential general information you need to know to administer drugs safely and effectively, including an overview of pharmacology and the principles of drug administration. In addition, the five steps of the nursing process are explained and related specifically to drug therapy.
- **Highly useful illustrations** throughout the text help you visualize selected mechanisms of action by showing how drugs work at the cellular, tissue, and organ levels. In addition, the inside front cover features a table listing all the drugs whose mechanisms of action are illustrated, as well as other drugs with the same mechanisms of action.
- **No-nonsense writing style** speaks in everyday language and uses the terms and abbreviations you typically encounter in your practice and your studies. To avoid sexist language, we alternate between male and female pronouns throughout the book.
- **Up-to-date drug information** includes the latest FDA-approved drugs, new and changed indications, new warnings, and newly reported adverse reactions.
- **Dosage adjustment,** headlined in color, alerts you to expected dosage changes for a patient with a specific condition or disorder, such as advanced age or renal impairment.
- **Warning,** displayed in color, calls attention to important facts that you need to know before, during, and after drug administration. For example, in the alatrofloxacin entry, this feature informs you that the drug is usually reserved for hospitalized patients and is given for no more than 2 weeks because of the high risk of severe liver damage.
- **Easy-to-use tables** showing route, onset, peak, and duration (see page *xv* for more details), and other tables in the appendices provide a time-saving way to track and check information. The appendices give you an overview of the most important facts and nursing considerations for important drug groups, including insulin preparations and oral allergen extracts, selected antihistamines, ophthalmics, topical drugs, antivirals, antineoplastic drugs, interferons, and antihypertensive combination drugs, as well as selected obstetrical drugs and vitamins. You'll also find handy instructions for calculating drug dosages and I.V. flow rates.

Drug Entries

The *Nurse's Drug Handbook* clearly and concisely presents all the vital facts on the drugs that you'll typically administer. To help you find the information you

need quickly, drug entries are organized alphabetically by generic drug name—from abatacept to zonisamide. For ease of use, every drug entry follows a consistent format. However, if specific details are unknown or don't apply, the heading isn't included so you can go right to the next section.

GENERIC AND TRADE NAMES

First, each entry identifies the drug's main generic name, as well as alternate generic names. (For drugs prescribed by trade name, you can quickly check the comprehensive index, which refers you to the appropriate generic name and page.)

Next, the entry lists the most common U.S. trade names for each drug. It also includes common trade names available only in Canada, marked (CAN).

CLASS, CATEGORY, AND SCHEDULE

Each entry lists the drug's chemical and therapeutic classes. With this information, you can compare drugs in the same chemical class but in different therapeutic classes, and vice versa.

The entry also lists the FDA's pregnancy risk category, which categorizes drugs based on their potential to cause birth defects. (For details, see *FDA pregnancy risk categories*.)

However, effective after June 30, 2015, new prescription drugs submitted to the FDA for approval will no longer be allowed to use the lettering system to categorize drugs based on their potential to cause birth defects. Instead, a new, more comprehensive text will be required in the label to explain the risks. Prescription drugs currently using the lettering system to identify potential for a drug to cause birth defects will be gradually phased into the new labeling requirement. Labeling of over-the-counter drugs will remain unchanged and is not affected by the FDA-mandated change.

Where appropriate, the entry also includes the drug's controlled substance schedule. (For details, see *Controlled substance schedules,* page *xv*.)

FDA pregnancy risk categories

Each currently prescribed drug may be placed in a pregnancy risk category based on the FDA's estimate of risk to the fetus. If the FDA hasn't provided a category, the *Drug Handbook* notes that the drug is "Not rated." The categories range from A to X, signifying least to greatest fetal risk. Note that pregnancy risk categories will no longer be used in drug labeling for drugs approved after June 30, 2015, and existing drug labels that use the category will be gradually phased into the new labeling requirements.

A Controlled studies show no risk

Adequate, well-controlled studies with pregnant women have failed to demonstrate a risk to the fetus in any trimester of pregnancy.

B No evidence of risk in humans

Adequate, well-controlled studies with pregnant women haven't shown increased risk of fetal abnormalities, despite adverse findings in animals, or, in the absence of adequate human studies, animal studies show no fetal risk. The chance of fetal harm is remote, but remains possible.

C Risk can't be ruled out

Adequate, well-controlled human studies are lacking, and animal studies have shown a risk to the fetus or are lacking as well. A chance of fetal harm exists if the drug is given during pregnancy, but the potential benefits may outweigh the risk.

D Positive evidence of risk

Studies in humans, or investigational or postmarketing data, have shown fetal risk. Nevertheless, potential benefits from the drug's use may outweigh risks. For example, the drug may be acceptable if needed in a life-threatening situation or to treat a serious disease for which safer drugs can't be used or are ineffective.

X Contraindicated in pregnancy

Studies in animals or humans, or investigational or postmarketing reports, have shown positive evidence of fetal abnormalities or risks that clearly outweigh any possible benefit to the patient.

Controlled substance schedules

The Controlled Substances Act of 1970 mandated that certain prescription drugs be categorized in schedules based on their potential for abuse. The greater their potential for abuse, the greater the restrictions on their prescription. The controlled substance schedules range from I to V, signifying highest to lowest abuse potential.

I High potential for abuse

No accepted medical use exists for schedule I drugs, which include heroin and lysergic acid diethylamide (LSD).

II High potential for abuse

Use may lead to severe physical or psychological dependence. Prescriptions must be written in ink or typewritten and must be signed by the prescriber. Oral prescriptions must be confirmed in writing within 72 hours and may be given only in a genuine emergency. No renewals are permitted.

III Some potential for abuse

Use may lead to low-to-moderate physical dependence or high psychological dependence. Prescriptions may be oral or written. Up to five renewals are permitted within 6 months.

IV Low potential for abuse

Use may lead to limited physical or psychological dependence. Prescriptions may be oral or written. Up to five renewals are allowed within 6 months.

V Subject to state and local regulation

Abuse potential is low; a prescription may not be required.

INDICATIONS AND DOSAGES

This section lists FDA-approved therapeutic indications. For each indication, you'll find the applicable drug form or route, age group (adults, adolescents, or children), and dosage (which includes amount per dose, timing, and duration, when known and appropriate).

ROUTE, ONSET, PEAK, AND DURATION

Quick-reference tables show the drug's onset, peak, and duration (when known) for each administration route. The onset of action is the time a drug takes to be absorbed, reach a therapeutic blood level, and elicit an initial therapeutic response. The peak therapeutic effect occurs when a drug reaches its highest blood concentration and the greatest amount of drug reaches the site of action to produce the maximum therapeutic response. The duration of action is the amount of time the drug remains at a blood level that produces a therapeutic response.

MECHANISM OF ACTION

This section concisely describes how a drug achieves its therapeutic effects at cellular, tissue, and organ levels, as appropriate. Illustrations of selected mechanisms of action lend exceptional clarity to sometimes complex processes.

INCOMPATIBILITIES

In this section, you'll be alerted to drugs or solutions that are incompatible with the topic drug when mixed in a syringe or solution, or when infused through the same I.V. line.

CONTRAINDICATIONS

An alphabetical list details the conditions and disorders that preclude administration of the topic drug.

INTERACTIONS

This section includes drugs, foods, and activities (such as alcohol use and smoking) that can cause important, problematic, or life-threatening interactions with the topic drug. For each interacting drug, food, or activity, you'll learn the effects of the interaction.

