



Dosage Forms, Routes of Administration, and Dispensing Medications

OBJECTIVES

After reading this chapter, you will be able to:

- Outline the components of a prescription, including commonly used abbreviations.
- Understand the “rights” of correct drug administration.
- Describe common dosage forms.
- Explain the most common routes of administration.
- Summarize the factors that influence the effects of drugs, particularly in elderly and pediatric populations.
- Explain the difference between dosage form and route of administration.
- Describe the properties of solid, semisolid, liquid, inhalation, and transdermal dosage forms.
- Describe inactive ingredients, various tablet coatings, and their functions.
- Describe various delayed-release dosage formulations.
- Compare and contrast different types of emulsions such as ointments, creams, and gels.
- Discuss the advantages of a transdermal dosage form.
- Explain the major routes of administration and the advantages and disadvantages associated with each route of administration.
- Explain the correct techniques for administration of eye drops, metered-dose inhalers, vaginal medications, and injections.

KEY TERMS

Additives	Immediate-release	Rectal
Aerosol	Incontinence	Ring
Alcoholic solution	Infection	Route of administration
Aqueous suspension	Infusion	Signa
Aromatic water	Inhalation	Solute
Binders	Inscription	Solution
Bolus dose	Intradermal	Solvent
Buccal	Intramuscular	Sprinkles
Caplet	Intravenous	Subcutaneous
Capsule	Irrigating solution	Sublingual
Chewable tablet	Lotion	Sugar-coated
Controlled-release	Lozenges	Suspension
Cream	Nasal	Spansule
Delayed-release	Noncompliance	Spirit
Depot	Oil-in-water (O/W)	Spray
Diluents	emulsion	Sprinkles
Dispersion	Ointment	Suppository
Dosage form	Ophthalmic	Sustained-release
Elixir	Oral disintegrating	Syringe
Emulsion	tablet (ODT)	Syrup
Emulsifying agent	Order	Tablet
Enteric-coated	Otic	Tincture
Excipients	Parenteral solution	Topical
Extended-release	Paste	Transdermal patch
Extract	Peroral (PO)	Urethral
Film-coated	Polypharmacy	Vaginal
Gel	Powder	Water-in-oil (W/O)
Granules	Prescription	emulsion
Homogenous	Preservatives	
Hydroalcoholic solution	Reconstitution	

Chapter Overview

The legal form that a prescriber utilizes to order a medication, medical device, or piece of medical equipment to be dispensed to a patient by a licensed pharmacist is called a prescription. A valid prescription must contain all the information necessary for a pharmacist to complete the prescriber's order. A pharmacy technician plays a key role in the preparation and dispensing of prescription products. This chapter covers the legally required elements of a prescription, as well as many of the common abbreviations used by prescribers to create prescription orders. To effectively read prescriptions and prepare prescription orders, it is essential for a pharmacy technician to possess a thorough understanding of common prescription abbreviations.

The Prescription

A **prescription** is a legal order for a specific product, to be dispensed to a patient by a licensed pharmacist. A prescription order can be made by any healthcare professional with prescribing authority. Although the most common issuer of prescription orders is a physician, prescription orders can also be issued by dentists, podiatrists, optometrists, physician assistants, nurse practitioners, and veterinarians in all 50 states.

Additionally, some states have granted limited prescribing authority to clinical psychologists and pharmacists. Physicians have broad prescribing authority, which means there are no limitations to what prescription products they may prescribe. Other healthcare professionals may have limited prescribing authority, which means there are specific restrictions in place for these prescribers. These restrictions are related to each professional's individual scope of practice and vary from state to state. For example, a dentist cannot order a medication for a patient's back pain and a veterinarian cannot order medications for a human patient.

Prescription orders are sometimes given to patients by their prescriber. A patient might then mail or hand-deliver a prescription to a pharmacy. Other times, prescriptions are transmitted by the prescriber or an agent of the prescriber (for example, a nurse in the prescriber's practice) directly to the pharmacy. A prescriber has several options for transmitting prescription orders to a pharmacy. Prescribers may mail prescriptions to the pharmacy, relay them via telephone, transmit them via fax, or use an e-prescribing service, which is a secure system that utilizes an Internet connection to deliver prescriptions directly to the pharmacy computer. Written prescription orders, whether given to the patient, faxed, or mailed to the pharmacy, must be signed by the prescriber. Telephone orders and e-prescribing orders are valid as long as they are relayed to the pharmacy by the prescriber or by an authorized agent of the prescriber. There are many special laws that relate to prescription orders for controlled substances, but these vary from state to state. For more information on these regulations visit your state board of pharmacy's Web site.

In an institutional setting, the term prescription is not used. Instead, the prescriber's request is referred to as an **order** or a **medication order**.

The Components of a Hard-Copy Prescription

Prescription components may vary from state to state, but typically should contain the following information **FIGURE 4.1**:

- The prescriber's name, address, and phone number
- The name of the patient
- The date the prescription was written
- The name, strength, dosage form, and quantity of medication or product ordered (also called the **inscription**)
- Directions for use (also called the **signa**, often referred to as "sig")
- The number of refills allowed
- If the prescriber requests "no generic substitution," it must be clearly noted

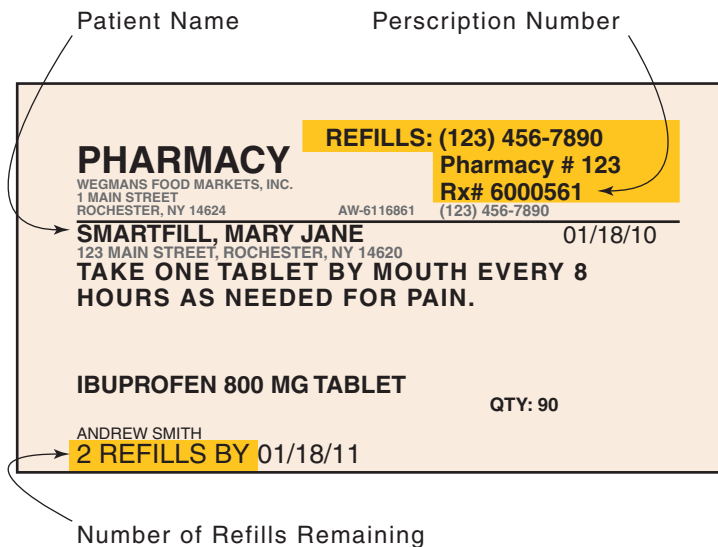


FIGURE 4.1 The essential components of a prescription.



A medication bottle that has the Rx symbol can only be dispensed with a legal prescription.

- If it is a prescription for a controlled substance, the prescriber's Drug Enforcement Administration (DEA) number
- The prescriber's hand-written signature

When accepting a prescription order from a customer, the role of a pharmacy technician begins with double-checking the prescription for accuracy and ensuring that all legal requirements have been met.

The Components of a Patient Prescription Label

Components of prescription labels may vary from state to state, but typically should contain the following information:

- The name of the patient
- The name of the prescriber
- The date the prescription was filled
- The number of refills remaining
- The date the prescription expires
- The date the product expires
- The name, strength, dosage form, and quantity of product dispensed (also called the inscription)
- Directions for use (also called the **signa**, often referred to as the “sig”)
- The name, address, and phone number of the pharmacy
- The Rx number
- If it is a prescription for a controlled substance, the statement “Caution: Federal law prohibits the transfer of this drug to any person other than the patient for whom it was prescribed” must be printed on the label
- Any necessary auxiliary labels

If a medication has the symbol Rx on the bottle, it can only be dispensed pursuant to a prescription.

Commonly Used Abbreviations

In most cases, the directions (signa) are written in shorthand, or an abbreviated form that allows for the easy writing of directions. Directions generally include how and when to take the medication ordered.

To fill the prescription safely, the pharmacy technician must have knowledge of commonly used abbreviations found in prescription orders. These abbreviations are standard usage for prescribers, pharmacists, and pharmacy technicians, but must be spelled out as simply as possible for the patient to ensure that the patient uses the medication properly. Never assume that directions are easily understood by a patient.

TABLE 4.1 contains a list of abbreviations used in writing prescriptions.

Here are several examples of the use of commonly used abbreviations, and their translations:



The label on a prescription bottle.

Table 4.1 Commonly Used Abbreviations

Abbreviation	Translation
ac	Before meals
am	Morning
AD	Right ear
AS	Left ear
AU	Both ears
bid	Twice a day
c̄	With
cap	Capsule
DAW	Dispense as written
D/C	Discontinue
g or gm	Gram
gr	Grain
gtt	Drop
h or hr or °	Hour
IM	Intramuscular
INH	Inhalation
IV	Intravenous
L	Liter
mcg	Microgram
mEq	Milliequivalent
mL	Milliliter
NKA	No known allergies
NKDA	No known drug allergies
npo	Nothing by mouth
OD	Right eye
OS	Left eye
OU	Both eyes
pc	After meals
PO	By mouth
PR	Per rectum
prn	As needed
q	Every
qid	Four times a day
qs	A sufficient quantity
SL	Sublingual
stat	Immediately
tab	Tablet
tid	Three times a day
top	Topically
ud	As directed
wk	Week

Example: iii gtts OS qid ud

Translation: Instill three drops into the left eye, four times a day as directed.

Example: 1 tab po tid×5 days

Translation: Take one tablet by mouth three times a day for five days.

Example: 1 supp pr bid prn

Translation: Insert one suppository rectally twice a day as needed.

