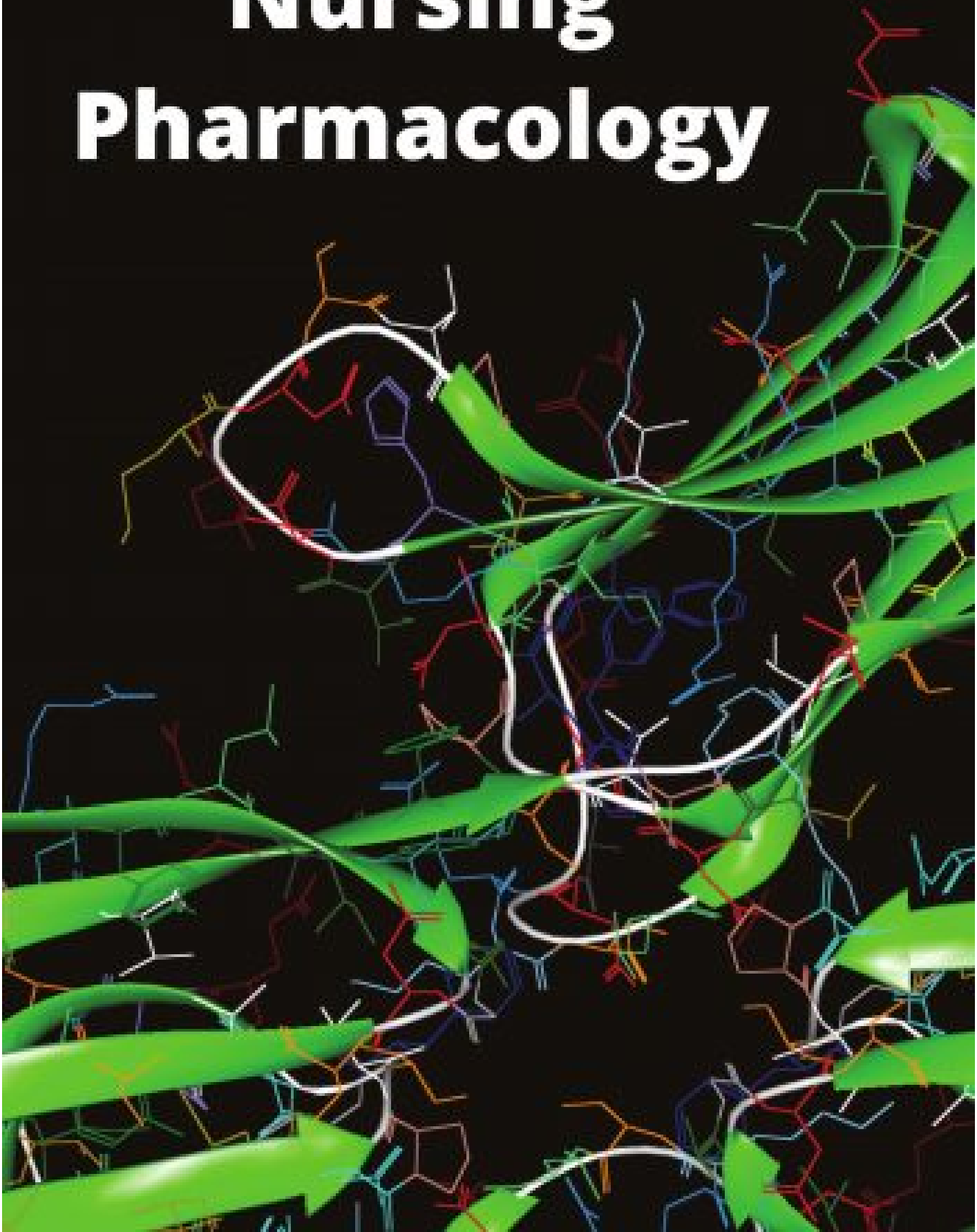
Nursing Pharmacology



Nursing Pharmacology

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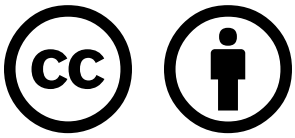
Open Resources for Nursing (Open RN)



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Introduction

This open access Nursing Pharmacology textbook is designed for entry-level undergraduate nursing students. It explains basic concepts of pharmacology and describes common medication classes. This book is not intended to be used as a drug reference book, but direct links are provided to DailyMed, which provides trustworthy information about marketed drugs in the United States.

This textbook is aligned with the Wisconsin Technical College System (WTCS) statewide nursing curriculum for the Nursing Pharmacology course (543-103). The project is supported by a $2.5 million Open Resources for Nursing (Open RN) grant from the Department of Education and is licensed under a Creative Commons Attribution 4.0 International License.

This book is available for download in multiple formats, but the online version is required for interaction with the adaptive learning activities included in each chapter.

The following video provides a quick overview of how to navigate the online version.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=4#oembed-1

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Preface

This open access Nursing Pharmacology textbook is designed for entry-level undergraduate nursing students. It may also be a helpful resource for students in other health programs. It explains basic concepts of pharmacology and describes common medication classes. This book is not intended to be used as a drug reference book, but it does provide direct links to DailyMed, a trustworthy U.S. National Library of Medicine website, that contains information about marketed drugs in the United States.

This textbook is aligned with the Wisconsin Technical College System (WTCS) statewide nursing curriculum for the Nursing Pharmacology course (543-103). Online learning activities are provided in each chapter using the free H5P software platform (https://h5p.org/). This textbook has also been uploaded to LibreTexts (https://libretexts.org/) for easy remixing by faculty. The project is supported by a $2.5 million Open Resources for Nursing (Open RN) grant from the Department of Education and is licensed under a Creative Commons Attribution 4.0 International License. However, these contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government. More information about the Open RN grant can be found at: cvtc.edu/OpenRN

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References

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I

Kinetics & Dynamics

1.1 Pharmacology Basics Introduction

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Learning Objectives

- Discuss the processes of pharmacokinetics
- Use multiple professional resources including technology to identify pertinent information related to drugs
- Describe the processes of pharmacodynamics
- Consider pharmacodynamic differences across the lifespan
- Differentiate among prescription drugs, over-the-counter drugs, herbals, and dietary supplements

Safe medication administration is a vital component of the nursing role. Each day it is common for nurses to make critical decisions regarding the safety, appropriateness, and effectiveness of the medications administered to their patients. Examples of decisions that a nurse might make during patient care include:

- Is my patient's heart rate within the correct range to receive this beta-blocker medication?
- Does my patient have adequate renal function prior to administering this dose of antibiotic?
- Is this pain medication effective in controlling my patient's discomfort?

In order to make safe medication administration decisions, the nurse must have a strong understanding of **pharmacology**. Symptom management, physical recovery, and individual well-being can be strongly connected to the use of medications in a patient's treatment plan. Before a student nurse reviews a medication order, checks a medication administration record, or removes a medication from a dispensing machine, it is important to have a foundational understanding of how medications work within the human body. Let's take a deeper look at the science of pharmacokinetics.

1.2 Pharmacokinetics

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Pharmacokinetics – Examining the Interaction of Body and Drug

Overview

Pharmacokinetics is the term that describes the four stages of absorption, distribution, metabolism, and excretion of drugs. **Drugs** are medications or other substances that have a physiological effect when introduced to the body. There are four basic stages for a medication to go through within the human body: absorption, distribution, metabolism, and excretion. This entire process is sometimes abbreviated **ADME. Absorption** occurs after medications enter the body and travel from the site of administration into the body's circulation. **Distribution** is the process by which medication is distributed throughout the body. **Metabolism** is the breakdown of a drug molecule. **Excretion** is the process by which the body eliminates waste. Each of these stages is described separately later in this chapter.

Research scientists who specialize in pharmacokinetics must also pay attention to another dimension of drug action within the body: time. Unfortunately, scientists do not have the ability to actually see where a drug is going or how long it is active. To compensate, they use mathematical models and precise measurements of blood and urine to determine where a drug goes and how much of the drug (or breakdown product) remains after the body processes it. Other indicators, such as blood levels of liver enzymes, can help predict how much of a drug is going to be absorbed.

Principles of chemistry are also applied while studying pharmacokinetics because the interactions between drug and body molecules are really just a series of chemical reactions. Understanding the chemical encounters between drugs and biological environments, such as the bloodstream and the oily surfaces of cells, is necessary to predict how much of a drug will be metabolized by the body.

Pharmacodynamics refers to the effects of drugs in the body and the mechanism of their action. As a drug travels through the bloodstream, it will exhibit a unique **affinity** for the drug-receptor site, meaning how strongly it will bind to the site. Examination of how drugs and receptor sites create a lock and key system (see Figure 1.1
"Drug and Receptor Binding" by Dominic Slausen at Chippewa Valley Technical College is licensed under CC BY 4.0
) is helpful to understand how drugs work and the amount of drug that may be left circulating within the

bloodstream. This concept is broadly termed as drug **bioavailability**. The bioavailability of drugs is an important feature that chemists and pharmaceutical scientists keep in mind when designing and packaging medicines. Unfortunately, no matter how effectively a drug works in a laboratory simulation, the performance in the human body will not always produce the same results, and individualized responses to drugs have to be considered. Although many responses to medications may be anticipated, one's unique genetic makeup may also have a significant impact on one's response to a drug. **Pharmacogenetics** is defined as the study of how people's genes affect their response to medicines.

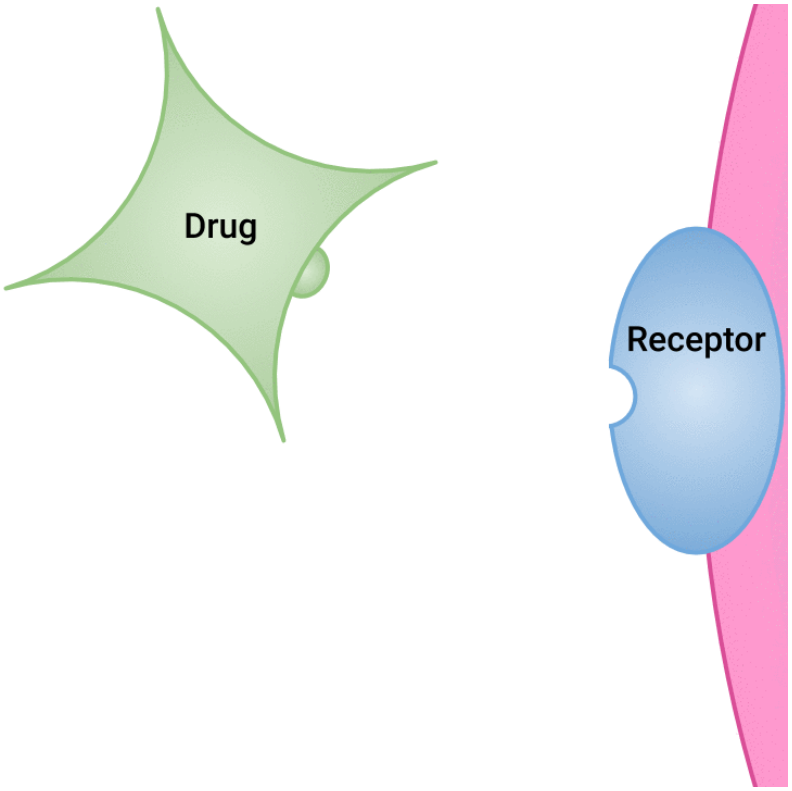

Figure 1.1 Pharmacodynamics: Drug and Receptor Binding

1.3 Absorption

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The first stage of pharmacokinetics is known as **absorption**. Absorption occurs after drugs enter the body and travel from the site of administration into the body's circulation. Medications can enter the body through various routes of administration. Common routes to administer medications include the following examples:

- oral (swallowing an aspirin tablet)
- enteral (administering to the GI tract such as via a NG tube)

- rectal (administering an acetaminophen [Tylenol] suppository)
- inhalation (breathing in medication from an inhaler)
- intramuscular (getting a flu shot in the deltoid muscle)
- subcutaneous (injecting insulin into the fat tissue beneath the skin)
- transdermal (wearing a nicotine patch)

When a medication is administered orally or enterally, it faces its biggest hurdle during absorption in the gastrointestinal (GI) tract. Medications made of protein that are swallowed or otherwise absorbed in the GI tract may quickly be deactivated by enzymes as they pass through the stomach and duodenum. If the drug does get into the blood from the intestines, part of it will be broken down by liver enzymes, known as the **first pass effect,** and some of it will escape to the general circulation to either become protein-bound (inactive) or stay free (and create an action at a receptor site). These metabolic effects are further described in the "Metabolism" section later in this chapter. Thus, providers who prescribe medications, as well as nurses, understand that several doses of an oral medication may be needed before enough free drug stays active in the circulation to exert the desired effect.

What to do?

A workaround to the first pass effect is to administer the medication using alternate routes such as dermal, nasal, inhalation, injection, or intravenous. Alternative routes of medication administration bypass the first pass effect by entering the bloodstream directly or via absorption through the skin or lungs. Medications that are administered directly into the bloodstream (referred to as intravenous medications) do not undergo absorption and are fully available for distribution to tissues within the body.

Alternative routes of medication have other potential problems to consider. For example, injections are often painful and cause a break in the skin, an important barrier to infection. They can also be costly and difficult to administer daily, may cause localized side effects, or contribute to unpredictable fluctuations in medication blood levels.

Figure 1.2 Applying Transdermal Patch

Transdermal application of medication is an alternate route that has the primary benefit of slow, steady drug delivery directly to the bloodstream—without passing through the liver first. (See Figure 1.2

"Applying transdermal patch.jpg" by British Columbia Institute of Technology (BCIT) is licensed under CC BY 4.0
for an image of applying a transdermal patch.) Drugs delivered transdermally enter the blood via a meshwork of small arteries, veins, and capillaries in the skin. This makes the transdermal route of drug delivery particularly useful when a medication must be administered over a long period of time to control symptoms. For example, transdermal application of fentanyl, a pain medication, can provide effective pain management over a long period of time; the scopalamine patch can control motion sickness over the duration of a cruise ship vacation; and the nitroglycerin patch is used to control chronic chest pain. Despite their advantages, skin patches have a significant drawback in that only very small drug molecules can enter the body through the skin, making this application route not applicable for all types of medications.

Inhaling drugs through the nose or mouth is another alternative route for rapid medication delivery that bypasses the liver (see Figure 1.3).
"Adult Using Asthma Inhaler" by NIAID is licensed under CC BY 2.0
) Metered-dose inhalers have been a mainstay of asthma therapy for several years, and nasal steroid medications are often prescribed for allergy and sinus problems.

Figure 1.3 Adult using inhaler

Emerging discoveries & recent developments

Researchers are currently exploring alternative methods of drug delivery such as the use of inhaled insulin powders. Afrezza® is an example of an inhaled insulin approved by the Food and Drug Administration (FDA) to assist with blood sugar control. This technology stems from novel uses of chemistry and engineering to manufacture insulin particles of just the right size for absorption. If too large, the insulin particles could lodge in the lungs; if too small, the particles will be exhaled.

Lifespan Considerations

Neonate & Pediatric: Gastric absorption in neonate and pediatric patients varies from that of their adult counterparts. In neonate and pediatric patients, the acid-producing cells of the stomach are immature until around the age of one to two years. Additionally, gastric emptying may be decreased because of slowed or irregular peristalsis (forward bowel movement). The liver of a neonatal or pediatric patient continues to mature, experiencing a decrease in first-pass elimination, resulting in higher drug levels in

the bloodstream.
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Older Adult: As a natural result of aging, older adults will experience decreased blood flow to tissues within the GI tract. In addition, there may be changes in the gastric (stomach) pH that may alter the absorption of certain medications. Older adult patients may also experience variations in available plasma proteins, which can impact drug levels of medications that are highly protein-bound. Consideration must also be given to the use of subcutaneous and intramuscular injections in older patients experiencing decreased cardiac output. Decreased drug absorption of medications can occur when peripheral circulation is decreased. Finally, as adults age, they often have less body fat, resulting in decreased absorption of medication from transdermal patches that require adequate subcutaneous fat stores for proper absorption.
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Table 1 summarizes route considerations that a nurse should consider when administering medication.

Table 1. Route Considerations

Oral (PO) or Enteral (NGT, GT, OGT) Ingestion

- Oral route is a convenient route for administration of solid as well as liquid formulations.
- Additional variables that may influence the rate and extent of absorption include enteric coating or extended-release formulations, acidity of gastric contents, gastric emptying rate, dietary contents, and presence of other drugs.
- First pass effect: Blood containing the absorbed drug passes through the liver, which can deactivate a substantial amount of the drug and decrease its bioavailability (the percentage of dose that reaches the systemic circulation).

Parenteral Injection

- Subcutaneous and intramuscular administration: Injections can be difficult for patients to self-administer at home or to administer on a daily basis. They can be costly and painful. Injections also cause a break in skin that is an important barrier to infection, can cause fluctuation in drug levels. and can cause localized side effects to skin.
- Intravenous (IV): IV drugs are fully available to tissues after administration into the bloodstream, offering complete bioavailability and an immediate effect. However, this route requires intravenous access that can be painful to the patient and also increases risk for infection. Medications must be administered in sterile fashion, and if two products are administered simultaneously, their compatibility must be verified. There is also an increased risk of toxicity.

Pulmonary Inhalation

- Inhalation allows for rapid absorption of drugs in gaseous, vaporized, or aerosol form.
- Absorption of particulates/aerosols depends on particle/droplet size, which influences depth of entry through the pulmonary tree to reach the alveoli.

- The ability of the patient to create successful inhalation, especially in the presence of bronchospasm, may also influence depth of entry in the pulmonary tree.

Topical and Transdermal Application

- Topical creams, lotions, and ointments are generally used for local effect; transdermal patch formulations are used for systemic effect.
- Absorption through the buccal or sublingual membranes may be rapid.
- Absorption through skin is generally slower but produces steady, long-term effect that avoids the first pass effect. However, absorption of medication is affected by blood flow to the skin.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=192#h5p-1

1.4 Distribution

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The second stage of pharmacokinetics is the process known as drug **distribution**. Distribution is the process by which medication is dispersed throughout the body via the bloodstream. Once a drug enters into systemic circulation by absorption or direct administration, it must be distributed into interstitial and intracellular fluids to get to the target cells. The distribution of a drug throughout the body is dependent on common factors such as blood flow, plasma protein binding, lipid solubility, the blood-brain barrier, and the placental barrier. Other factors include capillary permeability, differences between blood/tissue, and volume of distribution.

Distribution of a medication can also cause unintended adverse or side effects. Drugs are designed to primarily cause one effect, meaning they bind more strongly to one specific receptor site and predictably cause or block an action. However, side effects can occur when the drug binds to other sites in addition to the target tissue, causing secondary side effects. These side effects can range from tolerable to unacceptable resulting in the discontinuation of the medication. For example, a person might take the pain reliever ibuprofen (Advil) to treat a sore leg muscle, and the pain may be subsequently relieved, but there may also be stomach irritation as a side effect that may cause the person to stop taking ibuprofen.

Blood Flow

The blood stream carries medications to their destinations in the body. Many factors can affect the blood flow and delivery of medication, such as decreased flow (due to dehydration), blocked vessels (due to atherosclerosis), constricted vessels (due to uncontrolled hypertension), or weakened pumping by the heart muscle (due to heart failure). As an example, when administering an antibiotic to a patient with diabetes with an infected toe, it may be difficult for the antibiotic to move through the blood vessels all the way to the cells of the toe that is infected.

Once the drug is in the bloodstream, a portion of it may exist as free drug, dissolved in plasma water. Some of the drug will be reversibly taken up by red cells, and some will be reversibly bound to plasma

proteins. For many drugs, the bound forms can account for 95-98% of the total. This is important because it is the free drug that traverses cell membranes and produces the desired effect. It is also important because a protein-bound drug can act as a reservoir that releases the drug slowly and thus prolongs its action. With drug distribution, it is important to consider both the amount of free drug that is readily available to tissues, as well as the potential drug reserve that may be released over time.

Protein-Binding

A common factor impacting distribution of medication is plasma protein in the blood. Albumin is one of the most important proteins in the blood. Albumin levels can be decreased by several factors such as malnutrition and liver disease. A certain percentage of almost every drug gets bound to plasma proteins when it initially enters the bloodstream and starts to circulate. The portion of the drug that gets "protein-bound" is inactive while it is bound, but the portion of the drug that escapes initial protein binding becomes immediately "free" to bind to the target tissue and exert or block an action.

A patient taking several highly protein-bound medications often experiences greater side effects. Some drugs are able to competitively grab (or bind to) plasma proteins more easily than other drugs, thus taking up the available protein molecules first. This prevents secondary medications from binding strongly to protein and the intended target site. Instead, these medications float freely in the circulation without exerting action and increase the risk of side effects and toxicities.

Figure 1.4 Protein binding is like available seats on a bus

Think of protein binding like a bus stop (see Figure 1.4 'Renault Type r321 Service Bus' by Emslichter is licensed under CC0 1.0). Many passengers (or medication molecules) want to take a ride on the bus. Everyone is eager to get to their destination and interested in finding a seat. Some passengers are stronger and will get in the seats first (like drug molecules with greater protein-binding ability bind to the protein). Sometimes, there may not be enough seats on the bus, and some passengers are left at the bus stop. The passengers (medication molecules) who were left behind are "free" to move around and walk to their destination. They may strike out on their own and get "snatched" (connected to a target receptor site) while on foot. In a similar way, "free" drug particles that are not protein-bound are circulating in the bloodstream and connecting in a predictable fashion to receptor sites that have an affinity for that particular drug. These active drug molecules that did not bind to the protein (like those passengers that were unable to get a seat on the bus) will produce the first effect in the body. Over time, the medication molecules that are bound to the protein (like the passengers with seats on the bus) will get off the bus, start walking around, and get "snatched" to the receptor site that has affinity for them.

Blood-Brain Barrier

Medications destined for the central nervous system (the brain and spinal cord) face an even larger hurdle than protein-binding; they must also pass through a nearly impenetrable barricade called the

blood-brain barrier. This blockade is built from a tightly woven mesh of capillaries that protect the brain from potentially dangerous substances, such as poisons or viruses. Only certain medications made of lipids (fats) or have a "carrier" can get through the blood-brain barrier.

Research scientists have devised ways for certain medications to penetrate the blood-brain barrier. An example of this is the brand-named medication Sinemet®, which is a combination of two drugs: carbidopa and levadopa. Carbidopa is designed to carry the levadopa medication across the blood-brain barrier, where it enters the brain and is converted into dopamine to exert its effect on Parkinson's disease symptoms.

Some medications inadvertently bypass the blood-brain barrier and impact an individual's central nervous system function. For example, diphenhydramine (Benadryl®) is an antihistamine used to decrease allergy symptoms. However, it can also cross the blood-brain barrier, depress the central nervous system, and cause the side effect of drowsiness. In the case of a person who has difficulty falling asleep, this drowsy side effect may be useful, but for another person it may be problematic, as they try to safely carry out daily activities.

Placental Barrier

It is always important to consider the effects of medication during pregnancy or for patients who may become pregnant. The placenta is permeable to some medications, while others have not been specifically studied in pregnant patients. Some drugs can cause harm to the unborn fetus during any trimester. Therefore, it is imperative to always consult a healthcare provider regarding the safety of medications for use during pregnancy. This imperative is assumed in the remaining chapters discussing medication classes, and nurses should always check the most recent, evidence-based drug references before administering medications during pregnancy.

Lifespan Considerations

Neonate & Pediatric: Fat content in young patients is decreased because of greater total body water. Additionally, for the growing pediatric patient, the liver is still forming, and protein binding capacity is decreased and the developing blood-brain barrier allows more drugs to enter the brain.

Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Older Adult: The aging adult patient will experience a decrease in total body water and muscle mass. Body fat may increase and subsequently result in a longer duration of action for many medications. Serum albumin often also decreases, resulting in more active free drug within the body. This is one reason why many older adult patients require lower levels of medication.

Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Table 1.2 describes other factors that impact drug distribution.

Table 1.2. Other Factors that Impact Drug Distribution

1) Tissue differences in rates of uptake of drugs.

- Blood flow: distribution occurs most rapidly into tissues with a greater number of blood vessels that allow high blood flow (lungs, kidneys, liver, brain) and least rapidly in tissues with fewer numbers of blood vessels resulting in low blood flow (fat).
- Capillary permeability: permeability of capillaries is tissue-dependent. Distribution rates are relatively slower or non-existent into the CNS because of the tight junction between capillary endothelial cells and the blood-brain barrier. Capillaries of the liver and kidney are more porous, allowing for greater permeability.

2) Differences in tissue/blood ratios at equilibrium

- Dissolution of lipid-soluble drugs in adipose tissue
- Binding of drugs to intracellular sites
- Plasma protein-binding

3) Apparent Volume of Distribution

- Fluid compartments: plasma, extracellular water, total body water.
- The plasma half-life of a drug
    - **Half-life** is the amount of time it takes for half of the medication to be eliminated in the body. Half-life directly correlates to the duration of the therapeutic effect of a medication. Many factors can influence half-life, for example, liver disease or kidney dysfunction.

    - Information about half-life of a medication can be found in evidence-based medication references. For example, in the "Clinical Pharmacology" section of the Daily Med reference for furosemide, the half-life is approximately 2 hours.

1.5 Metabolism

Open Resources for Nursing (Open RN)

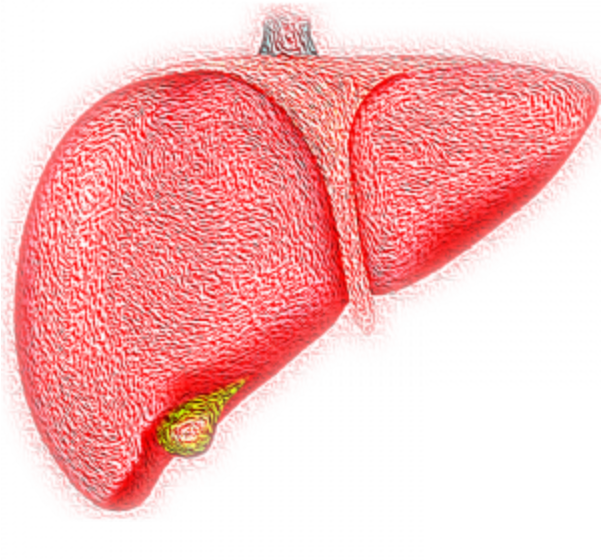


Figure 1.5 Liver

Once a drug has been absorbed and distributed in the body, it will then be broken down by a process known as **metabolism**. The breakdown of a drug molecule usually involves two steps that take place primarily in the body's chemical processing plant: the liver. (See Figure 1.5 'Liver Hepatic Organ Jaundice Bile Fatty Liver - Liver' by VSRao is licensed under CC0 for an image of a human liver.) Everything that enters the bloodstream—whether swallowed, injected, inhaled, absorbed through the skin, or produced by the body itself—is carried to this largest internal organ.

The biotransformations that take place in the liver are performed by the liver enzymes. Every one of your cells has a variety of enzymes, and each enzyme specializes in a particular job. Some enzymes break molecules apart, while others link small molecules into long chains. With drugs, the first step in metabolizing occurs through a process known as the **first pass effect**, in which orally administered drugs are broken down in the liver and intestines. This makes the substance easier to excrete in the urine. Medications made of protein that are swallowed or otherwise absorbed in the GI tract may quickly be deactivated by enzymes as they pass through the stomach and duodenum. If the drug enters the blood from the intestines, part of it will be broken down by liver enzymes, known as the first pass effect, and some of it will escape to the general circulation to either be protein-bound (inactive) or stay free (and create an action at a receptor site). Thus, several doses of an oral medication may be needed to maintain enough active free drug in the circulation to exert the desired effect.

Many of the products of enzymatic breakdown, which are called metabolites, are less chemically active than the original molecule. For this reason, scientists refer to the liver as a "detoxifying" organ. However, rather than being destroyed by liver enzymes, a few drugs are metabolized into an active form of an intended drug called a "prodrug." Prodrugs have chemical activities of their own—sometimes as powerful as those of the original drug. When prescribing certain drugs, healthcare providers must take into account these added effects. Once liver enzymes are finished working on a medicine, the now-inactive drug undergoes the final stage of its time in the body – excretion – as it exits via the urine or feces.

Lifespan Considerations

Neonate & Pediatric: The developing liver in infants and young children produces decreased levels of microsomal enzymes. This may result in a decreased ability of the young child or neonate to metabolize medications. In contrast, older children may experience increased metabolism and require higher doses of medications once the hepatic enzymes are fully produced.
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Older Adult: Hepatic metabolism may experience a significant decline in the older adult. As a result, dosages should be adjusted according to the patient's liver function and anticipated metabolic rate. First-pass metabolism is also decreased with aging; therefore, older adults may have higher "free" circulating drug concentrations and be at higher risk for side effects and toxicities.
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Critical Thinking Activity 1.5a

Metabolism can be influenced by many factors within the body. If a patient has liver damage, the patient may not be able to breakdown (metabolize) medications as efficiently. Dosages are calculated according to the liver's ability to metabolize and the kidney's ability to excrete.

When caring for a patient with cirrhosis, how does this condition impact the dosages prescribed for the patient?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

Did you know the power of grapefruit juice?

A Juicy Story

Did you know that, in some people, a single glass of grapefruit juice can alter levels of drugs used to treat allergies, heart diseases, and infections? Fifteen years ago, pharmacologists discovered this "grapefruit juice effect" by luck, after giving volunteers grapefruit juice to mask the taste of a medicine. Nearly a decade later, researchers figured out that grapefruit juice affects the metabolizing rates of some medicines by lowering levels of a drug-metabolizing enzyme, called CYP3A4 (part of the CYP450 family of drug-binding enzymes), in the intestines.

More recently, Paul B. Watkins of the University of North Carolina at Chapel Hill discovered that other juices like Seville (sour) orange juice—but not regular orange juice—have the same effect on the liver's ability to metabolize using enzymes. Each of ten people who volunteered for Watkins' juice-medicine study took a standard dose of felodopine (Plendil), a drug used to treat high blood pressure, diluted in grapefruit juice, sour orange juice, or plain orange juice. The researchers measured blood levels of Plendil at various times afterward. The team observed that both grapefruit juice and sour orange juice increased blood levels of Plendil, as if the people had received a higher dose. Regular orange juice had no effect. Watkins and his coworkers have found that a chemical common to grapefruit and sour oranges, dihydroxybergamottin, is likely the molecular culprit. Thus, when taking medications that use the CYP3A4 enzyme to metabolize, patients are advised to avoid grapefruit juice and sour orange juice.

1.6 Excretion

Open Resources for Nursing (Open RN)

Excretion is the final stage of a medication interaction within the body. The body has absorbed, distributed, and metabolized the medication molecules – now what does it do with the leftovers? Remaining parent drugs and metabolites in the bloodstream are often filtered by the kidney, where a portion undergoes reabsorption back into the bloodstream, and the remainder is excreted in the urine. The liver also excretes byproducts and waste into the bile. Another potential route of excretion is the lungs. For example, drugs like alcohol and the anesthetic gases are often eliminated by the lungs.

Critical Thinking Activity 1.6a

When providing care for a patient who has chronic kidney disease, how does this disease impact medication excretion?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

Routes of Excretion

Now let's further discuss the various routes of excretion from the body.

Kidney

The most common route of excretion is the kidney. As the kidneys filter blood, the majority of drug byproducts and waste are excreted in the urine. The rate of excretion can be estimated by taking into consideration several factors: age, weight, biological sex, and kidney function. Kidney function is measured by lab values such as serum creatinine, glomerular filtration rate (GFR), and creatinine clearance. If a patient's kidney function is decreased, then their ability to excrete medication is affected and drug dosages must be altered for safe administration.

Liver

As the liver filters blood, some drugs and their metabolites are actively transported by the hepatocytes (liver cells) to bile. Bile moves through the bile ducts to the gallbladder and then on to the small intestine. During this process, some drugs may be partially absorbed by the intestine back into the bloodstream. Other drugs are biotransformed (metabolized) by intestinal bacteria and reabsorbed. Unabsorbed drugs and byproducts/metabolites are excreted via the feces. If a patient is experiencing decreased liver function, their ability to excrete medication is affected and drug dosages must be decreased. Lab studies used to estimate liver function are called liver function tests and include measurement of the ALT and AST enzymes that the body releases in response to damage or disease.

Other Routes to Consider

Sweat, tears, reproductive fluids (such as seminal fluid), and breast milk can also contain drugs and byproducts/metabolites of drugs. This can pose a toxic threat, such as the exposure of an infant to breast

milk containing drugs or byproducts of drugs ingested by the mother. Therefore, it is vital to check all medications with a healthcare provider before administering them to a mother who is breastfeeding.

Putting it all together…

Prescribing and administering medications in a safe manner to patients is challenging and requires a team effort by pharmacists, healthcare providers, and nurses. In addition to the factors described in this chapter, there are many other considerations for safe medication administration that are further explained in the "Legal/Ethical"chapter.

Lifespan Considerations

Neonate & Pediatrics: Young patients have immature kidneys with decreased glomerular filtration, resorption, and tubular secretion. As a result, they do not clear medications as efficiently from the body. Dosing for most medications used to treat infants and pediatric patients is commonly based on weight in kilograms, and a smaller dose is usually prescribed. In addition, pediatric patients may have higher levels of free circulating medication than anticipated and may become toxic quickly. Therefore, frequent assessment of infants and children is vital for early identification of drug toxicity.
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Older Adult: Kidney and liver function often decrease with age, which can lead to decreased excretion of medications. Subsequently, medication may have a prolonged half-life with a greater potential for toxicity due to elevated circulating drug levels. Smaller doses of medications are often recommended for older patients due to these factors, which is commonly referred to as "Start low and go slow."
Fernandez, E., Perez, R., Hernandez, A., Tejada, P., Arteta, M., & Ramos, J. T. (2011). Factors and mechanisms for pharmacokinetic differences between pediatric population and adults. *Pharmaceutics, 3*(1), 53–72. https://doi.org/10.3390/pharmaceutics3010053

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=199#h5p-2

1.7 Pharmacodynamics

Open Resources for Nursing (Open RN)

Complex Interactions

So far, we have learned the importance of pharmacokinetics in describing how the body absorbs, moves, processes, and eliminates a medication. Now let's consider a drug's impact on the body, a series of complex interactions known as **pharmacodynamics**.

When considering how the cells of the body respond to medications, it is important to remember that the majority of drugs bind to specific receptors on the surface or interior of cells. However, there are many

other cellular components and non-specific sites that can serve as receptor sites where drugs can bind to create a response. For example, did you know that an osmotic laxative like magnesium citrate attracts and binds with water? This medication works to pull water content into the bowel and increases the likelihood of a bowel movement.

Other medications may inhibit specific enzyme binding sites in order to impact the functionality of a cell or tissue. For example, antimicrobial and antineoplastic drugs commonly work by inhibiting enzymes that are critical to the function of the cell. With blockage of the enzyme binding site, the cell microbe or neoplastic cell is no longer viable and cell death occurs.

Agonist and Antagonist Actions

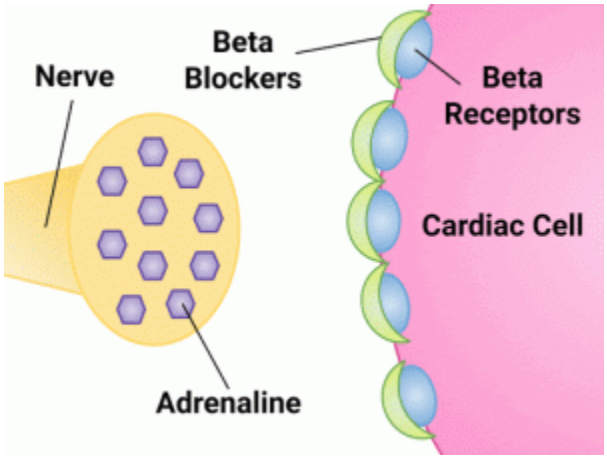


Figure 1.6 Mechanism of Action

Understanding the **mechanism of action**,

or how a medication functions within the body, is essential to understanding the processes medications go through to produce the desired effect (see Figure 1.6). Drugs have agonistic or antagonistic effects. A drug **agonist** binds tightly to a receptor to produce a desired effect. A drug **antagonist** competes with other molecules and blocks a specific action or response at a receptor site. For example, the cardiac medication atenolol (Tenormin) is a beta-1 receptor antagonist used to treat patients with hypertension or heart disease. Beta-1 receptor antagonist medications like atenolol produce several effects by blocking beta-1 receptors: a negative inotropic effect occurs by weakening the contraction of the heart, thus causing less work of the heart muscle; a negative chronotropic effect occurs when the heart rate is decreased; and a negative dromotropic effect occurs when the conduction of the electrical charge in the heart is slowed. Understanding the effects of a beta-1 antagonist medication allows the nurse to anticipate expected actions of the medication and the patient response. Agonistic and antagonistic effects on receptors are further discussed in the "Autonomic Nervous System" chapter.

Critical Thinking Activity 1.7a

Atenolol (Tenormin) is a beta-1 antagonist with a negative inotropic and chronotropic effects. What should a nurse assess before administration?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

1.8 Medication Types

Open Resources for Nursing (Open RN)

Prescription Medications, OTCs, Herbals, and Supplements

There are a variety of drug types and substances patients may utilize for symptom management or to enhance wellness. Having an accurate record and knowledge of the different types of substances a patient is taking is important to the patient's medical and nursing plan of care. It is also important to note any substances that are prescribed, over-the-counter, or herbal that have been taken in the past month, as some medications have a long half-life and still be in the body with the potential to interact with new medications.

A variety of substances available to the public include (but are not limited to) prescription medications (including brand name and generic drugs), over-the-counter medications, and herbals and supplements.

Prescription Medications

Drugs are prescribed by a licensed prescriber for a specific person's use and regulated through the United States Food and Drug Administration (FDA). More information about FDA approval of medications is described in the "Legal/Ethical" chapter. Prescription medications include brand-name medications and generic medications.

U.S. Food & Drug Administration. (2017, Nov. 13). *Prescription drug and over the counter drugs: Questions and answers.* https://www.fda.gov/drugs/questions-answers/prescription-drugs-and-over-counter-otc-drugs-questions-and-answers

Generic Medications

Generic medications can be safe and effective alternatives to their brand-name counterparts and often at a reduced cost. By FDA law, generic medications must have the same chemically active ingredient in

the same dose (i.e., they must be "bio-equivalent"). However, the excipients (the base substance that holds the active chemical ingredient into a pill form (such as talc) or the flavoring can be different. Some patients do not tolerate these differences in excipients very well. When prescribing a medication, the provider must indicate that a generic substitution is acceptable. Nurses are often pivotal in completing insurance paperwork on the patient's behalf if the brand-name medication is more effective or better tolerated by that particular patient. When studying medications in nursing school, it is important to know medications by their generic name, since the NCLEX exam does not currently include brand-name medications in their question format.

U.S. Food & Drug Administration. (2018, Jun. 19). *Patient education*. https://www.fda.gov/drugs/generic-drugs/patient-education

Over-the-Counter Medications

Over-the-counter (OTC) medications do not require a prescription. They can be bought at a store and may be used by multiple individuals. OTC medications are also regulated through the FDA. Some prescription medications are available for purchase as OTC in smaller doses. For example, diphenhydramine (Benadryl) is commonly prescribed as 50 mg every 6 hours, and the prescription strength is 50 mg. However, it can also be purchased OTC in 25 mg doses (or less for children.)

U.S. Food & Drug Administration. (2017, Nov. 13). *Prescription drug and over the counter drugs: Questions and answers.* https://www.fda.gov/drugs/questions-answers/prescription-drugs-and-over-counter-otc-drugs-questions-and-answers

Herbals & Supplements

Herbs and supplements may include a wide variety of substances including vitamins, minerals, enzymes, and botanicals. Supplements such as "protein powders" are marketed to build muscle mass and can contain a variety of substances that may not be appropriate for all individuals. These herbal and supplement substances are not regulated by the FDA and most have not undergone rigorous scientific testing for safety for the public. While patients may be tempted to try these herbals and supplements, there is no guarantee that they contain the ingredients listed on the label. It is also important to remember that there is a potential for adverse effects or even overdose if the herbal or supplement contains some of the same drug that was also prescribed to a patient.

U.S. Food & Drug Administration. (2017, Nov. 13). *What are dietary supplements?* https://www.fda.gov/food/information-consumers-using-dietary-supplements/tips-older-dietary-supplement-users#what

1.9 Examining Effect

Open Resources for Nursing (Open RN)

Onset, Peak, and Duration

Dosing considerations play an important role in understanding the effect that a medication may have on a patient. During administration, the nurse must pay close attention to the desired effect and therapeutic patient response, as well as the safe dose range for any medication. The nurse should have an understanding of medication **efficacy** in order to ensure its appropriateness. If a nurse is provided different medication choices according to a provider's written protocol, the nurse should select the option with the anticipated desired therapeutic response. Additionally, the nurse must be aware of the

overall **dose-response** based on the dosage selected.

Three additional principles related to the effect of a medication on a patient are onset, peak, and duration.

Onset: the onset of medication refers to when the medication first begins to take effect

Peak : the peak of medication refers to the maximum concentration of medication in the body, and the patient shows evidence of greatest therapeutic effect

Duration: the duration of medication refers to the length of time the medication produces its desired therapeutic effect

Consider this patient care example and apply the principles of onset, peak, and duration: A 67-year-old female post-operative patient rings the call light to request medication for pain related to the hip replacement procedure she had earlier that day. She notes her pain is "excruciating, a definite 9 out of 10." Her brow is furrowed, and she is grimacing in obvious discomfort. As the nurse providing care for the patient, you examine her post-operative medication orders and consider the pain medication options available to you. In reviewing the various options, it is important to consider how quickly a medication will work (onset), when the medication will reach maximum effectiveness (peak), and how long the pain relief will last (duration). Understanding these principles is important in effectively relieving the patient's pain and constructing an overall plan of care.

Critical Thinking Activities 1.9

Image of a circle containing a speech bubble with a question mark in it.

1. At 0500, your patient who had a total knee replacement yesterday rates his pain while walking as 7 out of 10. Physical therapy is scheduled at 0900. The patient has acetaminophen (Tylenol) 625 mg ordered every four hours as needed for discomfort. What should you consider in relation to the administration and timing of the patient's pain medication?

2. Your patient is prescribed NPH insulin to be given at breakfast and supper. As a student nurse, you know that insulin is used to decrease blood sugar levels in patients with diabetes mellitus. During report, you hear that the patient has been ill with GI upset during the night, and the nursing assistant just informed you he refused his breakfast tray. While reviewing this medication order, you consider the purpose of the medication and information related to the medication's onset,

peak, and duration. When reviewing the drug reference, you find the NPH insulin has an onset of about 1 – 3 hours after medication administration. What should you consider in relation to the administration and timing of the patient's insulin?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

Duration and Dosing

Now let's consider the implication of duration and dosing. Remember the duration of medication is correlated with the elimination. If a medication has a short half-life (and thus eliminated more quickly from the body), the therapeutic effect is shorter. These medications may require repeated dosing throughout the day in order to achieve steady blood levels of active free drug and a sustained therapeutic effect. Other medications have a longer half-life (and thus longer therapeutic duration) and are only given once or twice per day. For example, oxycondone immediate release is prescribed every 4 to 6 hours for the therapeutic effect of immediate relief of severe pain, whereas oxycodone ER (extended release) is prescribed every 12 hours for the therapeutic effect of sustained relief of severe pain.

1.10 Medication Safety

Open Resources for Nursing (Open RN)

Now that the basic concepts of medication onset, peak, and duration have been discussed, it is important to understand the value of the therapeutic window and therapeutic index in medication administration.

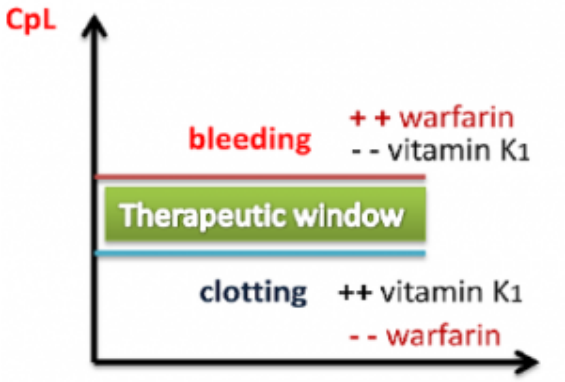


Figure 1.7 Therapeutic Window

Therapeutic Window

For every drug, there exists a dose that is minimally effective (the Effective Concentration) and another

dose that is toxic (the Toxic Concentration). Between these doses is the **therapeutic window,** where the safest and most effective treatment will occur (see Figure 1.7).
"Therapeutic Window" by Shefaa Alasfoor is licensed under CC BY-SA 3.0
Think of this area as the dosing "sweet spot."

For example, warfarin (Coumadin) is a medication used to prevent blood clotting and is monitored using a blood test called INR. Too high of a dose of warfarin would cause the INR to increase above the therapeutic window and put the patient at risk of bleeding. Conversely, too low of a dose of warfarin would cause the INR to be below the therapeutic window and put the patient at risk of clotting. It is vital that the nurse frequently monitors INR levels for a patient receiving warfarin to ensure the dosage appropriately reaches the therapeutic window and does not place the patient at risk for bleeding or clotting.

Peak and Trough Levels

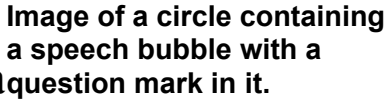
Now let's apply the idea of therapeutic window to the administration of medications requiring the monitoring of peak and trough levels, which is required in the administration of some IV antibiotics. It is important for the dosage of these medications to be **titrated** to achieve a desired therapeutic effect for the patient. Titration is often accomplished by closely monitoring the blood levels of the medication. A drug is said to be within the "therepeutic window" when the serum blood levels of an active drug remain consistently above the level of effective concentration (so that the medication is achieving its desired therapeutic effect) and consistently below the toxic level (so that no toxic effects are occurring). A **peak** drug level is drawn at the time when the medication is being administered and is known to be at the highest level in the bloodstream. A **trough** level is drawn when the drug is at its lowest in the bloodstream right before the next dose is given. Medications have a predicted reference range of normal values for peak and trough levels. These numbers assist the pharmacist and provider in gauging how the body is metabolizing, protein-binding, and excreting the drug, and assist in the adjustment of the prescribed drug doses to keep the medication within the therapeutic window. When administering IV medications that require peak or trough levels, it is vital for the nurse to time the administration of the medication according to the timing of these blood draws.

Therapeutic Index

Therapeutic Index is a quantitative measurement of the relative safety of a drug. It is a comparison of the amount of drug that produces a therapeutic effect versus the amount of drug that produces a toxic effect.

- A large (or high) therapeutic index number means there is a large therapeutic window between the effective concentration and the toxic concentration of a medication, so the drug is relatively safe.
- A small (or low) therapeutic index number means there is a small therapeutic window between the effective concentration and the toxic concentration. A drug with a narrow therapeutic range (i.e., having little difference between toxic and therapeutic doses) often has the dosage titrated according to measurements of the actual blood levels achieved in the person taking it. For example, patients who start taking phenytoin to control seizures have the drug levels in their blood stream measured frequently.

Critical Thinking Activity 1.10a



Mr. Parker has been receiving gentamicin 80 mg IV three times daily to treat his infective endocarditis. He has his gentamicin level checked one hour after the end of his previous gentamicin infusion was completed. The result is 30 mcg/ml. Access the link below to determine the nurse's course of action.