ADVERSE REACTIONS

Organized by body system, this section highlights common, serious, and life-threatening adverse reactions.

NURSING CONSIDERATIONS

Warnings, general precautions, and key information that you must know before, during, and after drug administration are

Teaching your patient about drug therapy

Your teaching about drug therapy will vary with your patient's needs and your practice setting. To help guide your teaching, each drug entry provides key information that you must teach your patient about that drug. For all patients, however, you also should:

- ✓ Teach the generic and trade name for each prescribed drug that he'll take after discharge—even if he took the drug before admission.
- ✓ Clearly explain why each drug was prescribed, how it works, and what it's supposed to do. To help your patient understand the drug's therapeutic effects, relate its action to her disorder or condition.
- ✓ Review the drug form, dosage, and route with the patient. Tell him whether the drug is a tablet, suppository, spray, aerosol, or other form, and explain how to take it correctly. Also, tell him how often to take the drug and for what length of time. Emphasize that he should take the drug exactly as prescribed.
- ✓ Describe the drug's appearance, and explain that scored tablets can be broken in half for safe, accurate dosing. Warn the patient not to break unscored tablets, because doing so may alter the drug dosage. If your patient has trouble swallowing capsules, explain that she can open ones that contain sprinkles and take them with food or a drink but that she shouldn't do this with capsules that contain powder. Also, warn her not to crush or chew enteric-coated, extended-release, sustained-release, or similar drug forms.
- ✓ Teach the patient about common adverse reactions that may occur. Advise him to notify the prescriber at once if a dangerous adverse reaction, such as syncope, occurs.
- ✓ Warn her not to suddenly stop taking a drug if she's bothered by unpleasant adverse reactions, such as a rash and mild itching. Instead, encourage her to discuss the reactions with her prescriber, who may adjust the dosage or substitute a drug that causes fewer adverse reactions.
- ✓ Because drugs may cause adverse reactions (such as dizziness and drowsiness) that can impair the patient's ability to perform activities that require alertness, help him develop a dosing schedule that prevents these adverse reactions.
- ✓ Inform the patient which adverse reactions resolve with time.
- ✓ Teach the patient how to store the drug properly. Let him know if the drug is sensitive to light or temperature and how to protect it from these elements.
- ✓ Instruct the patient to store the drug in its original container, if possible, with the drug's name and dosage clearly printed on the label.
- ✓ Inform the patient which devices to use—and which to avoid—for drug storage or administration. For example, warn him not to take liquid cyclosporine with a plastic cup or utensils.
- ✓ Teach the patient what to do if she misses a dose. Generally, she should take a once-daily drug as soon as she remembers—provided that she remembers within the first 24 hours. If 24 hours have elapsed, she should take the next scheduled dose, but she should not double the dose. If she has questions or concerns about missed doses, tell her to contact the prescriber.
- ✓ Provide information specific to the prescribed drug. For example, if a patient takes a diuretic to manage heart failure, instruct him to weigh himself daily at the same time of day, using the same scale, and wearing the same amount of clothing. Or, if the patient takes digoxin or an antihypertensive drug, teach him how to measure his pulse and blood pressure and how to record the measurements. Then instruct him to bring the diary to his regular appointments so the prescriber can monitor his response to the drug.
- ✓ Advise the patient to refill prescriptions promptly, unless she no longer needs the drug. Also instruct her to discard expired drugs because they may become ineffective or even dangerous over time.
- ✓ Warn the patient to keep all drugs out of the reach of children at all times.

detailed in this section. Examples include whether a pill can be crushed and how to properly reconstitute, dilute, store, handle, or dispose of a drug.

Patient teaching information is also included here. You'll find important guidelines for patients, such as how and when to take each prescribed drug, how to spot and manage adverse reactions, which cautions to observe, when to call the prescriber, and more. To save your time, however, this section doesn't repeat basic patient-teaching points. (For a summary of those, see *Teaching your patient about drug therapy,* page *xvi,* and *Federal guidelines for drug disposal,* page *xvii.*)

In short, Jones & Bartlett Learning *Nurse's Drug Handbook* is designed expressly to give you more of what you need. It puts vital drug information at your fingertips and helps you always stay current in this critical part of your practice or studies.

Federal guidelines for drug disposal

Give patients these important instructions for properly disposing of their unwanted prescription drugs:

- ✓ Take unused, unneeded, or outdated prescription drugs out of their original containers and throw them in the trash.
- ✓ Consider mixing discarded prescription drugs with a substance like coffee grounds or used cat litter and putting them in impermeable, nondescript containers, such as empty cans or sealable bags.
- ✓ Flush prescription drugs down the toilet only if the label or accompanying patient information specifically tells you to do so.
- ✓ See if your community has a pharmaceutical take-back program that allows citizens to bring unused drugs to a central location for proper disposal.

Foreword

Safe, effective drug therapy is one of your most important responsibilities. Not infrequently, a patient's life will depend on your ability to give drugs accurately and safely. In addition, you must keep up with the latest drug information, including newly approved drugs and recently reported life-threatening adverse reactions, as well as those drugs withdrawn from the market after widespread use.

Despite all the drug information available, medication errors remain one of the greatest threats to patients' well-being and a leading cause of lawsuits against nurses, physicians, and hospitals.

Your Responsibilities in Drug Therapy

Your basic responsibilities in drug therapy include the following:

- Administer the right drug in the right dose by the right route at the right time to the right patient using the right preparation and administration.
- Know the therapeutic use, dosage, interactions, adverse reactions, and warnings of each administered drug.
- Be aware of newly approved drugs that may be prescribed.
- Know about changes to existing drugs, such as new indications and dosages and recently discovered adverse reactions and interactions.
- Concentrate fully when preparing and administering drugs.
- Respond promptly and appropriately to serious or life-threatening adverse reactions, interactions, and complications.
- Instruct each patient about the drug, how it's administered, which effects it causes or may cause, and which reactions to watch for and report.

Several factors may reduce your ability to meet these basic responsibilities—and contribute to medication errors. First, hospitals and other healthcare facilities have budget constraints that may result in elimination of professional nursing positions or the hiring of less qualified technicians to fill them. This forces the remaining nurses to care for more patients. Second, many hospital patients are older and more acutely ill, and they typically receive more complex drug therapy than ever. Together, these factors place greater demands on you—increasing your stress level, reducing the time you have to concentrate on drug administration, and increasing your risk of making medication errors or overlooking serious adverse reactions or interactions.

The same factors reduce your time and energy for learning the latest drug facts—which you need to have at your command. You must have this information at your fingertips because your next patient may need a recently approved drug or a complex and unfamiliar drug regimen.

How can you balance your limited time with your need to know the latest developments?

Meeting Your Needs

Nurses and students need a reliable, accurate, easy-to-use, quick-reference drug book. They need a book clearly written by and for nurses that has been reviewed by experts in nursing and pharmacology. You hold such a book in your hands: Jones & Bartlett Learning *Nurse's Drug Handbook,* with features that are always current.

The content of *Nurse's Drug Handbook* was developed, written, and edited by experienced practicing nurses. Expert consultants, reviewers, and advisors—both nurses and pharmacists—help ensure the accuracy and reliability of the information covered in each entry and help target that information to your needs. What's more, every drug fact is checked against the most prominent drug references today, including the drug's package insert approved by the FDA, *American Hospital Formulary Service Drug Information, Drug Facts and Comparisons, The Physicians' Desk Reference,* the FDA's website of new drug approvals, and the

USP DI's *Drug Information for the Health Care Professional.* In addition, to help you quickly access much-needed information, the book is organized alphabetically by generic drug name, follows a consistent format, and is concise.

