Chapter 11

Principles of Pharmacology

Definitions

absorption the process by which medications travel through body tissues to the bloodstream.

action the therapeutic effect that a medication is expected to have on the body.

agonist medication that causes stimulation of receptors.

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

capsule gelatin shells filled with powdered or liquid medication.

contraindications when a medication would either harm the patient or have no positive effect.

diaphoretic sweating heavily.

dose the amount of the medication that is given.

enteral absorbed via the digestive system.

sypoglycemia extremely low blood sugar.

indications reasons or conditions for which a particular medication is given.

inhalation administered via inhalation into the lungs

intramuscular (IM) administered via the muscle.

intranasal (IN) administered into the nostril (usually via mucosal atomizer device).

intraosseous (IO) administered into the bone.

intravenous (IV) administered into the vein.

medication substance used to treat or prevent disease or relieve pain.

metered-dose inhaler (MDI) a device that delivers a consistent amount of medication using a short burst of aerosolized medicine via inhalation.

myocardial infarction (MI) heart attack

parenteral absorbed via means other than the digestive system.

per oral (PO) administered by the mouth.

per rectum (PR) administered by the rectum.

pharmacodynamics the process by which medication works on the body.

pharmacology the science of drugs, including their ingredients, preparation, uses, and actions on the body.

side effects any actions of a medication other than the desired ones.

solution liquid mixture of one or more substances that cannot be separated simply.

sublingual (SL) under the tongue; a medication route.

subcutaneous (SC) administered under the skin.

suspension substance that does not dissolve well in liquids.

sympathomimetic simulating sympathetic nervous action in physiological effect

systemic effect whole-body

tablet contain other materials that are mixed with the medication and compressed.

transdermal administered via the skin (alt. transcutaneous)

transcutaneous administered via the skin (alt. transdermal)

unintended effects effects that are undesirable but pose little risk to the patient.

untoward effects effects that can be harmful to the patient.

Abbreviations

IM	intramuscular
IN	intranasal
IO	intraosseous
IV	intravenous
MDI	metered-dose inhaler
MI	myocardial infarction
OTC	over-the-counter
PO	per oral
PR	per rectum
SC	subcutaneous
SL	sublingual

I. Medication Routes of Administration

As an EMT, you will

1. Administer medications.
2. Help patients self-administer medications.

Routes of Administration

absorption: via tissues to the blood stream

enteral medications enter the body through the digestive system.

parenteral medications enter the body through means other than the digestive system.

Table 11.1: Routes of Medication Administration

name	abbrev.	entry point	rate of absorption
enteral			
[per] oral	PO	by mouth	slow
[per] rectal	PR	by rectum	rapid
sublingual	SL	under the tongue	rapid
parenteral			
inhalation		inhaled into the lungs	rapid
intramuscular	IM	into the muscle	moderate
intranasal	IN	into the nostril (via mucosal atomizer device)	rapid
intraosseous	IO	into the bone	immediate
intravenous	IV	into the vein	immediate
subcutaneous	SC	beneath the skin	slow
transcutaneous (transdermal)		through the skin	slow

Medication Form

Medication form is chosen by the manufacturer to ensure ~~maximum profits~~ the following:

1. Proper route of administration
2. Timing of the medication's release into the bloodstream
3. Effects on the target organs or body systems

Tablets, Capsules

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

Solutions, Suspensions

Solutions are liquid mixtures of one or more substances that cannot be separated simply.
Does not need to be shaken. Can be given as an IV, IM, or SC injection
Example:
epinephrine using an auto-injected (i.e. an Epi-Pen)

Suspensions substances that do not dissolve well in liquids; will separate if undisturbed/filtered.
Very important to shake before using!
Injectable suspensions only via IM or SC
Examples:
activated charcoal (PO)
some hormone shots and vaccinations (IM or SC)
calamine lotion (topical)

Metered-dose inhaler (MDI)

Metered-dose inhalers (MDI) direct aerosolizable liquids and fine powders through the mouth and into the lungs via inhalation.
Delivers the same consistent dosage every time
Very important to shake before using!
Example:
asthma inhalers

Topical medications

Applied to skin surface
affects only that area
includes lotions, creams, and ointments
Examples:
Calamine lotion (lotion)
hydrocortisone cream (cream)
Neosporin ointment (ointment)

Transcutaneous medications

transcutaneous/transdermal medications are absorbed through the skin.