View information on Therapeutic Drug Levels

(Within the activity link, be sure to select "click to keep reading" in order to view drugs that are commonly checked, their target levels, and what abnormal results mean).

Based on the results in the above patient scenario, what action will the nurse take based on the result of the gentamicin level of 30 mcg/mL?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

1.11 Preparing for Administration

Open Resources for Nursing (Open RN)

Monitoring the Effects

As medications are administered, the nurse should perform careful patient assessments, trend the assessment results, and monitor for side effects or toxic adverse effects. Drug dosages should be evaluated for potency in action. **Potency** refers to the amount of the drug required to produce the desired effect. A drug that is highly potent may require only a minimal dose to produce a desired therapeutic effect, whereas a drug that has low potency may need to be given at much higher concentrations to produce the same effect. Consider the example of opioid versus non-opioid medications for pain control. Opioid medications often have a much higher potency in smaller doses to produce pain relief; therefore, the overall dose required to produce a therapeutic effect may be much less than for other analgesics.

The nurse preparing to administer medications must also be cognizant of drug selectivity and monitor for potential side effects and adverse effects. The **selectivity** of a drug refers to how readily the drug

targets specific cells to produce an intended therapeutic effect. Drugs that are selective will search out target sites to create a drug action, whereas non-selective drugs may impact many different types of cells and tissues, thus potentially causing side effects. A **side effect** occurs when the drug produces effects other than the intended effect. A side effect, although often undesirable, is generally anticipated by the provider and is a known unintended consequence of the medication therapy. Conversely, there are occasional occurrences of unanticipated effects that are dangerous to the patient. These dangerous occurrences are known as **adverse effects**. Adverse effects are relatively unpredictable, severe, and are reason to discontinue the medication.

1.12 Module Learning Activities

Open Resources for Nursing (Open RN)

Within this unit, you have been introduced to many concepts related to pharmacokinetics and pharmacodynamics. These basic concepts are important to understand as we move our study into closer examination of various medication classes, principles of administration, and consideration of how medications can be safely incorporated into the patient's plan of care.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=237#h5p-35

Image of a lightbulb inside a Lightbulb Momentcircle

Test your knowledge and application. Use the information in the text above, as well as the link to the Daily Med resource, to read more about the medications included in the patient scenarios. Additional pharmacokinetics information can be found under the "Clinical Pharmacology" section of each drug in Daily Med.

1. You are working in a nursing home caring for an 86 year-old stroke patient who complains of left knee pain secondary to arthritis. The patient has right-sided weakness and difficulty swallowing with no gag reflex. You review the patient's MAR, and note the provider has prescribed acetaminophen 325 mg either per oral or per rectal route. Which route would you choose and why?
2. Mr. Johnson is a 92-year-old male admitted to the medical-surgical unit for severe pneumonia, and the provider prescribed gentamicin antibiotic therapy. Upon review of the order, you notice

the initial dose is ordered at less than the standard recommended dose. What is the rationale behind the decreased starting gentamicin dose for this patient?

3. Sara is a nurse working on the medical-surgical floor. She is reviewing her patient's chart and notes her patient has a 0600 vancomycin infusion; however, the trough level is not available. The nurse phones the lab, and they state they will not be available to draw the trough level for an hour. What actions should the nurse take?
4. Sam is a nurse working on the cardiology floor. He has an order to administer a dose of atenolol (a beta-blocker medication) to a patient at 0800. What actions should the nurse take prior to administering the medication? What is the anticipated therapeutic effect of this medication?
5. Julia is a 56-year-old patient admitted to the cardiology unit with new-onset atrial fibrillation. She has been prescribed amiodarone for her irregular heartbeat and is set to receive her first dose with her morning breakfast tray. When you arrive in the room, you notice that she has grapefruit juice on her breakfast meal tray. Is this a concern? Why? What is the nurse's next action?
6. A nurse is caring for a 55-year-old male who recently was admitted to the medical-surgical unit for a total knee replacement. He is prescribed hydrocodone/acetaminophen 5/325 mg (Norco) every 6 hours for moderate pain. The patient complains of pain in the knee, rating it at a "6." Review the "Clinical Pharmacology" section for this medication using the Daily Med link, and answer the following questions:
    - When does the nurse anticipate the medication will peak in action?
    - When does the nurse anticipate another dose will be needed due to the half-life of this drug?

Note: Answers to the light bulb moments can be found in the "Answer Key" sections at the end of the book.

I. Glossary

Open Resources for Nursing (Open RN)

Absorption: The first stage of pharmacokinetics: medications enter the body and travel from site of administration into the body's circulation.

Adverse Effect: An unintended and potentially dangerous pharmacological effect that occurs when a medication is administered correctly.

Affinity: The strength of binding between drug and receptor.

Agonist: A drug that binds to a "receptor" and produces an effect.

Antagonist: A molecule that prevents the action of other molecules, often by competing for a cellular receptor; opposite of agonist.

Bioavailability: The presence of a drug in the blood stream after it is administered.

Blood-Brain Barrier: A nearly impenetrable barricade that is built from a tightly woven mesh of capillaries cemented together to protect the brain from potentially dangerous substances such as poisons or viruses.

Distribution: The second stage of pharmacokinetics; the process by which medication is distributed throughout the body.

Dose-Response: As the dose of a drug increases, the response should also increase. The slope of the curve is characteristic of the particular drug-receptor interaction.

Duration: The length of time that a medication is producing its desired therapeutic effect.

Efficacy: The maximum effect of which the drug is capable.

Excretion: The final stage of pharmacokinetics; the process whereby drug byproducts and metabolites are eliminated from the body.

First Pass Effect: The inactivation of orally or enterally administered drugs in the liver and intestines.

Mechanism of Action: How a medication works at a cellular level within the body.

Metabolism: The breakdown of a drug molecule via enzymes in the liver (primarily) or intestines (secondarily).

Onset: When a medication first begins to work and exerts a therapeutic effect.

Peak: When the maximum concentration of a drug is in the bloodstream.

Pharmacodynamics: The study of how drugs act at target sites of action in the body.

Pharmacogenetics: The study of how a person's genetic make-up affects their response to medicines.

Pharmacokinetics: The study of how the body absorbs, distributes, metabolizes, and eliminates drugs.

Pharmacology: The science dealing with actions of drugs on the body.

Pharmacy: The science of the preparation of drugs.

Potency: The drug dose required to produce a specific intensity of effect.

Selectivity: A "selective" drug binds to a primary and predictable site creating one desired effect. A "non-selective" drug can bind to many different and unpredictable receptor sites with potential side effects.

Side Effect: Effect of a drug, other than the desired effect, sometimes in an organ other than the target organ.

Therapeutic Index: A quantitative measurement of the relative safety of a drug that compares the amount of drug that produces a therapeutic effect versus the amount of drug that produces a toxic effect. Medication with a large therapeutic index is safer than a medication with a small therapeutic index.

Therapeutic Window: The dosing window in which the safest and most effective treatment will occur.

Legal/Ethical

2.1 Legal/Ethical Introduction

Open Resources for Nursing (Open RN)

Learning Objectives

- Identify drug administration guidelines within the State Nurse Practice Act
- Identify nursing responsibilities to prevent and respond to medication errors
- Identify nursing responsibilities associated with controlled substances
- Identify ethical responsibilities as they relate to medication errors
- Explain how nursing response reflects respect for a patient's rights and responsibilities with drug therapy
- Outline nursing actions within the scope of nursing practice as they relate to the administration of medication
- Demonstrate patient-centered care during medication administration by respecting a patient's gender and psychosocial and cultural needs
- Identify nursing responsibilities associated with safe medication administration
- Identify nursing responsibilities associated with patient medication education

Medication administration is an essential task nurses perform while providing patient care. However, safe medication administration is more than just a nursing task; it is a process involving several members of the health care team, as well as legal, ethical, social, and cultural issues. The primary focus of effective medication administration by all health professionals is patient safety. Although many measures have been put into place over the past few decades to promote improved patient safety, medication errors, and adverse effects continue to be a common event. The World Health Organization (WHO) estimates, "Unsafe medication practices and medication errors are a leading cause of injury and avoidable harm in health care systems across the world. Globally, the cost associated with medication errors has been estimated at $42 billion USD annually."
World Health Organization. (2019). *Patient safety*. https://www.who.int/patientsafety/medication-safety/en/.
This chapter will examine the legal and ethical foundations of medication administration by nurses, as well as the practice standards and cultural and social issues that must be considered to ensure safe and effective administration of medication.

2.2 Ethical and Professional Foundations of Safe Medication Administration by Nurses

Open Resources for Nursing (Open RN)

ANA Code of Ethics for Nurses

The American Nurses Association (ANA) is a professional organization that represents the interests of

the nation's 4 million registered nurses and is at the forefront of improving the quality of health care for all.
American Nurses Association. (2019). About ANA. https://www.nursingworld.org/ana/about-ana/.

The ANA developed the Code of Ethics for Nurses as a guide for carrying out nursing responsibilities in a manner consistent with quality in nursing care and the ethical obligations of the profession.
American Nurses Association. (2015). Code of ethics for nurses with interpretive statements. https://www.nursingworld.org/coe-view-only
Several provisions from the Code of Ethics impact how nurses should administer medication in an ethical manner. A summary of each provision from the Code of Ethics and how it affects medication administration is outlined below.

- **Provision 1** focuses on respect for human dignity and the right for self-determination: "The nurse practices with compassion and respect for the inherent dignity, worth, and unique attributes of every person."
- **Provision 2** states, "The nurse's primary commitment is to the patient…"
  American Nurses Association. (2015). Code of ethics for nurses with interpretive statements. https://www.nursingworld.org/coe-view-only
  In health care settings, nurses often experience several competing loyalties, such as to their employer, to the doctor(s), to their supervisor, or to others on the health care team. However, the patient should always receive the primary commitment of the nurse. Additionally, the patient has the right to accept, refuse, or terminate any treatment, including medications.
- **Provision 3** states, "The nurse promotes, advocates for, and protects the rights, health, and safety of the patient…"
  American Nurses Association. (2015). Code of ethics for nurses with interpretive statements. https://www.nursingworld.org/coe-view-only
  This provision includes a nurse's responsibility to promote a culture of safety for patients. If errors occur, they must be reported, and nurses should ensure responsible disclosure of errors to patients. This also includes proper disclosure of questionable practices, such as **drug diversion** or impaired practice by any professional.
- **Provision 4** involves authority, accountability, and responsibility by a nurse to follow legal requirements, such state practice acts and professional standards of care.
- **Provision 5** includes the responsibility of the nurse to promote health and safety.
- **Provision 6** focuses on virtues that make a nurse a morally good person. For example, nurses are held accountable to use their clinical judgment to avoid causing harm to patients (**maleficence**) and to do good (**beneficence**). When administering medications, nurses should validate the medication is doing more "good" than "harm" (adverse or side effects).
- **Provision 7** focuses on a nurse practicing within the professional standards set forth by their **state nurse practice act**, as well as standards established by professional nursing organizations.
- **Provision 8** explains that a nurse must address the **social determinants of health,** such as poverty, education, safe medication, and healthcare disparities.
  American Nurses Association. (2015). Code of ethics for nurses with interpretive statements. https://www.nursingworld.org/coe-view-only

Whenever a nurse provides patient care, the ANA Code of Ethics should be kept in mind.

Critical Thinking Activity 2.2a

Image of a lightbulb inside a circle

A nurse is preparing to administer medications to a patient. While reviewing the chart, the nurse notices two medications with similar mechanisms of action have been prescribed by two different providers.

What is the nurse's best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

ANA Professional Standards and Scope of Practice

The American Nurses Association (ANA) publishes the *Nursing: Scope and Standards of Practice*. This resource is updated regularly and outlines professional nursing performance according to national standards.
American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.). Available for all Chippewa Valley Technical College students and employees through OneSearch.

The ANA defines **nursing** as "the protection, promotion, and optimization of health and abilities, prevention of illness and injury, facilitation of healing, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, groups, communities, and populations." A **registered nurse (RN)** is defined as an individual who is educationally prepared and licensed by a state to practice as a registered nurse. Nursing practice is characterized by the following tenets:

- Caring and health are central to the practice of the registered nurse.
- Nursing practice is individualized to the unique needs of the healthcare consumer.
- Registered nurses use the nursing process to plan and provide individualized care for healthcare consumers.
- Nurses coordinate care by establishing partnerships to reach a shared goal of delivering safe, quality health care.
  American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.). Available for all Chippewa Valley Technical College students and employees through OneSearch.

State nurse practice acts further define the scope of practice of RNs and Licensed Practical Nurses (LPNs) within each state. The Wisconsin Nurse Practice Act is further discussed in the "Legal Foundations" section.

ANA Standards of Practice

ANA Standards of Practice are authoritative statements of duties that all registered nurses, regardless of role, population, or specialty, are expected to perform competently. **Standards of Practice** include assessment, diagnosis, outcome identification, planning, implementation, and evaluation (ADOPIE) components of providing patient care. Implementation also includes the components of health promotion and health teaching. Medication administration should include all components of ADOPIE.

Health Promotion and Patient Teaching

The ANA standards for patient teaching state, "The registered nurse employs strategies to promote health and a safe environment."
American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.). Available for all Chippewa Valley Technical College students and employees through OneSearch.

Specific behaviors related to patient teaching about medication include:

- Use health promotion and health teaching methods in collaboration with the patient's values, beliefs, health practices, developmental level, learning needs, readiness and ability to learn, language preference, spirituality, culture, and socioeconomic status.
- Provide patients with information about intended effects and potential adverse effects of the plan of care.
- Provide anticipatory guidance to patients to promote health and prevent or reduce the risk of negative health outcomes.
  American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.). Available for all Chippewa Valley Technical College students and employees through OneSearch.

In the book *Preventing Medication Errors* by the Institute of Medicine (2007), additional key actions to include when teaching patients about safe use of their medications are:

- Patients should maintain an active list of all prescription drugs, over-the-counter (OTC) drugs, and dietary supplements they are taking, the reasons for taking them, and any known drug allergies. Every provider involved in the medication-use process for a patient should have access to this list.
- Patients should be provided information about side effects, contraindications, methods for handling adverse reactions, and sources for obtaining additional objective, high-quality information.
  Institute of Medicine. (2007). *Preventing medication errors.* The National Academies Press. https://doi.org/10.17226/11623

ANA Standards of Professional Performance

ANA Standards of Professional Performance describe a competent level of behavior in the professional role, including activities related to ethics, culturally congruent practice, communication, collaboration, leadership, education, evidence-based practice, and quality of practice.
American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.). Available for all Chippewa Valley Technical College students and employees through OneSearch.

Cultural Congruent Practice

The ANA defines **culturally congruent practice** as the application of evidence-based nursing that is in agreement with the preferred cultural values, beliefs, worldview, and practices of the healthcare consumer and other stakeholders. **Cultural competence** represents the process by which nurses demonstrate culturally congruent practice. Nurses must assess the cultural beliefs and practices of their patients and implement culturally congruent interventions when administering medications and teaching about them. Additional information about cultural implications for medication administration is further discussed in the "Cultural and Social Determinants Related to Medication Administration" section later in this chapter.

Critical Thinking Activity 2.2b

A nurse is preparing to administer metoprolol, a cardiac medication, to a patient and implements the nursing process:

ASSESSES the vital signs prior to administration and discovers the heart rate is 48.

DIAGNOSES that the heart rate is too low to safely administer the medication per the parameters provided. Establishes the **OUTCOME** to keep the patient's heart rate within normal range of 60-100.

PLANS to call the physician, as well as report this incident in the shift handoff report.

Implements **INTERVENTIONS** by withholding the metoprolol at this time, documenting the incident that the medication is withheld, and notifying the provider.

Continues to **EVALUATE** the patient status throughout the shift after not receiving the metoprolol.

The nurse is providing patient teaching to a patient about the medication before discharge. The nurse provides a handout with instructions, as well as a list of the current medications.

What other information should be provided to the patient?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.


QUALITY
Self-Determination
Institutional Policies and Procedures
Nurse Practice Act and Rules and Regulations
Nursing's Professional Scope of Practice Standards of Practice, Code of Ethics, and Specialty Certification
EVIDENCE

Fig 2.1 ANA Model of Professional Nursing Practice Regulation

Figure 2.1 is an image from *Nursing: Scope and Standards of Practice* by the ANA (2015).
American Nurses Association. (2015). *Nursing : scope and standards of practice* (3rd ed.) Available for all Chippewa Valley Technical College students and employees through OneSearch.
It explains how professional scope of practice, standards, and code of ethics are the "base" of nursing practice. Nursing practice is further defined by the State's Nurse Practice Act, rules and regulations, institutional policies and procedures, and self-determination by the individual nurse. All these components are required to provide quality, safe patient care that is evidence-based.

2.3 Legal Foundations and National Guidelines for Safe Medication Administration

Open Resources for Nursing (Open RN)

There are many federal and state laws, as well as national guidelines, that have been established to protect public health and safety. This section will explain how the FDA, DEA, Joint Commission, CMS, a State's Nurse Practice Act, State Boards of Nursing, and state legislatures protect the consumer from medication harm.

2.3a – Food and Drug Administration

To protect the public, the U.S. Food and Drug Administration (FDA) is responsible for protecting the public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, and medical devices; and by ensuring the safety of our nation's food supply, cosmetics, and products that emit radiation.
U.S. Food and Drug Administration. (2019) https://www.fda.gov
Some of the ways that the FDA protects the public health regarding medications are by enforcing an official drug approval process based on evidence-based research; issuing Black Box Warnings for medications with serious adverse reactions; and regulating over-the-counter (OTC) medications. Each of these actions are further explained below.

Developing New Drugs

American consumers benefit from having access to the safest and most advanced pharmaceutical system in the world. The main consumer watchdog in this system is the FDA's Center for Drug Evaluation and Research (CDER).

The center's best-known job is to evaluate new drugs before they can be sold. CDER's evaluation not only prevents quackery, but also provides doctors and patients the information they need to use medicines wisely. The center ensures that drugs, both brand-name and generic, work correctly and that their health benefits outweigh their known risks.

Development and Approval Process of Drugs by the FDA

Drug companies conduct extensive research and work to develop and test a drug. The company then

sends CDER the evidence from these tests to prove the drug is safe and effective for its intended use. Before the drug is approved as safe for use in the United States, a team of CDER physicians, statisticians, chemists, pharmacologists, and other scientists reviews the company's data and proposed labeling. If this independent and unbiased review establishes a drug's health benefits outweigh its known risks, the drug is approved for sale. Before a drug can be tested in people, the drug company or sponsor performs laboratory and animal tests to discover how the drug works and whether it's likely to be safe and work well in humans. Next, a series of clinical trials involving volunteers is conducted to determine whether the drug is safe when used to treat a disease and whether it provides a real health benefit.

FDA Approval: What it Means

FDA approval of a drug means that data on the drug's effects have been reviewed by CDER, and the drug is determined to provide benefits that outweigh its known and potential risks for the intended population. The drug approval process takes place within a structured framework that includes:

- **Analysis of the target condition and available treatments:** FDA reviewers analyze the condition or illness for which the drug is intended and evaluate the current treatment landscape, which provide the context for weighing the drug's risks and benefits. For example, a drug intended to treat patients with a life-threatening disease for which no other therapy exists may be considered to have benefits that outweigh the risks even if those risks would be considered unacceptable for a condition that is not life threatening.
- **Assessment of benefits and risks from clinical data:** FDA reviewers evaluate clinical benefit and risk information submitted by the drug maker, taking into account any uncertainties that may result from imperfect or incomplete data. Generally, the agency expects that the drug maker will submit results from two well-designed clinical trials to be sure the findings from the first trial are not the result of chance or bias. In certain cases, especially if the disease is rare and multiple trials may not be feasible, convincing evidence from one clinical trial may be enough. Evidence that the drug will benefit the target population should outweigh any risks and uncertainties.
- **Strategies for managing risks:** All drugs have risks. Risk management strategies include an FDA-approved drug label, which clearly describes the drug's benefits and risks and information pertaining to the detection and management of any risks. Sometimes, more effort is needed to manage risks. In these cases, a drug maker may need to implement a Risk Management and Mitigation Strategy (REMS).

Although many of the FDA's risk-benefit assessments and decisions are straightforward, sometimes the benefits and risks are uncertain and may be difficult to interpret or predict. The agency and the drug maker may reach different conclusions after analyzing the same data, or there may be differences of opinion among members of the FDA's review team. As a science-led organization, the FDA uses scientific and technological information to make decisions through a deliberative process.
U.S. Food and Drug Administration. (2018, June 13). *Developing new drugs.* https://www.fda.gov/drugs/development-approval-process-drugs

Black Box Warnings

The Food and Drug Administration (FDA) approves a drug for marketing after determining that the drug's benefits of use outweigh the risks for the condition that the drug will treat. However, even with the rigorous FDA evaluation process, some safety problems surface only after a drug has been on the

market and has been used in a broader population. If a safety problem surfaces, **Black Box Warnings** are issued by the FDA and appear on a prescription drug's label. The purpose is to call attention to serious or life-threatening risks.
U.S. Food and Drug Administration. (2012, November). *Consumer health information.* https://www.fda.gov/media/74382/download

Image of lightbulb in a circle

Critical Thinking Activity 2.3a

Levofloxacin is an antibiotic that received FDA approval. However, after the drug was on the market, it was discovered that some patients who took levofloxacin developed serious, irreversible adverse effects such as tendon rupture. The FDA issued a Black Box Warning with recommendations to reserve levofloxacin for use in patients who have no alternative treatment options for certain indications: uncomplicated UTI, acute exacerbation of chronic bronchitis, and acute bacterial sinusitis.
This work is a derivative of Daily Med by U.S. National Library of Medicine in the public domain.

A nurse is preparing to administer medications to a patient and notices that levofloxacin has been prescribed for the indication of pneumonia. There is no other documentation in the provider's notes related to the use of this medication.

What is the nurse's best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

2.3b – U.S. Drug Enforcement Agency (DEA)

The U.S. Drug Enforcement Agency (DEA) enforces the controlled substances laws and regulations of the United States. This includes enforcement of the Controlled Substances Act (CSA) that pertains to the manufacture, distribution, and dispensing of legally produced controlled substances that nurses administer to patients.
U.S. Department of Justice - Drug Enforcement Administration. (n.d.). *Drug scheduling.*https://www.dea.gov/drug-scheduling

Because controlled substances have a greater chance of being misused and abused, there are additional laws and procedures that must be followed when working with these medications. The federal government administers some laws regarding controlled substances. The DEA is responsible for

enforcing these laws, and many federal laws are summarized in a document called the *Pharmacist's Manual*.
https://www.deadiversion.usdoj.gov/pubs/manuals/pharm2/index.html
Most controlled substance laws, however, come from the state governments. Health care professionals are responsible for following the most stringent of the two laws, whether it be state law or federal law.

Federal Laws

The following are excerpts of federal laws that are applicable to professional nursing.

Prescriptions: A prescription for a controlled substance may be written only by a provider (physician or mid-level provider like a nurse practitioner) that has a DEA registration number.

A prescription for a Schedule II (most controlled class of medications, like opioids) must be written or electronically sent to the pharmacy through DEA approved software. Prescriptions over the phone or fax are not accepted.

It is then up to state law to decide how long a written Schedule II prescription is valid and if there are any limits on the quantity of medication that can be dispensed.

Refilling a Schedule II medication is not allowed. Schedule III or IV medications may be refilled only 5 times.

Records: There is a "closed system" for record keeping of controlled substances to prevent diversion.

To maintain a "closed system" of record keeping for controlled substances, hospitals, clinics, and pharmacies must maintain records on the whereabouts of the medication from manufacturing the medication, receipt by the pharmacy, distribution to the patient, to disposal of waste. What does this look like in practice? Inventory counts of controlled medications occur frequently, controlled substance access by individual employees is audited often, detailed records are kept for all transactions, and waste is often disposed of differently than other pharmaceuticals.