To ensure that you're always current, Jones & Bartlett Learning *Nurse's Drug Handbook* is updated every year. This newest edition contains:

- Important new drug entries in the main part of the book and in the appendices.
- New drug facts on hundreds of existing entries, including updated information on new indications and dosages, new incompatibilities and interactions, new adverse reactions, and new nursing considerations.
- Hundreds of patient-teaching guidelines and suggestions.
- Thoroughly updated appendices on insulin preparations, oral allergen extracts, antiviral drugs, topical drugs, antihistamines, combination antihypertensive drugs, interferons, ophthalmic drugs, and antineoplastic drugs, as well as selected obstetrical drugs and vitamins.
- A comprehensive new index.

And as always, you'll find the same color-coded, highly readable type that reduces eyestrain as you speed to the information you need.

Getting More from Your Drug Reference Handbook

Whether you currently work in or are preparing to work in acute care, home care, long-term care, or another healthcare setting, you'll want your own copy of the *Nurse's Drug Handbook.* That's because this book can help you:

- Reduce your risk of medication errors because you'll have easy access to accurate, reliable drug information that's relevant to your practice.
- Stay current on the most up-to-date drug developments of the year.
- Improve your drug administration skills and patient care before, during, and after drug therapy.
- Quickly detect and manage serious or life-threatening adverse reactions and complications or prevent them from occurring.
- Save time because you won't have to sift through volumes of information to find what you need, search for a book that's up-to-date, or look through several drug handbooks to get enough information.
- Increase your confidence about drug administration and enhance your professional interactions with other healthcare team members.
- Ensure the delivery of safe, effective care.
- Improve the depth and quality of your patient teaching.

Reaping the Rewards

Your patients deserve the best and safest care possible—and you deserve to have the tools to deliver that care. Whether you're a student or an experienced clinician, Jones & Bartlett Learning *Nurse's Drug Handbook* will help you provide safe, effective drug therapy because of its practical, easy-to-understand, accurate, and reliable information on virtually all the drugs you're likely to administer.

This handbook has aided thousands of nurses in their patient care. Take it with you to the clinical setting, share it with your peers, and use it to enhance your present and future position in the nursing profession.

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Overview of Pharmacology

Understanding the basics of pharmacology is an essential nursing responsibility. Pharmacology is the science that deals with the physical and chemical properties, and biochemical and physiologic effects, of drugs. It includes the areas of pharmacokinetics, pharmacodynamics, pharmacotherapeutics, pharmacognosy, and toxicodynamics.

The *Nurse's Drug Handbook* deals primarily with pharmacokinetics, pharmacodynamics, and pharmacotherapeutics—the information you need to administer safe and effective drug therapy (discussed as follows). Pharmacognosy is the branch of pharmacology that deals with the biological, biochemical, and economic features of naturally occurring drugs. Toxicodynamics is the study of the harmful effects that excessive amounts of a drug produce in the body; in a drug overdose or drug poisoning, large drug doses may saturate or overwhelm normal mechanisms that control absorption, distribution, metabolism, and excretion.

Drug Nomenclature

Most drugs are known by several names—chemical, generic, trade, and official—each of which serves a specific function. (See *How drugs are named*.) However, multiple drug names can also contribute to medication errors. You may find a familiar drug packaged with an unfamiliar name if your institution changes suppliers or if a familiar drug is newly approved in a different dose or for a new indication.

Drug Classification

Drugs can be classified in various ways. Most pharmacology textbooks group drugs by their functional classification, such as psychotherapeutics, which is based on common characteristics. Drugs can also be classified according to their therapeutic use, such as antipanic or

How drugs are named

A drug's chemical, generic, trade, and official names are determined at different phases of the drug development process and serve different functions. For example, the various names of the commonly prescribed anticonvulsant divalproex sodium are:

- Chemical name: pentanoic acid, 2-propyl-, sodium salt (2:1), or ($C_{16}H_{31}O_4Na$)
- Generic name: divalproex sodium
- Trade name: Depakote
- Official name: divalproex sodium delayed-release tablets, USP

A drug's chemical name describes its atomic and molecular structure. The chemical name of divalproex sodium—pentanoic acid, 2-propyl-, sodium salt (2:1), or $C_{16}H_{31}O_4Na$ (pronounced valproate semisodium)—indicates that the drug is a combination of two valproic acid compounds with a sodium molecule attached to only one side.

Once a drug successfully completes several clinical trials, it receives a generic name, also known as the nonproprietary name. The generic name is usually derived from, but shorter than, the chemical name. The United States Adopted Names Council is responsible for selecting generic names, which are intended for unrestricted public use.

Before submitting the drug for FDA approval, the manufacturer creates and registers a trade name (or brand name) when the drug appears ready to be marketed. Trade names are copyrighted and followed by the symbol ® to indicate that they're registered and that their use is restricted to the drug manufacturer. Once the original patent on a drug has expired, any manufacturer may produce the drug under its own trade name.

A drug's official name is the name under which it's listed in the United States Pharmacopoeia (USP) and the National Formulary (NF).

antiobsessional drugs. Drugs within a certain therapeutic class may be further divided into subgroups based on their mechanisms of action. For example, the therapeutic class antineoplastics can be further classified as alkylating agents, antibiotic antineoplastics, antimetabolites, antimitotics, biological response modifiers, antineoplastic enzymes, and hormonal antineoplastics.

Pharmacokinetics

Pharmacokinetics is the study of a drug's actions—or fate—as it passes through the body during absorption, distribution, metabolism, and excretion.

ABSORPTION

Before a drug can begin working, it must be transformed from its pharmaceutical dosage form to a biologically available (bioavailable) substance that can pass through various biological cell membranes to reach its site of action. This process is known as absorption. A drug's absorption rate depends on its route of administration, its circulation through the tissue into which it's administered, and its solubility—that is, whether it's more water soluble (*hydrophilic*) or fat soluble (*lipophilic*).

Although drugs may penetrate cellular membranes either actively or passively, most drugs do so by *passive diffusion*, moving inertly from an area of higher concentration to an area of lower concentration. Passive diffusion may occur through water or fat. Passive diffusion through water—*aqueous diffusion*—occurs within large water-filled compartments, such as interstitial spaces, and across epithelial membrane tight junctions and pores in the epithelial lining of blood vessels. Aqueous diffusion is driven by concentration gradients. Drug molecules that are bound to large plasma proteins, such as albumin, are too large to pass through aqueous pores in this way. Passive diffusion through fat—*lipid diffusion*—plays an important role in drug metabolism because of the large number of lipid barriers that separate the aqueous compartments of the body. The tendency of a drug to move through lipid layers between aqueous compartments often depends on the pH of the medium—that is, the ability of the water-soluble or fat-soluble drug to form weak acid or weak base.

Drugs with molecules that are too large to readily diffuse may rely on active *diffusion*, in which special carriers on molecules, including peptides, amino acids, and glucose, transport the drug through the membranes. However, some molecules with selective membrane carriers can expel foreign drug molecules; this is why many drugs can't cross the blood–brain barrier.