Example: 0.5 mL SQ tid prn

Translation: Inject 0.5mL subcutaneously three times a day as needed.

Example: ii gtts OU qid

Translation: Instill two drops into both eyes, four times a day.

Example: 1 tab SL bid prn

Translation: Place one tablet under the tongue twice a day as needed.

Because of the concern over drug errors that have occurred from misinterpretation of prescription orders, the Institute for Safe Medication Practices (ISMP) has compiled a list of the most common misread abbreviations **TABLE 4.2**.

The ISMP has a list of error-prone abbreviations, symbols, and dose designations, which can be found at <http://www.ismp.org/tools/errorproneabbreviations.pdf>.

Table 4.2 Problematic Abbreviations Found on Prescription Orders

Abbreviations	Intended Meaning	Misinterpretation	Correction
μ g	Microgram	Mistaken as “mg”	Use “mcg”
AD, AS, AU	Right ear, left ear, each ear	Mistaken as OD, OS, OU (right eye, left eye, each eye)	Use “right ear,” “left ear,” or “each ear”
OD, OS, OU	Right eye, left eye, each eye	Mistaken as AD, AS, AU (right ear, left ear, each ear)	Use “right eye,” “left eye,” or “each eye”
BT	Bedtime	Mistaken as “BID” (twice daily)	Use “bedtime”
cc	Cubic centimeters	Mistaken as “u” (units)	Use “mL”
D/C	Discharge or discontinue	Premature discontinuation of medications if D/C (intended to mean “discharge”) has been misinterpreted as “discontinued” when followed by a list of discharge medications	Use “discharge” and “discontinue”
IJ	Injection	Mistaken as “IV” or “intrajugular”	Use “injection”
IN	Intranasal	Mistaken as “IM” or “IV”	Use “intranasal” or “NAS”
HS Hs	Half-strength, At bedtime, hours of sleep	Mistaken as bedtime Mistaken as half-strength	Use “half-strength” or “bedtime”
IU**	International unit	Mistaken as IV (intravenous) or 10 (ten)	Use “units”

Table 4.2 Problematic Abbreviations Found on Prescription Orders (Continued)

Abbreviations	Intended Meaning	Misinterpretation	Correction
o.d. or OD	Once daily	Mistaken as “right eye” (OD-oculus dexter), leading to oral liquid medications administered in the eye	Use “daily”
OJ	Orange juice	Mistaken as OD or OS (right or left eye); drugs meant to be diluted in orange juice may be given in the eye	Use “orange juice”
Per os	By mouth, orally	The “os” can be mistaken as “left eye” (OS-oculus sinister)	Use “PO,” “by mouth,” or “orally”
q.d. or QD**	Every day	Mistaken as q.i.d., especially if the period after the “q” or the tail of the “q” is misunderstood as an “i”	Use “daily”
qhs	Nightly at bedtime	Mistaken as “qh” or every hour	Use “nightly”
qn	Nightly or at bedtime	Mistaken as “qh” (every hour)	Use “nightly” or “at bedtime”
q.o.d. or QOD**	Every other day	Mistaken as “q.d.” (daily) or “q.i.d.” (four times daily) if the “o” is poorly written	Use “every other day”
q1d	Daily	Mistaken as q.i.d. (four times daily)	Use “daily”
q6PM, etc.	Every evening at 6 PM	Mistaken as every 6 hours	Use “daily at 6 PM” or “6 PM daily”
SC, SQ, sub q	Subcutaneous	SC mistaken as SL (sublingual); SQ Mistaken as “5 every”; the “q” in “sub q” has been mistaken as “every” (e.g., a heparin dose ordered “sub q 2 hours before surgery” misunderstood as every 2 hours before surgery)	Use “subcut” or “subcutaneously”
ss	Sliding scale (insulin) or ½ (apothecary)	Mistaken as “55”	Spell out “sliding scale;” use “one-half” or “1/2”
SSRI	Sliding scale regular insulin	Mistaken as selective-serotonin reuptake inhibitor	Spell out “sliding scale (insulin)”
SSI	Sliding scale insulin	Mistaken as Strong Solution of Iodine (Lugol’s)	
i/d	One daily	Mistaken as “tid”	Use “1 daily”
TIW or tiw (also BIW or biw)	TIW: 3 times a week	T/W mistaken as “3 times a day” or “twice in a week”	Use “3 times weekly”
	BIW: 2 times a week	B/W mistaken as “2 times a day”	Use “2 times weekly”

Table 4.2 Problematic Abbreviations Found on Prescription Orders (Continued)

Abbreviations	Intended Meaning	Misinterpretation	Correction
U or u**	Unit	Mistaken as the number 0 or 4, causing a 10-fold overdose or greater (e.g., 4U seen as “40” or 4u seen as “44”); mistaken as “cc” so dose given in volume instead of units (e.g., 4u seen as 4cc)	Use “unit”
UD	As directed (“ut dictum”)	Mistaken as unit dose (e.g., diltiazem 125 mg IV infusion “UD” misinterpreted as meaning to give the entire infusion as a unit [bolus] dose)	Use “as directed”
Dose Designations and Other Information	Intended Meaning	Misinterpretation	Correction
Trailing zero after decimal point (e.g., 1.0 mg)**	1 mg	Mistaken as 10 mg if the decimal point is not seen	Do not use trailing zeros for doses expressed in whole numbers
No leading zero before a decimal point (e.g., .5 mg)**	0.5 mg	Mistaken as 5 mg if the decimal point is not seen	Use zero before a decimal point when the dose is less than a whole unit
Drug name and dose run together (especially problematic for drug names that end in “l” such as Inderal40 mg; Tegretol300 mg)	Inderal 40 mg Tegretol 300 mg	Mistaken as Inderal 140 mg Mistaken as Tegretol 1300 mg	Place adequate space between the drug name, dose, and unit of measure
Numerical dose and unit of measure run together (e.g., 10mg, 100mL)	10 mg 100 mL	The “m” is sometimes mistaken as a zero or two zeros, risking a 10- to 100-fold overdose	Place adequate space between the dose and unit of measure
Abbreviations such as mg. or mL. with a period following the abbreviation	mg, mL	The period is unnecessary and could be mistaken as the number 1 if written poorly	Use mg, mL, etc. without a terminal period
Large doses without properly placed commas (e.g., 100000 units; 1000000 units)	100,000 units 1,000,000 units	100000 has been mistaken as 10,000 or 1,000,000; 1000000 has been mistaken as 100,000	Use commas for dosing units at or above 1,000, or use words such as 100 “thousand” or 1 “million” to improve readability
Drug Name Abbreviations	Intended Meaning	Misinterpretation	Correction
ARA A	vidarabine	Mistaken as cytarabine (ARA C)	Use complete drug name
AZT	zidovudine (Retrovir)	Mistaken as azathioprine or aztreonam	Use complete drug name
CPZ	Compazine (prochlorperazine)	Mistaken as chlorpromazine	Use complete drug name
DPT	Demerol-Phenergan-Thorazine	Mistaken as diphtheria-pertussis-tetanus (vaccine)	Use complete drug name
DTO	Diluted tincture of opium, or deodorized tincture of opium (Paregoric)	Mistaken as tincture of opium	Use complete drug name

Table 4.2 Problematic Abbreviations Found on Prescription Orders (Continued)

Abbreviations	Intended Meaning	Misinterpretation	Correction
HCl	hydrochloric acid or hydrochloride	Mistaken as potassium chloride (The “H” is misinterpreted as “K”)	Use complete drug name unless expressed as a salt of a drug
HCT	hydrocortisone	Mistaken as hydrochlorothiazide	Use complete drug name
HCTZ	hydrochlorothiazide	Mistaken as hydrocortisone (seen as HCT250 mg)	Use complete drug name
MgSO ₄ **	magnesium sulfate	Mistaken as morphine sulfate	Use complete drug name
MS, MSO ₄ **	morphine sulfate	Mistaken as magnesium sulfate	Use complete drug name
MTX	methotrexate	Mistaken as mitoxantrone	Use complete drug name
PCA	procainamide	Mistaken as patient controlled analgesia	Use complete drug name
PTU	propylthiouracil	Mistaken as mercaptopurine	Use complete drug name
T3	Tylenol with codeine (No. 3)	Mistaken as liothyronine	Use complete drug name
TAC	triamcinolone	Mistaken as tetracaine Adrenalin, cocaine	Use complete drug name
TNK	TNKase	Mistaken as “TPA”	Use complete drug name
ZnSO ₄	zinc sulfate	Mistaken as morphine sulfate	Use complete drug name
Stemmed Drug Names	Intended Meaning	Misinterpretation	Correction
“Nitro” drip	nitroglycerin infusion	Mistaken as sodium nitroprusside infusion	Use complete drug name
“Norflox”	norfloxacin	Mistaken as Norflex	Use complete drug name
“IV Vanc”	intravenous vancomycin	Mistaken as Invanz	Use complete drug name
Symbols	Intended Meaning	Misinterpretation	Correction
℥	Dram	Symbol for dram mistaken as “3”	Use the metric system
℥	Minim	Symbol for minim mistaken as “mL”	Use the metric system
x3d	For three days	Mistaken as “3 doses”	Use “for three days”
> and <	Greater than and less than	Mistaken as opposite of intended; Mistakenly use incorrect symbol; “< 10” Mistaken as “40”	Use “greater than” or “less than”
/ (slash mark)	Separates two doses or indicates “per”	Mistaken as the number 1 (e.g., “25 units/10 units” misread as “25 units and 110 units”)	Use “per” rather than a slash mark to separate doses
@	At	Mistaken as “2”	Use “at”
&	And	Mistaken as “2”	Use “and”
+	Plus or and	Mistaken as “4”	Use “and”
°	Hour	Mistaken as a zero (e.g., q2° seen as q 20)	Use “hr,” “h,” or “hour”
∅	zero, null sign	Mistaken as the numerals 4, 6, or 9	Use the number “0” or the word “zero”

**These abbreviations are included on The Joint Commission’s “minimum list” of dangerous abbreviations, acronyms, and symbols that must be included on an organization’s “Do Not Use” list, effective January 1, 2004. Visit www.jcaho.org for more information about this Joint Commission requirement.

