Chapter 11 - Principles of Pharmacology

2 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.

3 National EMS Education Standard Competencies (2 of 5)
   Principles of Pharmacology
   • Medication safety
   • Kinds of medications used during an emergency

4 National EMS Education Standard Competencies (3 of 5)
   Medication Administration
   • Self-administer medication
   • Peer-administer medication
   • Assist/administer medication to a patient

5 National EMS Education Standard Competencies (4 of 5)
   Emergency Medications
   • Names
   • Effects
   • Actions
   • Indications
   • Contraindications

6 National EMS Education Standard Competencies (5 of 5)
   Emergency Medications (cont’d)
   • Complications
   • Routes of administration
   • Side effects
   • Interactions
   • Dosages for the medications administered

7 Introduction (1 of 2)
   • Medications are an important intervention.
   • Medications may alleviate pain and improve the patient’s condition.
   • Failure to administer medications safely and competently can lead to serious consequences for the patient, including death.

8 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

9 How Medications Work (1 of 3)
   • Pharmacology is the science of drugs.
A medication is a substance used to:
- Prevent or treat disease
- Relieve pain

Pharmacodynamics is a process by which medication works on the body.

How Medications Work (2 of 3)
- Agonist: causes stimulation of receptors
- Antagonist: binds to a receptor and blocks other medications or chemicals
- Dose: amount of medication given
  - Depends on weight, age, desired action

How Medications Work (3 of 3)
- Action: therapeutic effect
- Indications: reasons or conditions
- Contraindications: harmful effects
  - Absolute
  - Relative
- Side effects
  - Unintended effects
  - Untoward effects

Medication Names (1 of 2)
- The generic name is a simple, clear, nonproprietary name.
  - Example: ibuprofen
- The trade name is the manufacturer’s brand name.
  - One drug may have more than one trade name.
  - Example: Tylenol

Medication Names (2 of 2)
- Prescription medications
- Over-the-counter (OTC) medications
- Recreational drugs
- Herbal remedies
- Enhancement drugs
- Vitamin supplements

Routes of Administration (1 of 5)
- Enteral medications enter the body through the digestive system.
- Parenteral medications enter the body by some other means.

Routes of Administration (2 of 5)
- Absorption is the process by which medications travel through body tissues to the bloodstream.
- Common routes of administration:
  - Per rectum (PR): by rectum
  - Oral or per os (PO): by mouth

Routes of Administration (3 of 5)
- Common routes of administration (cont’d):
  - Intravenous (IV): into the vein
  - Intravenous (IO): into the bone
- Subcutaneous (SC): beneath the skin
- Intramuscular (IM): into the muscle

**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 the nostril via a mucosal atomizer device

**Routes of Administration (5 of 5)**

**Medication Forms (1 of 2)**
- The form of medication usually dictates the route of administration.
- The manufacturer chooses the form to ensure:
  - Proper route of administration
  - Timing of the medication’s release into the bloodstream
  - Effects on the target organs or body systems

**Medication Forms (2 of 2)**
- Basic Forms
  - Tablets and capsules
  - Solutions and suspensions
  - Metered-dose inhalers
  - Topical medications
  - Transcutaneous medications
  - Gels
  - Gases for inhalation

**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.

**Solutions and Suspensions (1 of 2)**
- A solution is a liquid mixture of substances.
  - Mixture will not separate by filtering or letting it stand.
  - Many solutions can be given as an IV, IM, or SC injection.

**Solutions and Suspensions (2 of 2)**
- A suspension is substance that does not dissolve well in liquids.
  - Will separate if it stands or is filtered

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

**Topical Medications**
- Include lotions, creams, and ointments
- Applied to skin surface and affect only that area
• Examples
  – Lotion: calamine lotion
  – Cream: hydrocortisone cream
  – Ointment: Neosporin ointment

26 Transcutaneous Medications
(1 of 2)
• Designed to be absorbed through the skin
• Also referred to as transdermal
• May have systemic effects

27 Transcutaneous Medications
(2 of 2)
• Examples:
  – Nitroglycerin paste
  – Adhesive patch
• If you touch the medication with your skin, you will absorb it just like the patient.

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

29 Gases for Inhalation
• Outside the operating room, most commonly used is oxygen
• Usually delivered through a nonrebreathing mask or nasal cannula

30 General Steps in Administering Medication (1 of 2)
• Medications should be administered only under the authorization of medical control.
• Follow the "six rights" of medication administration.
• Medication errors almost always result from failure to follow these "six rights."

31 General Steps in Administering Medication (2 of 2)

32 Medication Administration
and the EMT (1 of 2)
• Unit may carry:
  – Oxygen
  – Oral glucose
  – Activated charcoal
  – Aspirin
  – Epinephrine

33 Medication Administration
and the EMT (2 of 2)
• Circumstances in which medications may be administered:
  – Peer-assisted administration
  – Patient-assisted administration
  – EMT-administered medications
Determined by:
- State and local protocols
- Medical control

**Medication Used by EMTs**

The state, department, and medical director will define which medications are carried on your ambulance.

**Oral Medications (1 of 5)**

- Advantages
  - Ease of access
  - Comfort level
- Disadvantages
  - The 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.