Wisconsin State Laws

Prescriptions: A Schedule II prescription is only good for 60 days after it is written.

Pharmacies and practitioners are required to participate in a prescription drug monitoring program when dispensing or prescribing a monitored prescription drug (most often opioid pain medications).

Wisconsin State Law Regarding Controlled Substance
Wisconsin Administrative Code (2020). Unform Controlled Substances Act. https://docs.legis.wisconsin.gov/code/admin_code/phar/8.pdf

Scheduled Medications

The Controlled Substances Act (CSA) places all substances that are regulated under existing federal law into one of five schedules. This placement is based on the substance's medical use, potential for abuse, and safety or dependence liability. Schedule I drugs have a high potential for abuse and the potential to create severe psychological and/or physical dependence, whereas Schedule V drugs represent the least

potential for abuse. An alphabetic listing of drugs and their schedule are located on the DEA website at "CSA Scheduling by Alphabetical Order."
U.S. Department of Justice - Drug Enforcement Administration.(n.d.). *Drug scheduling.*https://www.dea.gov/drug-scheduling
,
U.S. Department of Justice - Drug Enforcement Administration.(2019, August 21). *Controlled substances.*https://www.deadiversion.usdoj.gov/schedules/orangebook/c_cs_alpha.pdf

Sample medications for each schedule are included in Figure 2.2.
U.S. Department of Justice - Drug Enforcement Administration.(n.d.). Drug scheduling. https://www.dea.gov/drug-scheduling

Figure 2.2 Definitions and Sample Medications for Each Type of Scheduled Medication

Schedule	Definition	Examples
Schedule I	No currently accepted medical use and a high potential for abuse.	Heroin, LSD, and marijuana
Schedule II	High potential for abuse, with use potentially leading to severe psychological or physical dependence. These drugs are also considered dangerous.	Vicodin, cocaine, methamphetamine, methadone, hydromorphone (Dilaudid), meperidine (Demerol), oxycodone (OxyContin), fentanyl, Dexedrine, Adderall, and Ritalin
Schedule III	Moderate to low potential for physical and psychological dependence. Abuse potential is less than Schedule I and Schedule II drugs but more than Schedule IV.	Tylenol with codeine, ketamine, anabolic steroids, testosterone
Schedule IV	Low potential for abuse and low risk of dependence.	Xanax, Soma, Valium, Ativan, Talwin, Ambien, Tramadol
Schedule V	Lower potential for abuse than Schedule IV and consist of preparations containing limited quantities of certain narcotics. Generally used for antidiarrheal, antitussive, and analgesic purposes.	Robitussin AC with codeine, Lomotil, Lyrica

Drug overdoses are still a public health crisis in the United States, and the misuse of prescription opioids, which are scheduled medications, continue to contribute to a large percentage of overdose deaths. Many problems associated with drug abuse are the result of legitimately made controlled substances being diverted from their lawful purpose into illicit drug traffic. The mission of DEA's Diversion Control Division is to prevent, detect, and investigate the diversion of controlled pharmaceuticals from legitimate sources while ensuring an adequate and uninterrupted supply for legitimate medical, commercial, and scientific needs. The DEA provides education regarding related topics that apply to nurses such as drug diversion, state prescription drug monitoring systems, current drug trends, telemedicine, and proper drug disposal.
U.S. Department of Justice - Drug Enforcement Administration.(2019, August 21). *Controlled substances.*
https://www.deadiversion.usdoj.gov/schedules/orangebook/c_cs_alpha.pdf

Drug Diversion

Drug diversion involves the transfer of any legally prescribed controlled substance from the individual for whom it was prescribed to another person for any illicit use. The most common drugs diverted from the health care facility setting are opioids. Diversion of controlled substances is not uncommon and can result in substantial risk not only to the individual who is diverting the drugs but also to patients, coworkers, and employers. Impaired providers can harm patients by providing substandard care, denying medications to patients, or exposing patients to tainted substances. Tampering is the riskiest and most harmful type of diversion. Commonly, the diverter removes medication from a syringe, vial, or other container and injects himself or herself with the medication. The diverter then replaces the stolen medication with saline or sterile water or another clear medication or liquid. The "replacement liquid" is later used on the patient by an unaware provider. When tampering, the diverter may rarely use sterile technique. Ultimately the patient doesn't receive the required medication and may be exposed to the diverter's blood.

New, K. (2014, June 3). *Drug diversion defined: a patient safety threat.* Centers for Disease Control and Prevention.https://web.archive.org/web/20150716073835/http://blogs.cdc.gov/safehealthcare/2014/06/03/drug-diversion-defined-a-patient-safety-threat/

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Berge, K. H., Dillon, K. R., Sikkink, K. M., Taylor, T. K., & Lanier, W. L. (2012). Diversion of drugs within health care facilities, a multiple-victim crime: patterns of diversion, scope, consequences, detection, and prevention. *Mayo Clinic Proceedings, 87*(7), 674–682. https://www.ncbi.nlm.nih.gov/pubmed/22766087

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U.S. Department of Justice - Drug Enforcement Administration. (2019). https://www.deadiversion.usdoj.gov/prog_dscrpt/index.html

DEA at Rx Abuse Online Reporting

U.S. Department of Justice - Drug Enforcement Administration. (n.d.). *RX abuse online reporting: report incident.* https://apps2.deadiversion.usdoj.gov/rxaor/spring/main?execution=e1s1

The National Council of State Boards of Nursing (NCSBN) created a *Substance Abuse Disorder in Nursing* brochure.

Substance Abuse Disorder in Nursing Brochure

National Council State Board of Nursing. *Substance Abuse Disorder in Nursing brochure*. https://www.ncsbn.org/SUD_Brochure_2014.pdf

The brochure states, "Many nurses with substance use disorder (SUD) are unidentified, unreported, untreated, and may continue to practice where their impairment may endanger the lives of their patients. SUD among health care providers also creates significant legal and ethical responsibilities for colleagues who work with these individuals. You have a professional and ethical responsibility to report a colleague's suspected drug use to your nurse manager or supervisor and, in some states or jurisdictions, to the board of nursing. You have a vital role in helping to identify nurses with SUD, so it is necessary for you to be aware of the indicators that may signal that a nurse has a problem.

It can be hard to differentiate between the subtle signs of impairment and stress-related behaviors, but there are three areas to watch: behavior changes, physical signs, and drug diversion. Behavioral changes can include changes or shifts in job performance; absences from the unit for extended periods; frequent trips to the bathroom; arriving late or leaving early; and making an excessive number of mistakes, including medication errors. Behavioral changes can be physical, including subtle changes in appearance that may escalate over time; increasing isolation from colleagues; inappropriate verbal or emotional responses; and diminished alertness, confusion, or memory lapses. When nurses are using drugs and

unable to obtain them from a treating health care provider, they may turn to the workplace for access or diversion, often causing narcotic discrepancies, such as incorrect narcotic counts, large amounts of narcotic wastage, numerous corrections of medication records, frequent reports of ineffective pain relief from patients, offers to medicate coworkers' patients for pain, altered verbal or phone medication orders, and variations in controlled substance discrepancies among shifts or days of the week.

The earlier an SUD in a nurse is identified and treatment is started, the sooner patients are protected and the better the chances are of the nurse safely returning to work. You need to acknowledge that health care professionals are not immune to developing an SUD, and you should ignore stereotypes of what a "typical" person with a SUD looks like. It is important for nurses to not only be aware of the warning signs of SUD, but also be cognizant that SUD is a disease that can affect anyone regardless of age, occupation, economic circumstances, ethnic background, or gender. This will help you to identify issues in a coworker or colleague because you will be able to see behaviors and performance without the notion of "nurses wouldn't do that" or "someone like this would never have an SUD." In most states, a nurse may enter a nondisciplinary alternative-to-discipline program, which is designed to refer nurses for evaluation and treatment, monitor the nurse's compliance with treatment and recovery recommendations, monitor abstinence from drug or alcohol use, and monitor the practice upon return to work. You need to acknowledge that health care professionals are not immune to developing an SUD. When a colleague treated for an SUD eventually returns to work, it is important that you help to create a supportive environment that encourages continued recovery.

National Council of State Boards of Nursing (NCSBN). (2018, July). *A nurse's guide to substance use disorder in nursing.* https://www.ncsbn.org/SUD_Brochure_2014.pdf

Prescription Drug Monitoring Programs (PDMP)

In addition to drug diversion programs, prescription drug monitoring programs (PDMP) have been established in several states to address prescription drug abuse, addiction, and diversion. A PDMP is a statewide electronic database that collects designated data on substances dispensed in the state. By providing valuable information about controlled substance prescriptions that are dispensed in the state, it aids healthcare professionals in their prescribing and dispensing decisions. The PDMP also fosters the ability of pharmacies, healthcare professionals, law enforcement agencies, and public health officials to work together to reduce the misuse, abuse, and diversion of prescribed controlled substance medications.

U.S. Department of Justice - Drug Enforcement Administration. (2016, June 2). *State prescription drug monitoring programs.* https://www.deadiversion.usdoj.gov/faq/rx_monitor.htm

Wisconsin Prescription Drug Monitoring Program

Wisconsin ePDMP. (2019). https://pdmp.wi.gov/

Proper Drug Disposal

Figure 2.3 Controlled Substances Collection Receptacle to help prevent drug diversion

The Secure and Responsible Drug Disposal Act of 2010 allows users to dispose of controlled substances in a safe and effective manner. A Johns Hopkins study on sharing of medication found that 60% of people had leftover opioids they hung on to for future use; 20% shared their medications; 8% would likely share with a friend; 14% would likely share with a relative; and only 10% securely locked their medication.

U.S. Department of Justice - Drug Enforcement Administration. (2017, December 13). *Federal regulations and the disposal of controlled substances.* https://www.deadiversion.usdoj.gov/mtgs/drug_chemical/2017/wingert.pdf#search=drug%20disposal

This act has resulted in "National Take Back Days" in all 50 states, as well as new collection receptacles.

U.S. Department of Justice - Drug Enforcement Administration. (2017, December 13). *Federal regulations and the disposal of controlled substances.* https://www.deadiversion.usdoj.gov/mtgs/drug_chemical/2017/wingert.pdf#search=drug%20disposal

Nurses should teach patients who are prescribed controlled substances how to dispose of them properly so that they don't end up being abused or overdosed by another person. Figure 2.3

shows an example of a controlled substances collection receptacle to prevent drug diversion.

U.S. Department of Justice - Drug Enforcement Administration. (2017, December 13). *Federal regulations and the disposal of controlled substances.* https://www.deadiversion.usdoj.gov/mtgs/drug_chemical/2017/wingert.pdf#search=drug%20disposal

Critical Thinking Activity 2.3b

Image of lightbulb in a circle

A nurse is providing discharge education to a patient who recently had surgery and has been prescribed hydrocodone/acetaminophen tablets to take every four hours as needed at home. The nurse explains that when the medication is no longer needed when the post-op pain subsides, it should be dropped off at a local pharmacy for disposal in a collection receptacle. The patient states, "I don't like to throw anything away. I usually keep unused medication in case another family member needs it."

1. What is the nurse's best response?

A nurse begins a new job on a medical surgical unit. One of the charge nurses on this unit is highly regarded by her colleagues and appears to provide excellent care to her patients. The new nurse cares for a patient that the charge nurse cared for on the previous shift. The new nurse asks the patient about the effectiveness of the pain medication documented as provided by the charge nurse during the previous shift. The patient states, "I didn't receive any pain medication during the last shift." The nurse mentions this incident to a preceptor who states, "I have noticed the same types of incidents have occurred with previous patients, but didn't want to say anything."

2. What is the new nurse's best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

2.3c – Joint Commission

The **Joint Commission** is a national organization that accredits and certifies over 20,000 health care organizations in the United States. The mission of the Joint Commission is to continuously improve health care for the public by inspiring health care organizations to excel in providing safe and effective care of the highest quality and value.
The Joint Commission. (n.d.). https://www.jointcommission.org/
Some of the initiatives that the Joint Commission supports for promoting the safe use of medications include the development of a Safety Culture and associated root cause analyses, the Speak Up Campaign, and National Patient Safety Goals. Each of these initiatives is further explained below.

Safety Culture

The Joint Commission Center for Transforming Healthcare develops effective solutions for health care's most critical safety and quality problems with a goal to ultimately achieve zero harm to patients. Some of the projects the Center have developed include improved hand hygiene,
Joint Commission Center for Transforming Healthcare (2020). *Hand Hygiene.*
https://www.centerfortransforminghealthcare.org/improvement-topics/hand-hygiene
effective handoff communications,
Joint Commission Center for Transforming Healthcare (2020.) *Effective Hand-off Communications.*
https://www.centerfortransforminghealthcare.org/improvement-topics/hand-off-communications
and safe and effective use of insulin.
Joint Commission Center for Transforming Healthcare (2020). *Safe and Effective Use of Insulin*.
https://www.centerfortransforminghealthcare.org/improvement-topics/safe-and-effective-use-of-insulin

The Center has also been instrumental in creating a focus on a "Safety Culture" in health care organizations. A **safety culture** empowers staff to speak up about risks to patients and to report errors and near misses, all of which drive improvement in patient care and reduce the incident of patient harm. It has been estimated that the average cost of a medical error is $11,366, resulting in approximately $17.1 billion in costs in 2008. According to the Institute of Medicine, "The biggest challenge to moving toward a safer health system is changing the culture from one of blaming individuals for errors to one in which errors are treated not as personal failures, but as opportunities to improve the system and prevent harm."
The Joint Commission. (2014, November). *Facts about the safety culture project.*
https://www.centerfortransforminghealthcare.org/-/media/cth/documents/improvement-topics/cth_sc_fact_sheet.pdf

Creating A Safety Culture

As a result of the focus on creating a safety culture, whenever a medication error or a "near miss" occurs, nurses should submit an incident report according to their institution's guidelines. The incident report triggers a **root cause analysis** to help identify not only what and how an event occurred, but also why it happened. When investigators are able to determine why an event or failure occurred, they can create workable corrective measures that prevent future errors from occurring.
Patient Safety Network. (2019). *Root cause analysis.* https://psnet.ahrq.gov/primer/root-cause-analysis

An example of safety culture in action is from 2006, when three babies died after receiving incorrect heparin doses to flush their vascular access devices. A root cause analysis found that pharmacy technicians accidentally placed vials containing more concentrated heparin (10,000 units/mL) in storage locations in patient care areas designated for less concentrated heparin vials (10 units/mL). Additionally, the heparin vials were similar in appearance, so the nurses did not notice the incorrect dosage until after it was administered. In response to the root cause analysis, the hospital no longer stocks heparin 10 units/mL vials in pediatric units and uses saline to flush all peripheral lines. In the pharmacy, 10,000 units/mL heparin vials were separated from vials containing other strengths. Workable corrective measures were thus implemented to prevent future tragedies from occurring as a result of incorrect doses of heparin.
Institute for Safe Medication Practices. (2007, November 29). *Another heparin error: learning from mistakes so we don't repeat them.* https://www.ismp.org/resources/another-heparin-error-learning-mistakes-so-we-dont-repeat-them

Speak Up

The goal of the Joint Commission Speak Up™ initiative is to help patients become more informed and involved in their health care to help prevent medication errors. Speak Up™ materials are intended for the public and have been put into a simplified, easy-to-read format to reach a wider audience.
The Joint Commission. (2019). *Speak up: take medication safely.* https://www.jointcommission.org/assets/1/6/2019_HAP_NPSGs_final2.pdf

Joint Commission Patient Speak Up Brochure

National Patient Safety Goals

The **National Patient Safety Goals (NPSG)** were established by the Joint Commission in 2002 to help accredited organizations address specific areas of concern related to patient safety. Annually, the Joint Commission determines the current highest priority patient safety issues with input from practitioners, provider organizations, purchasers, consumer groups, and other stakeholders and develops National Patient Safety Goals.

Use the link below to read more information about the current NPSG for hospitals.
The Joint Commission. (2019). *2019 hospital national patient safety goals.* https://www.jointcommission.org/assets/1/6/2019_HAP_NPSGs_final2.pdf
Two of the current National Patient Safety Goals relate specifically to medication administration: Patient ID and Use Medicines Safely.

National Patient Safety Goals for Hospitals
The Joint Commission. (2019). *2019 hospital national patient safety goals.* https://www.jointcommission.org/assets/1/6/2019_HAP_NPSGs_final2.pdf

Patient ID

Use at least two ways to identify patients. For example, use the patient's name and date of birth. This is done to make sure that each patient gets the correct medicine and treatment.

Use Medicines Safely

Before a procedure, label medicines that are not labeled. For example, medicines in syringes, cups, and basins should be labelled in the area where medicines and supplies are set up.

Take extra care with patients who take medicines to thin their blood (anticoagulants).

Record and pass along correct information about a patient's medicines. Find out what medicines the patient is taking. Compare those medicines to new medicines given to the patient. Make sure the patient knows which medicines to take when they are at home. Tell the patient it is important to bring their up-to-date list of medicines every time they visit a doctor.

Joint Commission Official Do Not Use List

The Joint Commission maintains an Official Do Not Use List of abbreviations. These abbreviations have been found to commonly cause errors in patient care. Accredited agencies are expected to not use

these abbreviations on any written or pre-printed materials.

This list does not currently apply to preprogrammed health information technology systems (i.e., electronic medical records or CPOE systems), but it remains under consideration for the future.
The Joint Commission. (2019, June 28). *Facts about the official "do not use" list of abbreviations.* https://www.jointcommission.org/facts_about_do_not_use_list/

Official Do Not Use List

CMS: Centers for Medicare and Medicaid Services

The Centers for Medicare & Medicaid Services (CMS) is a federal agency within the United States Department of Health and Human Services (HHS) that administers the Medicare program and works in partnership with state governments to administer Medicaid. The CMS establishes and enforces regulations to protect patient safety in hospitals that receive Medicare and Medicaid funding.
U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

CMS regulations related to medication administration include identifying what should be included in a prescription for the administration of medication, using the “five rights” when administering medications, reporting concerns about a medication order, assessing and monitoring patients receiving medications, and documenting medication administration. Each of these regulations is further discussed below.

Medication Orders

Medications must be administered in response to an order from a practitioner or on the basis of a standing order that is appropriately authenticated subsequently by a practitioner. All practitioner orders for the administration of drugs and biologicals must include at least the following:

- Name of the patient
- Age and weight of the patient to facilitate dose calculation when applicable. Policies and procedures must address weight-based dosing for pediatric patients as well as in other circumstances identified in the hospital’s policies. (Note that dose calculations are based on metric weight (kg, or g for newborns)
- Date and time of the order
- Drug name
- Dose, frequency, and route
- Dose calculation requirements, when applicable
- Exact strength or concentration, when applicable
- Quantity and/or duration, when applicable
- Specific instructions for use, when applicable
- Name of the prescriber
  U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

Basic Safe Practices for Medication Administration: The Five Rights

CMS states that hospitals' policies and procedures must reflect accepted standards of practice that require the following information is confirmed prior to each administration of medication. This is often referred to as the "five rights" of medication administration practice.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=1016#h5p-12

U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids.* https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

Note: Recent literature has identified up to nine "rights" of medication administration, including Right patient, Right drug, Right route, Right time, Right dose, Right documentation, Right action (appropriate reason), Right form, and Right response. However, there does not (yet) appear to be consensus about expanding beyond the 5 "rights."
Elliott M, & Liu Y. (2010). The nine rights of medication administration: an overview. *British Journal of Nursing, 19*(5), 300–305.

Many agencies have implemented bar code medication scanning to improve safety during medication administration. Bar code scanning systems reduce medication errors by electronically verifying the "5 rights" of medication administration. For example, when a nurse scans a bar code on the patient's wristband and on the medication to be administered, the data is delivered to a computer software system where algorithms check various databases and generate real-time warnings or approvals. Research studies have shown that bar code scanning reduces errors resulting from administration of a wrong dose or wrong medication, as well as errors involving medication being given by the wrong route. However, it is important to remember that bar code scanning should be used in addition to performing the five rights of medication administration, not in place of this important safety process. Additionally, nurses should carefully consider their actions when errors occur during the bar code scanning process. Although it may be tempting to quickly dismiss the error and attribute it to a technology glitch, the error may have been triggered due to a patient safety concern that requires further follow-up before the medication is administered. It is important for nurses to investigate errors that occur during the bar code scanning process just as they would do if an error is discovered during the traditional five rights of medication process.

Concerns About Medication Orders

CMS encourages hospitals to promote a culture in which it is not only acceptable, but also strongly encouraged, for staff to bring to the attention of the prescribing practitioner questions or concerns they have regarding medication orders.
U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

Assessment/Monitoring of Patients Receiving Medications

CMS states that observing the effects medications have on the patient is part of the multifaceted

medication administration process. Patients must be carefully monitored to determine whether the medication results in the therapeutically intended benefit and to allow for early identification of adverse effects and timely initiation of appropriate corrective action. Depending on the medication and route/ delivery mode, monitoring may need to include assessment of:

- Clinical and laboratory data to evaluate the efficacy of medication therapy to anticipate or evaluate toxicity and adverse effects. For some medications, including opioids, this may include clinical data such as respiratory status, blood pressure, and oxygenation and carbon dioxide levels.
- Physical signs and clinical symptoms relevant to the patient's medication therapy, such as confusion, agitation, unsteady gait, pruritus, etc.
- Factors contributing to high risk for adverse drug events. Although mistakes may or may not be more common with these drugs, the consequences of errors are often harmful, sometimes fatal, to patients. In addition, certain factors place some patients at greater risk for adverse effects of medication. Factors include, but are not limited to, age, altered liver and kidney function, drug-to-drug interactions, and first-time medication use may contribute to increased risk.

The nurse should consider patient risk factors, as well as the risks inherent in a medication, when determining the type and frequency of monitoring. It is also essential to communicate information regarding patients' medication risk factors and monitoring requirements during hand-offs of the patient to other clinical staff. Adverse patient reactions, such as anaphylaxis or opioid-induced respiratory depression, require timely and appropriate intervention per established protocols and should be reported immediately to the practitioner responsible for the care of the patient. An example of vigilant post-medication administration monitoring would be for post-surgical patient who is receiving pain medication via a patient controlled analgesia (PCA) pump. Narcotic medications are often used to control pain but also have a sedating effect. Patients can become overly sedated and suffer respiratory depression or arrest, which can be fatal. In addition, the patient and/or family members should be educated to notify nursing staff promptly when there is difficulty breathing or other changes that might be a reaction to medication.

U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

Documentation

CMS regulations require that the documentation record of medication administration contain all practitioners' orders, nursing notes, reports of treatment, medication records, radiology and laboratory reports, vital signs, and other information necessary to monitor the patient's condition. Documentation is expected to occur after actual administration of the medication to the patient; advance documentation is not only inappropriate, but may result in medication errors. Proper documentation of medication administration actions taken and their outcomes is essential for planning and delivering future care of the patient.

U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. (2014). *Memo: requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

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American Society of Health-System Pharmacists (Ed.). (2018). ASHP guidelines on preventing medication errors in hospitals. *American Journal of Health-System Pharmacy, 75*, 1493–1517. https://www.ashp.org/-/media/assets/policy-guidelines/docs/guidelines/preventing-medication-errors-hospitals.ashx

Critical Thinking Activity 2.3c
Image of lightbulb
in a circle

A nurse is preparing to administer morphine, an opioid, to a patient who recently had surgery.