Most pharmacies will also give the patient an information sheet with more details regarding the proper administration of the medication, possible side effects, and adverse drug interactions.

In some cases, the prescription directions may be difficult to interpret. If there is a question regarding the information on the prescription, the pharmacist should be notified. In most cases, the pharmacist will be able to clarify the information or if necessary; call the physician for clarification.

The “Rights” of Correct Drug Administration

When a pharmacy technician fills a patient’s prescription, it is important to remember the basic “rights” of a patient with regard to medication safety. These rights offer useful guidelines when filling prescriptions. The rights of a patient to medication safety are as follows:

- The right patient—Always verify that the medication prescribed is for the correct patient. Use at least two patient identifiers.
- The right drug—Always check the medication bottle and medication against the original prescription, making sure to take into account the patient’s disease state.
- The right dose—Always check the original prescription to verify the strength of the medication, paying particular attention to the age of the patient.
- The right route—Always check the prescriber’s prescription order to make sure it agrees with the drug’s specified route of administration.
- The right time—Always check the prescription to determine the correct frequency and duration for the medication to be administered.

Dosage Forms

Drugs are seldom administered in pure form. They are formulated into various dosage forms to facilitate ease of administration and ensure safety and efficacy. A **dosage form** is a system or device by which the drug is delivered to the body. In a dosage form, the active ingredient is combined with the inert ingredients that facilitate administration of the drug.

The most common dosage forms are those that are administered orally. Taking an oral medication is the most convenient method to deliver medication, which in turn makes it the most in demand, which leads to mass production and ultimately lower manufacturing costs. Some medications are not available in oral form because they cannot be properly absorbed in the GI tract. For instance, heparin is only available as an injectable formulation because it is ineffective when administered orally. The route of administration and dosage form are also determined by other factors, including the age of the patient, the disease being treated, the area of the body that the drug needs to reach, the ease of administration, and the characteristics of the drug.

The active ingredient is responsible for a drug’s therapeutic effect.

An inert ingredient has little or no therapeutic value.

Dosage forms may also contain the following:

- Additives—**Additives** are inert ingredients that may be needed for a successful preparation of the dosage form.
- Binders—**Binders** promote adhesion of active and inactive ingredients in the tablets.
- Diluents—**Diluents** are additives used to increase the bulk weight or volume of a dosage form.
- Excipients—**Excipients** are inactive substances used as a carrier for the active ingredient.
- Preservatives—**Preservatives** are substances that prevent or minimize the growth of bacteria or other microorganisms in the dosage form, typically used in multi-dose vials. Single-dose vials are discarded immediately after use, while multi-dose vials, once opened, may be stored for a period. After a vial has been opened, however, the risk of bacterial overgrowth increases. To prevent or minimize the risk of bacterial overgrowth, preservatives are added to the medication.

Many top-selling drugs are available in several different dosage forms. It is important to know what dosage form is being requested because the strength of the medication may depend on the dosage form. It also ensures that the patient does not use a dosage form incorrectly, such as swallowing a suppository. Knowing the dosage form can serve as a double-check when a prescription calls for a certain strength of medication that is available in more than one dosage form.

The strength of the same medication can vary from one dosage form to another.

Solid Dosage Forms

Solid dosage forms include tablets, capsules, caplets, lozenges/troches, pastilles, powders, and granules. Solid dosage forms offer several advantages:

- Increased stability
- Ease of packaging, storage, and dispensing
- Convenience
- Little or no taste or smell

Solid dosage forms also allow for accurate dosing. The entire dose is contained within the contents of the solid dosage form, which minimizes measuring errors. Solid dosage forms may, however, be difficult to swallow, have a slow onset of action, and may be degraded by the acidic contents in the stomach.

Tablets/Caplets

Tablets are available in variety of sizes, shapes, colors, and thicknesses. They are formed in molds or produced by compression, and are composed of one or more active ingredients and one or more inert substances.

Some pharmaceutical manufacturers manufacture a hybrid of the capsule and tablet, called a caplet. A **caplet** is a tablet that is shaped like a capsule, but smooth-sided like a tablet. It is often easier to swallow than large tablets, and is more stable than capsules (discussed in a moment).

Most tablets and caplets are designed to be swallowed whole and dissolve in the gastrointestinal tract, but some are also made to be administered sublingually (under the tongue), buccally, or vaginally. Some tablets are available in a scored form so they may be easily broken in halves or quarters. Tablets can be formulated with delayed-release characteristics to allow for less-frequent dosing and/or side effects.



Tablets are manufactured in a variety of sizes and colors.

A **chewable tablet** is designed to be chewed. Chewable tablets contain a base that is flavored or colored. They are convenient for patients who have difficulty swallowing tablets or for children who are unable to swallow large tablets. An **oral disintegrating tablet (ODT)** is designed to dissolve in the mouth without water. These tablets are useful for pediatric and geriatric patients who have difficulty swallowing medication and in patients who are experiencing nausea and vomiting. Another benefit of ODTs is that they cannot be “cheeked” by patients who may attempt to be non-compliant with medication therapy that is administered by a caregiver, as with a nursing home patient.

Enteric-Coated Tablets

Tablets may have a coating applied to the outside to mask unpleasant flavor or odor, or to protect the drug from stomach contents. **Enteric-coated** tablets are coated with a substance that prevents dissolution of the drug in the stomach. They are meant to dissolve in the intestine to protect the drug from being broken down in the stomach or to protect the stomach lining from the drug. Enteric-coated dosage forms should not be chewed, broken, or crushed. Examples of drugs that are available in enteric-coated formulations include aspirin and potassium chloride.



Enteric coated tablets prevent dissolution of the drug in the stomach.

Film-Coated Tablets

Film-coated tablets are coated with a thin outer layer of water-soluble material that dissolves rapidly in the stomach. The coating is designed to cover the unpleasant taste or smell of the medication or protect sensitive drugs from deterioration due to air and light. Erythromycin is an example of a medication available as a film-coated tablet.

Sugar-Coated Tablets

Sugar-coated tablets are coated with an outside layer of sugar that protects the medication and improves the taste and the appearance of the medication.

Capsules

Capsules are a solid dosage form in which the drug is enclosed within a hard or soft gelatin shell. The gelatin shell dissolves in the stomach, releasing the drug. The gelatin shell may be transparent, semitransparent, or opaque. A capsule may contain powders, granules, crushed tablets, or liquids with one or more active ingredients and one or more inert ingredients. Capsules can be formulated with delayed-release characteristics to allow for less-frequent dosing and/or side effects.

Spansules are capsules that are filled with granules that dissolve at different rates, in effect causing a sustained

release of the active ingredients. **Sprinkles** or sprinkle capsules are similar to spansules but unique in that they are designed to be pulled apart and the contents sprinkled onto food, making it easier to administer the medication. The medication inside a sprinkle capsule is specially coated to allow the medication to be delivered after the contents have been ingested. They are convenient for patients who have difficulty swallowing large capsules or for children who are unable to swallow capsules.

Sizes of capsules range from 000 (largest) to 5 (smallest). The volume of powder that can be placed in a given capsule varies depending on the density of the powder being placed in the empty capsule.



Capsules come in a variety of sizes.

Dosage Formulations Designed to Alter the Rate of Release

Tablets and capsules can be designed in **immediate-release** formulations, in which the medication is released within a short period of time after the drug is taken. They can also be designed in **delayed-release** formulations, which administer the drug over an extended period of time. A delayed-release formulation may be enteric coated, thus delaying the release of the medication until the formulation has passed through the stomach. Dosage forms designed to vary the rate or extent of release include the following:

- **Controlled release**—**Controlled-release** dosage forms regulate the rate of release of the active ingredient. They are designed to vary the dissolution rate or re-release of the active drug. These dosage forms are also referred to as long-acting and timed-release formulations.
- **Sustained release**—**Sustained-release** dosage forms allow the frequency of dosing of a medication to be reduced compared to that of immediate-release dosage forms.
- **Extended release**—**Extended-release** dosage forms are formulated so that the active ingredient is released at a constant rate for a prolonged period so that the frequency of dosing is less than that of immediate-release dosage forms. They usually allow for once-daily dosing, as the contained medication is available over an extended period of time following ingestion of the formulation.

Compared to immediate-release preparations, advantages of extended-release dosage forms include the following:

- Constant drug levels following long-term administration
- Reduction in adverse side effects
- Reduction in the frequency of administration
- Increased patient compliance

Immediate-release formulations are designed to release the medication within a short period of time.

Lozenges, Troches, or Pastilles

Lozenges, also known as troches or pastilles, are hard, oval, or discoid solid dosage forms with a drug contained in a flavored sugar base. They are dissolved in the mouth and generally have local therapeutic effects. Over-the-counter lozenges for relief of sore throat are a common example of this dosage form. Antibiotics, analgesics, cough suppressants, and antiseptics are also available as lozenges. Troche sizes vary; they usually have a chalky consistency in order to dissolve in the mouth.

