Chapter 11

Principles of Pharmacology

Unit Summary

After students complete this chapter and the related course work, they will understand the significance and characteristics of general pharmacology and will be able to identify, describe, and demonstrate the steps for assisting/administering medications carried by the EMT.

National EMS Education Standard Competencies

Pharmacology

Applies fundamental knowledge of the medications that the EMT may assist/administer to a patient during an emergency.

Principles of Pharmacology

• Medication safety (pp 461–463)

• Kinds of medications used during an emergency (pp 464–475)

Medication Administration

• Self-administer medication (pp 463–464)

• Peer-administer medication (pp 463–464)

• Assist/administer medications to a patient (pp 463–464)

Emergency Medications

• Names (p 456)

• Effects (pp 455–456)

• Actions (p 455)

• Indications (p 456)

• Contraindications (p 456)

• Complications (p 456)

• Routes of administration (pp 456–458)

• Side effects (p 456)

• Interactions (p 465–466, 475–476)

• Dosages for the medications administered (pp 455, 462, 465–466)

Knowledge Objectives

1. Define the terms pharmacodynamics, intended effects, indications, side effects, unintended effects, and untoward effects. (pp 455–456)

2. Explain medication contraindications; include an example. (p 456)

3. Explain the differences between a generic medication name and a trade medication name; provide an example of each. (p 456)

4. Differentiate enteral and parenteral routes of medication administration. (p 456)

5. Describe rectal, oral, intravenous, intraosseous, subcutaneous, intramuscular, inhalation, sublingual, and transcutaneous routes of medication administration; include the rates of absorption. (pp 457–458)

6. Explain the solid, liquid, and gas forms of medication and routes of administration; provide examples of each. (pp 459–461)

7. List the “six rights” of medication administration; include how each one relates to EMS. (pp 461–463)

8. Explain the difference between direct orders (online) and standing orders (off-line) and the role of medical control. (p 463)

9. Discuss the medication administration circumstances involving peer-assisted medication, patient-assisted medication, and EMT-administered medication. (pp 463–464)

10. Know the generic and trade names, actions, indications, contraindications, routes of administration, side effects, interactions, and doses of 10 medications that may be administered by an EMT in an emergency as dictated by state protocols and local medical direction. (pp 463–475)

11. Describe the medication administration considerations related to special populations, including pediatric, geriatric, and pregnant patients. (pp 464, 472–473)

12. State the steps to should follow when dispensing medications to a patient using an auto-injector. (p 471)

13. Explain why determining what prescription and over-the-counter medications a patient is taking is a critical aspect of patient assessment during an emergency. (pp 475–476)

14. State the steps to take if a medication error occurs. (p 477)

Skills Objectives

1. Apply the six rights of medication administration. (pp 461–463)

2. Demonstrate how to administer oral medication to a patient. (pp 464, 467–468)

3. Demonstrate how to administer aspirin to a patient with chest pain. (p 468)

4. Demonstrate how to administer oral glucose to a patient with hypoglycemia. (p 468)

5. Demonstrate how to assist a patient with the sublingual administration of a medication. (p 468)

6. Demonstrate how to administer a medication by auto-injector. (p 471)

7. Demonstrate how to administer an intranasal medication. (pp 471–472)

Readings and Preparations

Review all instructional materials including ***Emergency Care and Transportation of the Sick and Injured***, **Eleventh Edition**, Chapter 11, and all related presentation support materials.

Support Materials

• Lecture PowerPoint presentation

• Case Study PowerPoint presentation

• Equipment needed to perform the psychomotor skills presented in this chapter

• Samples of medications that the EMT may find in the home (may include medication inserts, labels, OTC bottles/boxes, and old prescription bottles with names blocked out)

• Samples of medications that the local EMS agency carries

Enhancements

• Direct students to visit Navigate 2.

• Contact a local pharmacist and obtain current literature and package inserts for medications approved for EMTs to administer or assist in administering. Use these materials to impress upon students the potency and potential hazards of these medications.

