

**Chapter 7**

**Principles of Pharmacology**

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**National EMS Education Standard Competencies (1 of 5)**

**Pharmacology**

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

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**National EMS Education Standard Competencies (2 of 5)**

**Principles of Pharmacology**

- Medication safety
- Kinds of medications used during an emergency

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## National EMS Education Standard Competencies (3 of 5)

### Medication Administration

- Self-administer medication
- Peer-administer medication
- Assist/administer medication to a patient

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## National EMS Education Standard Competencies (4 of 5)

### Emergency Medications

- Names
- Effects
- Actions
- Indications
- Contraindications

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## National EMS Education Standard Competencies (5 of 5)

### Emergency Medications (cont'd):

- Complications
- Routes of administration
- Side effects
- Interactions
- Dosages for the medications administered

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## Introduction (1 of 2)

- Administering medications is a serious business.
- Medications may alleviate pain and improve patient's well-being.
- Used inappropriately, may cause harm and even death.

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## Introduction (2 of 2)

- As an EMT, you will:
  - Administer medications.
  - Help patients self-administer medications.
  - Ask patients about medication use.
  - Report patient information to hospital personnel.

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## How Medications Work (1 of 3)

- Pharmacology is the science of drugs.
- A medication is a chemical substance used to:
  - Prevent disease
  - Relieve pain
- Pharmacodynamics is a process by which medication works on the body.

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## How Medications Work (2 of 3)

- Agonist: causes stimulation of receptors
- Antagonist: binds to a receptor and blocks other medications
- Dose: amount of medication given
  - Depends on weight, age, desired action



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## How Medications Work (3 of 3)

- Action
- Indications
- Contraindications
- Side effects
  - Unintended effects
  - Untoward effects



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## Medication Names (1 of 2)

- Generic name is nonproprietary name
  - Original chemical name of medication
  - Example: ibuprofen
- Trade name is manufacturer's brand name.
  - One drug may have more than one trade name
  - Example: Tylenol



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## Medication Names (2 of 2)

- Prescription medications
- Over-the-counter (OTC) medications
- Street drugs
- Herbal medications
- Enhancement drugs
- Vitamin supplements



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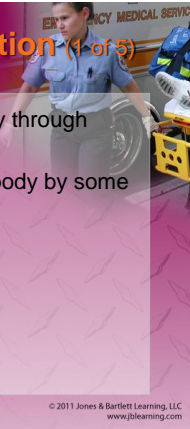
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## Routes of Administration (1 of 5)

- Enteral medications enter body through digestive system.
- Parenteral medications enter body by some other means.



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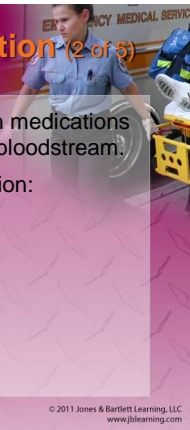
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## Routes of Administration (2 of 5)

- Absorption is process by which medications travel through body tissues to bloodstream.
- Common routes of administration:
  - Per rectum (PR)—by rectum
  - Oral or per os (PO)—by mouth



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## Routes of Administration (3 of 5)

- Common routes of administration (cont'd):
  - Intravenous (IV)—into the vein
  - Intraosseous (IO)—into the bone
  - Subcutaneous (SC)—beneath the skin
  - Intramuscular (IM)—into the muscle

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## Routes of Administration (4 of 5)

- Common routes of administration (cont'd):
  - Inhalation—inhaled into the lungs
  - Sublingual (SL)—under the tongue
  - Transcutaneous (transdermal)—through the skin
  - Intranasal (IN)—into nostril via mucosal atomizer device (MAD)

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## Routes of Administration (5 of 5)

Route	Rate
<b>Enteral</b>	
Per rectum (PR)	Rapid
Ingestion (oral)	Slow
<b>Parenteral</b>	
Intravenous (IV)	Immediate
Intraosseous (IO)	Immediate
Subcutaneous (SC)	Slow
Intramuscular (IM)	Moderate
Inhalation	Rapid
Sublingual (SL)	Rapid
Transcutaneous	Slow

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## Medication Forms (1 of 2)

- Form of medication usually dictates route of administration.
- Manufacturer chooses the form to ensure:
  - Proper route of administration
  - Timing of its release into the bloodstream
  - Effects on the target organs or body systems

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## Medication Forms (2 of 2)

- Basic Forms
  - Tablets and capsules
  - Solutions and suspensions
  - Metered-dose inhalers
  - Topical medications
  - Transcutaneous medications
  - Gels
  - Gases for inhalation

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## Tablets and Capsules

- Capsules are gelatin shells filled with powdered or liquid medication.
- Tablets often contain other materials that are mixed with the medication and compressed.