May have systematic effects (compare with **topical medications** whose effects are limited to applied area.)

Touching will absorb medication same as patient!

Examples:

nitroglycerin paste

adhesive patch

Gels

Semiliquid

Administered in capsules or plastic tubes

Example:

oral glucose

Gases for Inhalation

Outside of OR, most commonly used is oxygen

Usually delivered through a nonrebreathing mask or nasal cannula

Example:

oxygen

II. Administering Medication

The 6 "Rights" of Medication Administration

Right patient : Patient who needs medication = patient who receives medication.

Right medication : Verify that it is the correct medication and prescription.

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

Right route : Verify the route of the medication.

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

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

Unit may carry:

- Oxygen
- Oral glucose
- Activated charcoal
- Aspirin
- Epinephrine

Circumstances in which medications may be administered:

1. Peer-assisted administration
2. Patient-assisted administration
3. EMT-administered medications

Determined by state and local protocols, medical control
The state, department, and medical director will define which medications are carried on your ambulance.

Table 11.2: Advantages & Disadvantages of Medication Administration Routes

Advantages	**Route of Administration**	**Disadvantages**
ease of access comfort level	PO	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
easy to advise patients quick absorption	SL	Constant evaluation of the airway Possible choking Not for uncooperative or unconscious patients
quick, easy access without using vein stable blood flow to muscle	IM	Use of a needle (and subsequent pain) Patients may fear pain or injury

Table 11.3: Drugs that can be Administered by EMTs

Drug	**Routes of Admin.**	**Forms**	**Uses**	**Contraindications**
activated charcoal	PO	suspension	Reduces the amount of medication being absorbed	Do not give to patients with altered level of consciousness.
oral glucose	PO	gel, tablet	Treats hypoglycemia	Do not give to an unconscious patients, or one who cannot protect the airway.
aspirin	PO	tablet	Useful during heart attack	Hypersensitivity to aspirin Liver damage, bleeding disorder, asthma Should not be given to children
nitrogylcerin	SL, inhalation (1 spray = 1 tablet)	SL tablet, metered-dose spray	Relieves angina pain Increases blood flow Relaxes veins	Possibility of MI, if no relief Should not be used with erectile dysfunction medications
epinephrine	IM	auto-injector	Treats life-threatening anaphylaxis	Do not give to patients with hypertension, hypothermia, MI, or wheezing.
Naloxone	IN	atomizer	Reverses the effects of opioid overdose	The effects of naloxone may not last as long as those of opioids; repeat doses may be necessary. Can cause severe withdrawal symptoms; patients may become violent
oxygen	inhalation	gas: nonrebreathing mask (preferred) nasal cannula	When a patient is not breathing, having trouble getting air	Ensure no open flames in vicinity

III. Potential Test Questions

1. What are enteral medication routes?

   Per oral, per rectal, sublingual

2. What are parenteral medication routes?

   intramuscular, intranasal, intraosseous, intravenous, subcutaneous, transcutaneous (transdermal)

3. What are the differences between capsules and tablets?

   Capsules are gelatin shells filled with powder or liquid. Tablets having their ingredients compressed under high pressure; may contain other materials mixed with the medication.

4. What are the differences between solutions and suspensions?

   A solution contains substances that *cannot be separated by standing or filtering*, whereas a solution will separate if undisturbed or filtered.

5. What should you do before administering a suspension?

   Shake or swirl

   Why?