1. Explain the 5 rights that the nurse will check prior to administering this medication to the patient.
2. Outline 3 methods the nurse can confirm patient identification.
3. What should the nurse assess prior to administering this medication to the patient?
4. What should be monitored after administering this medication?
5. What should the nurse teach the patient (and/or family member) about this medication?
6. What information should be included in the shift handoff report about this medication?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

2.3d – Wisconsin State Statutes, Nurse Practice Act, and Board of Nursing

In additional to federal laws, national regulations, guidelines, and initiatives, there are state laws that govern nursing. For regulations specific to nursing, the Wisconsin state legislature enacts a Nurse Practice Act and delegates authority to the Wisconsin State Boards of Nursing to enforce the Nursing Practice Act.
Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf

The purpose of the Wisconsin Board of Nursing is to protect the public through licensure, education, legislation, and discipline. The Nurse Practice Act (NPA), as stated in Wisconsin Statutes Chapter 440 (Department of Safety and Professional Services) and 441 (Board of Nursing), grants the Board of Nursing the authority to regulate education as well as the licensure and practice of registered nurses (RNs), licensed practical nurses (LPNs), and advanced practice nurse prescribers (APNPs).
Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf

It is important for all nurses to understand their scope of practice as outlined in the Nurse Practice Act (NPA) and Wisconsin Board of Nursing Administrative Rules. Each nurse is accountable for the quality of care he or she provides and is expected to practice at the level of education, knowledge, and skill ordinarily expected of one who has completed an approved nursing program. Furthermore, all nurses are

expected to recognize the limits of their knowledge and experience and to appropriately address situations that are beyond their competency. Nurses are responsible to be knowledgeable regarding all laws and rules that relate to their nursing practice.
Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf

Wisconsin Board of Nursing
Wisconsin Department of Safety and Professional Services. (n.d.). *Board of nursing Wisconsin Administrative Code.* https://dsps.wi.gov/Pages/RulesStatutes/Nursing.aspx

Wisconsin Practice Act: Standards of Practice

The Wisconsin Nurse Practice Act outlines the standards of care provided by a registered nurse (RN), also known as the **Nursing Process**. An RN utilizes the nursing process in the execution of general nursing procedures in the maintenance of health, prevention of illness, or care of the ill. This standard is met through steps of the nursing process, including:

- **Assessment:** The systematic and continual collection and analysis of data about the health status of a patient culminating in the formulation of a nursing diagnosis.
- **Planning:** Development of a nursing plan of care for a patient, which includes goals and priorities derived from the nursing diagnosis.
- **Intervention:** The nursing action to implement the plan of care by directly administering care or by directing and supervising nursing acts delegated to LPNs or less skilled assistants.
- **Evaluation:** The determination of a patient's progress or lack of progress toward goal achievement, which may lead to modification of the nursing diagnosis.
  Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf

Wisconsin Practice Act: Rules of Conduct

The Wisconsin Nurse Practice Act also outlines Rules of Conduct expected of nurses. Nurses can receive disciplinary action from the Board of Nursing ranging from a reprimand to revocation of their license if they do not follow the Rules of Conduct. It is important for nurses to protect their licenses to maintain current knowledge about expected rules of conduct in each state where they practice nursing. Details regarding rules and conduct and grounds for denying or taking disciplinary action by the Wisconsin Board of Nursing can be found in Chapter N7, "Rules of Conduct."
Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf
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Wisconsin State Legislature. (2016, August). *Chapter N 7 rules of conduct.*https://docs.legis.wisconsin.gov/code/admin_code/n/7.pdf

Chapter N7, "Rules of Conduct", of the Wisconsin Nurse Practice Act.

Common reasons related to medication administration for the Board of Nursing to take disciplinary action against a nursing license include, but are not limited to:

- Noncompliance with federal, jurisdictional, or reporting requirements, including:
  - Practicing beyond the scope of practice.
- Confidentiality, patient privacy, consent, or disclosure violations.

- Fraud, deception or misrepresentation, including:
    - Falsification of patient documentation.
- Unsafe practice or substandard care, including:
    - Failing to perform nursing with reasonable skill and safety.
    - Departing from or failing to conform to the minimal standards of acceptable nursing practice that may create unnecessary risk or danger to a patient's life, health, or safety. Actual injury to a patient need not be established.
    - Failing to report to or leaving a nursing assignment without properly notifying appropriate supervisory personnel and ensuring the safety and welfare of the patient or client.
    - Practicing nursing while under the influence of alcohol, illicit drugs, or while impaired by the use of legitimately prescribed pharmacological agents or medications.
    - Inability to practice safely due to alcohol or other substance use, psychological or physical illness or impairment.
    - Executing an order which the licensee knew or should have known could harm a patient.
- Improper supervision or allowing unlicensed practice.
- Improper prescribing, dispensing, or administering medication or drug-related offenses.

Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCouncils/NUR/20190110NURAdditionalMaterials.pdf

Wisconsin Statutes, Chapter 961: Uniform Controlled Substances Act

The Wisconsin Statutes are a compilation of the general laws of the state of Wisconsin and include chapters related to the regulation of nursing, as well as the Uniform Controlled Substances Act.

Wisconsin Statutes

Chapter 441 defines the Board of Nursing and relates to the Regulation and Licensure of Nursing. Chapter 961 is the Uniform Controlled Substances Act. The Wisconsin legislature finds that the abuse of controlled substances constitutes a serious problem for society. As a partial solution, laws regulating controlled substances have been enacted with penalties. Chapter 961 does not apply to the nondrug use of peyote and mescaline in the bona fide religious ceremonies of the Native American Church. See the link below for more information about the regulations related to Schedule I through V drugs in the State of Wisconsin.

Wisconsin State Legislature. (n.d.). *Chapter 961 uniform uncontrolled substances act.* https://docs.legis.wisconsin.gov/statutes/statutes/961

Chapter 961: Uniform Controlled Substances Act

Wisconsin's Enhanced Prescription Drug Monitoring Program (ePDMP)

The ePDMP is a new tool to help combat the ongoing prescription drug abuse epidemic in Wisconsin. By providing valuable information about controlled substance prescriptions that are dispensed in the state, it aids healthcare professionals in their prescribing and dispensing decisions. The ePDMP also fosters the ability of pharmacies, healthcare professionals, law enforcement agencies, and public health officials to work together to reduce the misuse, abuse, and diversion of prescribed controlled substance medications. See the link below to read more information about Wisconsin's ePDMP.

Wisconsin ePDMP. (2019). https://pdmp.wi.gov/

Wisconsin's Enhanced Prescription Drug Monitoring Program (ePDMP)

Wisconsin Department of Safety and Professional Services: Professional Assistance Procedure (PAP)

The Professional Assistance Procedure (PAP) is a voluntary non-disciplinary program to provide support for credentialed professionals with substance abuse disorder who are committed to their own recovery. The goal is to protect the public by promoting early identification of chemically dependent professionals and encouraging rehabilitation. It provides an opportunity for qualified participants to continue practicing, without public discipline, while being monitored and supported in their recovery.

Wisconsin's Professional Assistance Procedure
Wisconsin Department of Safety and Professional Services. (n.d.). *Wisconsin nurse practice act (NPA) course.* https://dsps.wi.gov/Documents/BoardCcouncils/NUR/20190110NURAdditionalMaterials.pdf

Critical Thinking Activity 2.3d
Image of lightbulb in a circle

A nurse is disciplined by the Wisconsin Board of Nursing for an incident reported by her employer that she arrived at her shift intoxicated. The nurse shares with a nursing colleague, "I love taking care of patients. I worked so hard to obtain my nursing license – I don't want to lose it. I know my drinking has gotten out of control, but I don't know where to turn."

What is the best advice by the nursing colleague for this nurse with a drinking problem?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

2.4 Cultural and Social Determinants Related to Medication Administration

Open Resources for Nursing (Open RN)

Critical Thinking Activity

Image of lightbulb in a circle

A nurse is providing patient education to a mother regarding a liquid antibiotic prescribed for her child to take at home. The prescription states amoxicillin 250 mg 1 teaspoon (5 ml) every 8 hours for 7 days. After talking with the mother, the nurse realizes the family does not have measuring spoons in their home.

> What is the nurse's best response?
> Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

In additional to the legal and ethical considerations affecting the safe administration of medication, there are also cultural and social influences that the nurse must consider. The United States has become increasingly diverse in the last century. According to the 2010 U.S. Census, approximately 36 percent of the population belongs to a racial or ethnic minority group. Though health indicators such as life expectancy and infant mortality have improved for most Americans, some minorities experience a disproportionate burden of preventable disease, death, and disability compared with non-minorities.
Centers for Disease Control and Prevention. (2018, July 17). *Health equity.* https://www.cdc.gov/minorityhealth/index.html

The American Nurses Association Scope and Standards of Practice states that the need for health care is universal and transcends differences with respect to the culture; values; and preferences of the individual, family, group, community, and population. Diversity characterizes today's healthcare environment, and nursing is responsive to the changing needs of society. To effectively promote meaningful patient outcomes that maximize quality of life across the lifespan, the ANA states that nurses must embrace diversity and engage in culturally congruent practice. **Culturally congruent practice** is the application of evidence-based nursing that is in agreement with the preferred cultural values, beliefs, worldview, and practices of the healthcare consumer and other stakeholders. **Cultural competence** represents the process by which nurses demonstrate culturally congruent practice.
American Nurses Association. (2015). *Nursing: Scope and Standards of Practice* (3rd edition). Available for all Chippewa Valley Technical College students and employees through OneSearch.

In addition to cultural beliefs, conditions in the places where people live, learn, work, and play affect a wide range of health risks and outcomes. These conditions are known as social determinants of health (SDOH). Differences in health are striking in communities with poor SDOH such as unstable housing, low income, unsafe neighborhoods, or substandard education. By applying what we know about SDOH, nurses can not only improve an individual's health, but also improve health equity for communities and the population as a whole. Healthy People is a government agency that provides science-based, ten-year national objectives for improving the health of all Americans. Healthy People 2020 highlights the importance of addressing SDOH with a goal to "create social and physical environments that promote good health for all" as one of the four overarching goals for the decade.
Social Determinants of Health: Know What Affects Health by Centers for Disease Control and Prevention is available in the

public domain
,
Social Determinants of Health by Healthypeople.gov is available in the public domain

The U.S. Department of Health and Human Services has also set national standards for Culturally and Linguistically Appropriate Services (CLAS) in health and healthcare. The national CLAS standards are intended to advance health equity, improve quality, and help eliminate health care disparities by "providing effective, equitable, understandable, and respectful quality care and services that are responsive to diverse cultural health beliefs and practices, preferred languages, health literacy, and other communication needs."
U.S. Department of Health and Human Services, Office of Minority Health. (n.d.). *National standards for culturally and linguistically appropriate services (CLAS) in health and health care.* https://thinkculturalhealth.hhs.gov/assets/pdfs/EnhancedNationalCLASStandards.pdf

The U.S. Department of Health and Human Services (HHS) defines **health literacy** as "the degree to which individuals have the capacity to obtain, process, and understand basic health information needed to make appropriate health decisions. Adequate health literacy may include being able to read and comprehend essential health-related materials such as information on a prescription bottle. A nurse that values health literacy makes it a priority to implement systems and interventions such as visual aids and counseling that increase understanding and thereby advance patient safety.
Health Literacy by Healthypeople.gov is available in the public domain

National CLAS Standards

Examples of Culturally Congruent Practice Related to Medication Therapy

There are several instances when a nurse must assess and accommodate a patient's culture or social determinants of health when administering or teaching about medications. One example was provided above when a nurse should assist a patient to read a prescription bottle and its instructions to advocate for patient safety.

Another example of culturally congruent practice is when a nurse must consider cultural or religious beliefs, such as fasting, when administering medications. For example, a Muslim patient may participate in the Ramadan, which requires 12-hour fasting. A nurse can advocate for the patient and assist in altering the scheduling of medication to accommodate the patient's belief and avoid the risk of treatment failure.

Drug Intake During Ramadan
Aadil, N., Houti, I. E., and Moussamih, S. (2004). Drug intake during Ramadan. *BMJ (Clinical research ed.), 329*, 778–782. https://doi.org/10.1136/bmj.329.7469.778

A third example of culturally congruent practice is considering when a patient's ethnic background may affect their ability to respond to medications. For example, African Americans often require combination therapy to treat hypertension, whereas Asian and Hispanic patients often respond better to lower doses of antidepressants.

You can read more about these cultural accommodations at the following article links:

Treatment of Hypertension Among African Americans: The Jackson Heart Study

Prescribing Medication for Asians with Mental Disorders

Harman, J., Walker, E. R., Charbonneau, V., Akylbekova, E. L., Nelson, C., and Wyatt, S. B. (2013). Treatment of hypertension among African Americans: the Jackson heart study. *Journal of Clinical Hypertension, 15*(6), 367–374. https://www.ncbi.nlm.nih.gov/pubmed/23730984

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Chen, J. P., Barron, C., Lin, K. M., & Chung, H. (2002). Prescribing medication for Asians with mental disorders. *The Western Journal of Medicine, 176*(4), 271–275.

The US Department of Health and Human Services has created a free module for nurses to learn more about cultural competency.

Culturally Competent Nursing Care: A Cornerstone of Caring.

2.5 Preventing Medication Errors

Open Resources for Nursing (Open RN)

When a nurse administers medication, the ultimate goal is to provide patient safety and to prevent harm from medications. However, medical errors and adverse effects of medication therapy continue to be a significant problem in the United States. This section will discuss initiatives established by the Institute of Medicine (IOM), the World Health Organization (WHO), the Institute for Safe Medication Practices (ISMP), and Quality and Safe Education for Nurses (QSEN).

Institute of Medication (IOM)

IOM Report: To Err is Human

The national focus on reducing medical errors has been in place for almost two decades. The Institute of Medicine (IOM) released an initial report in 1999 titled *To Err is Human: Building a Safer Health System*. The report stated that at that time, errors caused between 44,000 and 98,000 deaths every year in American hospitals and over one million injuries. Health care appeared to be far behind other high-risk industries in ensuring basic safety. The IOM report called for a 50% reduction in medical errors over five years. Its goal was to break the cycle of inaction regarding medical errors by advocating a comprehensive approach to improving patient safety. The IOM 1999 report changed the nature of the patient safety conversation from focusing on dispensing blame to improving systems.
Institute of Medicine. (2000). *To Err Is Human: Building a Safer Health System*. The National Academies Press. https://doi.org/10.17226/9728 footnote]Stelfox, H. T., Palmisani, S., Scurlock, C., Orav, E. J., and Bates, D. W. (2006). The "To Err is Human" report and the patient safety literature. *Quality & Safety in Health Care, 15*(3), 174–178. doi: 10.1136/qshc.2006.017947

IOM: Preventing Medication Errors

Despite the progress made in patient safety since the *To Err is Human* report, medication errors remain extremely common, and the national health care system continues to implement initiatives to prevent error. In 2007, the IOM published a followup report titled *Preventing Medication Errors,* reporting that more than 1.5 million Americans are injured every year in American hospitals, and the average hospitalized patient experiences at least one medication error each day. This report emphasized actions that health care systems, providers, funders, and regulators could take to improve medication safety.

These recommendations included actions such as having all U.S. prescriptions written and dispensed electronically, promoting widespread use of medication reconciliation, and performing additional research on drug errors and their prevention. The report also emphasized actions that patients can take to prevent medication errors, such as maintaining active medication lists and bringing their medications to appointments for review.
Institute of Medicine. (2007). *Preventing medication errors.* The National Academies Press. https://doi.org/10.17226/11623

The *Preventing Medication Errors* report included specific actions for nurses to improve medication safety. Figure 2.2 lists these key actions.
Institute of Medicine. (2007). *Preventing medication errors.* The National Academies Press. https://doi.org/10.17226/11623

Improving Medication Safety: Actions for Nurses

- Establish safe work environments for medication preparation, administration, and documentation; for instance, reduce distractions and provide appropriate lighting.
- Maintain a culture of rigorous commitment to principles of safety in medication administration (for instance, the five rights of medication safety and cross-checks with colleagues, where appropriate).
- Remove barriers and facilitate the involvement of patient surrogates in checking the administration and monitoring the medication effects.
- Foster a commitment to patients' rights as co-consumers of their care.
- Develop aids for patients or their surrogates to support self-management of medications.
- Enhance communication skills and team training to be prepared and confident in questioning medication orders and evaluating patient responses to drugs.
- Actively advocate for the development, testing, and safe implementation of electronic health records.
- Work to improve systems that address "near misses" in the work environment.
- Realize they are part of a system and do their part to evaluate the efficacy of new safety systems and technology.
- Contribute to the development and implementation of error reporting systems, and support a culture that values accurate reporting of medication errors.

Figure 2.2 Improving Medication Safety: Actions By Nurses

WHO Global Patient Safety Challenge: Medication Without Harm

Unsafe medication practices and medication errors are a leading cause of injury and avoidable harm in health care systems in America and across the world. Globally, the cost associated with medication errors has been estimated at $42 billion USD annually. Errors can occur at different stages of the medication use process. Multiple interventions to address the frequency and impact of medication errors have already been developed, yet their implementation is varied. In 2019, the World Health Organization (WHO) identified "Medication Without Harm" as the theme for the third Global Patient Safety Challenge with the goal of reducing severe, avoidable medication-related harm by 50% over the next five years. As part of the *Global Patient Safety Challenge: Medication Without Harm,* WHO has prioritized three areas to protect patients from harm while maximizing the benefit from medication:

- Medication safety in high-risk situations

- Medication safety in **polypharmacy**
- Medication safety in transitions of care
  World Health Organization. (2019). *Medication safety in key action areas*. https://www.who.int/patientsafety/medication-safety/technical-reports/en/

The World's Health Organization's Patient Safety Page

A summary of these three areas and the strategies to reduce harm is provided below. View the patient video explaining how to avoid harm from medications, or click on the "Real Life Stories" link to read patient stories about harm caused by medications.

Medication Without Harm

World Health Organization. (WHO). (2017, October 17). WHO: Medication Without Harm [Video]. YouTube. https://youtu.be/MWUM7LIXDeA

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1025#oembed-1

Real Life Stories

Figure 2.3
This image is a derivative of Medication Safety in High Risk Situations by World Health Organization, https://apps.who.int/iris/handle/10665/325131 page 7, licensed under CC BY-NC-SA 3.0
describes the key steps for ensuring medication safety.

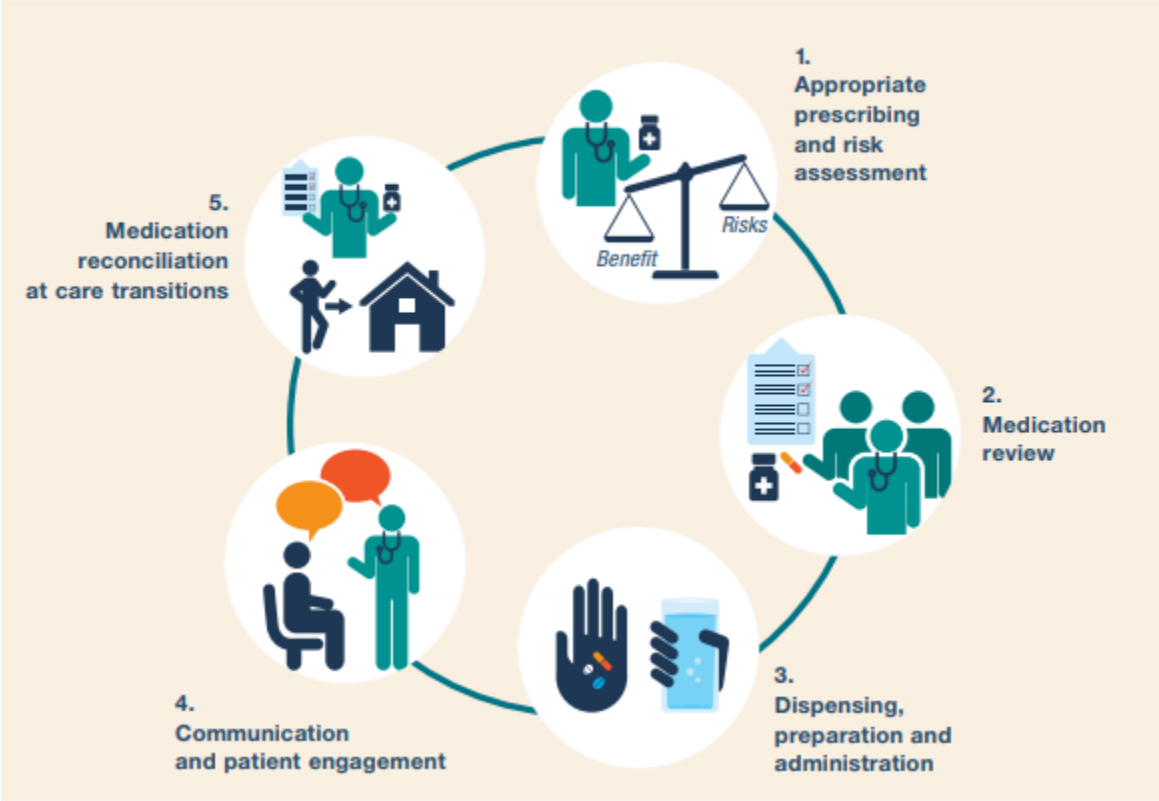


Figure 2.3 Key Steps for Ensuring Medication Safety

Medication Safety in High-Risk Situations

Medication safety in high-risk situations include high-risk medications, provider-patient relations, and systems factors.

High-risk (High-Alert) Medications

High-risk medications are drugs that bear a heightened risk of causing significant patient harm when they are used in error. Although mistakes may or may not be more common with these medications, the consequences of an error are more devastating to patients. High-risk medication can be remembered using the mnemonic "A PINCH." Figure 2.4 describes these medications included with the "A PINCH" mnemonic.

High-Risk Medicine Group	Examples of Medicines
A: Anti-infective	Amphotericin
	Aminoglycosides
P: Potassium and other electrolytes	Injections of potassium, magnesium, calcium, hypertonic sodium chloride
I: Insulin	All insulins
N: Narcotics & Other Sedatives	Hydromorphone, oxycodone, morphine
	Fentanyl
	Benozdiazepines
C: Chemotherapeutic Agents	Methotrexate, Vincristine
H: Heparin & Anticoagulants	Warfarin, Enoxaparin

Figure 2.4 Demonstrating "A Pinch"

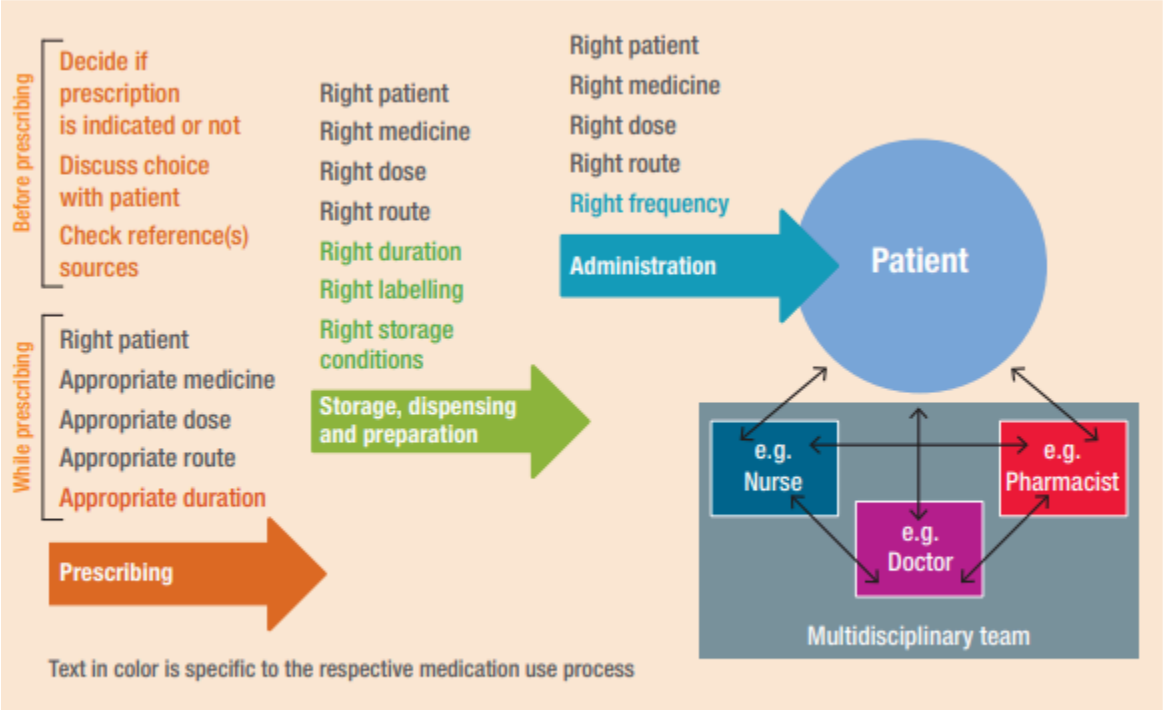
Note: Based on research, the Institute of Safe Medication Practices (ISMP) has expanded this list. The list can be viewed at:
ISMP List of High-Alert Medications in Acute Care Settings

Provider-Patient Relations

In addition to high-risk medications, a second component of medication safety in high-risk situations includes provider and patient factors. This component relates to either the health care professional providing care or the patient being treated. Even the most dedicated health care professional is fallible and can make errors. The act of prescribing, dispensing, and administering a medicine is complex and involves several health care professionals.