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## Solutions and Suspensions (1 of 2)

- Solution is liquid mixture of substances.
  - Mixture will not separate by filtering or letting it stand.
  - Example: nitroglycerin spray



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## Solutions and Suspensions (2 of 2)

- Suspension is substance that does not dissolve well in liquids.
  - Will separate if it stands or is filtered



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## Metered-Dose Inhalers (1 of 2)

- Liquids or solids broken into small enough droplets or particles may be inhaled.
- Metered-dose inhaler (MDI) directs such substances through mouth into lungs.
- Delivers same amount each time.



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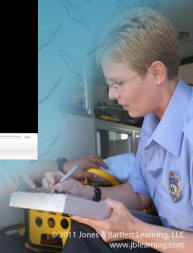
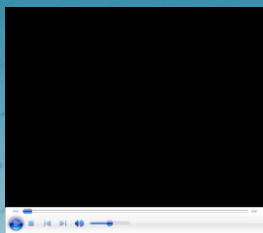
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## Metered-Dose Inhalers (2 of 2)



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## Topical Medications

- Include lotions, creams, ointments
- Applied to skin surface and only affect that area
- Examples
  - Lotion: Calamine lotion
  - Cream: hydrocortisone cream
  - Ointment: Neosporin ointment



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## Transcutaneous Medications (1 of 2)

- Also referred to as transdermal
- Designed to be absorbed through skin
- Many have systemic effects.
- Examples:
  - Nitroglycerin paste
  - Adhesive patch



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## Transcutaneous Medications (2 of 2)

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



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## Gels

- Semiliquid
- Administered in capsules or through plastic tubes
- Example: oral glucose for patient with diabetes



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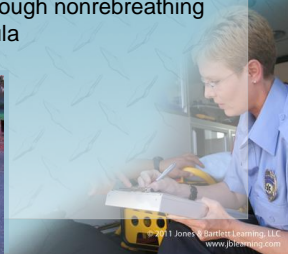
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## Gases for Inhalation

- Outside operating room, most common is oxygen.
- Usually delivered through nonrebreathing mask or nasal cannula



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## General Steps in Administering Medication (1 of 2)

- Only administer medications with order from medical control.
- Follow “six rights” of medication administration

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## General Steps in Administering Medication (2 of 2)

**Table 7-3** The “Six Rights” of Medication Administration

- Right patient
- Right medication
- Right dose
- Right route
- Right time
- Right documentation

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## Medication Administration and the EMT (1 of 2)

- Unit may carry:
  - Oxygen
  - Oral glucose
  - Activated charcoal
  - Aspirin
  - Epinephrine

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## Medication Administration and the EMT (2 of 2)

- Circumstances to administer medications
  - Peer-assisted medication
  - Patient-assisted medication
  - EMT-administered medication
- Determined by:
  - State and local protocols
  - Medical control

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## Oral Medications (1 of 6)



- Advantages
  - Ease of access
  - Comfort level

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## Oral Medications (2 of 6)



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## Oral Medications (3 of 6)

- Disadvantages
  - Digestive tract can be easily affected by foods, stress, and illness.
  - Speed of movement of food through the tract dramatically changes the speed of absorption.

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## Oral Medications (4 of 6)

- Activated charcoal
  - Keeps drugs from being absorbed
  - Ground into fine powder
  - Frequently suspended with sorbitol
  - Administered by mouth
  - Do not give to patients with altered LOC.
    - Or who have ingested an acid, alkali, or petroleum

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## Oral Medications (5 of 6)

- Oral glucose
  - A sugar that cells use for energy
  - Treats hypoglycemia
  - EMTs only give it by mouth.
  - Do not give to unconscious patient or one who cannot protect airway.