   To ensure that the patient gets receives the right amount of medication.

   Why?

   Suspensions contain substances that do not dissolve well; they will separate if they stand or are filtered.

6. What is an example of a solution?

   epinephrine administered via auto-injector (i.e. an EpiPen)

7. What is an example of a suspension?

   Activated charcoal

8. What is the difference between a metered-dose inhaler and a nebulizer?

   Nebulizer has electric components and must be recharged

9. What is the difference between transdermal medications and topical medications?

   topical medications affect only the intended site, transdermal medications can have systemic effects.

Chapter 12

Shock

HA! HA! NOT ON THE TEST!

~~Definitions~~

~~flail chest~~ ~~a condition in which 3 or more ribs are fractured in 2 or more places, or in association with a fracture of the sternum so that a segment of the chest wall is effectively detached from the rest of the thoracic cage.~~

Chapter 13

BLS Resuscitation

Definitions

active compression-decompression CPR technique that involves compressing the chest and then actively pulling it back up to its neutral position and beyond.

anoxia absence of oxygen.

atrial fibrillation (a-fib) upper heart chambers contract irregularly

automated external defibrillator (AED) Device that detects treatable life-threatening cardiac arrhythmias (ventricular fibrillation and ventricular tachycardia) and delivers the appropriate electrical shock to the patient.

aortocaval compression Relating to the aorta and the vena cava.

apneic Absence of spontaneous breathing.

automated implanted cardioverter-defibrillator (AICD) see *pacemaker*.

Basic life support (BLS) Noninvasive, emergency lifesaving care that is used to treat medical conditions, including airway obstruction, respiratory arrest, and cardiac arrest.

bradycardia slow heart rate

cardiopulmonary resuscitation (CPR) the combination of chest compressions and rescue breathing used to establish adequate ventilation and circulation in a patient who is not breathing and has no pulse.

cyanosis Bluish discoloration of the skin resulting from poor circulation or inadequate oxygenation of the blood.

fundus part of a hollow organ that is farthest from the opening.

gastric distention A condition in which air fills the stomach, often as a result of high volume and pressure during artificial ventilation

head tilt-chin lift manuever A combination of two movements to open the airway by tilting the forehead back and lifting the chin; not used for trauma patients.

hypercarbia increased level of carbon dioxide (CO_2) in the bloodstream.

hyperventilation Rapid or deep breathing that lowers the blood carbon dioxide (CO_2) level below normal.

hypotension Blood pressure that is *lower* than the normal range.

hypoxia A dangerous condition in which the body's tissues and cells do not have enough oxygen.

impedance threshold device (ITD) A valve device placed between the endotracheal tube and a bag-valve mask that limits the amount of air entering the lungs during the recoil phase between chest compressions.

intrathoracic Within the chest (thoracic) cavity.

ischemia Decreased oxygen supply.

jaw-thrust maneuver Technique to open the airway by placing the fingers behind the angle of the jaw and bringing the jaw forward; use for patients who may have a cervical spine injury.

load-distributing band (LDB) Circumferential chest compression device composed of a constricting band and backboard that is either electrically or pneumatically driven to compress the heart by putting inward pressure on the thorax.

opiod Narcotic drug that, when taken in excess, depresses central nervous system, causing respiratory arrest followed by cardiac arrest.

pacemaker deliver shocks directly to the heart if necessary.
Also called an *automated implanted cardioverter-defibrillator [AICD]*

stoma an opening through the skin and into an organ or other structure.

tachycardia = very fast heart rate

ventricular fibrillation (v-fib) disorganized contraction of the lower chambers of the heart

ventricular tachycardia (v-tac) very fast heart rate

xiphoid process cartilaginous section at the lower end of the sternum.