The patient should be the center of what should be a "prescribing partnership."

See Figure 2.5.



Source: Adapted, with the permission of the publisher, from Routledge *(94)*.

Figure 2.5 Prescribing partnership

Patients also can present risk factors. For example, it is well-known that adverse drug events occur most often at the extremes of life (in the very young and in older people). In the older population, frail patients are likely to be receiving several medications concurrently, which adds to the risk of adverse drug events. In addition, the harm of some of these medication combinations may sometimes be synergistic and be greater than the sum of the risks of harm of the individual agents. In neonates (particularly premature neonates), elimination routes through the kidney or liver may not be fully developed. The very young and those of old age are also less likely to tolerate adverse drug reactions, either because their homeostatic mechanisms are not yet fully developed or may have deteriorated. Medication errors in children, where doses may have to be calculated in relation to body weight or age, are also a source of major concern. Additionally, certain medical conditions predispose patients to an increased risk of adverse drug reactions, particularly renal or hepatic dysfunction and cardiac failure. Interprofessional strategies to address these potential harms are based on a systems approach with a "prescribing partnership" between the patient, the prescriber, the pharmacist, and the nurse, as outlined in Figure 2.5.

Systems Factors

In addition to high-risk medications and provider-patient relations, systems factors also contribute to medication safety in high-risk situations. Systems factors, also called the environment in hospitals, can contribute to error-provoking conditions for several reasons. The unit may be busy or understaffed,

which can contribute to inadequate supervision or failure to remember to check important information. Interruptions during critical processes (e.g., administration of medicines) can also occur, which can have significant implications for patient safety. Tiredness and the need to multitask when busy or flustered can also contribute to error and can be compounded by poor electronic medical record design. Preparing and administering intravenous medications is also particularly error prone. Strategies for reducing errors include checking at each step of the medication administration process; preventing interruptions; electronic provider order entry; and utilizing prescribing assessment tools, such as the Beers Criteria for potentially inappropriate medication use in older adults.

Medication Safety in Polypharmacy

A second area of the WHO *Medications Without Harm* initiative relates to medication safety in polypharmacy. Polypharmacy is the concurrent use of multiple medications. Although there is no standard definition, polypharmacy is often defined as the routine use of five or more medications. This includes over-the-counter, prescription and/or traditional, and complementary medicines used by a patient. As the population ages, more people are likely to suffer from multiple long-term illnesses and take multiple medications. It is therefore essential to take a person-centered approach to ensure that medications are appropriate for the individual to gain the most benefits without harm and to ensure that patients are integral to the decision making process. Appropriate polypharmacy is present when all medicines are prescribed for the purpose of achieving specific therapeutic objectives that have been agreed with the patient; therapeutic objectives are actually being achieved or there is a reasonable chance they will be achieved in the future; medication therapy has been optimized to minimize the risk of adverse drug reactions; and the patient is motivated and able to take all medicines as intended.
Inappropriate polypharmacy is present when one or more medicines are prescribed that are not or no longer needed, either because there is no evidence-based indication, the indication has expired or the dose is unnecessarily high; one or more medicines fail to achieve the therapeutic objectives they are intended to achieve; one or the combination of several medicines put the patient at a high risk of adverse drug reactions; or because the patient is not willing or able to take one or more medicines as intended.

When patients move across care settings, medication review is important to prevent harm caused by inappropriate polypharmacy. Figure 2.6 includes the questions that should be addressed during a medication review with a multidisciplinary approach that includes the nurse.

Step-By-Step Approach to Conducting a Patient-Centered Medication Review

		Review diagnoses and identity therapeutic objectives with respect to:
Aims	**1. What matters to the patient?**	• Understanding goals of medication therapy • Management of existing health problems • Prevention of future health problems
		Identify essential medications (not to be stopped without specialist advice) such as:
Need	**2. What are the essential medications?**	• Medications that have essential replacement functions (e.g., thyroxine) • Medications to prevent rapid symptomatic decline (e.g., medications for Parkinson's disease)

	3. Does the patient take unnecessary medications?	***Identify and review the (continued) need for medications:*** • With temporary indications • With higher-than-usual maintenance doses • With limited benefit in general for the indication they are used for • With limited benefit for the particular patient under review
Effectiveness	**4. Are therapeutic objectives being achieved?**	***Identify the effect of adding/intensifying medication therapy to achieve therapeutic objectives:*** • To achieve symptom control • To achieve biochemical/clinical targets • To prevent disease progression/exacerbation

		Identify patient safety risks by checking for:
Safety	**Does the patient have/is at risk of adverse drug reactions?**	• Drug-disease interactions • Drug-to-drug interactions • Robustness of monitoring mechanisms for high-risk medications • Risk of accidental overdosing
		Identify adverse drug effects by checking for:
	Does the patient know what to do if they are ill?	• Specific symptoms/laboratory markers (e.g., hypokalaemia) • Cumulative adverse drug effects • Medications that may be used to treat adverse drug reactions caused by other medications

		Identify unnecessarily costly medication by:
Costs	**Is therapy cost-effective?**	• Considering more cost-effective alternative (but balance against effectiveness, safety, convenience)
		Evaluate the patient understanding of the outcomes:
		• Does the patient understand the rationale for taking their medications? • Consider teach-back technique to ensure full understanding
		Ensure medication changes are tailored to patient preferences:
Patient-centeredness	**7. Is the patient willing and able to take medication as intended?**	• Is the medication route appropriate for this patient? • Is the dosing schedule convenient for this patient? • Consider what assistance the patient might have and when this is available • Consider the patient's ability to take the medicines as intended.
		Agree and communicate plan:
		• Discuss with the patient therapeutic objectives and treatment priorities • Collaborate with the patient to determine which medicines are sufficiently effective to continue or consider discontinuation • Inform relevant health care and social care change in treatments across care transitions

Figure 2.6 Step-by-step approach to conducting a patient-centered medication review

Medication Safety in Transitions of Care

A third area of the WHO *Medications Without Harm* initiative relates to medication safety during transitions of care. View the interactive activity below to see how medications are reconciled during transitions of care from admission to discharge in a hospital setting.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=1025#h5p-13

Medication errors can occur during these changes in settings. Figure 2.7

is an image from the World Health Organization showing ranges of percentage of errors that occur during common transitions of care.

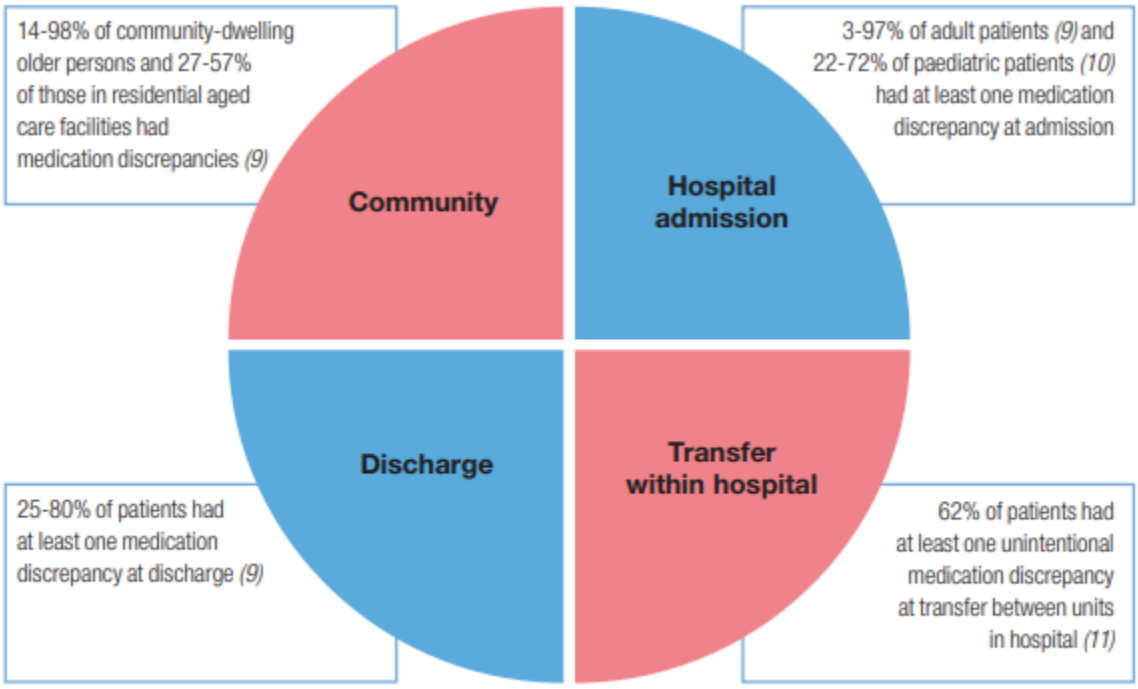


Fig 2.7 Medication discrepancies at various transitions of care

Key strategies for improving medication safety during transitions of care include:

- Implementing formal structured processes for medication reconciliation at all transition points of care. Steps of effective medication reconciliation are to build the best possible medication history by interviewing the patient and verifying with at least one reliable information source, reconciling and updating the medication list, and communicating with the patient and future health care providers about changes in their medications.

- Partnering with patients, families, caregivers, and health care professionals to agree on treatment plans, ensuring patients are equipped to manage their medications safely, and ensuring patients have an up-to-date medication list.
- Where necessary, prioritizing patients at high risk of medication-related harm for enhanced support such as post-discharge contact by a nurse.

Image of lightbulb

Critical Thinking Activity 2.5ain a circle

A nurse is performing medication reconciliation for an elderly patient admitted from home. The patient does not have a medication list and cannot report the names, dosages, and frequencies of the medication taken at home.

What other sources can the nurse use to obtain medication information?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

Institute for Safe Medication Practices (ISMP)

The Institute for Safe Medication Practices (ISMP) is respected as the gold standard for medication safety information. It is a nonprofit organization devoted entirely to preventing medication errors. ISMP collects and analyzes thousands of medication error and adverse event reports each year through its voluntary reporting program and then issues alerts regarding errors happening across the nation. The ISMP has established several prevention strategies for safe medication administration, including lists of high-alert medications, error-prone abbreviations to not use, Do Not Crush medications, look alike-sound alike drugs, and error-prone conditions that lead to error by student nurses. Each of these initiatives is further described below.

Institute for Safe Medication Practices. (2007, October 18). *Error-prone conditions that lead to student nurse-related errors*. https://www.ismp.org/resources/error-prone-conditions-lead-student-nurse-related-errors

ISMP website

High-Alert Medications

High-alert medications are drugs that bear a heightened risk of causing significant patient harm when they are used in error. Although mistakes may or may not be more common with these drugs, the consequences of an error are clearly more devastating to patients. As discussed earlier in the "WHO"

section of this chapter, an acronym that can be used to remember the basic list of high-alert medication is “A PINCH.” The ISMP list contains additional medication to the mnemonic “A PINCH.”

Strategies for safe administration of high-alert medication include:

- Standardizing the ordering, storage, preparation, and administration of these products
- Improving access to information about these drugs
- Employing clinical decision support and automated alerts
- Using redundancies such as automated or independent double checks when necessary

ISMP List of High-Alert Medications in Acute Care Settings

Error-Prone Abbreviations

ISMP’s List of Error-Prone Abbreviations, Symbols, and Dose Designations contains abbreviations, symbols, and dose designations that have been reported through the ISMP National Medication Errors Reporting Program as being frequently misinterpreted and involved in harmful medication errors. These abbreviations, symbols, and dose designations should never be used when communicating medical information. Note that this list has additional abbreviations than those contained in the Joint Commission’s Do Not Use List of Abbreviations. Click on the link below for the ISMP list of error-prone abbreviations to avoid. Some examples of abbreviations that were commonly used that should now be avoided are qd, qod, qhs, BID, QID, D/C, subq, and APAP.
Institute for Safe Medication Practices. (2017, October 2). *List of error-prone abbreviations.* https://www.ismp.org/recommendations/error-prone-abbreviations-list

Strategies to avoid mistakes related to error-prone abbreviations include not using these abbreviations in medical documentation. Furthermore, if a nurse receives a prescription containing an error-prone abbreviation, it should be clarified with the provider and the order rewritten without the abbreviation.

ISMP List of Error-Prone Abbreviations to Avoid

Do Not Crush List

The IMSP maintains a list of oral dosage medication that should not be crushed, commonly referred to as the “Do Not Crush” list. These medications are typically extended-release formulations. The list can be accessed by using the link below.
Institute for Safe Medication Practices. (2020, February 21). *Oral dosage forms that should not be crushed.* https://www.ismp.org/recommendations/do-not-crush

Strategies for preventing harm related to oral medication that should not be crushed include requesting an order for a liquid form or a different route if the patient cannot safely swallow the pill form.

ISMP Do Not Crush List

Look-Alike and Sound-Alike (LASA) Drugs

ISMP maintains a list of drug names containing look-alike and sound-alike name pairs such as Adderall and Inderal. These medications require special safeguards to reduce the risk of errors and minimize harm.

Safeguards may include:

- Using both the brand and generic names on prescriptions and labels
- Including the purpose of the medication on prescriptions
- Changing the appearance of look-alike product names to draw attention to their dissimilarities
- Configuring computer selection screens to prevent look-alike names from appearing consecutively

Institute for Safe Medication Practices. (2019, February 28). *List of confused drug names.* https://www.ismp.org/recommendations/confused-drug-names-list

ISMP Look Alike-Sound Alike List of Medications

Error Prone Conditions That Lead to Student Nurse Related Error

When analyzing errors involving student nurses reported to the USP-ISMP Medication Errors Reporting Program and the PA Patient Safety Reporting System, it appears that many errors arise from a distinct set of error-prone conditions or medications. Some student-related errors are similar in origin to those that seasoned licensed healthcare professionals make, such as misinterpreting an abbreviation, misidentifying drugs due to look-alike labels and packages, misprogramming a pump due to a pump design flaw, or simply making a mental slip when distracted. Other errors stem from system problems and practice issues that are rather unique to environments where students and hospital staff are caring together for patients. See the link to the list of these error prone conditions that should be avoided.

Error Prone Conditions That Lead to Student Nurse Related Error

Critical Thinking Activity 2.5b
Image of lightbulb
in a circle

A nurse is preparing to administer insulin to a patient. The nurse is aware that insulin is a medication on the ISMP list of high-alert medications.

What strategies should the nurse implement to ensure safe administration of this medication to the patient?

Note: Answers to the Critical Thinking activities can be found in the “Answer Key” sections at the end of the book.

Quality and Safety Education for Nurses (QSEN)

The Quality and Safety Education for Nurses (QSEN) project's vision is to "inspire health care professionals to put quality and safety as core values to guide their work." QSEN began in 2005 and is funded by the Robert Wood Johnson Foundation. Based on the Institute of Medicine (2003) competencies for nursing, QSEN further defined these quality and safety competencies for educating nursing students:

- Patient-Centered Care
- Teamwork & Collaboration
- Evidence-Based Practice
- Quality Improvement
- Safety
- Informatics

QSEN Institute. (n.d.). *Project overview*. http://qsen.org/about-qsen/project-overview/

Learn activities that teach nursing students how to provide safe, quality care to their patients.
QSEN website

Below are supplementary learning resources related to patient safety and preventing error during medication administration.

The Josie King Story and Medical Errors

Healthcare.gov. (2011, May 25). Introducing the Partnerships for Patients with Sorrel King [Video]. YouTube. https://youtu.be/ak_5X66V5Ms

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1025#oembed-2

As a student, when you prepare to administer medications to your patients during clinical, your instructor will ask you questions to ensure safe medication administration.

See an example of the typical questions that a clinical instructor might ask.
Enhancing Medication Safety in Clinical: A Video for Students and Nursing Faculty

Watch a QSEN Powerpoint presentation related to the revision of hospital policies to reduce error prone conditions for student nurses when administering medication.
QSEN Powerpoint

Summary of Nursing Considerations for Safe and Effective Medication Administration

Medication administration by nurses is not just a task on a daily task list; it is a system-wide process in collaboration with the healthcare team to ensure safe and effective treatment. As part of the medication administration process, the nurse must consider ethics, laws, national guidelines, and cultural/social determinants before administering medication to a patient. The nurse is the vital "last stop" for preventing errors and potential harm from medications before they reach the patient. A list of nursing

considerations whenever administering medications are outlined below.

Nursing Considerations for Safe and Effective Medication Administration

BEFORE Administering Medication

Ethics

- Will this medication do more good than harm for this patient at this point in time?
- Has the patient (or the patient's decision maker) had a voice in the decision making process regarding use of this medication? Have they been informed about this medication and the potential risks/benefits to consider?
- If there are any ethical concerns, advocate for patient rights and autonomy and contact the provider and/or pursue the proper chain of command.

Legal and National Guidelines

- Be sure the prescription/order contains the proper information according to CMS guidelines.
- Are there any FDA Black Box Warnings for this drug? If so, is the patient aware of the risks and what to do if they occur? This discussion should be documented.
- Is this a controlled substance? If so, follow guidelines for controlled substances in terms of counting, wasting, and disposal. For prescriptions for outpatient use, advocate that Prescription Drug Monitoring Program guidelines are followed.
- Be aware of signs of drug diversion in other healthcare team members and follow up appropriately in the chain of command. You can also directly submit an online tip to the DEA at Rx Abuse Online Reporting.
- Follow the Joint Commission "SPEAK UP" guidelines if you have any concerns about the safe use of this medication, including, but not limited to:
    - Unclear or "do not use" abbreviations
    - Strategies for look alike-sound alike medications
    - Any other concerns for error
- Follow your state's practice act regarding Scope of Practice and Rules of Conduct. Is administering this medication appropriate for your scope of practice and for this patient? If not, protect your patient from harm and your nursing license by notifying the appropriate contacts within your agency.
- Is this medication administration occuring during a transition of care from unit to unit, home to agency, or in preparation for discharge? If so, be sure proper medication reconciliation has been completed.

DURING Administration

- Use the Nursing Process as you ASSESS if this drug is appropriate to administer at this time and PLAN continued monitoring. Consider lifespan and disease process implications. If you NOTICE any findings that this medication may not be appropriate at this time for this patient, withhold the medication and contact the provider.
- Assess if there are any cultural or social determinants that will impact the patient's ability to use these medications safely and effectively. IMPLEMENT appropriate accommodations as needed

and notify the provider.
- Follow National Patient Safety Goals as you correctly identify the patient and follow guidelines to use medicines safely.
- If this is a "high-alert" medication, follow recommendations for safe administration (such as adding a second RN check, etc.).
- Reduce distractions in your environment as you prepare and administer medications.
- Do not crush medications unless safe to do so.
- Follow JC and CMS standards:
    - Check 5 rights before administering to patient
    - Educate the patient about their medication
    - Dispose of waste controlled substances appropriately
    - Document appropriately

AFTER Administration

- Continue to EVALUATE the patient for potential side effects/adverse effects, as well as therapeutic effects of the medications.
- Document and verbally share your findings during handoff reports for safe continuity of care.
- If an error occurs, file an incident report and participate in root cause analysis to determine how to prevent it from happening again.

Supplementary Resources

For more information related to medication safety, go to these supplementary resources.

Culturally Competent Nursing Care: A Cornerstone of Caring. Free Educational Program.

FDA (2018) Safe Use Initiative – Current Projects

Institute for Safe Medication Practices. The Five Rights: A Destination Without a Map.

Improvement Stories: Beyond the Five Rights.

ISMP. 2018-2019 Targeted Medication Safety Best Practices for Hospitals.

Koharchik, L., & Flavin, P. M. (2017). Teaching students to administer medications safely. *American Journal of Nursing*, (1), 62. Retrieved from OneSearch.

Lippincott Procedures (2018). Safe medication administration practices, general. Accessed August 16, 2019.

WHO (2014). The High 5s Project: Implementation guide. Assuring medication accuracy at transitions in care: medication reconciliation

2.6 Module Learning Activities

Open Resources for Nursing (Open RN)

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=1165#h5p-11

II. Glossary

Open Resources for Nursing (Open RN)

American Nurses Association (ANA): The professional organization that represents the interests of the nation's 4 million registered nurses.

Beneficence: To "do good."

Black Box Warnings: The strongest warnings issued by the Federal Drug Association (FDA) that signify a drug carries a significant risk of serious or life-threatening adverse effects.

Code of Ethics for Nurses: Developed by the American Nurses Association as a guide for carrying out nursing responsibilities in a manner consistent with quality in nursing care and the ethical obligations of the profession.

Cultural Competence: The process by which nurses demonstrate culturally congruent practice.

Culturally Congruent Practice: The application of evidence-based nursing that is in agreement with the preferred cultural values, beliefs, worldview, and practices of the healthcare consumer and other stakeholders.

Do Not Crush List: A list of medications that should not be crushed, often due to a sustained-release formulation.

Drug Diversion: The transfer of any legally prescribed controlled substance from the individual for whom it was prescribed to another person for any illicit use.

Error-Prone Abbreviations: Abbreviations, symbols, and dose designations that are frequently misinterpreted and involved in harmful medication errors.

Five Rights of Medication Administration: Standards of practice that require the following information is confirmed prior to each administration of medication: right patient, right drug, right dose, right time, and right route.

Health Literacy: The degree to which individuals have the capacity to obtain, process, and understand basic health information needed to make appropriate health decisions.

High-Risk Medications: Drugs that bear a heightened risk of causing significant patient harm when they are used in error.

Inappropriate Polypharmacy: Present when one or more medicines are prescribed that are not or no longer needed.

Joint Commission: A national organization that accredits and certifies health care organizations in the United States.

Look-Alike and Sound-Alike (LASA) Drugs: Medications that require special safeguards to reduce the risk of errors and minimize harm.

Maleficence: Causing harm to patients.

National Patient Safety Goals (NPSGs): Goals established by the Joint Commission to help accredited organizations address specific areas of concern related to patient safety.

Nursing: The protection, promotion, and optimization of health and abilities, prevention of illness and injury, facilitation of healing, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, groups, communities, and populations, as defined by the American Nurses Association.

Nursing Process: Standards of Practice that include Assessment; Diagnosis; Outcome Identification; Planning; Implementation; and Evaluation components of providing patient care.

Nursing Scope and Standards of Practice: A document created by the American Nurses Association that outlines professional nursing performance according to national standards.

Polypharmacy: The concurrent use of multiple medications.

Prescription Drug Monitoring Programs (PDMP): A statewide electronic database that collects designated data on substances dispensed in a state to address prescription drug abuse, addiction, and diversion.

Professional Assistance Procedure: A voluntary non-disciplinary program to provide support for credentialed professionals in Wisconsin with substance abuse disorder who are committed to their own recovery.

Registered Nurse (RN): An individual who is educationally prepared and licensed by a state to practice as a registered nurse.

Root Cause Analysis: An analysis after an error occurs to help identify not only what and how an event occurred, but also why it happened. When investigators are able to determine why an event or failure occurred, they can create workable corrective measures that prevent future errors from occurring.