Powders and Granules

Powders are finely ground mixtures of dry drugs and inactive ingredients that can be used topically or internally. When used internally, they should be dissolved in water prior to ingestion. **Granules** are larger than powders and are wetted, allowed to dry, and ground into coarse, irregularly shaped pieces. Granules are generally more stable than powders and are more suitable for use in solutions because they are not as likely to float on the surface of a liquid.

Semisolid Dosage Forms

Semisolid agents are different in their composition from liquids or solids. They are usually intended for topical application. They may be applied to the skin, placed on mucous membranes, or used in the nasal, rectal, or vaginal cavity. These dosage forms are too thick to be considered a liquid dosage form and not solid enough to be considered a solid dosage form. Examples include ointments, creams, lotions, gels, pastes, and suppositories.

An **emulsion** is a type of semi-solid dosage form. It is a mixture of two substances that are unblendable. One substance is dispersed in the other. An **oil-in-water (O/W) emulsion** contains a small amount of oil dispersed in water. A **water-in-oil (W/O) emulsion** contains a small amount of water dispersed in oil. An emulsion, which has a different composition than the two individual liquids that are mixed together, is dispensed in containers that hold liquids.

An emulsion is a mixture of two liquids that do not blend.

Ointments

An **ointment** is applied externally to the skin or mucous membranes. An ointment is an example of a W/O emulsion because it contains a small amount of water dispersed throughout oil. Ointments can also be formulated and sterilized for use in the eye. Ointments contain medication in a glycol or oil base and can effectively cover the surface of the skin. Examples of ointments include erythromycin ophthalmic ointment and Neosporin. Ointments are generally greasier than creams or gels, and can leave an oily residue at the site of application.

An ointment is an example of a water-in-oil (W/O) emulsion.

Creams

A **cream** contains suspensions or solutions of drugs intended for external use. A cream is an example of an O/W emulsion because it contains a small amount of oil dispersed in water. Creams can be easily massaged into the skin, without leaving an oily residue. They usually have medications in a base that is part oil and part water.

Creams can also be formulated for vaginal or rectal use. Examples of creams include hydrocortisone cream, benzoyl peroxide cream, and betamethasone valerate cream.

A cream is an example of an oil-in-water (O/W) emulsion.

Lotions

A **lotion** is an O/W emulsion that is thinner than a cream because its base contains more water. Lotions penetrate into the skin and can cover large areas without leaving an oily residue. Examples of lotions include calamine lotion and hydrocortisone lotion.

A lotion is an example of an oil-in-water (O/W) emulsion that is thinner than a cream.

Gels

A **gel** contains solid medication particles, like a suspension, in a thick liquid. It can be used internally and externally. The particles in a gel are ultrafine and are linked to form a semisolid. Gels penetrate the skin without leaving a residue. Examples of gels include aluminum hydroxide gel and benzocaine gel.

Pastes

A **paste** contains more solid material and less liquid base than a solid. Pastes are like ointments, but are stiffer, less greasy, and applied more thickly. One example of a paste is zinc oxide.

Suppositories

A **suppository** is designed to be inserted rectally, vaginally, or urethrally. The suppository base is an inactive ingredient, which melts or dissolves in the body cavity, releasing the medication. Some suppositories are designed for local action, while others are used as vehicles for systemic drugs. A hydrocortisone rectal suppository is used for local relief. Suppositories are often used in children and in adults who are unable to take oral medications. Rectal suppositories bypass the stomach, which is helpful if the patient has nausea or vomiting. They are also used to treat inflammatory bowel disease or pain. Vaginal suppositories are used to treat yeast infections and vaginal atrophy. Examples of suppositories include miconazole vaginal suppositories and bisacodyl rectal suppositories.

Liquid Dosage Forms

Liquid dosage forms contain one or more active ingredients in a liquid vehicle such as a solution, suspension, or emulsion. The drug may be dissolved in the vehicle or suspended as very fine particles. They can be administered by many routes, but are often less stable than medications in solid dosage forms.

Liquid dosage forms offer several advantages:

- They allow for easier dosage adjustments, particularly for pediatric patients.
- They are easier to swallow, particularly for pediatric and geriatric patients.
- The onset of action is faster than that of solid dosage forms.
- They are easier to place down a feeding tube.

Liquid dosage forms have several disadvantages:

- Loss of potency occurs faster than with solid dosage forms.

- There is difficulty in masking bitter taste or odor.
- There is a need for preservatives because liquid doses provide an excellent medium for the growth of microorganisms.
- There is a potential for dosing inaccuracy.
- They are inconvenient.

Solutions

A **solution** is an evenly distributed (**homogenous**) mixture of one or more dissolved medications (**solutes**) in a liquid vehicle (**solvent**). Solutions can be classified by vehicle as an **aqueous solution** (water-based), an **alcoholic solution** (alcohol-based), or a **hydroalcoholic solution** (water- and alcohol-based). Solutions can be for internal and external use.

Solutions can also be classified by their contents:

- Aromatic water—**Aromatic water** is a solution of water that contains oil or other substances that are volatile. They usually have a pleasant smell.
- Elixir—An **elixir** is a clear, sweet solution that contains dissolved medication in a base of water and ethanol (hydroalcoholic).
- Syrup—**Syrup** is a sugar-based solution that may be medicated or non-medicated. Syrups mask the taste of the drug.
- Extract—An **extract** is a powder or liquid derived from animal or plant sources in which all or most of the solvent has been evaporated.
- Tincture—A **tincture** is an alcoholic or hydroalcoholic solution that contains plant extracts.



Various injectable dosage forms.

- Spirit—A **spirit** is an alcoholic or hydroalcoholic solution that contains volatile, aromatic ingredients.
- Irrigating solution—An **irrigating solution** is a solution that is used for cleansing an area of the body.

Solutions can also be classified by their method of administration as topical, systemic, epicutaneous, percutaneous, oral, otic, ophthalmic, parenteral, vaginal, or urethral.

A **parenteral solution** is a sterile solution that is administered by a needle or catheter via injection or infusion. It can be administered in an **intravenous (IV)**, **intramuscular (IM)**, **subcutaneous (SC)**, or **intra dermal (ID)** manner.

Injectable dosage forms are marketed in ampules, vials, pre-filled syringes, and pre-filled infusion bags. Most vials contain solutions up to 50mL. A vial will contain either a single dose, which is meant for withdrawal of one dose before the vial is discarded, or multi-dose, which means the vial can be pierced multiple times to retrieve multiple doses. Some vials come in powder form and will need to have diluents added before administration. The addition of a diluent to a powder vial is called

reconstitution. The vial will give information as to how much and which diluent is needed to obtain a specific concentration. Pre-filled syringes or infusion bags have the medication in ready-to-administer form.

Dispersions

Some drugs do not dissolve in the solvents that are used to prepare liquid dosage forms. In a **dispersion**, the medication is not dissolved, but distributed throughout the vehicle. A **suspension** is a mixture of undissolved, very fine, solid particles distributed through a gas, liquid, or solid. Most suspensions contain medications distributed in water; this type of suspension is called an **aqueous suspension**. Suspensions are used for drugs that are not able to dissolve readily into a solution. Suspensions need to be shaken prior to use and should contain a “shake well” auxiliary label. The pharmacy tech must shake a suspension prior to pouring an amount from a stock bottle into a bottle for dispensing.

Injectable suspensions allow for insoluble drugs to be administered intramuscularly or subcutaneously. They are often used for **depot** therapy, where the drug is released over a long period of time.

Suspensions have the following characteristics:

- The suspended material should be evenly distributed when the container is shaken.
- It should pour freely from the bottle or pass easily through a syringe or needle.
- When used externally, it should dry quickly and spread easily over the affected area.

As mentioned, an emulsion is a mixture of two liquids that are immiscible (do not blend). It is a dispersion, with one liquid being dispersed in the other. They vary in their viscosity from liquids such as lotions to semisolid dosage forms such as ointments and creams. In an emulsion, one liquid is broken into small particles and evenly scattered throughout the other liquid. The liquid that is in small particles is called the internal phase, and the other liquid is called the external phase. The two liquids will separate into two phases unless an **emulsifying agent**, an ingredient used to bind together substances that normally do not mix, is used. An emulsifying agent is a chemical that has water-loving and lipid-loving properties that can keep oil and water together.

Enemas

Enemas are used to deliver medication, rectally, a way that bypasses the stomach. Enemas are manufactured in a water base and can also be used to evacuate the lower intestine to prepare for surgeries or examinations involving the intestine.



Enemas can be used to evacuate the lower intestine.

An enema can be used to deliver medication to bypass the stomach.



Nitroglycerin is available in a transdermal patch formulation.

Inhalation Dosage Forms

Some patient populations, such as asthmatic patients, need to have their medications delivered to a specific site in the body, such as the bronchial tree. Gases, vapors, aerosols, powders, sprays, solutions, and suspensions intended to be inhaled via the nose or mouth are known as inhalations, after the term **inhalation**, or the acts of inhaling or breathing in. The medication particles must be extremely fine to reach these areas effectively. Devices that enable the medication to reach the lungs easily include vaporizers, humidifiers, and nebulizers.

An **aerosol** is a spray that contains very fine liquid or solid drug particles in a gas propellant that is packaged under pressure. An aerosol dosage form consists of the medication, the container, and the propellant. Pressurized

aerosol containers should be stored away from heat. The medication may be released as a spray, foam, or solid, depending on the formulation of the product and on the design of the valve. Aerosols have a rapid onset of action because the drug bypasses the gastrointestinal tract.