Heart terms

atrial fibrillation (a-fib) upper heart chambers contract irregularly

bradycardia slow heart rate

tachycardia very fast heart rate

ventricular fibrillation (v-fib) disorganized contraction of the lower chambers of the heart

ventricular tachycardia (v-tac) very fast heart rate

Abbreviations

ABCs	airway (obstruction) breathing (respiratory arrest) circulation (cardiac arrest)
AED	automated external defibrillat[ion/or]
AHA	American Heart Association
ALS	advanced life support
BLS	basic life support
BVM	bag-valve mask
CPR	cardiopulmonary resuscitation
ITD	impedance threshold device
IV	intravenous
LDB	load-distributing band
ROSC	return of spontaneous circulation
SCA	sudden cardiac arrest
v-fib	disorganized contraction of the lower chambers of the heart
v-tac	ventricular tachycardia

I. Basic life support (BLS)

BLS is noninvasive, emergency lifesaving care that is used to treat medical conditions, including airway obstruction, respiratory arrest, and cardiac arrest.

BLS sequence (use ABC mnemonic):

airway (obstruction)

breathing (respiratory arrest)

circulation (cardiac arrest)

Difference between BLS and ALS ALS involves advanced lifesaving procedures such as cardiac monitoring, administration of intravenous (IV) fluids and medications, and the use of advanced airway adjuncts.

Permanent brain damage is possible after only 4-6 minutes without oxygen.
To survive cardiac arrest, effective CPR at an adequate rate and depth with minimal interruptions is essential until defibrillation can be administered.

II. BLS Procedures

According to the American Heart Association 88% of sudden cardiac arrests occur in the home

The 'Chain of Survival'

1. Recognition and activation of the emergency response system
    a) Laypeople must recognize the early warning signs of cardiac emergency to call 9-1-1
    b) Requires public education and awareness
2. Immediate high-quality CPR
3. Rapid defibrillation
    a) AED must be used as soon as it is available *without stopping chest compressions*
4. basic and advanced emergency medical services
    a) ALS: high-quality CPR, early defibrillation, and use of devices and/or drugs.

5. Advanced life support and post arrest care

    a) comprehensive, multidisciplinary system of care including mild therapeutic hypothermia and other treatments

CPR steps

1. Restore circulation by performing chest compressions to circulate blood.
2. 100-120 chest compressions per minute for 2 minutes
    - Depth of 2 inches to 2.4 inches (5 - 6cm)
    - Open airway with the jaw-thrust or head tilt-chin lift maneuver
3. Restore breathing by providing rescue breaths via mouth-to-mask ventilation, or bag-valve mask (BVM) minister
    - 2 breaths over 1 second while watching for chest rise.

Differences in providing CPR for infants, children and adults

1. CPR emergencies for infants and children require CPR usually have different underlying causes
2. Anatomical differences: children and infants have smaller airways than adults

Adults: usu. cardiac arrest →respiratory arrest

Children & infants: usu. respiratory arrest →respiratory arrest

Complications from chest compressions are rare but can include fractured ribs lacerated liver and a fractured sternum.

III. Assessing the Need for BLS

When not to start CPR

1. If the scene is unsafe
2. If the patient has obvious signs of death (obv. mortal damage, dependent lividity, rigor mortis, putrefaction)
3. If the patient/their physician has DNR or no CPR order

Special AED situations

automated implanted cardioverter-defibrillator (AICD)

Automated implanted cardioverter-defibrillators (AICD), commonly known as **pacemakers**, deliver shocks directly to the heart if necessary

Identifying AICDs AICDs create a hard lump beneath the skin on the upper-left side of the chest (just below the clavicle)

AED usage with AICDs

Do not pads directly over the device: this reduces effectiveness of AED shock.

- Place AED pads at least 1 inch (2.5 cm) away from the device.
- Occasionally, implanted device will deliver shocks to the patient
  - If you observe the patient's **muscles twitching**:
    continue CPR and wait 30 – 60 seconds before delivering the shock from the AED.

Patient's chest is wet

If patient's chest is wet, the electrical current may move across the skin rather than between the pads.