Drug absorption begins at the administration route. The three main administration route categories are enteral, parenteral, and transcutaneous. Depending on its nature or chemical makeup, a drug may be better absorbed from one site than from another.

Enteral Administration

Enteral administration consists of the oral, nasogastric, and rectal routes.

Oral: Drugs administered orally are absorbed in the GI tract and then proceed by the hepatic portal vein to the liver and into the systemic circulation. Although generally considered the preferred route, oral drug administration has a number of disadvantages:

- The oral route doesn't always yield sufficiently high blood concentrations to be effective.
- Bioavailability may be less than optimal because of incomplete absorption and first-pass elimination (the part of metabolism that occurs during transit through the liver before the drug reaches the general circulation).
- Drug absorption may be incomplete if the drug is degraded by digestive enzymes or the acidic pH in the stomach or if it's excreted from the liver into the bile.
- Food in the GI tract, gastric emptying time, and intestinal motility may also impede drug absorption.

Nasogastric: Drugs administered through a nasogastric tube enter the stomach directly and are absorbed in the GI tract.

Rectal: Rectal drugs and suppositories also enter the GI tract directly after being inserted in the rectum and absorbed through the rectal mucosa. After being absorbed into the lower GI tract, rectal drugs enter the circulation through the inferior vena cava, bypassing the liver and thus avoiding first-pass metabolism. Suppositories, however, tend to travel upward into the rectum, where veins, such as the superior hemorrhoidal vein, lead to the liver. As a result, drug absorption by this route is often unreliable and difficult to predict.

Parenteral Administration

Parenteral routes may be used whenever enteral routes are contraindicated or inadequate. These routes include intramuscular (I.M.), intravenous (I.V.), subcutaneous, and intradermal administration. Drug absorption is much faster and more predictable after parenteral administration than after enteral administration.

I.M.: Drugs administered by the I.M. route are injected deep into the muscle, where they're absorbed relatively quickly. The rate of drug absorption depends on the vascularity of the injection site, the physiochemical properties of the drug, and the solution in which the drug is contained.

I.V.: I.V. drug administration involves injecting or infusing the drug directly into the blood circulation, allowing for rapid distribution throughout the body. This route usually provides the greatest bioavailability.

Subcutaneous: Drugs administered by the subcutaneous route are injected into the connective tissue just below the skin and are absorbed by simple diffusion from the injection site. The factors that affect I.M. absorption also affect subcutaneous absorption. Absorption by the subcutaneous route may be slower than by the I.M. route.

Intradermal: Drugs administered intradermally, such as purified protein derivative (PPD), are injected into the dermis, from which they diffuse slowly into the local microcapillary system.

Transcutaneous Administration

Transcutaneous drug administration allows drug absorption through the skin or soft-tissue surface. Drugs may be inhaled, inserted sublingually, applied topically, or administered by the eyes, ears, nose, or vagina.

Inhalation: Inhaled drugs may be given as a powder and aerosolized or mixed in solution and nebulized directly into the respiratory tract, where they're absorbed through the alveoli. Inhaled drugs are usually absorbed quickly because of the abundant blood flow in the lungs, though some inhaled drugs have low systemic absorption.

Sublingual: Sublingual drug administration involves placing a tablet, troche, or lozenge under the tongue. The drug is absorbed across the epithelial lining of the mouth, usually quickly. This route avoids first-pass metabolism.

Topical: Topical drugs—creams, ointments, lotions, and patches—are placed on the skin and then cross the epidermis into the capillary circulation. They may also be absorbed through sweat glands, hair follicles, and other skin structures. Absorption by the skin is enhanced if the drug is in a solution.

Ophthalmic: Ophthalmic drugs include solutions and ointments that are instilled or applied directly to the cornea or conjunctiva as well as small, elliptical disks that are placed directly on the eyeball behind the lower eyelid. The movements of the eyeball promote distribution of these drugs over the surface of the eye. Although ophthalmic drugs produce a local effect on the conjunctiva or anterior chamber, some preparations may be absorbed systemically and therefore produce systemic effects.

Otic: Drops administered into the external auditory canal, otic drugs are used to treat infection or inflammation and to soften and remove ear wax. Otic solutions exert a local effect and may result in minimal systemic absorption with no adverse effects.

Nasal: Nasal solutions and suspensions are applied directly to the nasal mucosa by instillation or inhalation to produce local effects, such as vasoconstriction to reduce nasal congestion. Some nasal solutions, such as vasopressin, are administered by this route specifically to produce systemic effects.

Vaginal: Vaginal drugs include creams, suppositories, and troches that are inserted into the vagina, sometimes using a special applicator. These drugs are administered locally to treat such conditions as bacterial and fungal infections.

DISTRIBUTION

Distribution is the process by which a drug is transported by the circulating fluids to various sites, including its sites of action. To ensure maximum therapeutic effectiveness, the drug must permeate all membranes that separate it from its intended site of action. Drug distribution is influenced by blood flow, tissue availability, and protein binding. Drugs that cannot distribute to the tissues in which they are needed are not effective.

METABOLISM

Drug metabolism is the enzymatic conversion of a drug's structure into substrate molecules or polar compounds that are either less active or inactive and are readily excreted. Drugs can also be synthesized to larger molecules. Metabolism may also convert a drug to a more toxic compound. Because the primary site of drug metabolism is the liver, children, the elderly, and patients with impaired hepatic function are at risk for altered therapeutic effects.

Biotransformation is the process of changing a drug into its active metabolite. Compounds that require metabolic biotransformation for activation are known as *prodrugs*. During phase I of biotransformation, the parent drug is converted into an inactive or partially active metabolite. Much of the original drug may be eliminated during this phase. During phase II, the inactive or partially active metabolite binds with available substrates, such as acetic acid, glucuronic acid, sulfuric acid, or water, to form its active metabolite. When biotransformation leads to synthesis, larger molecules are produced to create a pharmacologic effect.

EXCRETION

The body eliminates drugs by both metabolism and excretion. Drug metabolites—and, in some cases, the active drug itself—are eventually excreted from the body, usually through bile, feces, and urine. The primary organ for drug elimination is the kidney. Impaired renal function may alter drug elimination, thereby altering the drug's therapeutic effect. Other excretion routes include evaporation through the skin, exhalation from the lungs, and secretion into saliva and breastmilk.

A drug's elimination half-life is the amount of time required for half of the drug to be eliminated from the body. The half-life roughly correlates with the drug's duration of action and is based on normal renal and hepatic function. Typically, the longer the half-life, the less often the drug has to be given and the longer it remains in the body.

Pharmacodynamics

Pharmacodynamics is the study of the biochemical and physiologic effects of drugs and their mechanisms of action. A drug's actions may be structurally specific or nonspecific. Structurally specific drugs combine with cell receptors, such as proteins or glycoproteins, to enhance or inhibit cellular enzyme actions. Drug receptors are the cellular components affected at the site of action. Many drugs form chemical bonds with drug receptors, but a drug can bond with a receptor only if it has a similar shape—much the same way that a key fits into a lock. When a drug combines with a receptor, channels are either opened or closed and cellular biochemical messengers, such as cyclic adenosine monophosphate or calcium ions, are activated. Once activated, cellular functions can be turned either on or off by these messengers.

Structurally nonspecific drugs, such as biological response modifiers, don't

combine with cell receptors; rather, they produce changes within the cell membrane or interior.