**Oral Medications (2 of 5)**

Confirm that the patient has a patent airway and is able to swallow, and then instruct the patient to swallow or chew the medication.

**Oral Medications (3 of 5)**

- Activated charcoal
  - Reduces the amount of medication being absorbed
  - Ground into fine powder
  - Frequently suspended with sorbitol
  - Administered by mouth
  - Do not give to patients with altered level of consciousness.

**Oral Medications (4 of 5)**

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

**Oral Medications (5 of 5)**

- Aspirin
  - Reduces fever, pain, and inflammation
  - Inhibits platelet aggregation
    - Useful during heart attack
  - Contraindications
    - Hypersensitivity to aspirin
    - Liver damage, bleeding disorder, asthma
    - Should not be given to children
Sublingual Medications (1 of 5)

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

Sublingual Medications (2 of 5)

- Nitroglycerin
  - Relieves angina pain (cardiac patients)
  - Increases blood flow
  - Relaxes veins

Sublingual Medications (3 of 5)

- Nitroglycerin (cont’d)
  - Before administering:
    - Check blood pressure
    - Obtain order to administer
  - Possibility of MI, if no relief
  - Should not be used with erectile dysfunction medications
  - May cause mild headache

Sublingual Medications (4 of 5)

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

Sublingual Medications (5 of 5)

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

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.

**Intramuscular Medications (2 of 5)**

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

**Intramuscular Medications (3 of 5)**

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

**Intramuscular Medications (4 of 5)**

- **Epinephrine (cont’d)**
  - Allergens cause body to over-release histamine.
  - Epinephrine acts as antidote to reverse the effects of histamine.
  - Dispensed from an auto-injector

**Intramuscular Medications (5 of 5)**

- **Naloxone**
  - Used to reverse the effects of an opioid overdose
  - Important considerations:
    - Consult medical direction
    - Effects may not last as long as opioids; repeated doses may be necessary
    - Can cause severe withdrawal symptoms
    - Consider your safety

**Intranasal Medications**

- **Naloxone**
  - The most common technique for naloxone administration is via the intranasal route.

**Inhalation Medications (1 of 5)**

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

**Inhalation Medications (2 of 5)**

- **MDIs and nebulizers**
  - Liquid turned into mist or spray
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- Medication breathed in and delivered to alveoli
- Fast absorption rate
- Easy route to access
- Portable

53 Inhalation Medications (3 of 5)
- Use a spacer to avoid spray misdirection
  - Fits over the inhaler like a sleeve
  - Patient sprays the prescribed dose into the chamber and then breathes in and out of the mouthpiece
  - Especially useful with young children

54 Inhalation Medications (4 of 5)
- Small-volume nebulizers Easier to use than MDIs
  - Take longer to deliver medication
  - Require an external air or oxygen source
  - More effective in patients with moderate to severe respiratory distress
  - Can be used while a patient is on CPAP and during BVM ventilation

55 Inhalation Medications (5 of 5)
- Patients use:
  - “Rescue inhaler” MDIs to relieve bronchial spasms quickly
  - Maintenance or controller inhaler
  - The only medication that is effective during an acute attack of shortness of breath is fast-acting rescue inhalers.

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

57 Medication Errors (1 of 2)
- Inappropriate use of a medication that could lead to patient harm
- May be possible to minimize errors if circumstances are understood
- Ensure the environment does not contribute to errors.

58 Medication Errors (2 of 2)
- If a medication error occurs:
  - Provide appropriate patient care.
  - Notify medical control.
  - Follow protocols.
  - Document thoroughly, accurately, and honestly.
  - Talk with your partner, supervisor, or medical director.

59 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 the field of science that deals with the study of drugs and medications.

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

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.

Review

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.
   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 the patient's health and condition.

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.
      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 the patient's health and condition.

Review

3. Which of the following routes of medication administration has the fastest effect?
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A. Oral
B. Intravenous
C. Subcutaneous
D. Intramuscular

Review
Answer: B
Rationale: Because its administration is directly into a vein, a drug given intravenously enters the body quickly. The intravenous route is the fastest acting of all the routes of medication administration.

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

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.

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.

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.

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.

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.

5. **Review**

You are managing a 62-year-old woman who complains 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.

**Answer:** B

**Rationale:** Nitroglycerin is a vasodilator and lowers blood pressure (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.

5. **Review (1 of 2)**

You are managing a 62-year-old woman who complains 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.

**Rationale:** Administration of nitroglycerin is based on the patient’s blood pressure, not on the patient’s heart rate.

5. **Review (2 of 2)**

You are managing a 62-year-old woman who complains 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.

6. **Review**

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.

**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.

**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

**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.

   **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.

**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

**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 patient 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

   **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.

88 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 patient with a documented low blood sugar
      Rationale: Oral glucose should not be given to unconscious patients.

89 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.

90 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.

91 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.

92 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

93 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.

94 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.

Review (1 of 2)
10. The process by which medications travel through body tissues until they reach the bloodstream is called:
   A. adsorption.
      Rationale: In adsorption, particles bind to a surface.
   B. onset of action.
      Rationale: Onset of action is the time that it takes for a medication to start doing what it is prescribed for.

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.