Safety Culture: The culture of a health care agency that empowers staff to speak up about risks to patients and to report errors and near misses, all of which drive improvement in patient care and reduce the incident of patient harm.

Scheduled Medications: The Controlled Substances Act (CSA) places all substances that are regulated under existing federal law into one of five schedules, ranging from Schedule I drugs with a high potential for abuse and the potential to create severe psychological and/or physical dependence, to Schedule V drugs with the least potential for abuse.

Social Determinants of Health: Poverty, education, safe medication, and other healthcare disparities

that affect a patient's health.

Standards of Practice: Authoritative statements of duties by the American Nursing Association that all registered nurses, regardless of role, population, or specialty, are expected to perform competently. Standards of Practice include Assessment, Diagnosis, Outcome Identification, Planning, Implementation, and Evaluation components of providing patient care.

Standards of Professional Performance: Describe a competent level of behavior in the professional role, including activities related to ethics, culturally congruent practice, communication, collaboration, leadership, education, evidence-based practice, and quality of practice as defined by the American Nursing Association.

State Nurse Practice Act: Laws enacted by state legislatures setting professional standards of nursing care to which nurses are held accountable by the State Board of Nursing.

State Board of Nursing: A group of officials who enforce the State Nurse Practice Act.

Substance Use Disorder: A pattern of behaviors that ranges from misuse to dependency or addiction, whether it is alcohol, legal drugs, or illegal drugs. Addiction is a complex disease with serious physical, emotional, financial, and legal consequences.

III

Antimicrobials

3.1 Antimicrobials Introduction

Open Resources for Nursing (Open RN)

Learning Objectives

- Identify the classifications and actions of antimicrobial medications
- Give examples of when, how, and to whom antimicrobial drugs may be administered
- Identify the side effects and special considerations associated with antimicrobial therapy
- Include considerations and implications of using antimicrobial medications across the lifespan
- Include evidence-based concepts when using the nursing process
- Identify and interpret related laboratory tests

Have you ever been prescribed an antibiotic for an infection and asked, "Why do I have to finish taking all these pills when I already feel better"? Or, perhaps you wondered why the healthcare provider chose a certain medication over another or why the pharmacist told you to avoid certain foods when taking a certain antibiotic.

You may have had these questions in your own healthcare experiences. It is important to remember that if you have these questions, many of your patients will as well. Learning about the various types of antimicrobials and how they work will help you provide better health education to your patients.

Did you know that the use of antimicrobial agents dates back to ancient times?

Although the discovery of antimicrobials and their subsequent widespread use is commonly associated with modern medicine, there is evidence that humans have been exposed to antimicrobial compounds for millennia. Chemical analyses of the skeletal remains of people from between 350 and 550 AD of people living near the Nile River have shown residue of the antimicrobial agent tetracycline in high enough quantities to suggest the purposeful fermentation of tetracycline-producing Streptomyces during the beer-making process. The resulting beer, which was thick and gruel-like, was used to treat a variety of ailments in both adults and children, including gum disease and wounds.

Additionally, the antimicrobial properties of plants and honey have been recognized by various cultures around the world, including Indian and Chinese herbalists who have long used plants for a wide variety of medical purposes. Healers of many cultures understood the antimicrobial properties of fungi, and their use of moldy bread or other mold-containing products to treat wounds have been well documented for centuries.

3.2 Antimicrobial Basics

Open Resources for Nursing (Open RN)

Basic Concepts Related to Antimicrobial Therapy

Before we learn about medications that are used to treat infections in our patients, we must first understand the basics of microbiology. Let's begin with a review of bacteria. Bacteria are found in nearly every habitat on earth, including within and on humans. Most bacteria are harmless or considered helpful, but some are pathogens. A **pathogen** is defined as an organism causing disease to its host. Pathogens, when overgrown, can cause significant health problems or even death for your patients.

Bacteria may be identified when a patient has an infection by using a culture and sensitivity test or a gram stain test. Antimicrobials may be classified as broad-spectrum or narrow-spectrum, based on the variety of bacteria they effectively treat. Additionally, antibiotics may be bacteriostatic or bactericidal in terms of how it targets the bacteria. Finally, the mechanism of action is also considered in the selection of an antibiotic.

In addition to antibiotics, antimicrobials also include medications used to treat viruses and fungi. Each of these topics will be discussed in more detail below, along with the issue of drug resistance.

Culture and Sensitivity

When a patient presents signs or symptoms of an infection, healthcare providers will begin the detective work needed to identify the source of the infection. A **culture** is a test performed to examine different body substances for the presence of bacteria or fungus.

These culture samples are commonly collected from a patient's blood, urine, sputum, wound bed, etc. Nurses are commonly responsible for the collection of culture samples and must be conscientious to

collect the sample prior to the administration of antibiotics. Antibiotic administration prior to a culture can result in a delayed identification of the organism and complicate the patient's recovery. Once culture samples are collected, they are then incubated in a solution that promotes bacterial or fungal growth and spread onto a special culture plate.
Kristof, K. and Pongracz, J. (2016). Interpretation of blood microbiology results - function of the clinical microbiologist. *The Journal of the International Federation of Clinical Chemistry and Laboratory Medicine, 27*(2), 147-155. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4975230/

Clinical microbiologists subsequently monitor the culture for signs of organism growth to aid in the diagnosis of the infectious pathogen. A **sensitivity analysis** is often performed to select an effective antibiotic to treat the microorganism. If the organism shows **resistance** to the antibiotics used in the test, those antibiotics will not provide effective treatment for the patient's infection. Sometimes a patient may begin antibiotic treatment for an infection, but will be switched to a different, more effective antibiotic based on the culture and sensitivity results.
Vorvick, L. (Ed.). (2019, February 7). *Sensitivity analysis.* https://medlineplus.gov/ency/article/003741.htm

Gram Positive vs. Gram Negative

A **gram stain** is another type of test that is used to assist in classification of pathogens. Gram stains are useful for quickly identifying if bacteria are "gram positive" or "gram negative," based on the staining patterns of their cellular walls. Utilizing gram stain allows microbiologists to look for characteristic violet (Gram +) or red/pink (Gram -) staining patterns when they examine the organisms under a microscope.
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Identification of bacteria as gram positive or gram negative assists the healthcare provider in quickly selecting an appropriate antibiotic to treat the infection.

Sample Gram Positive Infections

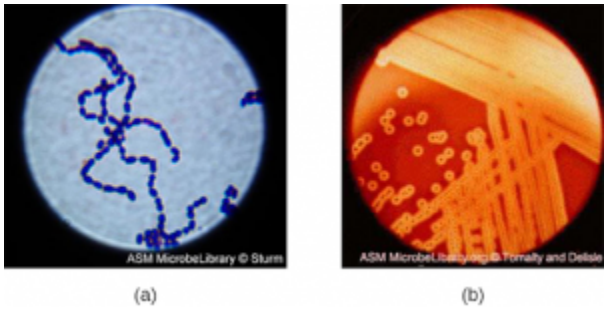

Figure 3.1 Gram Stain Specimen
Streptococcus

Streptococcus, the name which comes from the Greek word for twisted chain, is responsible for many types of infectious diseases in humans. Streptococcus is an example of a **Gram + infection** and is identified by its ability to lyse, or breakdown, red blood cells when grown on blood agar.

S. pyogenes is a type of β-hemolytic *Streptococcus.* This species is considered a pyogenic pathogen because of the associated pus production observed with infections it causes (see Figure 3.1 "OSC Microbio 04 04 Strep.jpg" by CNX OpenStax is licensed under CC BY 4.0 Access for free at

https://openstax.org/books/microbiology/pages/4-4-gram-positive-bacteria
for an image of Streptococcus undergoing gram staining). *S. pyogenes* is the most common cause of bacterial pharyngitis (strep throat); it is also a common cause of various skin infections that can be relatively mild (e.g., impetigo) or life threatening (e.g., necrotizing fasciitis, also known as flesh-eating disease).

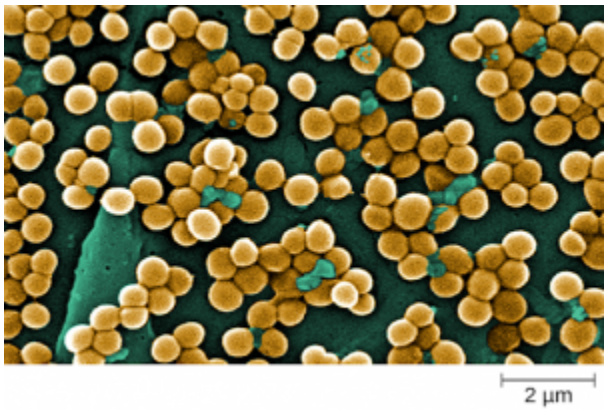

Figure 3.2 Staphylococcus aureus illustrates the typical “grape-like” clustering of cells

Staphylococcus is a second example of a Gram + bacteria. The bacteria Staphylococcus comes from a Greek word for bunches of grapes, which describes their microscopic appearance in culture. Strains of S. aureus cause a wide variety of infections in humans, including skin infections that produce boils, carbuncles, cellulitis, or impetigo. Many strains of S. aureus have developed resistance to antibiotics. Some antibiotic-resistant strains are designated as **methicillin-resistant S. aureus (MRSA)** and **vancomycin-resistant S. aureus (VRSA)** . These strains are some of the most difficult to treat because they exhibit resistance to nearly all available antibiotics, not just methicillin and vancomycin. Because they are difficult to treat with antibiotics, infections can be lethal. MRSA and VRSA are also contagious, posing a serious threat in hospitals, nursing homes, dialysis facilities, and other places where there are large populations of elderly, bedridden, and/or immunocompromised patients.

See Figure 3.2

for an image of Staphylococcus bacteria microscopically.

Sample Gram Negative Infections

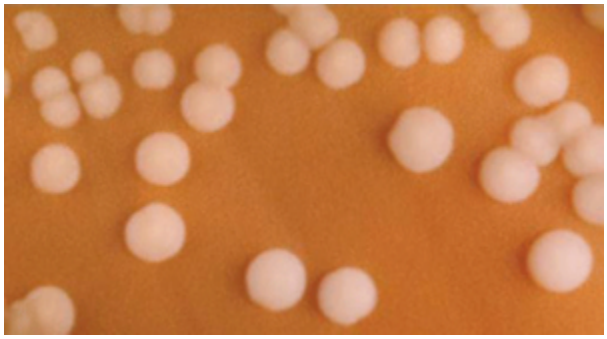

Figure 3.3 Neisseria meningitidis growing in colonies on a chocolate agar plate

Gram negative bacteria often grow between aerobic and anaerobic areas (such as in the intestines). Some gram negative bacteria cause severe, sometimes life-threatening disease. The genus *Neisseria*, for example, includes the bacteria *N. gonorrhoeae*, the causative agent of the sexually transmitted infection gonorrhea, and *N. meningitides*, the causative agent of bacterial meningitis. See Figure 3.3 "OSC Microbio 04 02 Neisseria.jpg" by CNX OpenStax is licensed under CC BY 4.0 Access for free at https://openstax.org/books/microbiology/pages/4-2-proteobacteria
for an image of Neisseria meningitides. Another common gram negative infection that is seen in hospitalized patients is *Escherichia coli* (E. Coli). This is a frequent culprit for urinary tract infections due to its presence in the GI tract.

Broad-Spectrum vs. Narrow-Spectrum Antimicrobials

Spectrum of activity is one of the factors that providers use when selecting antibiotics to treat a patient's infection. A **narrow-spectrum antimicrobial** targets only specific subsets of bacterial pathogens.
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For example, some narrow-spectrum drugs only target gram positive bacteria, but others target only gram negative bacteria. If the pathogen causing infection has been identified in a culture and sensitivity test, it is best to use a narrow-spectrum antimicrobial and minimize collateral damage to the normal microbacteria.

A **broad-spectrum antimicrobial** targets a wide variety of bacterial pathogens, including both gram positive and gram negative species, and is frequently used to cover a wide range of potential pathogens while waiting on the laboratory identification of the infecting pathogen. Broad-spectrum antimicrobials are also used for polymicrobial infections (a mixed infection with multiple bacterial species) or as prophylactic prevention of infections with surgery/invasive procedures. Finally, broad-spectrum antimicrobials may be selected to treat an infection when a narrow-spectrum drug fails because of development of drug resistance by the target pathogen.
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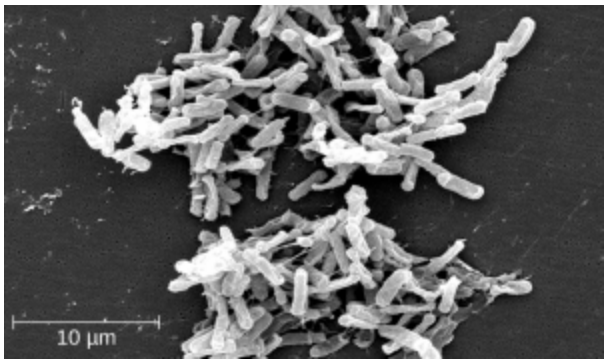


Figure 3.4 Clostridium difficile, a gram-positive, rod-shaped bacterium, causes severe colitis and diarrhea, often after the normal gut microbiota is eradicated by antibiotics

One risk associated with using broad-spectrum antimicrobials is that they will also target a broad spectrum of the normal microbacteria that can cause diarrhea. They also increase the risk of a **superinfection** , a secondary infection in a patient having a preexisting infection. A superinfection develops when the antibacterial intended for the preexisting infection kills the protective microbiota, allowing another pathogen resistant to the antibacterial to proliferate and cause a secondary infection. Common examples of superinfections that develop as a result of antimicrobial use include yeast infections (candidiasis) and pseudomembranous colitis caused by **Clostridium difficile (C-diff)**, which can be fatal.

Probiotics, such as lactobacillus, are commonly used for individuals with C-diff to introduce normal bacteria into the gastrointestinal system and improve bowel function. See Figure 3.4

for an image of C-diff microscopically.

Let's recap…

- A broad-spectrum antibiotic will treat gram positive **and** gram negative bacteria.
- A narrow-spectrum antibiotic will treat **either** gram positive **or** gram negative bacteria.

If a patient is started on an antibiotic that is gram + and the culture identifies a gram – organism, the medication will not improve the patient's status. The selection of an incorrect antibiotic can lead to adverse reactions and increase bacterial resistance.

At times, a broad spectrum antibiotic may be administered prior to receiving the culture report due to the severity of the illness of the patient. Once the culture is reported, the antibiotic therapy is tailored to the patient. It is the nurse's responsibility to review culture results and ensure that the results have been communicated to the prescribing provider.

Antibacterials Actions — Bacteriostatic vs. Bactericidal

When a provider selects an antibacterial drug, it is important to consider how and where the drug will ultimately target the bacteria. Antibacterial drugs can be either bacteriostatic or bactericidal in their

interactions with the offending bacteria. **Bacteriostatic** drugs cause bacteria to stop reproducing; however, they may not ultimately kill the bacteria. In contrast, **bactericidal** drugs kill their target bacteria.

The decision about whether to use a bacteriostatic or bactericidal drug often depends on the type of infection and the overall immune status of the patient. In a healthy patient with strong immune defenses, both bacteriostatic and bactericidal drugs can be effective in achieving clinical cure. However, when a patient is immunocompromised, a bactericidal drug is essential for the successful treatment of infections. Regardless of the immune status of the patient, life-threatening infections such as acute endocarditis require the use of a bactericidal drug to eliminate all offending bacteria.

Mechanism of Action

Another consideration in the selection of an antibacterial drug is the drug's mechanism of action. Each class of antibacterial drugs has a unique **mechanism of action** , the way in which a drug affects microbes at the cellular level. For example, cephalosporins act on the integrity of the cell wall. In contrast, aminoglycosides impact ribosome function and inhibit protein synthesis, which stops the proliferation of cells.

See Figure 3.5

for a summary of how various antibiotics affect the cell wall, the plasma membrane, the ribosomes, the metabolic pathways, or DNA synthesis of bacteria.

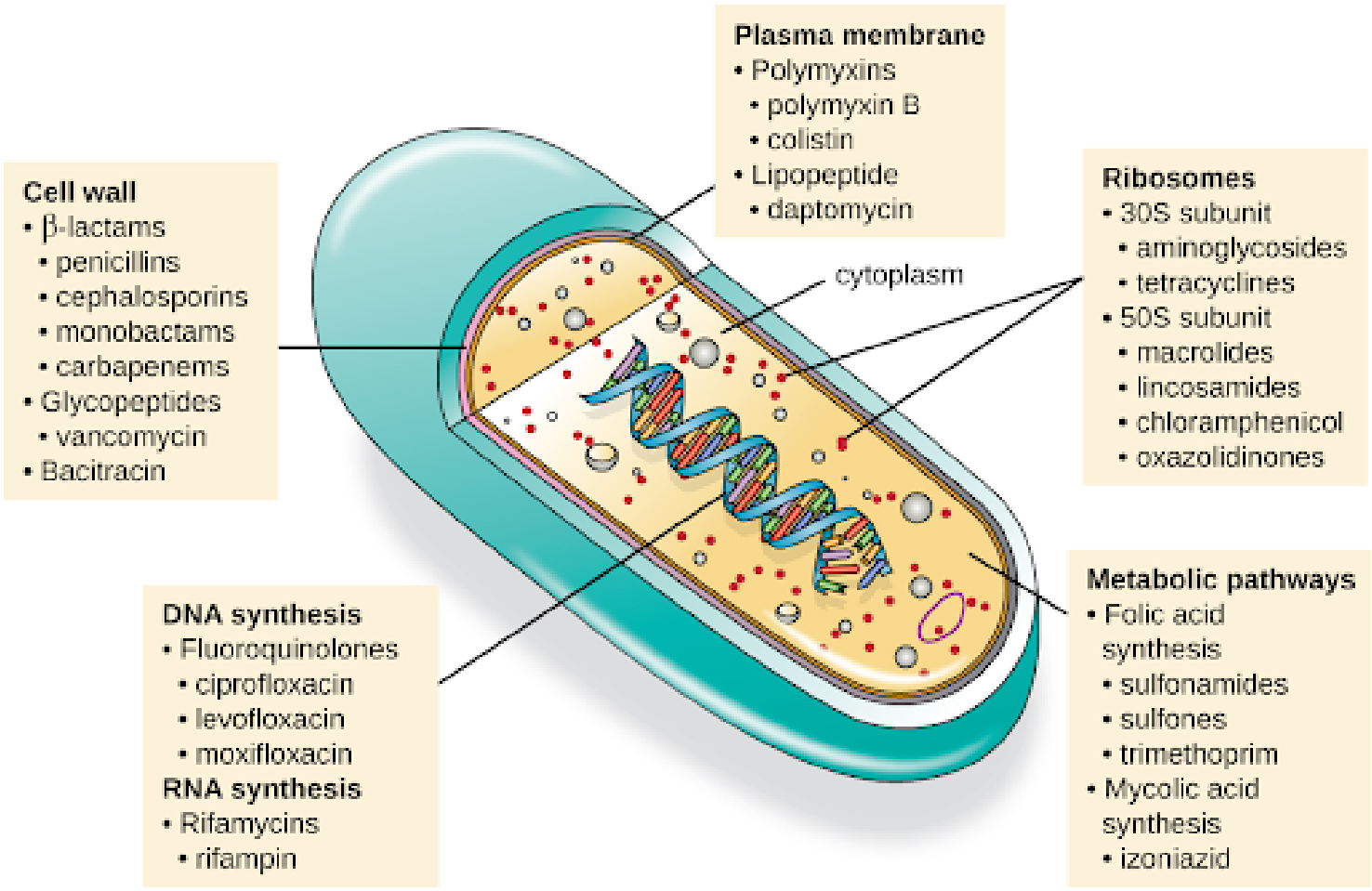


Figure 3.5 Various mechanisms of actions of antimicrobial medication

Antiviral

Similar to antibacterial medications, **antiviral** drugs directly impact interaction and reproduction of the offending microorganism. Antibacterial medications are required for treating bacterial infections; antivirals treat specific viral infections. For example, oseltamivir (Tamiflu) is commonly prescribed to treat influenza. Unlike antimicrobials, antiviral medications do not kill the offending virus, but they work to reduce replication and development of the virus.

Antifungal

Antifungal, or antimycotic agents, are medications that are used to treat fungal infections. These medications work by killing the cells of the fungus or inhibiting the reproduction of the cells. Unlike antibacterial and antiviral medications, many antifungals are applied topically to the affected area. Fungal infections commonly affect surface areas of the body, including the toes, nails, mouth, groin, etc. For example, *Candida albicans* is a type of fungi that when overgrown in the mouth produces oral thrush. Patients experiencing thrush may be prescribed oral antifungal swish and spit medication such as nystatin.

Drug Resistance

Although there is a wide availability of medications that are useful for treating infection, greater limitations in effectiveness are being seen. According to the Centers for Disease Control (2019), each year in the United States, at least 2 million people are infected with an antibiotic-resistant infection, and more than 23,000 die.
Centers for Disease Control and Prevention. (2019). *About antimicrobial resistance.* https://www.cdc.gov/drugresistance/about.html

Prevention Strategies

In the United States and many other countries, most antimicrobial drugs are self-administered by patients at home. Unfortunately, many patients stop taking antimicrobials once their symptoms dissipate and they feel better. If a 10-day course of treatment is prescribed, many patients only take the drug for 5 or 6 days, unaware of the negative consequences of not completing the full course of treatment.

The Problem: A shorter course of treatment not only fails to kill the target organisms to the expected levels but also assists in creating drug-resistant variants within the body. A patient's nonadherence amplifies drug resistance when the recommended course of treatment is long.

For example, treatment for tuberculosis (TB) has a recommended treatment regimen lasting from 6 months to a year. The CDC estimates that about one third of the world's population is infected with TB, most living in underdeveloped or underserved regions where antimicrobial drugs are available over the counter. In such countries, there may be even lower rates of adherence than in developed areas. Nonadherence leads to antibiotic resistance and more difficulty in controlling pathogens. As a direct result, the emergence of multidrug-resistant strains of TB is becoming a huge problem.

The over prescription of antimicrobials also contributes to antibiotic resistance. Patients often demand antibiotics for diseases that do not require them, like viral colds and ear infections. Pharmaceutical companies aggressively market drugs to physicians and clinics, making it easy for them to give free samples to patients, and some pharmacies even offer certain antibiotics free to low-income patients with a prescription.

In recent years, various initiatives have aimed to educate parents and clinicians about the judicious use of antibiotics. However, previous studies have shown the parental expectations for antimicrobial prescriptions for children actually increased.

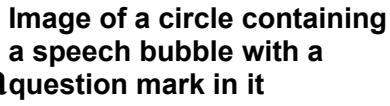
One possible solution that is being explored is a regimen called directly observed therapy (DOT), which involves the supervised administration of medications to patients. Patients are either required to visit a health-care facility to receive their medications, or health-care professionals must administer medication in patients' homes or another designated location. DOT has been implemented in many cases for the treatment of TB and has been shown to be effective; indeed, DOT is an integral part of WHO's global strategy for eradicating TB.

But is this a practical strategy for all antibiotics? Would patients taking penicillin, for example, be more or less likely to adhere to the full course of treatment if they had to travel to a health-care facility to receive each dose? Who would pay for the increased cost associated with DOT? When it comes to overprescription, should providers or drug companies be policed when it comes to over prescribing antibiotics to enforce best practices? What group should assume this responsibility, and what penalties

would be effective in discouraging overprescription?

This is a complex issue with no clear, easy solution. However, what is clear is that all patients need extensive education regarding the judicious and complete use of medications to increase adherence and decrease the opportunity for antimicrobial resistance.

Critical Thinking Activity 3.2a



Reflecting on current healthcare challenges regarding the ongoing emergence of antimicrobial resistant organisms, what actions could you take within your nursing practice to help prevent drug resistance?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=256#h5p-36

3.3 Administration Considerations

Open Resources for Nursing (Open RN)

The administration of antimicrobial drug therapy involves special considerations to ensure that the therapeutic drug effect is achieved while maintaining patient safety and minimizing complications.