The mechanisms by which drugs interact with the body are not always known. Drugs may work by physical action (such as the protective effects of a topical ointment) or chemical reaction (such as an antacid's effect on the gastric mucosa), or by modifying the metabolic activity of invading pathogens (such as an antibiotic) or replacing a missing biochemical substance (such as insulin).

AGONISTS

Agonists are drugs that interact with a receptor to stimulate a response. They alter cell physiology by binding to plasma membranes or intracellular structures. *Partial agonists* can't achieve maximal effects even though they may occupy all available receptor sites on a cell. *Strong agonists* can cause maximal effects while occupying only a small number of receptor sites on a cell. *Weak agonists* must occupy many more receptor sites than strong agonists to produce the same effect.

ANTAGONISTS

Antagonists are drugs that attach to a receptor but don't stimulate a response; instead, they inhibit or block responses that would normally be caused by agonists. *Competitive antagonists* bind to receptor sites that are also compatible with an agonist, thus preventing the agonist from binding to the site. *Noncompetitive antagonists* bind to receptor sites that aren't occupied by an agonist; this changes the receptor site so that it's no longer recognized by the agonist. *Irreversible antagonists* work in much the same way that noncompetitive ones do, except that they permanently bind with the receptor.

Antagonism plays an important role in drug interactions. When two agonists that cause opposite therapeutic effects, such as a vasodilator and a vasoconstrictor, are combined, the effects cancel each other out. When two antagonists, such as morphine and naloxone, are combined, both drugs may become inactive.

Pharmacotherapeutics

Pharmacotherapeutics is the study of how drugs are used to prevent or treat disease. Understanding why a drug is prescribed for a certain disease can assist you in prioritizing drug administration with other patient care activities. Knowing a drug's desired and unwanted effects may help you uncover problems not readily apparent from the admitting diagnosis. This information may also help you prevent such problems as adverse reactions and drug interactions.

A drug's *desired effect* is the intended or expected clinical response to the drug. This is the response you start to evaluate as soon as a drug is given. Dosage adjustments and the continuation of therapy often depend on your accurate evaluation and documentation of the patient's response.

An *adverse reaction* is any noxious and unintended response to a drug that occurs at therapeutic doses used for prophylaxis, diagnosis, or therapy. Adverse reactions associated with excessive amounts of a drug are considered drug overdoses. Be prepared to follow your institution's policy for reporting adverse drug reactions.

An *idiosyncratic response* is a genetically determined abnormal or excessive response to a drug that occurs in a particular patient. The unusual response may indicate that the drug has saturated or overwhelmed mechanisms that normally control absorption, distribution, metabolism, or excretion, thus altering the expected response. You may be unsure whether a reaction is adverse or idiosyncratic. Once you report the reaction, the pharmacist usually determines the appropriate course of action.

An *allergic reaction* is an adverse response that results from previous exposure to the same drug or to one that's chemically similar to it. The patient's

immune system reacts to the drug as if it were a foreign invader and may produce a mild hypersensitivity reaction, characterized by localized dermatitis, urticaria, angioedema, or photosensitivity. Allergic reactions should be reported to the prescriber immediately and the drug should be discontinued. Follow-up care may include giving drugs, including antihistamines and corticosteroids, to counteract the allergic response.

An *anaphylactic reaction* involves an immediate hypersensitivity response characterized by urticaria, pruritus, and angioedema. Left untreated, an anaphylactic reaction can lead to systemic involvement, resulting in shock. It's often associated with life-threatening hypotension and respiratory distress. Be prepared to assist with emergency life-support measures, especially if the reaction occurs in response to I.V. drugs, which have the fastest rate of absorption.

A *drug interaction* occurs when one drug alters the pharmacokinetics of another drug—for example, when two or more drugs are given concurrently. Such concurrent administration can increase or decrease the therapeutic or adverse effects of either drug. Some drug interactions are beneficial. For example, when taken with penicillin, probenecid decreases the excretion rate of penicillin, resulting in higher blood levels of penicillin. Drug interactions also may occur when a drug's metabolism is altered, often owing to the induction of or competition for metabolizing enzymes. For example, H_2-receptor agonists, which reduce secretion of the enzyme gastrin, may alter the breakdown of enteric coatings on other drugs. Drug interactions due to carrier protein competition typically occur when a drug inhibits the kidneys' ability to reduce excretion of other drugs. For example, probenecid is completely reabsorbed by the renal tubules and is metabolized very slowly. It competes with the same carrier protein as sulfonamides for active tubular secretion and so decreases the renal excretion of sulfonamides. This particular competition can lead to an increased risk of sulfonamide toxicity.

Special Considerations

Although every drug has a usual dosage range, certain factors—such as a patient's age, weight, culture and ethnicity, gender, pregnancy status, and renal and hepatic function—may contribute to the need for dosage adjustments. When you encounter special considerations such as these, be prepared to reassess the prescribed dosage to make sure that it's safe and effective for your patient.

CULTURE AND ETHNICITY

Certain drugs are more effective or more likely to produce adverse effects in particular ethnic groups or races. For example, blacks with hypertension respond better to thiazide diuretics than do patients of other races; on the other hand, blacks also have an increased risk of developing angioedema with angiotensin-converting enzyme (ACE) inhibitors. A patient's religious or cultural background also may call for special consideration. For example, a drug made from porcine products may be unacceptable to a Jewish or Muslim patient.

ELDERLY PATIENTS

Because aging produces certain changes in body composition and organ function, elderly patients present unique therapeutic and dosing problems that require special attention. For example, the weight of the liver, the number of functioning hepatic cells, and hepatic blood flow all decrease as a person ages, resulting in slower drug metabolism. Renal function may also decrease with aging. These processes can lead to the accumulation of active drugs and metabolites as well as increased sensitivity to the effects of some drugs in elderly patients. Because they're also more likely to have multiple chronic illnesses, many elderly patients take multiple prescription drugs each day, thus increasing the risk of drug interactions.

CHILDREN

Because their bodily functions aren't fully developed, children—particularly those under age 12—may metabolize drugs differently than adults. In infants, immature renal and hepatic functions delay metabolism and excretion of drugs. As a result, pediatric drug dosages are very different from adult dosages.

The FDA has provided drug manufacturers with guidelines that define pediatric age categories. Unless the manufacturer provides a specific age range, use these categories as a guide when administering drugs:

- neonates—birth up to age 1 month
- infants—ages 1 month to 2 years
- children—ages 2 to 12
- adolescents—ages 12 to 16.

PREGNANCY

The many physiologic changes that take place in the body during pregnancy may affect a drug's pharmacokinetics and alter its effectiveness. Additionally, exposure to drugs may pose risks for the developing fetus. Before administering a drug to a pregnant patient, be sure to check its assigned FDA pregnancy risk category, or the new more comprehensive text for drugs approved after June 30, 2015, and intervene appropriately.

Principles of Drug Administration

Because there are thousands of drugs and hundreds of facts about each one, taking responsibility for drug administration can seem overwhelming. One way that you can enhance your understanding of the principles of drug administration is to *associate, ask*, and *predict* during the critical thinking process. For example, associate each drug with general information you may already know about the drug or drug class. *Ask* yourself why a drug is administered by a certain route and why it's given multiple times throughout the day rather than only once. Learn to *predict* a drug's actions, uses, adverse effects, and possible drug interactions based on your knowledge of the drug's mechanism of action. As you apply these principles to drug administration, you'll begin to intuitively know which facts you need to make rational clinical decisions.