**Content connections:** Inform students that as they proceed to other lessons, they will be better able to apply their basic knowledge of pharmacology to specific conditions such as heart disease, hypertension, and diabetes.

**Cultural considerations:** Discuss cultural attitudes toward medications, keeping in mind that some cultures do not advocate taking medicine for pain and may have alternative ways of treating illness that might seem at odds with students’ perception of the norm. In addition, some cultures and religions may prescribe special dietary requirements that conflict with certain types and forms of medications (such as those made from animal products).

Teaching Tips

• Be careful not to assume that all students understand even the most basic information about medications. Accurate understanding about medications may vary widely.

• Consider projecting a prescription label and an OTC medication label and having a short pretest to assess students’ ability to understand the labels.

Unit Activities

**Writing assignments:** Assign a “patient” to each student. The patient should have a medical history that includes medication. Ask students to research which medication(s) a patient with this condition might be taking (encourage use of both generic and trade names). Students should also research what the medication does in the body. Limit the assignments to the most common conditions and no more than two medications.

**Student presentations:** Ask pairs of students to discuss information about barriers to medication compliance and possible consequences. They should also propose solutions to this very real issue. Barriers of compliance include:

• The patient does not remember the medication guidelines.

• The patient does not understand the label (eg, the patient cannot read, the patient does not understand the language, the patient has poor vision).

• The patient is not able to access the medication (eg, the patient cannot open the bottle, the patient is confined to bed).

• The patient is not able to afford the medication.

**Group activities:** Assign each group one of the medications found on the EMT medications chart (**Table 11-4**). If possible, provide actual samples of the medication. In addition to presenting the facts about the medication, student groups can create a scenario in which the medication is used and present their skit to the class. Encourage students to role-play realistic parts such as the patient, the EMT, and family members.

**Medical terminology review:** Write a few paragraphs from the role of a fictional patient describing in everyday language his or her medication and its effects. For example:

I’m taking this pill for my arthritis pain. It helps ease the pain and also reduces swelling in my joints. I’m supposed to take one pill in the morning and one at night. I have to be careful that I don’t get an upset stomach when I take this medication, because the doctor told me it could cause ulcers. The doctor said that if I’m going to be drinking any alcohol that I shouldn’t take the pill that day. Also, if I have any itching or vomiting, I should stop taking the medicine right away. The doctor also said that it might make me a little sleepy, but that it’s okay if that happens.

Using the terminology presented in this chapter, students should be able to identify indications, untoward effects, side effects, dosage, contraindications, and intended effects of the medication. Consider adding a word list to the assignment to guide students.

Pre-Lecture

### You Are the Provider

“You Are the Provider” is a progressive case study that encourages critical thinking skills.

### Instructor Directions

**1.** Direct students to read the “You Are the Provider” scenario found throughout Chapter 11.

**2.** You may wish to assign students to a partner or a group. Direct them to review the discussion questions at the end of the scenario and prepare a response to each question. Facilitate a class dialogue centered on the discussion questions and the Patient Care Report.

**3.** You may also use this as an individual activity and ask students to turn in their comments on a separate piece of paper.

Lecture

I. Introduction

A. Medications are an important intervention available to you as an EMT.

B. When used appropriately, medications may alleviate pain and improve a patient’s condition.

C. Failure to administer medications safely and competently can lead to serious consequences for the patient, including death.

D. As an EMT, you will:

1. Administer medications

2. Help patients self-administer medications

3. Ask patients about medication use and allergies

4. Report patients’ medication information to hospital personnel

II. How Medications Work

A. Medical definitions

1. Pharmacology: the science of drugs, including their ingredients, preparation, uses, and actions on the body

2. Medication: a substance used to treat or prevent disease or relieve pain

3. Pharmacodynamics: the process by which medication works on the body

a. A medication can either increase or decrease a normal function of the body.