Let's consider some of the variables that may impact antimicrobial administration:

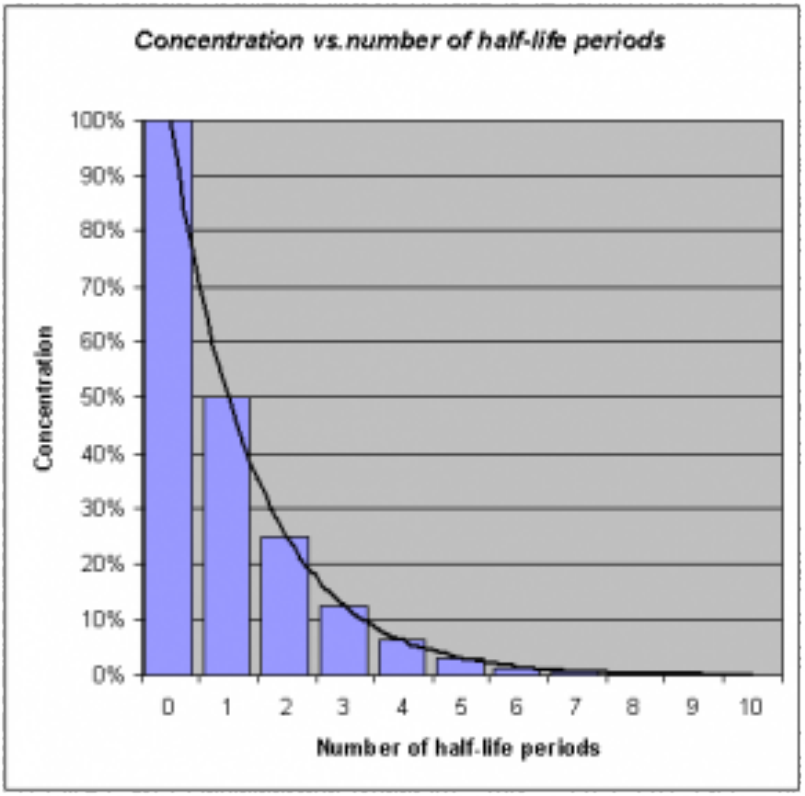


Figure 3.6 Medication concentration over time demonstrates half-life

Half-Life

Many antimicrobial medications are administered to ensure a certain therapeutic level of medication remains in the bloodstream and may require interval or repeated dosing throughout the day. For example, the **half-life**, or rate at which 50% of a drug is eliminated from the plasma, can vary significantly between drugs. Some drugs have a short half-life of only 1 hour and must be given multiple times a day, but other drugs have half-lives exceeding 12 hours and can be given as a single dose every 24 hours. Although a longer half-life can be considered an advantage for an antibacterial when it comes to convenient dosing intervals, the longer half-life can also be a concern for a drug with serious side effects. Medications that have longer half-life and more concerning side effects will exert these side effects over a longer period of time.

See Figure 3.6
"Concentration_vs_number_of_half-life_periodes.png" by OPPSD is licensed under CC BY-SA 3.0
for an illustration of half-lives and the time it takes for a medication to be eliminated from the bloodstream.

Lifespan Considerations

A majority of medications are calculated specifically based on the patient's size, weight, and renal function. Patient age and size are especially vital in pediatric patients. A child's stage of development and the size of their internal organs will greatly impact how the body absorbs, digests, metabolizes, and eliminates medications.

Liver & Renal Function

Additionally, there are many antimicrobial medications that will require tailored dosing based on individual patient response and the potential impact of the medication on the patient's liver and renal function. For more information about the effects of liver and renal function on medications, refer to Chapter 1 regarding metabolism and excretion. Often times, pharmacists and providers will collect drug peak and trough drug blood levels to determine how an individual patient's body is responding to an antimicrobial. Follow-up interval dosing is then prescribed based on these blood levels. This is especially important for older adults or those with known liver/renal impairment. Individuals with diminished liver and renal function are more prone to drug toxicity because of the reduced ability of the body to metabolize or clear medications from the body. For more information about peak and trough levels, refer to Chapter 1 regarding medication safety.

Dose Dependency/Time Dependency

The goal of antimicrobial therapy is to select an optimal dosage that will result in clinical cure, while reducing the patient complications or significant side effects. Many medications may be **dose dependent**. This means that there is a more significant killing of the bacterial with increasing levels of the antibiotic. For example, fluroquinolones are dose-dependent medications with the treatment goal to optimize the amount of the drug. Other medications are **time dependent**. Time-dependent medications have optimal bacterial killing effect at lower doses over a longer period of time. Time-dependent antimicrobials exert the greatest effect by binding to the microorganism for an extensive length of time. Penicillin is an example of a time-dependent medication where the goal is to optimize the duration of exposure.

Route

It is also important to consider the route of drug administration within the patient's body. Many of us may have been prescribed oral antibiotics and have simply filled our prescription and completed the drug regimen within the comfort of our own homes. However, there are many types of infections or disease processes that do not respond well to the use of oral antimicrobial therapy. For these diseases, patients may require intravenous or intramuscular injections. Patients requiring intravenous or intramuscular injections may need to be hospitalized, have home health nursing arranged, or travel to the hospital/clinic for their therapy. Concerns with treatment compliance exists with all routes of administration. For more information about considerations regarding routes of administration, refer to Chapter 1 on absorption. See Figure 3.7

for an illustration of three common routes of medication within the body.

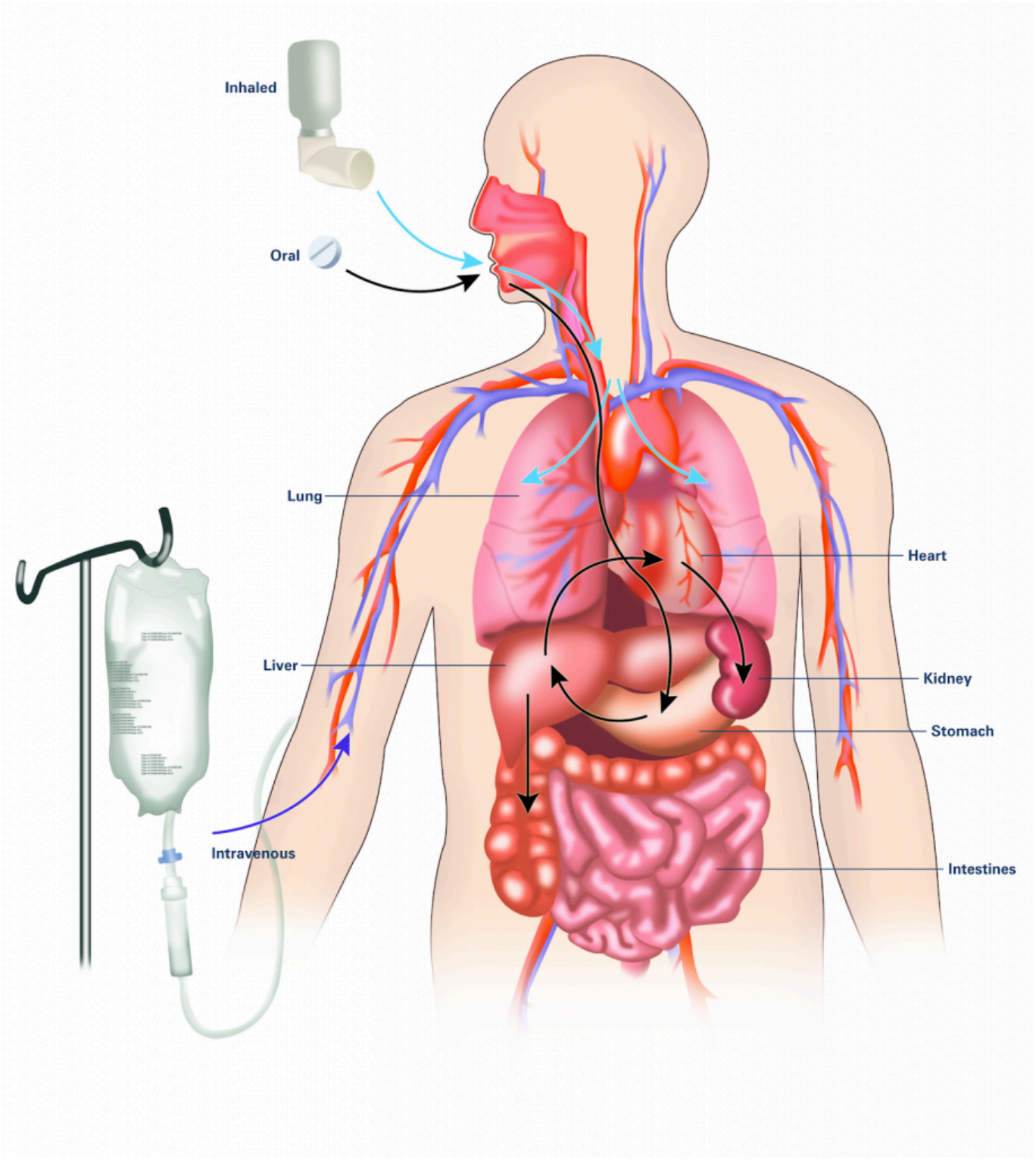


Figure 3.7 Common routes of medication administration include oral, inhalation, and IV

Drug Interactions

For the optimum treatment of select infections, two antibacterial drugs may be administered together. Concurrent drug administration produces a **synergistic interaction** that is better than the efficacy of either drug alone. In this case, TWO is truly better than ONE! A classic example of synergistic drug

combinations is trimethoprim and sulfamethoxazole (Bactrim). Individually, these two drugs provide only bacteriostatic inhibition of bacterial growth, but combined, the drugs are bactericidal.

Although synergistic drug interactions provide a benefit to the patient, **antagonistic interactions** produce harmful effects. Antagonism can occur between two antimicrobials or between antimicrobials and non-antimicrobials being used to treat other conditions. The effects vary depending on the drugs involved, but antagonistic interactions cause diminished drug activity, decreased therapeutic levels due to elevated metabolism and elimination, or increased potential for toxicity due to decreased metabolism and elimination.

Let's consider an example of these antagonistic interactions.

Many antibacterials are absorbed most effectively from the acidic environment within the stomach. However, if a patient takes antacids, the antacids increase the pH of the stomach and negatively impact the absorption of the antibacterial, thus decreasing their effectiveness in treating an infection.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=258#h5p-37

3.4 Nursing Process

Open Resources for Nursing (Open RN)

Now that we have reviewed antimicrobial basics and administration considerations, we will take a closer look at specific antimicrobial classes and administration considerations, therapeutic effects, adverse effects, and specific teaching needed for each class of antimicrobials. But before we do that, let's reexamine the importance of the nursing process in guiding the nurse who administers antimicrobial medications. The nursing process consists of assessment, diagnosis, outcome identification, planning, implementation of interventions, and evaluation. For more information about the nursing process, refer to the Chapter 2 sub-module on "Ethical and Professional Foundations of Safe Medication Administration by Nurses." Because diagnosis, outcome identification, and planning are specifically tailored to the individual patient, we will broadly discuss considerations related to assessment, implementation of interventions, and evaluation when administering antimicrobials.

Nursing Process: Assessment

Although there are numerous details to consider when administering medications, it is important to always first think more broadly about what you are giving and why. As a nurse who is administering an antimicrobial, you must remember some important broad considerations.

First, let's think of the WHY?

Antimicrobials are given to prevent or treat infection. If a patient is prescribed an antimicrobial, an

important piece of the nursing assessment should be to look for signs and symptoms of infection. The nurse should always know WHY the patient is receiving an antimicrobial to evaluate if the patient is improving or deteriorating. Remember, the nurse must assess how this medication is working, and having pre-administration assessment information is an important part of this process. Typical data that a nurse collects at the start of a shift include a baseline temperature, heart rate, blood pressure, and white blood cell count. Focused assessments are then made based on the type of infection. For example, if it is a wound infection, the wound should be assessed. If it is a respiratory infection, the nurse should assess the patient's lung sounds. If a patient has a urinary tract infection (UTI), the urine and symptoms related to a UTI should be assessed. Additionally, whenever a patient has an infection, it is important to continually monitor for the development of sepsis, a life-threatening condition caused by severe infection. Early signs of sepsis include new onset confusion, elevated heart rate, decreased blood pressure, increased respiratory rate, and elevated fever.

Additional baseline information to collect prior to the administration of any new medication order includes a patient history, current medication use including herbals or other supplements, and history of allergy or previous adverse response. Many patients with an allergy to one type of antimicrobial agent may experience cross-reactivity to other classes. This information should be appropriately communicated to the prescribing provider prior to the administration of any antimicrobial medication.

Nursing Process: Implementation of Interventions

With administration of the antimicrobial medication, it is important for the nurse to anticipate any additional interventions associated with the medications. For example, antimicrobials often cause gastrointestinal upset (GI) such as nausea, diarrhea, etc. The patient should be educated about these potential side effects, and proper interventions should be taken to minimize these occurrences. For example, the nurse may instruct the patient to take certain antimicrobials with food to diminish the chance of GI upset, whereas other medications should be taken on an empty stomach for optimal absorption.

Hypersensitivity/allergic reactions are always a potential adverse reaction, especially when administering the first dose of a new antibiotic, and the nurse should monitor for these symptoms closely and respond appropriately by immediately notifying the prescriber. Hypersensitivity reactions are immune responses that are exaggerated or inappropriate to an antigen and can range from itching to anaphylaxis. Anaphylaxis is a medical emergency that can cause life-threatening respiratory failure. Early signs of anaphylaxis include, but are not limited to, hives and itching, the feeling of a swollen tongue or throat, shortness of breath, dizziness, and low blood pressure.

Nursing Process: Evaluation

Finally, it is important to always evaluate the patient's response to a medication. With antimicrobial medications, the nurse should assess for absence of or decreasing signs of infection, indicating the patient is improving. It is important to document these findings to reflect the patient's trended response.

Additionally, it is also important for the nurse to promptly identify and communicate signs of worsening infection to the provider. For example, increasing white blood cell count, temperature, heart rate, and respiratory rate may indicate that the patient's body is experiencing a life-threatening response to the infection. These signs of worsening clinical assessment require prompt intervention to prevent further clinical deterioration. Additionally, patients receiving antibiotics should be closely monitored for developing a complication called "C-diff," resulting in frequent, foul-smelling stools. C-diff requires the

implementation of modified contact precautions, including the use of soap and water, not hand sanitizer, as well as antibiotic therapy.

Kelly, C.P., Lamon, J.T., & Bakken, J.S. (2019). Clostridioides (formerly Clostridium) difficile infection in adults: Treatment and prevention. *UpToDate.* Retrieved on July 8, 2019, from https://www.uptodate.com/contents/clostridioides-formerly-clostridium-difficile-infection-in-adults-treatment-and-prevention?search=Clostridioides%20(formerly%20Clostridium)%20difficile%20infection%20in%20adults&source=search_result&selecte

3.6 Cephalosporins

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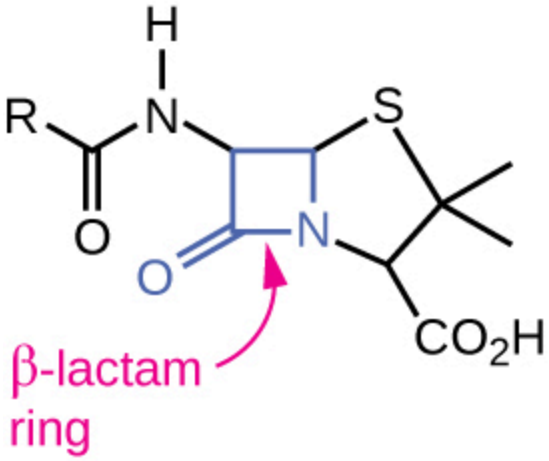
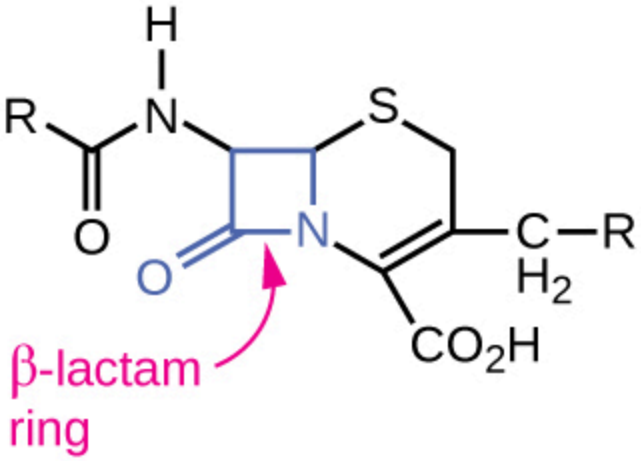


penicillin



cephalosporin

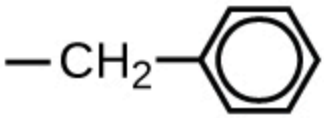
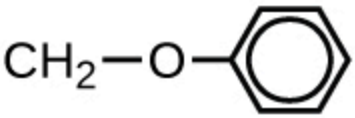
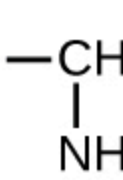
R group			
Drug name	penicillin G	penicillin V	ampic
Spectrum of activity	G+ and a few G−	similar to penicillin G	G+ a G− th penic
Route of administration	parenteral	oral	paren and c

Figure 3.8 Comparison of beta-lactam ring structure across different classes of medications, spectrum of activity and
licensed under CC BY 4.0 Access for free at https://openstax.org/books/microbiology/pages/14-3-mechanisms-of-antibacterial-drugs[/footn

Cephalosporins are a slightly modified chemical "twin" to penicillins due to their beta lactam chemical structure. (See Figure 3.8 for a comparison of the beta-lactam ring structure, spectrum of activity, and route of administration across different classes of medications.) Because of these similarities, some patients who have allergies to penicillins may experience cross-sensitivity to cephalosporins.

Indications: Cephalosporins are used to treat skin and skin-structure infections, bone infections, genitourinary infections, otitis media, and community-acquired respiratory tract infections.

Mechanism of Action: Cephalosporins are typically bactericidal and are similar to penicillin in their action within the cell wall. Cephalosporins are sometimes grouped into "generations" by their antimicrobial properties. The 1st-generation drugs are effective mainly against gram-positive organisms. Higher generations generally have expanded spectra against aerobic gram-negative bacilli. The 5th-generation cephalosporins are active against methicillin-resistant Staphylococcus aureus (MRSA) or other complicated infections.
Werth, B.J. (2018, August). *Cephalosporins.* Merck Manual Professional Version. https://www.merckmanuals.com/professional/infectious-diseases/bacteria-and-antibacterial-drugs/cephalosporins

Specific Administration Considerations: Patients who are allergic to pencillins may also be allergic to cephalosporins. Patients who consume cephalosporins while drinking alcoholic beverages may experience disulfiram-like reactions including severe headache, flushing, nausea, vomiting, etc.
Ren, S., Cao, Y., Zhang, X., Jiao, S., Qian, S., & Liu, P. (2014). Cephalosporin induced disulfiram-like reaction: a retrospective review of 78 cases. *International Surgery, 99*(2), 142–146. https://www.internationalsurgery.org/doi/full/10.9738/INTSURG-D-13-00086.1

Additionally, like penicillins, cephalosporins may interfere with coagulability and increase a patient's risk of bleeding. Cephalosporin dosing may require adjustment for patients experiencing renal impairment. Blood urea nitrogen (BUN) and creatinine should be monitored carefully to identify signs of nephrotoxicity.

Patient Teaching & Education: Patients who are prescribed cephalosporins should be specifically cautioned about a disulfiram reaction, which can occur when alcohol is ingested while taking the medication. Additionally, individuals should be instructed to monitor for rash and signs of superinfection (such as black, furry overgrowth on tongue; vaginal itching or discharge; loose or foul-smelling stool) and report to the prescribing provider.

It is also important to note that cephalosporin can enter breastmilk and may alter bowel flora of the infant. Thus, use during breastfeeding is often discouraged.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the cephalosporin medication grid in Table 3.6.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019.

Table 3.6 Cephalosporin Medication Grid

Class/Subclass	Prototype/ Generics	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Cephalosporins	1st generation: cephalexin Cefazolin 2nd generation: cefprozil 3rd generation: ceftriaxone 4th generation: cefepime 5th generation: ceftolozane	Check for allergies, including if allergic to penicillin Dosage adjustment if renal impairment Use with caution with seizure disorder PO: Administer without regard to food; if GI distress, give with food IV: Reconstitute drug with sterile water or normal saline; shake well until dissolved. Inject into large vein or free-flowing IV solution over 3-5 minutes Drug interaction: anticoagulants	Monitor for systemic signs of infection: -WBCs – Fever Monitor actual site of infection Monitor culture results, if obtained	Common side effects: -Nausea -Vomiting -Epigastric distress -Diarrhea Monitor for: -Rash -C-diff Nephrotoxicity if pre-existing renal disease Elevated INR and bleeding risk Development of hemolytic anemia

Critical Thinking Activity 3.6a

Using the above grid information, consider the following clinical scenario question:

Mrs. Jenkins is an 89-year-old patient admitted to the medical surgical floor for treatment of a skin infection. The admitting provider prescribes Cefazolin 1 gram every 8 hours IV.

Mrs. Jenkins' admission laboratory tests include renal laboratory studies reflecting:

Creatinine: 1.3 mg/dL (Normal range: 1.2 mg/dL
U.S. National Library of Medicine, Medline Plus. (2020, February 13). *Basic metabolic panel.* https://medlineplus.gov/ency/article/003462.htm

Blood urea nitrogen (BUN): 25 mg/dL (Normal: 8-20 mg/dL)

Glomerular Filtration Rate: 55 ml/min (Normal: 90-120 ml/min)
U.S. National Library of Medicine, Medline Plus. (2020, February 13). *Glomerular filtration rate.* https://medlineplus.gov/ency/article/007305.htm

On Day 3 Mrs. Jenkins has renal laboratory studies performed again. The results are:

Creatinine: 1.6 mg/dL

Blood urea nitrogen (BUN): 57 mg/dL

Glomerular Filtration Rate: 20 ml/min

Are Day 3 findings expected or not? What course of action should the nurse take?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.5 Penicillins

Open Resources for Nursing (Open RN)

Now that we have reviewed antimicrobial basics, administration considerations, and the nursing process when administering antimicrobials, we will take a closer look at specific antimicrobial classes and administration considerations, therapeutic effects, adverse effects, and specific teaching needed for each class of antimicrobials. Each of the following sections of this chapter is based on a class or subclass of anti-infective medications. Each section discusses the mechanism of action, specific administration considerations, and common patient teaching for this class/subclass of medication. Each section is then followed by a medication table with a common generic medication and its specific administration considerations, therapeutic effects, and side effects/adverse effects for this medication.

Penicillins

Penicillin was the first antibiotic discovered and its detection came as a bit of an accident. In 1928, Alexander Fleming, a professor of bacteriology at St. Mary's Hospital in London, discovered penicillin accidentally growing in a petri dish in his lab. The penicillin was the result of mold juice that had grown there inadvertently. Fleming noted that this "mold juice" inhibited the growth of Staphylococcus bacteria that was previously growing in the petri dish. Subsequently, the first antibiotic discovery was made.
American Chemical Society International Historic Chemical Landmarks. *Discovery and development of penicillin.* http://www.acs.org/content/acs/en/education/whatischemistry/landmarks/flemingpenicillin.html

Indications: Penicillins are prescribed to treat a variety of infectious processes such as Streptococcal infections, Pneumococcal infections, and Staphylococcal infections. Penicillins may be administered orally, IV, or intramuscularly.

Mechanism of Action: Penicillins are bactericidal and kill bacteria by interfering with the synthesis of proteins needed in their cellular walls.