Prescriptions for patients in hospitals and other institutions typically are written by a physician on a form called the *physicians order sheet* or they're directly input into a computerized system with an electronic signature. Drugs are prescribed based not only on their specific mechanisms of action but also on the patient's profile, which commonly includes age, ethnicity, gender, pregnancy status, smoking and drinking habits, and use of other drugs.

"Rights" of Drug Administration

Always keep in mind the following "rights" of drug administration: the right drug, right time, right dose, right patient, right route, and right preparation and administration.

RIGHT DRUG

Many drugs have similar spellings, different concentrations, and several generic forms. Before administering any drug, compare the exact spelling and concentration of the prescribed drug that appears on the label with the information contained in the medication administration record or drug profile.

Regardless of which drug distribution system your facility uses, you should read the drug label and compare it to the medication administration record at least three times:

- before removing the drug from the dispensing unit or unit dose cart
- before preparing or measuring the prescribed dose
- before opening a unit dose package (just before administering the drug to the patient).

RIGHT TIME

Various factors can affect the time that a drug is administered, such as the timing of meals and other drugs, scheduled diagnostic tests, standardized times used by the institution, and factors that may alter the consistency of blood levels and drug absorption. Before administering any p.r.n. drug, check the patient's chart to ensure that no one else has already administered it and that the specified time interval has passed. Also, document administration of a p.r.n. drug immediately.

RIGHT DOSE

Whenever you're dispensing an unfamiliar drug or are in doubt about a dosage, check the prescribed dose against the range specified in a reliable reference. Be sure to consider any reasons for a dosage adjustment that may apply to your particular patient. Also, make sure you're familiar with the standard abbreviations your institution uses for writing prescriptions.

RIGHT PATIENT

Always compare the name of the patient on the medication record with the name on the patient's identification bracelet. When using a unit dose system, compare the name on the drug profile with that on the identification bracelet.

RIGHT ROUTE

Each drug prescription should specify the administration route. If the administration route is missing from the prescription, consult the prescriber before

giving the drug. Never substitute one route for another unless you obtain a prescription for the change.

RIGHT PREPARATION AND ADMINISTRATION

For drugs that need to be mixed, poured, or measured, be sure to maintain aseptic technique. Follow any specific directions included by the manufacturer regarding diluent type and amount and the use of filters, if needed. Clearly label any drug that you've reconstituted with the patient's name, the strength or dose, the date and time that you prepared the drug, the amount and type of diluent that you used, the expiration date, and your initials.

Administration Routes

Drugs may be administered by a variety of routes and dosage forms. A particular route may be chosen for convenience or to maximize drug concentration at the site of action, to minimize drug absorption elsewhere, to prolong drug absorption, or to avoid first-pass metabolism.

Different dosage forms of the same drug may have different drug absorption rates, times of onset, and durations of action. For example, nitroglycerin is a coronary vasodilator that may be administered by the I.V., sublingual, oral, or buccal route, or as a topical ointment or disk. The I.V., sublingual, and buccal forms of nitroglycerin provide a rapid onset of action, whereas the oral, ointment, and disk forms have a slower onset and a prolonged duration of action.

Drug administration routes include the enteral, parenteral, and transcutaneous routes.

ENTERAL

The enteral route consists of oral, nasogastric, and rectal administration. Drugs administered enterally enter the blood circulation by way of the GI tract. This route is considered the most natural and convenient route as well as the safest. As a result, most drugs are taken enterally, usually to provide systemic effects.

Oral

- *Tablets:* Tablets, the most commonly used dosage form, come in a variety of colors, sizes, and shapes. Some tablets are specially coated for various purposes. Enteric coatings permit safe passage of a tablet through the stomach, where some drugs may be degraded or may produce unwanted effects, to the environment of the intestine. Some coatings protect the drug from the destructive influences of moisture, light, or air during storage; some coatings actually contain the drug, such as procainamide; still others conceal a bad taste. Coatings are also used to ensure appropriate drug release and absorption. Some tablets shouldn't be crushed or broken because doing so may alter drug release.
- *Capsules:* Capsules are solid dosage forms in which the drug and other ingredients are enclosed in a hard or soft shell of varying size and shape. Drugs typically are released faster from capsules than from tablets.
- *Solutions:* Drugs administered in solution are absorbed more rapidly than many of those administered in solid form; however, they don't always produce predictable drug levels in the blood. Some drugs in solution should be administered with meals or snacks to minimize their irritating effect on the gastric mucosa.
- *Suspensions:* Suspensions are preparations consisting of finely divided drugs in a suitable vehicle, usually water. Suspensions should be shaken before administration to ensure the uniformity of the preparation and administration of the proper dosage.

Nasogastric

Drugs administered through a nasogastric or gastrostomy tube enter the stomach directly, bypassing the mouth and esophagus. They're usually administered in liquid form because an intact tablet or capsule could cause an obstruction in a gastric tube. Sometimes a tablet may be crushed or a capsule opened for

nasogastric administration; however, doing so will affect the drug's release. You may need to consult a pharmacist to determine which tablets can be crushed or capsules opened.

Rectal

Some enteral drugs are administered rectally—as suppositories, solutions, or ointments—to provide either local or systemic effects. When inserted into the rectum, suppositories soften, melt, or dissolve, releasing the drug contained inside them. The rectal route may be preferred for drugs that are destroyed or inactivated by the gastric or intestinal environment or that irritate the stomach. It also may be indicated when the oral route is contraindicated because of vomiting or difficulty swallowing.

The drawbacks of rectal administration include inconvenience, noncompliance, and incomplete or irregular drug absorption.

PARENTERAL

In parenteral drug administration, a drug enters the circulatory system through an injection rather than through GI absorption. This administration route is chosen when rapid drug action is desired; when the patient is uncooperative, unconscious, or unable to accept medication by the oral route; or when a drug is ineffective by other routes. Drugs may be injected into the joints, spinal column, arteries, veins, and muscles. However, the most common parenteral routes are the intramuscular (I.M.), intravenous (I.V.), subcutaneous (SubQ), and intradermal (I.D.) routes. Drugs administered parenterally may be mixed in either a solution or a suspension; those mixed in a solution typically act more rapidly than those mixed in a suspension. Parenteral administration has several disadvantages: The drug can't be removed or the dosage reduced once it has been injected, and injections typically are more expensive to administer than other dosage forms because they require strict sterility.

Intramuscular

I.M. injections are administered deep into the anterolateral aspect of the thigh (vastis lateralis), the dorsogluteal muscle (gluteus maximus), the upper arm (deltoid), or the ventrogluteal muscle (gluteus medius). I.M. injections typically provide sustained drug action. This route is commonly chosen for drugs that irritate the subcutaneous tissue. The drug should be injected as far as possible from major nerves and blood vessels.

Intravenous

In I.V. drug administration, an aqueous solution is injected directly into the vein—typically of the forearm. Drugs may be administered as a single, small-volume injection or as a slow, large-volume infusion. Because drugs injected I.V. don't encounter absorption barriers, this route produces the most rapid drug action, making it vital in emergency situations. Except for I.V. fat emulsions used as nutritional supplements, oleaginous preparations aren't usually administered by this route because of the risk of fat embolism.

Subcutaneous

The subcutaneous route may be used to inject small volumes of medication, usually 1 ml or less. Subcutaneous injections typically are given below the skin in the abdominal area, lateral area of the anterior thigh, posterior surface of the upper arm, or lateral lumbar area. Injection sites should be rotated to minimize tissue irritation if the patient receives frequent subcutaneous injections—as, for example, in a patient who takes insulin.