A **spray** consists of a container that has a valve assembly unit that contains various bases, such as alcohol or water, in a pump-type dispenser. When activated, it emits a fine dispersion of liquid, solid, or gaseous material.

Transdermal Dosage Forms

A **transdermal patch** dosage form is designed to hold a specific amount of medication to be released into the skin and absorbed into the bloodstream over time via a patch or disk. The patch consists of a backing, drug reservoir, control membrane, and adhesive layer. The backing is removed and the adhesive layer is applied to the skin. The drug is slowly absorbed across the membranes of the skin and into the skin where optimal absorption into the bloodstream will occur. Patches are convenient because they can be applied easily and minimize stomach upset. They can also improve compliance because they eliminate the need for more frequent dosing that is often associated with oral dosage forms. Drugs such as nitroglycerin, fentanyl, scopolamine, and nicotine are administered in this manner for their systemic effects.

Not all medications designed to be administered transdermally are in the form of patches. Some gels are also formulated to be administered transdermally. These gels are also designed to hold a specific amount of medication to be absorbed into the skin and bloodstream over time. The drug is slowly absorbed across the membranes of the skin and into the skin, where optimal absorption in the bloodstream will occur.

Routes of Administration

Medications can be administered by many different routes. A **route of administration** is the way to get a drug into or onto the body. Sometimes, combinations of routes are used at the same time. The age and condition of the patient often determines the route of administration. The oral route is the most common route of administration. Following is a list of routes of administration:

- Buccal—Administered inside the mouth on the mucosa of the cheek
- Dental—Application to teeth or gums
- Epidural—Injection on or outside the dura mater of the spinal cord
- External—Applied externally to the skin or hair
- Implant—Placing a drug form, drug-delivery device, or other device at the desired administration site by insertion in a body tissue or body cavity by surgical or other appropriate insertion procedures
- In vitro—Occurs within the laboratory or controlled experimental environment rather than in the body
- Inhalation—Drug administration into the lungs (either during a drawn or forced breath)
- Injection—A set of one or more injectable routes or the route of injection is not specified
- Intra-arterial—Injection into an artery or intra-arterial port
- Intra-articular—Injection into a joint
- Intracavernosal—Injection into the corpora cavernosa
- Intradermal—Injection within the epidermis (skin)
- Intramuscular—Injection into a muscle group
- Intraocular—Injection, implantation, or surgical irrigation within the eyeball
- Intraperitoneal—Administration into the intraperitoneal cavity, commonly by injection or instillation into an intraperitoneal catheter port
- Intrapleural—Injection into the pleura or pleural cavity
- Intrathecal—Injection into a subarachnoid or subdural space
- Intrauterine—Administered into the uterus
- Intravenous—Injection directly into a vein or into a venous line port
- Intravesical—Administered into the bladder
- Irrigation—To flush a body cavity or site with a stream of liquid
- Mouth/Throat—Applied to a mucus membrane of the oral cavity or throat
- Nasal—Administered via the nose
- Ophthalmic—Administered onto the surface of the eyeball or into the conjunctival sac
- Oral—Taken by mouth
- Otic—Commonly administered into the external ear canal
- Perfusion—Administration (pumping) of a fluid through an organ or tissue
- Rectal—Administered into the rectum (in the anal canal beyond the anal sphincter)
- Subcutaneous—Injection through the skin into the loose subcutaneous tissue under the skin
- Sublingual—Administered under the tongue
- Transdermal—Applied topically (e.g., a patch or ointment), with absorption through the skin for local or systemic effect
- Translingual—Drug absorption through the tongue into systemic circulation after application on the tongue
- Urethral—Administered via insertion or instillation into the urethra
- Vaginal—Administered into the vagina

Peroral

The **peroral (PO)** route is commonly referred to as the oral route. It means that the drug is administered orally through the mouth and swallowed to reach the stomach. It must then undergo dissolution in the stomach, absorption in either the stomach or small intestine, activation in the liver, and distribution to the tissue before it exerts its therapeutic effect.

Advantages of the oral route are that it is safe and convenient and easy to tolerate. In addition, the medications are usually less expensive, and are available in extended-release forms. A patient can take one or more tablets or, if the tablet is scored, a portion of the tablet. Sustained-release and extended-release tablets provide a longer duration of action and, in some cases, fewer side effects. Liquid solutions and suspensions are useful in those patients who have difficulty swallowing. They also work more quickly than tablets and capsules because they are already in liquid form and ready to be absorbed.

Disadvantages include a time delay between administration of the drug and the onset of action, the possible interference of food and other drugs with absorption of the drug, and the possible degradation of the drug by gastrointestinal fluids. Side effects that occur with sustained-release medications also take longer to subside. Liquid formulations sometimes have an unpleasant taste, which may make compliance more difficult. Patients who are experiencing nausea or vomiting or who are sedated or otherwise unable to swallow should not take medications via the oral route.

Sublingual (under the tongue) and **buccal** (between the cheek and gum) routes of administration are used when a rapid onset of action is needed. The medication is absorbed directly by the blood vessels under the tongue or in the lining of the mouth. When taking the medication sublingually, the patient should hold the tablet under the tongue until the medication dissolves **FIGURE 4.2**. Nitroglycerin is the most commonly used sublingual tablet. Drugs administered sublingually have a rapid onset of action because they enter the bloodstream directly. When taking the medication buccally, the patient should place the tablet between the gums and cheek and hold the tablet there until it dissolves.

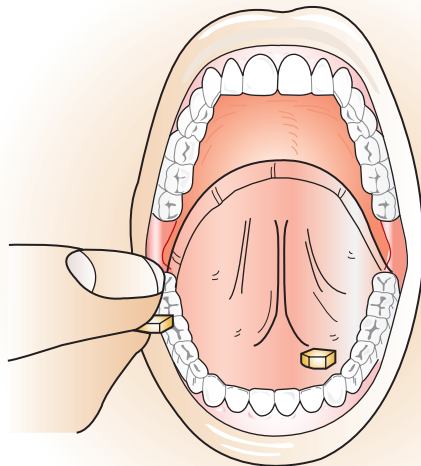


FIGURE 4.2 The correct way to take a medication that is administered sublingually.

Following Directions with Oral Medications

Patients should receive verbal and written instructions from the pharmacist about what foods and behaviors to avoid while taking their medication. Auxiliary labels added to the medication container can help ensure that the drug is taken correctly.

Dispensing Oral Medications

Dispensing measuring spoons, oral syringes, droppers, and cups with the liquid medication can help ensure that the patient or caregiver measures the dose correctly. Many directions, both on prescription and over-the-counter products, include use of teaspoonful or table-spoonful, but most household utensils are often inaccurate. Many over-the-counter liquid preparations come with a measuring cup for ease of administration. Most pharmacies will provide measuring spoons or cups, syringes, or droppers with the medication.

An oral syringe is often used to deliver a precise amount of liquid medication to children. It is a calibrated syringe that has a plunger and barrel, which is used to slowly administer liquid medication to infants and small children or to patients who have difficulty opening their mouth.

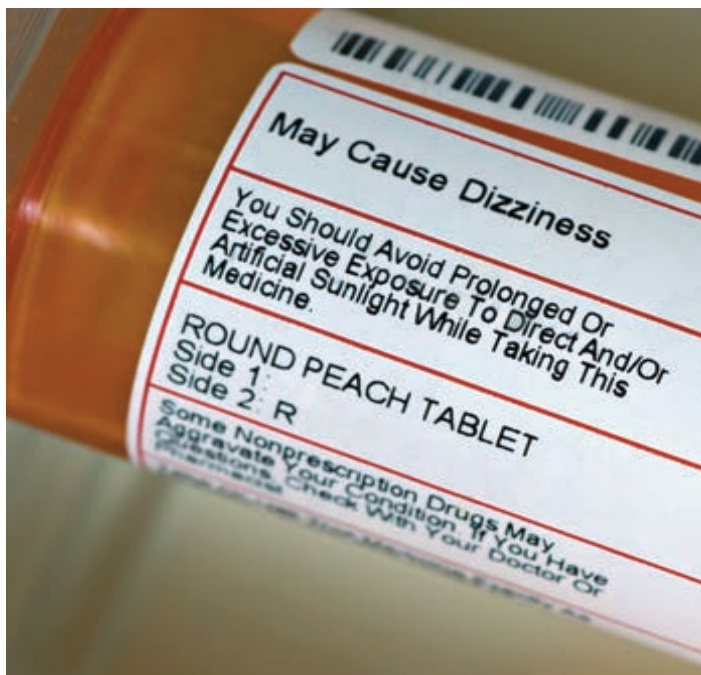
Droppers can be used to deliver a small amount of medication to an infant. It consists of a small squeezable bulb and a hollow tube with a narrow point. The size of the drop can vary from one medication to another, depending on the thickness or viscosity of the medication.

Some solutions and suspensions have specific storage requirements and limited dates of expiration. Some antibiotics must be refrigerated after reconstitution and are only good for 7 to 14 days. Suspensions must be shaken before administration to ensure that the medication is uniformly distributed into solution.

Suspensions must have an auxiliary label, "Shake Well," to ensure that the medication is shaken before administration.