4. Agonist: medication that causes stimulation of receptors

5. Antagonist: medication that binds to a receptor and blocks other medications or chemicals from attaching there

6. Dose: the amount of the medication that is given, which depends on:

a. Patient’s weight

b. Patient’s age

c. Desired action of the medication

7. Action: the therapeutic effect that a medication is expected to have on the body

8. Indications: reasons or conditions for which a particular medication is given

9. Contraindications: when a medication would either harm the patient or have no positive effect

a. Absolute contraindications: when the medication should never be given

b. Relative contraindications: when the benefits of administering the drug may outweigh the risks

10. Side effects: any actions of a medication other than the desired ones

a. Unintended effects: effects that are undesirable but pose little risk to the patient

b. Untoward effects: effects that can be harmful to the patient

B. Medication names

1. The generic name is a simple, clear, nonproprietary name.

a. Generic names are not capitalized.

2. The trade name is the brand name that a manufacturer gives to a drug.

a. Examples: Tylenol, Lasix

b. Trade names begin with a capital letter.

c. One drug may have more than one trade name.

3. Prescription drugs are distributed only by pharmacists and require a physician’s order.

4. Over-the-counter (OTC) drugs may be purchased directly without a prescription.

5. Other kinds of drugs

a. Recreational drugs (eg, heroin, cocaine)

b. Herbal remedies

c. Enhancement drugs

d. Vitamin supplements

6. Any medication that a patient takes can be pharmacologically active and can cause an effect, so ask patients about any and all medications or drugs they are taking.

C. Routes of administration

1. Enteral medications enter the body through the digestive system.

a. Often in pill or liquid form, such as cough medicine

b. Medications administered via this route tend to be absorbed slowly and are not commonly used in an emergency setting.

2. Parenteral medications enter the body by some other means.

a. Often in liquid form administered through needles or syringes

b. Absorbed more quickly and offer a more predictable and measurable response

3. Absorption: the process by which medications travel through body tissues to the bloodstream

4. Common routes of administration

a. Per rectum (PR)

i. “By rectum”

ii. Easy to administer; provides reliable absorption

b. Oral (PO)

i. “By mouth”

ii. Enters the bloodstream through the digestive system

iii. Takes as long as 1 hour for absorption to occur

c. Intravenous (IV) injection

i. “Into the vein”

ii. Fastest delivery, but cannot be used for all medications

d. Intraosseous (IO) injection

i. “Into the bone”

ii. Reaches the bloodstream through the bone marrow

iii. Requires drilling a needle into the outer layer of bone

e. Subcutaneous (SC) injection

i. “Beneath the skin”

ii. Injection given into the fatty tissue between the skin and muscle

f. Intramuscular (IM) injection

i. “Into the muscle”

ii. Usually absorbed quickly

iii. Not all medications can be administered by the IM route.

iv. Examples:

(a) EpiPen auto-injector

(b) Mark-1 auto-injector

g. Inhalation

i. Breathed into the lungs

ii. Absorbed into the bloodstream quickly

iii. Forms include aerosols, fine powders, and sprays

h. Sublingual (SL)

i. “Under the tongue”

ii. Enters through the oral mucosa under the tongue and is absorbed into the bloodstream within minutes

iii. Example: nitroglycerin tablets

i. Transcutaneous (transdermal)

i. “Through the skin”

ii. Applied as a patch to the skin

iii. Longer-lasting effect than other routes

iv. Examples:

(a) Nicotine patch

(b) Nitroglycerin patch

j. Intranasal (IN)

i. Relatively new format for the delivery of medication

ii. The medication is pushed through a device called a mucosal atomizer device (MAD) that aerosolizes the liquid for delivery into the nostril.

iii. Quick absorption

iv. Examples:

(a) Flu vaccine

(b) Naloxone

III. Medication Forms

A. The form of a medication usually dictates the route of administration.

1. The manufacturer chooses the form to ensure:

a. Proper route of administration

b. Timing of the medication’s release into the bloodstream

c. Effects on the target organs or body systems

B. Tablets and capsules

1. Most medications given by mouth are in tablet or capsule form.

2. Capsules are gelatin shells filled with powder or liquid medication.

3. Tablets often contain other materials that are mixed with the medication and compressed.

C. Solutions and suspensions

1. Solution: a liquid mixture of one or more substances that cannot be separated simply

2. Solutions can be given by almost any route.

a. When given by mouth, solutions may be absorbed from the stomach fairly quickly because the medication is already dissolved

b. Many solutions can be given as an IV, IM, or SC injection.