Intradermal

Common sites for intradermal injection are the arm and the back. Because only about 0.1 ml may be administered intradermally, this route is rarely used except in diagnostic and test procedures, such as screening for allergic reactions.

TRANSCUTANEOUS

In transcutaneous administration, a drug crosses the skin layers from either

the outside (dermal) or the inside (mucocutaneous). This route includes sublingual, inhalation, ophthalmic, otic, nasal, topical, and vaginal administration.

Sublingual

In sublingual administration, tablets are placed under the tongue and allowed to dissolve. Nitroglycerin is commonly administered by this route, which allows rapid drug absorption and action. The sublingual route also avoids first-pass metabolism.

Inhalation

Some drugs may be inhaled orally or nasally to produce a local effect on the respiratory tract or a systemic effect. Although drugs given by inhalation avoid first-pass hepatic metabolism, the lungs can also serve as an area of first-pass metabolism by providing respiratory conversion to more water-soluble compounds.

Ophthalmic

Ophthalmic solutions and ointments are applied directly to the cornea or conjunctiva for enhanced local penetration and decreased systemic absorption. These drugs usually are used in eye examinations and to treat glaucoma. Ophthalmic solutions pose a greater risk of drug loss through the nasolacrimal duct into the nasopharynx than ophthalmic ointments do.

Otic

Otic solutions are instilled directly into the external auditory canal for local penetration and decreased systemic absorption. These drugs, which include anesthetics, antibiotics, and anti-inflammatory drugs, usually require occlusion of the ear canal with cotton after instillation.

Nasal

Nasal solutions and suspensions are applied directly to the nasal mucosa for enhanced local penetration and decreased systemic absorption. These drugs are usually used to reduce the inflammation typically associated with seasonal or perennial rhinitis.

Topical

Topical drugs—including creams, ointments, lotions, and pastes—are applied directly to the skin. Transdermal delivery systems, usually in the form of an adhesive patch or a disk, are among the latest developments in topical drug administration. Because they provide slow drug release, these systems are typically used to avoid first-pass metabolism and ensure prolonged duration of action.

Vaginal

Vaginal troches, suppositories, and creams are inserted into the vagina for slow, localized absorption. Body pH that differs from blood pH causes drug trapping or reabsorption, which delays drug excretion through the renal tubules. Vaginal secretions are alkaline, with a pH of 3.4 to 4.2, whereas blood has a pH of 7.35 to 7.45.

Drug Therapy and the Nursing Process

A systematic approach to nursing care, the nursing process helps guide you as you develop, implement, and evaluate your care and ensures that you'll deliver safe, consistent, and effective drug therapy to your patients. The nursing process consists of five steps, including assessment, nursing diagnosis, planning, implementation, and evaluation. Even though documentation is not a step in the nursing process, you're legally and professionally responsible for documenting all aspects of your care before, during, and after drug administration.

Assessment

The first step in the nursing process, assessment involves gathering information that's essential to guide your patient's drug therapy. This information includes the patient's drug history, present drug use, allergies, medical history, and physical examination findings. Assessment is an ongoing process that serves as a baseline against which to compare any changes in your patient's condition; it's also the basis for developing and individualizing your patient's plan of care.

DRUG HISTORY

The patient's drug history is critical in your planning of drug-related care. Ask about his previous use of over-the-counter and prescription drugs, as well as herbal remedies. For each drug, determine:

- the reason the patient took it
- the prescribed dosage
- the administration route
- the frequency of administration
- the duration of the drug therapy
- any adverse reactions the patient may have experienced and how he handled them.

Also determine if the patient has a history of drug abuse or addiction. Depending on his physical and emotional state, you may need to obtain the drug history from other sources, such as family members, friends, other caregivers, and the medical record.

PRESENT DRUG USE

Ask about the patient's current use of over-the-counter and prescription drugs, as well as herbal remedies. As you did in the drug history, find out the specific details for each drug (dosage, route, frequency, and reason for taking). Also ask the patient if he thinks the drug has been effective and when he took the last dose.

If the patient uses herbal remedies, similarly explore the use of these products, because herbs may interact with certain drugs. Also ask about the patient's use of recreational drugs, such as alcohol and tobacco, as well as illegal drugs, such as marijuana and heroin. If the patient acknowledges use of these drugs, be alert for possible drug interactions. This information also may provide you with insight about the patient's response—or lack of response—to his current drug treatment plan.

Try to find out if the patient has any other problems that might affect his compliance with the drug treatment plan, and intervene appropriately. For instance, a patient who is unemployed and has no health insurance may fail to fill a needed prescription. In such a case, contact an appropriate individual in your facility who may be able to help the patient obtain financial assistance.

Be sure to ask the patient if his drug treatment plan requires special monitoring or follow-up laboratory tests. For example, patients who take antihypertensives need to have their blood pressure checked routinely, and those who take warfarin must have their prothrombin time tested regularly. Other patients must undergo periodic blood tests to assess their hepatic and renal function. Determine whether the patient has complied with this part of his treatment plan, and ask him if he knows the results of the latest monitoring or laboratory tests.

ALLERGIES

Find out if the patient is allergic to any drugs or foods. If he has an allergy, explore it further by determining the type of drug or food that triggers a reaction, the first time he experienced a reaction, the characteristics of the reaction, and other related information. Keep in mind that some patients consider annoying symptoms, such as indigestion, an allergic reaction. However, be sure to document a true allergy according to your facility's policy to ensure that the patient doesn't receive that drug or any related drug that may cause a similar reaction. Also, document allergies to foods because they may lead to drug interactions or adverse drug reactions. For example, sulfite is a food additive as well as a drug additive, so a patient with a known allergy to sulfite-containing foods is likely to react to sulfite-containing drugs.

MEDICAL HISTORY

While reviewing your patient's medical history, determine if he has any acute or chronic conditions that may interfere with his drug therapy. Certain disorders involving major body systems, such as the cardiovascular, GI, hepatic, and renal systems, may affect a drug's absorption, transport, metabolism, or excretion and interfere with its action; they also may increase the incidence of adverse reactions and lead to toxicity. For each disorder identified, try to determine when the condition was diagnosed, what drugs were prescribed, and who prescribed them. This information can help you determine whether the patient is receiving incompatible drugs and whether more than one prescriber is managing his drug therapy.

Ask a female patient if she is or may be pregnant or if she is breastfeeding. Many drugs are safe to use during pregnancy, but others may harm the fetus. Also, some drugs are distributed into breastmilk. If your patient is or might be pregnant, check the FDA's pregnancy risk category for the prescribed drug and notify the prescriber if the drug may pose a risk to the fetus. If the patient is breastfeeding, find out if the drug is distributed in breastmilk and intervene appropriately.

PHYSICAL EXAMINATION FINDINGS

As part of the physical examination, note the patient's age and weight. Be aware that age determines the dosage of certain drugs, such as sedatives and hypnotics, whereas weight determines the dosage of others, including some I.V. antibiotics and anticoagulants. As you perform the physical examination, note any abnormal findings that may point to body organ or system dysfunction. For example, if you detect liver enlargement and ascites, the patient may have impaired hepatic function, which can affect the metabolism of a drug he's taking and lead to harmful adverse or toxic effects. Also note whether a body organ or system appears to be responding to drug treatment. For example, if a patient has been taking an antibiotic to treat chronic bronchitis, thoroughly evaluate his respiratory status to measure his progress. Be sure to assess the patient for possible adverse reactions to the drugs he's taking.