Parenteral

The parenteral route of administration bypasses the gastrointestinal tract. Drugs that are administered by this route can be given over a short (seconds to minutes) or extended (days) period of time. This route of administration distributes the drug systemically throughout the body to exert a systemic effect. Parenteral administration may be necessary when drugs are inactivated in the stomach or undergo significant first-pass metabolism, so swallowing them



Auxiliary labels provide important information to help the patient take the drug correctly.



Use of dosing aids can promote more accurate dosing for infants and young children who need to take liquid medications.



Some drugs can be administered intramuscularly.

would be ineffective. The majority of drugs for parenteral administration are formulated as solutions, but they may also be emulsions or suspensions. Drugs that are administered by this route are given via injection and must be sterile and free from particles. Drugs that are administered by this route are administered into the vein (IV), subcutaneously (SC), intradermally (ID) or intramuscularly (IM). When a drug is given all at once or over a short period of time, it is called a **bolus dose** and is administered by IV push via a syringe or needle. If it is infused into a vein over hours or days, it is called a constant infusion.

Advantages of this route include that it can be used in patients who cannot take medications orally, it has a faster onset of action, and

it can be used for drugs that are unstable in the acidic environment of the stomach. The IV route is the fastest route of drug administration.

Disadvantages of this route include pain at the injection site, risk of infection, and the drugs are usually more expensive. Another disadvantage is that, because injectable drugs exert their action quickly, there is little or no time to alter its availability if the wrong dose is given or an adverse reaction occurs. IV injections must be free from air bubbles and particulate matter to prevent an embolism or blockage. Absorption of the drug by the IM or SC route is not as predictable as the IV route, but drugs administered via this route may have a longer duration of action because they can be given as depot formulations, and thus are not metabolized quickly.

When a drug is administered by injection into a muscle, it is called intramuscular (IM). The most common sites for intramuscular injection are the upper arm, the thigh, or the buttock. The advantages of IM injection include a more rapid onset of action than oral dosage forms. The disadvantages of this route of administration include that it is difficult to reverse, it may cause pain or bruising, absorption may be incomplete, and only a small volume of drug can be injected. It should also be used cautiously in patients with decreased muscle mass.

When a drug is administered below the skin, it is called subcutaneous (SC, SQ, or subQ). Drugs that are administered by this route are absorbed more slowly than by IV or IM routes. The main advantage of this route is that patients can be taught to self-administer their medication.

Disadvantages include only a limited volume of drug can be injected and it should also be used cautiously in patients with bleeding disorders or those who are receiving anticoagulants.

Drugs that are available in injectable formulations and given parenterally can be administered intravenously, subcutaneously, or intramuscularly.

Using Injectable Medications

Most parenteral preparations are prepared in a sterile-water, normal saline, or other sterile solution. Only trained healthcare professionals or patients who have been taught how to administer injectable medications should give injections.

A **syringe** is a calibrated medical instrument that is used to accurately draw up, measure, or deliver medication to a patient. The two types of syringes that are com-

monly used for injections are glass syringes and plastic syringes. Glass syringes are expensive and must be sterilized prior to use. Plastic syringes are easier to use because they are disposable and do not need to be sterilized prior to use. Syringe barrels can vary in size, depending upon the volume of medication needed. A needle is attached to the syringe to facilitate delivery of medication to the patient or to pierce the core of a vial to draw up the medication.

All drugs administered IV, SC, or IM must be sterile.

Intravenous Injections or Infusions

A medication can be given via an intravenous injection or as an **infusion**. It can be used to deliver antibiotics, IV fluids, pain medications, or nutritional supplements. These medications are usually administered into the vein of the arm.

Intramuscular Injections

Intramuscular injections (IM) can be used to deliver a small volume of medication (2 to 3mL). It can be used to deliver antibiotics, pain medications, vitamins, iron, and some vaccines. IM injections are usually injected into the upper, outer portion of the buttock. In children, it can also be given in the deltoid muscles of the shoulder. IM injections are administered at a 90-degree angle with a 22 to 25 gauge, 1/2- to 1-inch needle **FIGURE 4.3**.

Subcutaneous Injections

Subcutaneous injections (SC) can be used to deliver a small volume of medication (less than 1mL) into the subcutaneous tissue. SC injections are usually injected on the outside of the upper arm, the top of the thigh, or the



Syringes come in a variety of sizes. The syringe that should be used will depend on the volume of medication needed.

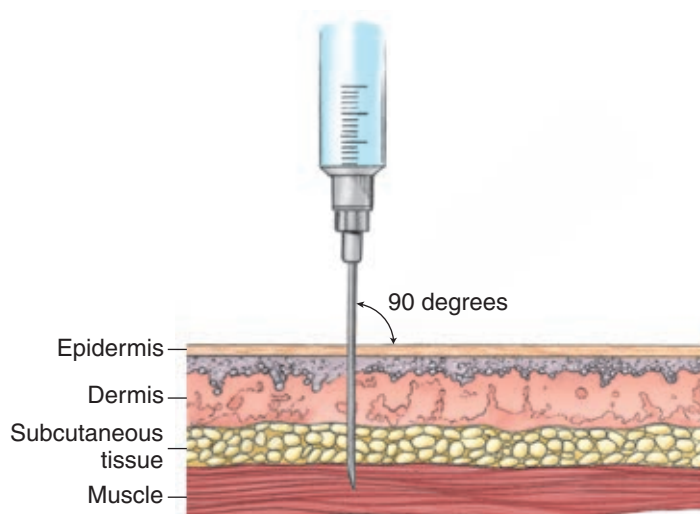


FIGURE 4.3 The correct way to administer an IM injection.

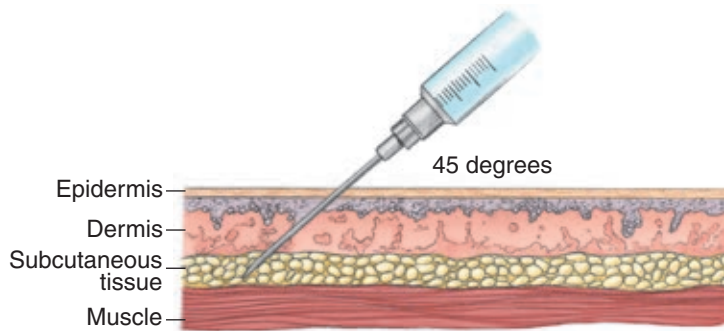


FIGURE 4.4 The correct way to administer an SC injection.

lower part of the abdomen. SC injections are administered at a 45 degree angle with a 25 to 26 gauge needle (with diabetic needle gauges now available up to 31 gauge) and a $\frac{3}{8}$ - to $\frac{5}{8}$ -inch needle **FIGURE 4.4**. In lean or obese patients, the injections should be administered closer to a 90-degree angle.

Topical

Topical route of administration refers to the application of a drug to the surface of the skin or mucous membranes. Drug forms administered this way include creams, ointments, gels, lotions, sprays, powders, aerosols, and transdermal formulations. The effects of topical preparations range from systemic (affecting the entire body) to localized (affecting a small area). The skin has many openings, including sweat glands, hair follicles, and pores through which drugs can pass through the skin. Topical agents can be used to fight skin infections, reduce inflammation, and protect the skin.

Advantages of topical agents include ease of application, fewer adverse effects than the same drug administered orally, and rapidity of action at the site of application. Most drugs that are applied topically are not well absorbed systemically, thereby reducing the incidence of side effects. Creams and gels are more cosmetically appealing and less greasy than ointments. Lotions can be applied easily and are easiest to use on hairy parts of the body. Transdermal formulations are convenient to use, and patient compliance is improved.

Topical drugs may cause skin irritation. Many topical agents are not adequately absorbed transdermally and therefore cannot be given topically. Ointments are generally sticky and leave an oily residue, but have a longer duration of action because of their prolonged contact time with the skin.

Medications can be administered via the **ophthalmic** route by instilling one drop or drops of medication into the conjunctival sac of the eye. All ophthalmic preparations must be sterile and are available in cream, ointment, or liquid formulations. Most ophthalmic medications are



A patient receives medication intravenously.

used to treat eye infections, inflammation, or conditions such as glaucoma. Drugs can also be administered via the **otic** route by instilling one drop or drops of medication into the ear. Medications used to treat ear conditions do not need to be sterile because they do not typically penetrate a sterile environment. They can be used to treat an ear infection, remove earwax buildup or reduce pain. If the patient has a tube in the ear, a suspension should be used instead of a solution. Most medications administered via this route are solutions and suspensions. Ophthalmic medications can be used to treat ear conditions, but otic medications cannot be used in the eye.

Medications can also be administered via the **nasal** route by instilling one or more drops of medication or one or more sprays into the nasal passages. Most nasal sprays are used to treat symptoms of colds and allergies.

Medications administered by the **rectal** route, through the anus and into the rectum, are commonly in the form of a suppository or an enema. They can be used if a person is vomiting and cannot take the medication orally or if the person is unconscious and needs medication. Rectal administration is preferred for drugs that are destroyed by stomach contents or that are metabolized too quickly by the liver. Ointments and creams are available for use rectally to treat inflammation. Drugs administered by this route may provide a local or systemic effect. The disadvantage of this route is that most people don't feel comfortable using this route of administration. The amount of drug absorbed rectally is also unpredictable and varies from one person to another depending on the retention time of the suppository.