3. Suspension: a mixture of finely ground particles that are distributed evenly throughout a liquid by shaking or stirring but do not dissolve

a. Suspensions separate if they stand or are filtered.

b. It is important to shake or swirl a suspension before its administration.

D. Metered-dose inhalers (MDIs)

1. Liquids or solids that are broken into small enough droplets or particles may be inhaled.

2. A spray canister directs such substances through the mouth and into the lungs.

3. Delivers the same amount of medication each time it is used

4. Often used for respiratory illnesses such as asthma or emphysema

E. Topical medications

1. Include lotions, creams, and ointments

2. Applied to the skin surface and affect only that area

F. Transcutaneous medications

1. Also referred to as transdermal medications

2 Absorbed through the skin

3. Unlike topical medications, which affect only the intended site, many transdermal medications have systemic (whole-body) effects, such as nitroglycerin paste or patch.

4. If you touch the medication with your skin, you will absorb it just like the patient.

G. Gels

1. Semiliquid

2. Administered in capsules or through plastic tubes

3. Example: oral glucose for patient with diabetes

H. Gases for inhalation

1. Usually delivered through a nonrebreathing mask or nasal cannula

2. Oxygen is the medication most commonly used in gas form outside the operating room.

IV. General Steps in Administering Medication

A. Medications should be administered only under the authorization of online or off-line medical direction.

B. Follow the “six rights.”

1. Right patient: Ensure that the patient who needs the medication is the person who receives the medication.

2. Right medication: Verify the proper medication and prescription.

3. Right dose: Verify the form and dose of the medication.

4. Right route: Verify the route of the medication.

5. Right time: Check the expiration date and condition of the medication.

6. Right documentation: Document your actions and the patient’s response.

**C. Medication errors almost always result from failure to follow these six rights.**

V. Medication Administration and the EMT

A. Over the years, EMTs have been allowed increasing responsibility to work with medications.

B. Many departments have strict guidelines on when an EMT is allowed to administer a medication.

1. Peer-assisted medication

a. You administer medication to yourself or your partner.

b. Example: You were exposed to a toxic agent.

2. Patient-assisted medication

a. You assist the patient with administering his or her own medication.

b. Examples: epinephrine auto-injector, nitroglycerin, metered-dose inhaler

3. EMT-administered medication

a. The EMT directly administers the medication to the patient.

b. The patient may be severely confused or unable to understand the need for the medication.

c. Examples: oxygen, oral glucose, aspirin

C. Medical control, state guidelines, and local protocols determine what an EMT in your system may administer.

1. Refer to your local standards to obtain a listing of how and when EMTs can administer medications.

VI. Medications Used by EMTs

A. Oral medications

1. Considerations

a. Advantages

i. Ease of access

b. Disadvantages

i. The digestive tract can be easily affected by foods, stress, and illness.

2. Activated charcoal

a. Many poisonings involve overdoses taken by mouth.

b. Activated charcoal reduces the amount of medication being absorbed by the body by binding the drug to its surface (adsorption).

c. Frequently suspended with sorbitol (a sugar), which has a laxative effect that causes the medication and the charcoal to move quickly through the digestive system

d. Administered by mouth (may be unappealing to patients, so use a covered container and ask the patient to drink the fluid through a straw)

e. May stain clothing

f. Should not be given to patients who:

i. Have altered level of consciousness (risk of aspiration)

ii. Have ingested an acid, an alkali, or a petroleum product

3. Oral glucose

a. Glucose is a sugar that cells use for energy; it is necessary for brain cells.

b. Hypoglycemia: extremely low blood glucose

c. Oral glucose can counteract the effects of hypoglycemia.

d. An EMT can give glucose only by mouth.

i. Available as a gel designed to be spread on the mucous membranes between the cheek and gum

ii. Also available as glucose tablets

e. Never administer oral medications to an unconscious patient or to one who is unable to swallow or protect the airway.