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## Oral Medications (6 of 6)

- Aspirin
  - Reduces fever, pain, inflammation
  - Inhibits platelet aggregation
    - Useful during heart attack
  - Contraindications
    - Hypersensitivity to aspirin
    - Liver damage, bleeding disorder, asthma
    - Children during fever-causing illness

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## Sublingual Medications (1 of 6)

- Advantages
  - Easy to advise patients
  - Quick absorption
- Disadvantages
  - Constant evaluation of the airway
  - Possible choking
  - Not for uncooperative or unconscious patients

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## Sublingual Medications (2 of 6)

- Nitroglycerin
  - Relieves angina pain (cardiac patients)
  - Increases blood flow
  - Relaxes veins
  - Before administering:
    - Check blood pressure
    - Obtain order to administer

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## Sublingual Medications (3 of 6)

- Nitroglycerin (cont'd)
  - Possibility of MI, if no relief
  - Should not be used with erectile dysfunction medications
  - May cause mild headache



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## Sublingual Medications (4 of 6)

- Nitroglycerin (cont'd)
  - Administration by tablet
    - Sublingually under tongue
    - Slight tingling or burning
    - Storage is important.
  - Administration by metered-dose spray
    - On or under tongue
    - One spray = one tablet



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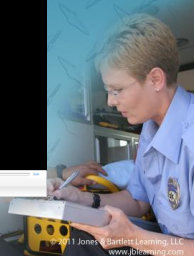
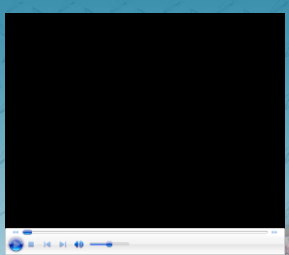
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## Sublingual Medications (5 of 6)



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## Sublingual Medications (6 of 6)

- There are administration considerations (for both tablet and spray).
  - Wait 5 minutes before repeating dose.
  - Monitor vital signs.
  - Wear gloves.
  - Know local protocols.



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## Intramuscular Medications (1 of 5)

- Advantages
  - Quick, easy access without using vein
  - Stable blood flow to muscles
- Disadvantages
  - Use of a needle (and subsequent pain)
  - Patients may fear pain or injury.



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## Intramuscular Medications (2 of 5)

- Epinephrine
  - Controls fight-or-flight response
  - Primary medication for delivery IM
  - Also called adrenaline, released inside body under stress
  - Sympathomimetic



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## Intramuscular Medications (3 of 5)

- Epinephrine (cont'd)
  - Increases heart rate and constricts blood vessels
  - Do not give to patients with hypertension, hypothermia, an MI, wheezing.
  - May be delivered with an auto-injector to treat life-threatening anaphylaxis

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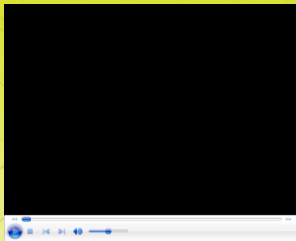
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## Intramuscular Medications (4 of 5)



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## Intramuscular Medications (5 of 5)



- Epinephrine (cont'd)
  - Allergens cause body to release histamine.
  - Epinephrine acts as antidote to histamine.
  - Dispensed from auto-injector
  - Follow local protocols.

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## Inhalation Medications (1 of 2)



- Oxygen
  - All cells need it to survive.
  - Generally administered via:
    - Nonrebreathing mask
      - Preferred method
    - Nasal cannula
      - Those who cannot tolerate a mask

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## Inhalation Medications (2 of 2)

- MDIs and nebulizers
  - Liquid turned into mist or spray
  - Medication is breathed in and delivered to alveoli.
  - Absorption rate is fast.
  - Easy route to access
  - Portable

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## Patient Medications

- Patient assessment includes finding out medications patient is taking.
  - Provides vital clues to patient's condition
  - Guides treatment
  - Will be useful to emergency department

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## Summary (1 of 8)

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

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## Summary (2 of 8)

### Medication routes:

- Per rectum (PR)
- Oral (per os, PO)
- Intravenous (IV)
- Intraosseous (IO)
- Subcutaneous (SC)
- Intramuscular (IM)
- Inhalation
- Sublingual (SL)
- Transcutaneous
- Intranasal (IN)

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## Summary (3 of 8)

- Medication forms
  - Tablets and capsules
  - Solutions and suspensions
  - Metered-dose inhalers (MDIs)
  - Topical medications
  - Transcutaneous medications
  - Gels
  - Gases for inhalation

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## Summary (4 of 8)

- The administration of any medication requires approval by medical control, through direct orders given online or standing orders that are part of the local protocols.