Patient is submerged in water

1. Pull patient out of the water
2. Quickly dry skin before attaching AED pads
3. Do **not** delay CPR to dry the patient thoroughly
   - instead, quickly wipe off as much moisture as possible from the chest

Patient lying in small puddle of water or snow

- AED can be used but again the patient's chest should be quickly dried as much as possible

transdermal medication

patches you may encounter patient who is receiving medication through transdermal medication patch such as nitroglycerin if the medication patch interferes with AED pad placement them remove the patch with your gloved hands and wiped the skin to remove any residue prior to attaching the AED pad

IV. Devices and Techniques to Assist Circulation

active compression-decompression CPR

Technique that involves compressing the chest and then actively pulling it back up to its neutral position and beyond. May increase the amount of blood that returns to the heart and thus the amount of blood ejected from the heart during the compression phase

impedance threshold device (IPD)

Valve device placed between the ET tube and it BVM may also be placed between the bag and mask if an ET tube is not in place limits air entering the lungs during the *recoil phase* between chest compressions Results in *negative* intrathoracic pressure that may draw more blood towards the heart ultimately resulting in improved cardiac filling and circulation. it is not currently recommended for use with conventional CPR if our OSC occurs than the IPD should be removed

mechanical piston device

device that depresses the sternum via plunger mounted on a backboard.

Positioning supine on backboard
plunger centered over the patient's thorax (same place hands would go).

LVAD

The effectiveness of CPR depends on the amount of blood circulated throughout the body as a result of chest compressions before you consider the use of mechanical devices to assist circulation ensure that your manual chest compressions her concerns distantly high quality

V. Special resuscitation circumstances

Opioid overdose

Narcotic that when taken in excess depresses the central nervous system causes respiratory arrest followed by cardiac arrest.

Naloxone Chest compressions ventilation defibrillation take priority over naloxone administration do not delay other interventions while awaiting the patient's response to naloxone therapy May have a **pulse** but **not breathing**: BVM ventilation *is the most critical treatment*, followed by naloxone (if available).

Pregnancy & cardiac arrest

Priority provide high-quality CPR. Relieve pressure off the *aorta* and *vena cava.* When patient lies supine, the pregnant uterus can *compress the aorta and vena cava (aortocaval compression)*
If pregnant patient is **not** in cardiac arrest: position her on the **left side** to relieve pressure on the vessels aorta and vena cava.

If she is in cardiac arrest, this is impractical. because she must remain in the supine position to maximize effectiveness of compressions therefore if the top the patient's uterus (fundus) can be felt at or above the level of the umbilicus perform manual displacement of the uterus to the patient's left to relieve aorta painful compression while CPR is being performed

Whenever you assist the patient remember that his or in some patient apps that in some cases family members may experience a psychological crisis that turns to medical crisis and may become patients themselves

VI. Potential Test Questions

1. How does BLS differ from ALS?
   ALS involves advanced lifesaving procedures such as cardiac monitoring, administration of IV fluids and medications, and the use of advanced airway adjuncts.

2. What is the difference between hypoxia and ischemia?
   Hypoxia is when oxygen saturation is below 90%, while ischemia is when blood supply to tissue is interrupted.
   ischemia leads to hypoxia.

3. What conditions must be present for a patient to be placed into the recovery position? Unconscious, no traumatic injuries, breathing on their own.