Assess the patient's neurologic function to make sure that he can understand his drug regimen and carry out required tasks, such as performing a fingerstick to obtain blood for glucose measurement. If the patient can't understand essential drug information, you'll need to identify a family member or another person who is willing to become involved in the teaching process.

Nursing Diagnosis

Based on information derived from the assessment and physical examination findings, the nursing diagnoses are statements of actual or potential problems that a nurse is licensed to treat or manage alone or in collaboration with other members of the healthcare team. They're worded according to guidelines established by NANDA International.

One of the most common nursing diagnoses related to drug therapy is *knowledge deficit*, which indicates that the patient doesn't have sufficient

understanding of his drug regimen. However, adverse reactions are the basis for most nursing diagnoses related to drug administration. For example, a patient receiving an opioid analgesic might have a nursing diagnosis of *constipation* related to decreased intestinal motility or *ineffective breathing* pattern related to respiratory depression. A patient receiving long-term, high-dose corticosteroids may have a risk for *impaired skin integrity* related to cortisone acetate or *self-concept disturbance* related to physical changes from prednisone therapy. Many antiarrhythmics cause orthostatic hypotension and thus may place an elderly patient at *high risk for injury* related to possible syncope. Broad-spectrum antibiotics, especially penicillin, may lead to the overgrowth of *Clostridium difficile*, a bacterium that is normally present in the intestine. This overgrowth in turn may lead to pseudomembranous colitis, characterized by abdominal pain and severe diarrhea. The nursing diagnoses in such a case might include *potential for infection* related to bacterial overgrowth, *alteration in comfort* related to abdominal pain, and *fluid balance deficit* related to diarrhea.

Planning

During the planning phase, you'll establish expected outcomes—or goals—for the patient and then develop specific nursing interventions to achieve them. Expected outcomes are observable or measurable goals that should occur as a result of nursing interventions and sometimes in conjunction with medical interventions. Developed in collaboration with the patient, the outcomes should be realistic and objective and should clearly communicate the direction of the plan of care to other nurses. They should be written as behaviors or responses for the patient, not the nurse, to achieve and should include a time frame for measuring the patient's progress. An example of a typical expected outcome is, *The patient will accurately demonstrate self-administration of insulin before discharge*. Based on each outcome statement you establish, you'd then develop appropriate nursing interventions, which might include drug administration techniques, patient teaching, monitoring of vital signs, calculation of drug dosages based on weight, and recording of intake and output.

Implementation

As you implement the nursing interventions, be sure to stringently follow the classic rule of drug administration: administer the right dose of the right drug by the right route to the right patient at the right time. Also, keep in mind that you have a legal and professional responsibility to follow institutional policy regarding standing orders, prescription renewal, and the use of nursing judgment. During the implementation phase, you'll also begin to evaluate the patient's expected outcomes and nursing interventions and make necessary changes to the plan of care.

Evaluation

Evaluation is an ongoing process rather than a single step in the nursing process. During this phase, you evaluate each expected outcome to determine whether or not it has been achieved and whether the original plan of care is working or needs to be modified. In evaluating a patient's drug treatment plan, you should determine whether or not the drug is controlling the signs and symptoms for which it was prescribed. You also should evaluate the patient for psychological or physiologic responses to the drug, especially adverse reactions. This constant monitoring allows you to make appropriate and timely suggestions for changes to the plan of care, such as dosage adjustments or changes in delivery routes, until each expected outcome has been achieved.

Documentation

You're responsible for documenting all your actions related to the patient's drug therapy, from the assessment phase to

evaluation. Each time you administer a drug, document the drug name, dose, time given, and your evaluation of its effect. When you administer drugs that require additional nursing judgment, such as those prescribed on an as-needed basis, document the rationale for administering the drug and follow-up assessment or interventions for each dose administered.

If you decide to withhold a prescribed drug based on your nursing judgment, document your action and the rationale for it, and notify the prescriber of your action in a timely manner. Whenever you notify a prescriber about a significant finding related to drug therapy, such as an adverse reaction, document the date and time, the person you contacted, what you discussed, and how you intervened.

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Class and Category

Chemical class: Soluble fusion protein, human recombinant fusion protein
Therapeutic class: Antirheumatic
Pregnancy category: C

Indications and Dosages

➤ *To reduce signs and symptoms, induce major clinical response, inhibit progression of structural damage, and improve physical function in patients with moderate to severe active rheumatoid arthritis and an inadequate response to methotrexate or a tumor necrosis factor antagonist*

I.V. INFUSION

Adults weighing more than 100 kg (220 lb). *Initial:* 1,000 mg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 1,000 mg infused over 30 min every 4 wk starting at wk 8.

Adults weighing 60 to 100 kg (132 to 220 lb). *Initial:* 750 mg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 750 mg infused over 30 min every 4 wk starting at wk 8.

Adults weighing less than 60 kg (132 lb). *Initial:* 500 mg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 500 mg infused over 30 min every 4 wk starting at wk 8.

SUBCUTANEOUS INJECTION

Adults. Following a single I.V. loading dose as per body weight categories listed above, 125 mg given within a day, followed by 125 mg once wk. Alternate if unable to receive I.V. loading dose: 125 mg once wk.

DOSAGE ADJUSTMENT For patient transitioning from I.V. therapy to SubQ injection, first SubQ dose should be administered instead of the next scheduled I.V. dose.

➤ *To reduce signs and symptoms of moderate to severe active polyarticular juvenile idiopathic arthritis*

I.V. INFUSION

Children ages 6 to 17 weighing more than 100 kg (220 lb). *Initial:* 1,000 mg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 1,000 mg infused over 30 min every 4 wk starting at wk 8.

Children ages 6 to 17 weighing 75 to 100 kg (165 to 220 lb). *Initial:* 750 mg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 750 mg infused over 30 min every 4 wk starting at wk 8.

Children ages 6 to 17 weighing less than 75 kg (165 lb). *Initial:* 10 mg/kg infused over 30 min, repeated in 2 to 4 wk. *Maintenance:* 10 mg/kg infused over 30 min every 4 wk starting at wk 8.

Mechanism of Action

Inhibits T-cell activation by binding to CD80 and CD86 to block interaction with CD28. CD28 is part of the costimulatory signal needed for full activation of T cells. Activated T cells have been implicated in the pathogenesis of rheumatoid arthritis. With decreased proliferation of T cells, inflammation and other evidence of rheumatoid arthritis decrease.

Incompatibilities

Don't infuse abatacept solution with other drugs in the same intravenous line concurrently because it is not known whether the drugs may interact.

Contraindications

Hypersensitivity to abatacept or its components

Interaction

DRUGS

immunosuppressants: Possibly increased risk of serious infection
live-virus vaccines: Possibly decreased response to vaccine, and risk of infection with live virus
tumor necrosis factor antagonists: Increased risk of serious infection

Adverse Reactions

CNS: Dizziness, fever, headache
CV: Hypertension, hypotension
EENT: Nasopharyngitis, rhinitis, sinusitis
GI: Abdominal pain, diarrhea, diverticulitis, dyspepsia, nausea
GU: Acute pyelonephritis, UTI
MS: Back or limb pain