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## Summary (5 of 8)

- Six rights of medication administration
  - Right patient
  - Right medication
  - Right dose
  - Right route
  - Right time
  - Right documentation

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## Summary (6 of 8)

- After the medication has been administered, document:
  - Reassessed vital signs
  - Patient's history
  - Assessment
  - Treatment
  - Response findings

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## Summary (7 of 8)

- EMS medications
  - Activated charcoal
  - Oral glucose
  - Aspirin
  - Nitroglycerin
  - Epinephrine
  - Oxygen

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## Summary (8 of 8)

- Knowing what medications a patient takes is important to:
  - Provide vital clues about your patient's condition
  - Inform you of any chronic or underlying conditions
  - Guide your treatment
  - Report to the emergency department physician

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## Review



1. Pharmacology is defined as the:
  - A. study of cells and tissues.
  - B. study of drugs and medications.
  - C. effects of medications in the lungs.
  - D. distribution of drugs to the body's tissues.

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## Review

**Answer: B**

**Rationale:** Pharmacology is a field of science that deals with the study of drugs and medications.

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## Review (1 of 2)

1. Pharmacology is defined as the:

- A. study of cells and tissues.  
**Rationale:** This is physiology, which is a branch of biology.
- B. study of drugs and medications.  
**Rationale:** Correct answer

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## Review (2 of 2)

1. Pharmacology is defined as the:

- C. effects of medications in the lungs.  
**Rationale:** This is pharmacodynamics, which includes the processes of the body's response to medications.
- D. distribution of drugs to the body's tissues.  
**Rationale:** This is pharmacokinetics, which studies medication distribution within the body.

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## Review



2. Which of the following statements regarding medications is FALSE?

- A. Many medications are known by different names.
- B. Some medications affect more than one body system.
- C. Over-the-counter drugs must be prescribed by a physician.
- D. EMTs should ask about any herbal remedies or vitamins that the patient may be taking.

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## Review

**Answer: C**

**Rationale:** Over-the-counter (OTC) drugs, such as aspirin, Tylenol, or Motrin, do not require a physician prescription. They can be purchased at a supermarket or drugstore. Most medications have a generic name and a trade name. For example, acetaminophen is the generic name for Tylenol, and ibuprofen is the generic name for Motrin.

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## Review (1 of 2)

2. Which of the following statements regarding medications is FALSE?

- A. Many medications are known by different names.  
**Rationale: True, medications can have several different names.**
- B. Some medications affect more than one body system.  
**Rationale: True, medications can affect many different body systems.**

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## Review (2 of 2)

2. Which of the following statements regarding medications is FALSE?

C. Over-the-counter drugs must be prescribed by a physician.

**Rationale:** Correct answer

D. EMTs should ask about any herbal remedies or vitamins that the patient may be taking.

**Rationale:** True, herbal remedies and vitamins can have interactions and effects on patient's health and condition.

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## Review



3. Which of the following routes of medication administration has the fastest effect?

A. Oral

B. Intravenous

C. Subcutaneous

D. Intramuscular

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## Review

**Answer:** B

**Rationale:** Because its administration is directly into a vein it enters the body quickly. The intravenous route is the fastest acting of all the routes of medication administration.

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## Review (1 of 2)

3. Which of the following routes of medication administration has the fastest effect?
- A. Oral  
Rationale: The medication must be absorbed through the mucous membranes first to get to the circulatory system.
  - B. Intravenous  
Rationale: Correct answer

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## Review (2 of 2)

3. Which of the following routes of medication administration has the fastest effect?
- C. Subcutaneous  
Rationale: The medication must pass through the layers of skin before reaching the circulatory system.
  - D. Intramuscular  
Rationale: The medication needs to travel to the circulatory system.

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## Review



4. When administered to a patient, a metered-dose inhaler will:
- A. deliver the same dose each time it is administered.
  - B. be ineffective when given to patients with asthma.
  - C. deliver a different dose each time it is administered.
  - D. be delivered to the lungs over a period of 6 to 8 hours.

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## Review

**Answer: A**

**Rationale:** The metered-dose inhaler (MDI) delivers the same dose of medication each time it is used. Drugs given via the MDI act very quickly and are commonly prescribed to patients with asthma, emphysema, and other airway diseases.