4. Aspirin

a. Reduces fever, pain, and inflammation

b. Inhibits platelet aggregation (clumping), which is useful during a potential heart attack

c. Contraindications

i. Hypersensitivity to aspirin

ii. Preexisting liver damage, bleeding disorders, and asthma

iii. Should not be given to children

B. Sublingual medications

1. Considerations

a. Advantages

i. Easy to talk with awake and alert patients and advise them to place a pill under their tongue

ii. Absorption is relatively quick.

b. Disadvantages

i. Any medication placed in the mouth requires constant evaluation of the airway.

ii. Should not be used if the patient is uncooperative or unconscious

2. Nitroglycerin

a. Many cardiac patients carry fast-acting nitroglycerin to relieve angina pain.

b. Nitroglycerin increases blood flow by relieving the spasms and causes arteries to dilate by relaxing muscles of the coronary arteries and veins.

c. Also relaxes veins throughout the body so that less blood is returned to the heart, decreasing workload and blood pressure

d. Before administration

i. Check the patient’s blood pressure before administering nitroglycerin.

(a) If the systolic blood pressure is less than 100 mm Hg, nitroglycerin may have a harmful effect.

(b) Even a patient who has adequate blood pressure should sit or lie down with the head elevated before taking this medication (to avoid fainting).

(c) If a significant drop in blood pressure occurs and the patient feels dizzy or sick, have the patient lie down.

ii. Obtain a medical order or follow local protocols to administer nitroglycerin.

e. Can have potentially fatal interactions with erectile dysfunction (ED) medications taken within the past 24 hours:

i. Sildenafil (Viagra)

ii. Tadalafil (Cialis)

iii. Vardenafil (Levitra)

iv. Erectile dysfunction drugs may be used by both men and women.

f. Administration by tablet

i. Place the tablet under tongue, where it dissolves.

ii. The patient should experience a slight tingling or burning sensation.

iii. Should be stored in its original glass container with the cap screwed on tightly

g. Administration by metered-dose spray

i. Deposits medication on or under the tongue

ii. One spray equals one tablet.

h. Know and follow your local protocols.

C. Intramuscular medications

1. Considerations

a. Advantages

i. Provides quick and easy access to the circulatory system without the need for placing a needle within a vein

ii. Blood flow to the muscles is relatively stable even during circumstances of severe illness or injury.

b. Disadvantages

i. Use of a needle and subsequent pain

2. Epinephrine (adrenaline)

a. Also known as adrenaline

b. Released inside the body when there is sudden stress

c. Main hormone that controls the body’s fight-or-flight response

d. Sympathomimetic (mimics the effect of the sympathetic nervous system)

e. Effects

i. Increases heart rate

ii. Constricts blood vessels, causing increased blood pressure

iii. Dilates passages in the lungs

f. Should be given only to patients who are experiencing a life-threatening allergic reaction.

g. Epinephrine may be dispensed from an auto-injector.

i. Automatically delivers a preset amount of the medication (usually 0.3 mg)

h. Some services do not permit EMTs to carry epinephrine but do allow them to assist patients in administering their own epinephrine.

**D. Intranasal medications**

1. Naloxone

a. Used to reverse the effects of an opioid overdose

b. The most common technique for naloxone administration is via the intranasal route.

1. Place the atomizer in one nostril, pointing up and slightly outward.
2. Administer a half dose (1 ml. maximum) into each nostril.

E. Inhalation medications

1. Oxygen

a. By far the most commonly administered medication in the prehospital setting

b. All cells, especially those in the heart and brain, need oxygen to function properly.

c. Generally administered:

i. Via a nonrebreathing mask at 10 to 15 L/min

ii. Via nasal cannula at 2 to 6 L/min

d. Must also provide artificial ventilations if the patient is not breathing (using a bag-valve mask at 15 L/min)

e. Ensure that there are no open flames, lit cigarettes, or sparks in the area in which you are administering oxygen.