Medications administered by the **vaginal** or **urethral** route come in suppositories, creams, ointments, foams, gels, and **rings**, which are vaginal dosage forms used to administer hormones for birth control or hormone-replacement therapy. An etonogestrel/ethinyl estradiol vaginal ring (Nuvaring) is considered birth control, while the estradiol acetate vaginal ring (Femring) is considered hormone-replacement therapy. Drugs must be inserted into the vagina or urethra to exert either a local or systemic effect. When used for a local effect, the drug provides a higher concentration of medication at the site and minimizes side effects seen when the drug is absorbed systemically. They can be used to treat infection, to treat inflammation, or for local or systemic birth control. These medications are sometimes difficult to use and can be uncomfortable.

Proper application or use of topical medications can ensure that the desired therapeutic effect is achieved. Improper technique or use can increase the risk of systemic absorption and side effects.

Ointments, Creams, Lotions, Gels

Some topical preparations have special instructions for use. In order to use them safely, patients should receive proper instructions on how to use them. For example, capsaicin cream, available over the counter, should be applied with gloves because the active ingredient can cause burning and irritation if accidentally rubbed near the eyes. Some drugs such as topical corticosteroids should be applied sparingly because using a thick layer can increase systemic absorption and increase the incidence of adverse effects.

Transdermal Patches

Patches can be applied to the arm, chest, back and behind the ear, usually in a hair-free area. The site of application should be rotated to minimize skin reactions. The duration of action for each transdermal formulation varies from one drug to another. Some patches should be changed daily, while others are changed every three to seven days. Some patches, such as nitroglycerin patches, exert their effect for 24 hours when worn for only 12 hours. Doctors recommend removing the patch at bedtime to

minimize the development of tolerance. Localized heat from sun exposure, heating pads, electric blankets, hot tubs, and hot lamps should be avoided when using some transdermal formulations because it can increase absorption of the active drug into the bloodstream, resulting in an increase in adverse effects or toxicity.

The duration of therapeutic effect of a transdermal formulation varies from one drug to another.

Ophthalmic Medications

Proper instillation of an ophthalmic preparation is necessary to avoid contamination of the eye. Ophthalmic medications must be at room or body temperature before instillation into the eye. Follow the manufacturer's recommendations for storage of ophthalmic preparations to ensure drug stability and minimize bacterial overgrowth.

Proper hand-washing techniques should be followed to prevent contamination of the application site or the medication container. The tip of the medication container should not touch the eye; this will help minimize contamination of the medication.

To instill a drop into the eye, the patient's head should be tilted back **FIGURE 4.5A**. A finger should be placed in the corner of the eye to prevent loss of the medication through the tear duct. Only one drop of medication should be administered at a time, and the eye should be kept closed for one to two minutes after application. If instilling more than one medication, wait at least five to 10 minutes between administrations of different drugs. If a solution or suspension and ointment are to be administered at the same time, administer the solution or suspension first and then wait five to 10 minutes before applying the ointment. To apply an ointment into the eye, the lower eyelid should be pulled down with one or two fingers to create a pouch **FIGURE 4.5B**. Only one thin layer of medication should be applied in the pouch at a time, and the



FIGURE 4.5 The correct way to administer an ophthalmic medication. A. Drops. B. Ointment.

eye should be kept closed for 30 seconds after application to let the ointment absorb.

Otic Medications

Otic preparations must be at room or body temperature before instillation into the ear.

Otics that are too hot could rupture the eardrum; those that are too cold can cause discomfort or pain.

To instill a drop into the ear, the patient's head should be tilted to the side so that the ear faces up. Patients who are under three years old should have their earlobes pulled back and down and those older than three should have their earlobes pulled back and up. After instillation, the patient should remain in this position for five minutes.

Inhaled Medications

Medications can also be administered via inhalation. This route delivers the medication from the mouth to the respiratory system. There are two types of inhalers: those that use a propellant to push the drug into the lungs (metered-dose inhaler) and those that use a dry powder to release the medication as the patient takes a deep, quick breath. The type of inhaler needed depends on the medication and the level of convenience required. Advantages of inhalants include convenience and portability. The onset of action is usually quick, but when used incorrectly, the medication will not be able to reach the lungs.

Proper administration of inhaled medications is necessary to ensure that the medication reaches the lungs. Some medications require that patients rinse their mouths thoroughly after each dose, not only to remove the aftertaste, but more importantly, to avoid developing an oral fungal infection. Spacer devices can ensure that a higher concentration of medication is inhaled and help improve drug delivery to the lungs.

Here is the proper technique for using a metered-dose inhaler:

1. Take off the cap and shake the container.
2. Breathe out all the way.
3. Hold the inhaler 1 to 2 inches in front of mouth.
4. Breathe in slowly through your mouth and press down on the inhaler. Breathe in as deeply as you can.
5. Hold your breath and count to 10.
6. Repeat if more than one puff is required.

Vaginal Medications

The vaginal route is used to treat bacterial or fungal infections or to provide hormone-replacement therapy. Some vaginal creams or ointments require the use of an applicator tube. This route is also used for some forms of contraception.

Here is the proper technique for the administration of vaginal medications:

1. Empty the bladder.
2. Wash the vaginal area and dry thoroughly.
3. Wash hands thoroughly.

An otic preparation should never be used in the eye, but an ophthalmic preparation can be used in the ear.



A metered-dose inhaler delivers a specific amount of medicine in aerosol form.

4. Attach the applicator to the opening of the tube and squeeze the medication into the applicator until it reaches the recommended dose.
5. Lie down, spread your legs, and open the labia with your free hand. (You can also stand with your feet apart and knees bent.)
6. Gently insert the applicator about 2 inches into the vagina and release the labia.
7. Push the plunger of the applicator until it stops.
8. Remove the applicator from the vagina and wash hands.
9. If the applicator is reusable, wash and dry the applicator.

Rectal Medications

Rectal medications are administered for a localized effect on the rectum or for a systemic effect when a patient is vomiting, unable to swallow, or unconscious. Rectal medicine is most commonly used as a localized treatment for constipation or as a topical treatment for rectal inflammation or **infection**.

Here is the proper technique for the administration of rectal suppositories:

1. Wash hands thoroughly.
2. If the suppository is soft, place in cold water to harden it before removing it from the wrapper.
3. Remove the suppository from the foil wrapper.
4. Lubricate the suppository with Vaseline or K-Y Jelly.
5. Lie on your side with the lower leg straightened out and the upper leg bent in toward the stomach.
6. Lift the upper buttock to expose the rectum.
7. Insert the pointed end of the suppository into the rectum.
8. Hold the buttocks together for a few seconds.
9. Remain lying down for 15 minutes.
10. Wash hands thoroughly.

Factors That Influence Drug Action

Many factors can influence the effect that a drug has on the body. For example, age, gender, and the presence of disease can affect the metabolism and elimination of a drug in the body. Children and the elderly often require a reduced dose because of their reduced weight or because of the inability of the liver to metabolize the medication adequately.

Patients with concomitant diseases are often unable to absorb, metabolize, or eliminate certain medications. Diseases that alter the normal gastrointestinal flora or change the environment of the stomach may also adversely affect the metabolism of drugs. In addition, impaired liver or kidney function may affect the metabolism and elimination of some drugs. Finally, nutritional status can affect the metabolism of some drugs. Before a medication is prescribed, the patient should have a medical evaluation.

Psychological and genetic factors can also influence the way a drug is metabolized in the body or eliminated from the body. Genes can control the release of chemicals and enhance or decrease the metabolism of certain drugs. Psychological factors can influence the body's ability to release certain chemicals necessary for the metabolism of certain drugs, or may interfere with the body's ability to absorb a drug.

Elderly Patients

Aging affects both the physiological processes in the body as well as the pharmacokinetic and pharmacodynamic processes that drugs undergo in the body. Elderly patients also tend to take more medications because they tend to have multiple chronic diseases. This can also increase the risk of drug-drug interactions and adverse side effects.

Changes in Physiology

Physiological changes that occur in the body do not occur at the same rate for each individual. The normal changes that occur in physiologic function with age are not related to disease. It is often difficult to predict when these changes will occur. Changes that occur as a result of aging can affect the metabolism and elimination of some drugs. Following is a list of some of the changes that can occur with age:

- Optic changes—Visual changes can occur and acuity can be compromised as the lenses of the eye become less elastic and more dense. Macular degeneration and cataracts can also occur in the elderly.
- Auditory changes—Hearing loss, especially in higher frequencies, can occur. Impairment of perception is common, which also results in a delay in the processing of auditory stimulation.
- Gastrointestinal changes—Decreases in esophageal motility, rate of gastric emptying, and saliva production are common complaints in the elderly.
- Pulmonary changes—Reduced oxygen in the blood, increased carbon dioxide in the blood, and a decrease in maximum intake and exhalation can occur as a result of increased rigidity of the chest wall. Complicating matters is the fact that many elderly patients have diseases such as chronic obstructive pulmonary disease (COPD) and cardiac disease.
- Cardiovascular changes—Elderly patients with cardiovascular disease have limited ability to meet the demand for increased oxygen to maintain cardiac output.
- Urinary changes—Instability of the bladder muscle, overflow, and sphincter weakness can result in **incontinence** (inability to hold urine in the bladder) or leakage. Elderly patients also have a higher incidence of renal insufficiency.
- Hormonal changes—Changes in hormone levels are a normal part of the aging process.
- Body changes—The amount of lean body mass and total body mass decreases with age, while the proportion of fat increases. The production of albumin, a blood plasma protein, also decreases with age. This can affect the amount of drug that is bound to plasma protein and the amount of free drug available to exert a therapeutic effect.

Response to Medication

Changes in the body can alter the response to medication. These physiological changes that occur as a result of aging can also affect the absorption, distribution, metabolism and elimination of some drugs.