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## Review (1 of 2)

4. When administered to a patient, a metered-dose inhaler will:
- A. deliver the same dose each time it is administered.  
**Rationale: Correct answer**
  - B. be ineffective when given to patients with asthma.  
**Rationale: An inhaler is usually prescribed for patients with asthma.**

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## Review (2 of 2)

4. When administered to a patient, a metered-dose inhaler will:
- C. deliver a different dose each time it is administered.  
**Rationale: An inhaler is metered to deliver the same dose every time.**
  - D. be delivered to the lungs over a period of 6 to 8 hours.  
**Rationale: The medication is delivered straight to the lungs, almost immediately, because it is inhaled.**

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## Review



5. You are managing a 62-year-old woman who is complaining of crushing chest pain. Her blood pressure is 84/64 mm Hg and her heart rate is 110 beats/min. Medical control advises you to assist her in taking her prescribed nitroglycerin. After receiving this order, you should:
- A. reassess the patient's heart rate and then assist with the nitroglycerin.
  - B. repeat the patient's blood pressure to the physician and confirm the order.
  - C. wait 10 minutes, reassess the blood pressure, and then give the nitroglycerin.
  - D. administer the nitroglycerin to the patient and then reassess her blood pressure.

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## Review

**Answer: B**

**Rationale:** Nitroglycerin is a vasodilator and lowers the BP; therefore, it should not be given to patients with a systolic BP less than 100 mm Hg. If you receive an order to give nitroglycerin to a patient with a systolic BP less than 100 mm Hg, you should ensure that the physician is aware of the patient's BP, then reconfirm the order.

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## Review (1 of 2)

5. You are managing a 62-year-old woman who is complaining of crushing chest pain. Her blood pressure is 84/64 mm Hg and her heart rate is 110 beats/min. Medical control advises you to assist her in taking her prescribed nitroglycerin. After receiving this order, you should:
- A. reassess the patient's heart rate and then assist with the nitroglycerin.  
**Rationale:** Administration of nitroglycerin is based upon the patient's blood pressure and not the patient's heart rate.
  - B. repeat the patient's blood pressure to the physician and confirm the order.  
**Rationale:** Correct answer

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## Review (2 of 2)

5. You are managing a 62-year-old woman who is complaining of crushing chest pain. Her blood pressure is 84/64 mm Hg and her heart rate is 110 beats/min. Medical control advises you to assist her in taking her prescribed nitroglycerin. After receiving this order, you should:

- C. wait 10 minutes, reassess the blood pressure, and then give the nitroglycerin.

**Rationale:** You should ensure that the physician is aware of the patient's blood pressure and then reconfirm the order.

- D. administer the nitroglycerin to the patient and then reassess her blood pressure.

**Rationale:** Nitroglycerin is a vasodilator and lowers the patient's blood pressure. This medication should not be given to patients with a systolic blood pressure less than 100 mm Hg.

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## Review



6. Activated charcoal is indicated for patients who have ingested certain drugs and toxins because it:

- A. acts as a direct reversal agent for most medications.
- B. induces vomiting before the chemical can be digested.
- C. detoxifies the drug before it can cause harm to the patient.
- D. binds to chemicals in the stomach and delays absorption.

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## Review

**Answer: D**

**Rationale:** Activated charcoal is an adsorbent—that is, it binds to harmful chemicals that have been ingested. This binding effect delays digestion and absorption of the chemical by the body.

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## Review (1 of 2)

6. Activated charcoal is indicated for patients who have ingested certain drugs and toxins because it:
- A. acts as a direct reversal agent for most medications.  
**Rationale: Activated charcoal binds with chemicals.**
  - B. induces vomiting before the chemical can be digested.  
**Rationale: Activated charcoal is not the medication used to induce vomiting.**

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## Review (2 of 2)

6. Activated charcoal is indicated for patients who have ingested certain drugs and toxins because it:
- C. detoxifies the drug before it can cause harm to the patient.  
**Rationale: Activated charcoal binds with chemicals, delays absorption, and helps in getting chemicals through the digestive system.**
  - D. binds to chemicals in the stomach and delays absorption.  
**Rationale: Correct answer**

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## Review



7. With regard to pharmacology, the term “action” refers to the:
- A. ability of a drug to cause harm.
  - B. ability of a drug to produce side effects.
  - C. amount of time it will take the drug to work.
  - D. expected effect of a drug on the patient’s body.