2. Metered-dose inhalers and nebulizers

a. Used to administer liquid medications that have been turned into a fine mist by a flow of air or oxygen

b. Medication is atomized, breathed into the lungs, and delivered to the alveoli

c. Advantages

i. Fast and relatively easy route to access

d. Disadvantages

i. Patient needs to be cooperative and control breathing

ii. Cannot be used for unconscious patients

3. Medications administered using an MDI

a. An MDI requires a great deal of coordination to administer.

i. May be difficult to achieve when a person is having trouble breathing

b. Use a spacer (adapter) to avoid spray misdirection.

i. A spacer fits over the inhaler like a sleeve.

ii. A spacer has an opening for the inhaler at one end and a mouthpiece on the other end.

iii. The patient sprays the prescribed dose into the chamber and then breathes in and out of the mouthpiece until the mist is completely inhaled.

c. The only medications that will be effective during an acute attack of shortness of breath are fast-acting rescue inhalers (eg, albuterol [Proventil or Ventolin]).

VII. Patient Medications

A. Patient assessment includes finding out which medications the patient is currently taking.

B. This information may provide vital clues to the patient’s condition.

1. May help guide your treatment

2. May be extremely useful to the emergency department physician

3. Can help you determine a chronic or underlying condition when a patient is unable to relate his or her medical history

C. Discover what the patient takes and transport the medications or a list of them with you to the emergency department.

D. Ask about any nonprescription drugs (eg, OTC, herbal, or illegal drugs).

VIII. Medication Errors

1. A medication error is inappropriate use of a medication that could lead to patient harm.
2. Ensure that the environment does not contribute to errors.
3. Ensure lighting is sufficient.
4. Organize equipment.
5. Limit distractions as much as possible.
6. Consider using a “cheat sheet” to help yourself remember all crucial steps to medication administration.
7. If a medication error does take place:
8. Rapidly provide any appropriate patient care that is required.
9. Notify medical control as quickly as possible.
10. Follow your local protocols.
11. Document the incident thoroughly, accurately, and honestly.
12. Talk with your supervisor or medical director.
    1. Represents an opportunity to learn
    2. Identifies areas to target during quality improvement

Post-Lecture

This section contains various student-centered end-of-chapter activities designed as enhancements to the instructor’s presentation. As time permits, these activities may be presented in class. They are also designed to be used as homework activities.

## Assessment in Action

This activity is designed to assist the student in gaining a further understanding of issues surrounding the provision of prehospital care. The activity incorporates both critical thinking and application of basic EMT knowledge.

### Instructor Directions

**1.** Direct students to read the “Assessment in Action” scenario located in the Prep Kit at the end of Chapter 11.

**2.** Direct students to read and individually answer the quiz questions at the end of the scenario. Allow approximately 10 minutes for this part of the activity. Facilitate a class review and discussion of the answers, allowing students to correct responses as may be needed. Use the quiz question answers noted below to assist in building this review. Allow approximately 10 minutes for this part of the activity.

**3.** You may wish to ask students to complete the activity on their own and turn in their answers on a separate piece of paper.

### Answers to Assessment in Action Questions

**1.** **Answer:** B generic name

**2.** **Answer**: A indication.

**3.** **Answer**: C side effects.

**4.** **Answer**: A Document the medication names and dosages.

**5.** **Answer**: D Drug interactions from this many medications are a concern.

**6. Answer**: B EMT-administered.

**7.** **Answer**: C Injection

**8.** **Answer**: A The MDI route does *not* require an external oxygen source.

**9.** **Answer**: Medications delivered intravenously have the fastest onset of action because they are delivered directly into the bloodstream.

**10.** **Answer**: Many times patients may not consider OTC medications, vitamins, or herbal supplements important to mention because they are usually not prescribed by a physician. However, this information is crucial because OTC medications, vitamins, and herbal supplements frequently interact with prescription medications, which may be the cause of the patient’s problem or may contribute to it.

## Assignments

A. Review all materials from this lesson and be prepared for a lesson quiz to be administered (date to be determined by the instructor).

B. Read Chapter 12, “Shock,” for the next class session.