- Absorption—Decreases in GI fluid secretion and motility can delay the absorption of some drugs. Absorption of some drugs can also be delayed by a reduction in the rate of gastric emptying. Changes in the gastrointestinal flora and environment of the stomach can also affect the dissolution and degradation of certain drugs.

- **Distribution**—The amount of free drug that is available can be altered by changes in body composition. In the elderly, a drug that is highly protein-bound can be toxic even when administered at normal doses because the amount of albumin decreases with age.
- **Metabolism**—Blood flow decreases by about 1% a year, beginning at age 35. This decline results in a decrease in clearance of the drug, allowing the drugs to accumulate to potentially toxic levels.
- **Elimination**—Most elderly patients have some degree of renal or hepatic dysfunction. The reduced filtration rate and reduction in blood flow and tubular secretions that result with aging can also affect the amount of drug that can be eliminated by the kidney.



Tools such as a pillbox can help patients who take multiple medications remember when to take them.

Elderly patients tend to have multiple, chronic diseases that require long-term treatment with multiple medications. As a result, they are more likely to experience multiple adverse drug reactions. The term used to describe concurrent use of multiple medications is **polypharmacy**. When many drugs are prescribed for a patient, the potential for drug interactions is also high. The majority of adverse drug reactions in the elderly are the result of three drugs: warfarin, insulin, and digoxin.

The Beers list was initially created to help clinicians determine which medications should be avoided in nursing-home patients because seniors in nursing homes are particularly at risk for suffering medication-related problems.

It was written by Dr. Mark Beers, a physician specializing in medical issues pertaining to the elderly. It is now useful for elderly patients in other settings. This list is periodically updated.



The Beers list is a list of medications that should be avoided or used cautiously in the elderly.

Aging can also affect the memory. The inability to adequately understand or remember directions for medication administration can lead to unintentional underdosing or overdosing, failure to take the drug, or taking a drug prescribed for another person. **Noncompliance** or failure to adhere to the prescribed

drug regimen is especially common in the elderly. The pharmacy technician can play an important role in ensuring that elderly patients get written information and dosing aids that can help them remember to take their medication.

Noncompliance is the failure to adhere to the prescribed drug regimen.

Children

As children grow, their bodies undergo physiologic changes that can affect the absorption, distribution, metabolism, and elimination of a drug. Understanding these changes can help eliminate underdosing or overdosing that can occur in this patient population.

Body-surface area is the best measure to use to determine a dose because it correlates with all body parameters. Age is often used to determine the dose of a medication,

but it does not take into account the weight of a child or the variation in the relationship between age and the degree of physiologic development. Body weight is most often used because it is easy to obtain. Children who are small for their age should receive doses at the lower end of the recommended dosage range, and those who are large for their age should receive doses at the higher end of the recommended dosage range. Larger children may also need a dose that is recommended for the next-higher age bracket.

Always double-check all calculations, make sure the dose is appropriate for the child's age, and reevaluate all dosages.



Tech Math Practice

Question: Calculate the quantity to dispense for the following:

Sig: one tablet tid for 30 days.

Answer: The abbreviation tid means three times a day.

$3 \text{ tablets/day} \times 30 \text{ days} = 90 \text{ tablets.}$

Question: Calculate the quantity to dispense for the following:

Dispense a 10-day supply.

Sig: 3 cap bid.

Answer: The abbreviation bid means twice a day.

$3 \text{ capsules/dose} \times 2 \text{ doses/day} = 6 \text{ capsules/day.}$

$6 \text{ capsules/day} \times 10 \text{ days} = 60 \text{ capsules.}$

Question: Calculate the quantity to dispense for the following:

Dispense a 30-day supply.

Sig: $1\frac{1}{2}$ tab bid.

Answer: The abbreviation bid means twice a day.

$1\frac{1}{2} \text{ tablets/dose} \times 2 \text{ doses/day} = 3 \text{ tablets/day.}$

$3 \text{ tablets/day} \times 30 \text{ days} = 90 \text{ tablets.}$

Question: Calculate the quantity to dispense for the following:

Dispense a 15-day supply.

Sig: $\frac{1}{2}$ tab bid po.

Answer: The abbreviation bid means twice a day.

$\frac{1}{2} \text{ tab/dose} \times 2 \text{ doses/day} = 1 \text{ tab/day.}$

$1 \text{ tab/day} \times 15 \text{ days} = 15 \text{ tablets.}$

Question: Calculate the quantity to dispense for the following:

Dispense a 30-day supply.

Sig: $1\frac{1}{2}$ tab qid po.

Answer: The abbreviation qid means four times a day.

$1\frac{1}{2} \text{ tablets/dose} \times 4 \text{ doses/day} = 6 \text{ tablets/day.}$

$6 \text{ tablets/day} \times 30 \text{ days} = 180 \text{ tablets.}$

Question: A prescription for an ophthalmic solution reads “Instill one drop in affected eye twice a day” and instructs the pharmacy to dispense a 10-day supply. The medication is available as 20gtts/mL in a 1mL and 5mL bottle. Which bottle size should be dispensed?

Answer: $1 \text{ drop/dose} \times 2 \text{ doses/day} = 2 \text{ drops/day}$.

$2 \text{ drops/day} \times 10 \text{ days} = 20 \text{ drops}$.

$20 \text{ drops} \div 20\text{gtts/mL} = 1\text{mL}$.

The 1mL size bottle should be dispensed.

WRAP UP

Chapter Summary

- A prescription is a written or verbal request for a medication.
- The “rights” for correct drug administration offer useful guidelines when filling prescriptions.
- Drugs can be administered in a variety of dosage forms. The choice of dosage form will depend on the patient, the desired effect, the dose required, the duration of desired effect, and the properties of the medication.
- Solid dosage forms include tablets, capsules, and caplets. They can be coated to mask the taste, prolong the duration of action, or to protect the medication from degradation in the stomach.
- Liquid dosage forms include suspensions, solutions, and emulsions. They have a faster onset of action than solid dosage forms.
- Topical dosage forms include creams, gels, ointments, and transdermal patches.
- Routes of administration include oral, topical and parenteral. The decision of which route to use will depend on the site, medication, desired effect, and duration of action.
- Topical administration includes the ophthalmic, inhalation, nasal, vaginal, urethral, and rectal routes of administration.
- Parenteral administration includes IV, IM, and SC routes of administration.
- Elderly and pediatric patients have special needs that can affect the way their medication should be administered and the way their bodies react to drugs.

Learning Assessment Questions

1. Parenteral medications are often used for which of the following reasons?
 - A. They have a faster onset of action.
 - B. They bypass the acidic secretions of the stomach.
 - C. The patient cannot take medication by mouth.
 - D. All of the above.
2. Administration of a medication between the cheek and gum is called which of the following?
 - A. Buccal
 - B. Sublingual
 - C. Topical
 - D. Intramuscular
3. An ointment is an example of which of the following?
 - A. W/O emulsion
 - B. O/W emulsion
 - C. Dispersion
 - D. Elixir
4. Which of the following routes of administration has the fastest onset of action?
 - A. Oral
 - B. Intravenous
 - C. Transdermal
 - D. Sublingual
5. To what does the abbreviation PO refer?
 - A. By mouth or orally
 - B. Rectally
 - C. Intradermally
 - D. Subcutaneously
6. The parenteral route of administration bypasses which of the following?
 - A. Veins
 - B. Gastrointestinal tract
 - C. Heart
 - D. All of the above
7. Lozenges are also known as which of the following?
 - A. Capsules
 - B. Pastilles
 - C. Suppositories
 - D. All of the above

8. Drugs administered into the eye are given by what route?
- A. Otic
 - B. Rectal
 - C. Ophthalmic
 - D. Oral
9. Which of the following is not a solid dosage form?
- A. Emulsion
 - B. Tablet
 - C. Capsule
 - D. Powder
10. Medication dosage forms include which of the following?
- A. Liquids
 - B. Solids
 - C. Semisolids
 - D. All of the above
11. The rectal route of administration is useful if the patient is which of the following?
- A. Unconscious
 - B. Vomiting
 - C. Nauseated
 - D. All of the above
12. Where are intramuscular injections given?
- A. Under the skin
 - B. In the muscle
 - C. In the vein
 - D. In the artery
13. Extended-release tablets should not be which of the following?
- A. Crushed
 - B. Cut without specific directions from the manufacturer for cutting along a scored tablet
 - C. Chewed
 - D. All of the above
14. Injection of a drug into the subcutaneous layer of fat is known as what route of administration?
- A. IM
 - B. SC
 - C. IV
 - D. ID
15. A prescription label must have which of the following?
- A. The patient's name
 - B. The name of the drug
 - C. The name and address of the pharmacy
 - D. All of the above
16. Which of the following drugs causes the most ADRs in the elderly?
- A. Warfarin
 - B. Heparin
 - C. Nitroglycerin
 - D. Aspirin
17. If the prescriber directs usage, a drug prepared for the ophthalmic route may also be used where ?
- A. In the ear
 - B. In the nose
 - C. In the rectum
 - D. In the vagina
18. Drugs administered into the ear are given by what route?
- A. Rectally
 - B. Ophthalmic
 - C. Otic
 - D. Buccal
19. Advantages of transdermal patches include which of the following?
- A. Convenience
 - B. Improved patient compliance
 - C. Ease of administration
 - D. All of the above
20. The abbreviation TID means which of the following?
- A. Three times daily
 - B. Twice a day
 - C. Four times a day
 - D. Immediately