4. Under what circumstances does an EMT **not** start CPR?
   - If the scene is unsafe
   - If the patient has obvious signs of death (obv. mortal damage, dependent lividity, rigor mortis, putrefaction)
   - If the patient/their physician has DNR or no CPR order

Table 13.1: Review of BLS procedures

Procedure	**Adult**	**Child** Age 1 month – 1 year	**Infant** Age 1 year – onset of puberty
Circulation			
pulse check	carotid artery	carotid or femoral artery	brachial artery
compression area	center of the chest, in between the nipples	center of the chest, in between the nipples	just below the nipple line
compression width	heel of both hands	heel of one or both hands	Two-finger technique, or two-thumb encircling -hands technique
compression depth	2 – 2.4 in. (5 – 6 cm)	at least $\frac{1}{3}$ anterior-posterior diameter (˜2 in. or 5cm)	At least $\frac{1}{3}$ anterior-posterior diameter (˜1.5 in. or 4 cm)
compression rate	100 to 120/min		
compression-to-ventilation ratio*	10:1		
Foreign body obstruction	**Responsive:** abdominal thrusts (Heimlich); chest thrust if the patient is pregnant or has obesity **Unresponsive**: CPR	**Responsive:** abdominal thrusts (Heimlich) **Unresponsive:** CPR	**Responsive:** back slaps, chest thrusts **Unresponsive:** CPR
Airway			
airway positioning	head tilt-chin lift;jaw-thrust if spinal injury suspected		
Breathing			
ventilations	1 breath every 5 – 6 sec. (10 – 12 breaths/min); ˜1 second per breath; visible chest rise	1 breath every 3–5 seconds (12 to 20) breaths/min; ˜1 second per breath; visible chest rise	1 breath every 3–5 seconds (12 to 20) breaths/min; ˜1 second per breath; visible chest rise
ventilations (with advanced airway placed)	1 breath every 6 seconds (rate of 10 breaths/min)	1 breath every 6 seconds (rate of 10 breaths/min)	1 breath every 6 seconds (rate of 10 breaths/min)

Appendix A

Flash Cards

Chapter 11 – Principles of Pharmacology

- What are enteral medication routes?
  Per oral, per rectal, sublingual
- What are parenteral medication routes?
  intramuscular, intranasal, intraosseous, intravenous, subcutaneous, transcutaneous (transdermal)
- What are the differences between capsules and tablets?
  Capsules are gelatin shells filled with powder or liquid. Tablets having their ingredients compressed under high pressure; may contain other materials mixed with the medication.

Chapter 13 – BLS Resuscitation

- The effectiveness of CPR depends on
  the amount of blood circulated throughout the body as a result of chest compressions
- Permanent brain damage is possible after only ___ without oxygen.
  4 – 6 minutes
- the preferred method to dislodge a severe airway obstruction in adults and children; also called the Heimlich maneuver.
  abdominal-thrust maneuver
- A technique that involves compressing the chest and then actively pulling it back up to its neutral position or beyond (decompression); may increase the amount of blood that returns to the heart, and thus, the amount of blood ejected from the heart during the compression phase.
  active compression decompression CPR
- Noninvasive emergency lifesaving care that is used to treat medical conditions, including airway obstruction, respiratory arrest, and cardiac arrest.
  BLS

- The combination of chest compressions and rescue breathing used to establish adequate ventilation and circulation in a patient who is not breathing and has no pulse.

  CPR
- The total percentage of time during a resuscitation attempt in which active chest compressions are being performed.

  chest compression fraction
- Rapid or deep breathing that lowers the blood carbon dioxide level below normal; may lead to increased intrathoracic pressure, decreased venous return, and hypotension when association with BVM use.

  hyperventilation
- A valve device placed between the endotracheal tube and a bag-valve mask that limits the amount of air entering the lungs during the recoil phase between chest compressions.

  impedance threshold device
- A lack of oxygen that deprives tissues of necessary nutrients, resulting from partial or complete blockage of blood flow; potentially reversible because permanent injury has not yet occurred.

  ischemia
- A circumferential chest compression device composed of a constricting band and backboard that is either electrically or pneumatically driven to compress the heart by putting inward pressure on the thorax.

  load-distributing band
- A device that depresses the sternum via a compressed gas-powered or electric powered plunger mounted on a backboard.

  mechanical piston device
- The return of a pulse and effective blood flow tot he body in a patient who previously was in cardiac arrest.

  Return of spontaneous circulation (ROSC)