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## Review

**Answer: D**

**Rationale:** As it applies to pharmacology, the term “action” refers to the effect that a drug is expected to have on a patient’s body. Prior to administering *any* drug, the EMT must be aware of its action(s) on the body.

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## Review

7. With regard to pharmacology, the term “action” refers to the:

- A. ability of a drug to cause harm.  
**Rationale:** This is called a **contraindication**.
- B. ability of a drug to produce side effects.  
**Rationale:** This is any **action of a medication other than the desired ones**.
- C. amount of time it will take the drug to work.  
**Rationale:** This is the **onset of action**.
- D. expected effect of a drug on the patient’s body.  
**Rationale:** **Correct answer**

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## Review



8. Which of the following patients is the BEST candidate for oral glucose?

- A. Conscious patient who is showing signs of hypoglycemia
- B. Unconscious diabetic with a documented low blood sugar
- C. Conscious diabetic patient suspected of being hyperglycemic
- D. Semiconscious patient with signs and symptoms of low blood sugar

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## Review

**Answer: A**

**Rationale:** Oral glucose is given to diabetic patients with suspected or documented hypoglycemia (low blood sugar). It should not be given to unconscious patients or those who are otherwise unable to swallow because it may be aspirated into the lungs.

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## Review (1 of 2)

8. Which of the following patients is the BEST candidate for oral glucose?
- A. Conscious patient who is showing signs of hypoglycemia  
**Rationale: Correct answer**
  - B. Unconscious diabetic with a documented low blood sugar  
**Rationale: Oral glucose should not be given to unconscious patients.**

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## Review (2 of 2)

8. Which of the following patients is the BEST candidate for oral glucose?
- C. Conscious diabetic patient suspected of being hyperglycemic  
**Rationale: Oral glucose is used for the treatment of hypoglycemia (low blood sugar).**
  - D. Semiconscious patient with signs and symptoms of low blood sugar  
**Rationale: Oral glucose should not be given to those patients who are unable or may become unable to swallow.**

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## Review



9. Epinephrine is given to patients with anaphylactic shock because of its effects of:
- A. bronchodilation and vasodilation.
  - B. bronchodilation and vasoconstriction.
  - C. vasodilation and bronchoconstriction.
  - D. bronchoconstriction and vasoconstriction.

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## Review

**Answer: B**

**Rationale:** The two major complications associated with anaphylactic shock are bronchoconstriction, which impairs air movement in and out of the lungs, and vasodilation, which causes a drop in blood pressure. Epinephrine reverses these processes by causing bronchodilation and vasoconstriction, thereby improving breathing and increasing the blood pressure, respectively.

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## Review (1 of 2)

9. Epinephrine is given to patients with anaphylactic shock because of its effects of:
- A. bronchodilation and vasodilation.  
**Rationale: Epinephrine dilates the bronchi but constricts the circulatory system.**
  - B. bronchodilation and vasoconstriction.  
**Rationale: Correct answer**

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## Review (2 of 2)

9. Epinephrine is given to patients with anaphylactic shock because of its effects of:
- C. vasodilation and bronchoconstriction.  
**Rationale:** Epinephrine constricts the circulatory system and dilates the bronchi.
  - D. bronchoconstriction and vasoconstriction.  
**Rationale:** Epinephrine dilates the bronchi and constricts the circulatory system.

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## Review



10. The process by which medications travel through body tissues until they reach the bloodstream is called:
- A. adsorption.
  - B. onset of action.
  - C. absorption.
  - D. transformation.

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## Review

**Answer: C**

**Rationale:** The process by which medications travel through body tissues until they reach the bloodstream is called absorption. Adsorption refers to the binding of one chemical to another. Activated charcoal, for example, delays absorption of certain chemicals into the bloodstream because it adsorbs (binds to) them in the stomach.

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## Review (1 of 2)

10. The process by which medications travel through body tissues until they reach the bloodstream is called:
- A. adsorption.  
Rationale: This is when particles bind to a surface.
  - B. onset of action.  
Rationale: This is the time that it takes for a medication to start doing what it is prescribed for.

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## Review (2 of 2)

10. The process by which medications travel through body tissues until they reach the bloodstream is called:
- C. absorption.  
Rationale: Correct answer
  - D. transformation.  
Rationale: This has nothing to do with medication administration.

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