I. Introduction

A. Vascular Access

1. Often needed in emergency medicine for patients in hemodynamically unstable condition and in need of intravenous (IV) fluids, various medications, or both
2. Techniques
   a. Cannulation of a peripheral extremity vein
   b. External jugular vein cannulation
   c. Intraosseous infusion

II. Fluids and Electrolytes

A. Fluids

1. Body composed mostly of water
   a. Environment in which the chemical reactions necessary to life take place
   b. Transport medium for nutrients, hormones, and waste materials
2. Total body water (TBW) constitutes 60% of the weight of an adult male.
   a. Intracellular fluid (ICF) is the water contained inside the cells (45% of body weight).
   b. Extracellular fluid (ECF) is the water outside of cells (15% of body weight), and is divided into two types of fluids (interstitial fluid and intravascular fluid).
   c. Interstitial fluid is the water bathing the cells (10.5% of body weight).
   d. Intravascular fluid (plasma) is the water within the blood vessels carrying red blood cells, white blood cells, and vital nutrients (4.5% of body weight).
3. The fluids in the body are composed of dissolved elements and water (solution).
   a. A solvent is the fluid that does the dissolving, or the solution that contains the dissolved components.
   b. A solute is the dissolved particles contained in the solvent.

B. Electrolytes

1. Organic molecules (eg, table sugar, $C_6H_{12}O_6$) contain carbon whereas inorganic molecules (eg, table salt, NaCl) do not contain carbon.
   a. Inorganic molecules give rise to electrolytes (so called because of their ability to conduct electricity) when they dissolve in water into their charged components.
2. Electrolytes (ions) are reactive and dangerous if left to circulate in the body.
   a. The body uses the energy stored in these charged particles.
   b. They regulate everything from water levels to cardiac functions and muscle contractions.
3. Water stabilizes the electrolyte charges so that they can aid in the metabolic functions necessary for life.
4. Each electrolyte has a unique property or value to the body.
   a. If the electrolyte has an overall positive charge, it is called a cation.

   b. If it has an overall negative charge, it is called an anion.
   c. Major cations include sodium, potassium, calcium, and magnesium.
   d. Major anions include bicarbonate, chloride, and phosphorus.
5. The unit of measurement for electrolytes is the milliequivalent (mEq).
   a. Represents the chemical combining power of the ion based on the number of available ionic charges
6. Sodium (Na^+)
   a. Principle extracellular cation needed to regulate distribution of water throughout the body
7. Potassium (K^+)
   a. 98% of potassium is found in the cells, making it the principle intracellular cation.
   b. Neuromuscular function and converts glucose into glycogen
   c. Potassium levels are regulated by insulin.
   d. Hypokalemia: low potassium levels can lead to decreased skeletal muscle function, gastrointestinal disturbances, and alterations in cardiac function.
   e. Hyperkalemia: high potassium levels can lead to hyperstimulation of neural cell transmission, resulting in cardiac arrest.
8. Calcium (Ca^{++})
   a. Principle cation for bone growth
   b. Plays an important part in the functioning of the heart muscle, nerves, and cell membranes, and is necessary for blood clotting
   c. Hypocalcemia: low serum calcium levels can lead to overstimulation of nerve cells; symptoms include muscle cramps, abdominal cramps, carpopedal spasms, hypotension, and vasoconstriction.
   d. Hypercalcemia: high serum calcium levels can lead to decreased stimulation of nerve cells; symptoms include skeletal muscle weakness, lethargy, ataxia, vasodilation, and hot, flushed skin.
9. Magnesium (Mg^{++})
   a. Coenzyme in the metabolism of proteins and carbohydrates
   b. Controls neuromuscular irritability
10. Bicarbonate (HCO_3^-)
   a. Levels are the determining factor between acidosis and alkalosis in the body.
   b. Primary buffer used in circulating body fluids
11. Chloride (Cl^-)
   a. Primarily regulates the pH of the stomach
   b. Regulates extracellular fluid
12. Phosphorus (P)
   a. Important component in adenosine triphosphate (ATP), the body's energy source

C. Nonelectrolytes

1. Solutes with no electrical charge
2. Glucose and urea

III. Fluid and Electrolyte Movement

A. Chemical and Biologic Tenets

1. Unequal concentrations on different sides of a cell membrane will move to balance themselves equally on both sides of the membrane.
   a. Balance of compounds on either side of the cell membrane
   b. Balance of charges (positive or negative) on either side of the cell membrane
2. Concentration gradient
   a. Created when concentrations are greater on one side of the cell membrane than the other
   b. The natural tendency for materials is to flow from an area of higher concentration to one of lower concentration.
   c. Categorized by the type of materials that flow down them (chemical or electrical)

B. Diffusion

1. The movement across a cell membrane from areas of higher concentration to areas of lower concentration

C. Filtration

1. Type of diffusion often used by the kidneys to clean blood
2. Water carries dissolved compounds across the cell membranes of the tubules of the kidney.
   a. The tubules trap dissolved compounds while letting water pass through.
   b. Antidiuretic hormone (ADH) prevents the loss of water from the kidneys by causing its reabsorption into the tubules.

D. Active Transport

1. Often, a cell must maintain an imbalance of compounds to achieve some metabolic purpose.
2. To maintain imbalance, the cell must use energy (ATP) and actively transport compounds across its membrane.

E. Osmosis

1. Chief influence of the concentration of fluid in compartments
2. If two solutions are separated by a semipermeable membrane, water will flow across the membrane from the solution of lower solute concentration to the solution of higher solute concentration, equalizing the solute concentrations on both sides.
3. The effects of osmotic pressure on a cell constitute the tonicity of the solution.
   a. Reflects the concentration of sodium and the movement of water in relation to sodium levels inside and outside the cell

F. Abnormal States of Fluid and Electrolyte Balance

1. Homeostasis is the internal environment's resistance to change
   a. An ill or injured body may be unable to maintain homeostasis.

   b. Excesses or deficits of fluid and electrolytes may occur.
2. A healthy person loses approximately 2 to 2.5 L of fluid daily through urine output and through the lungs (exhalation) and skin.
   a. In illness, abnormal states of hydration may occur.
3. Dehydration
   a. Inadequate total systemic fluid volume
   b. Usually a chronic condition of the elderly or very young
   c. Signs and symptoms include decreased level of consciousness, postural hypotension, tachypnea, dry mucous membranes, tachycardia, poor skin turgor, and flushed, dry skin.
   d. Causes include diarrhea, vomiting, gastrointestinal drainage, hemorrhage, and insufficient fluid or food intake.
4. Overhydration
   a. Total systemic fluid volume increases
   b. Fluid backup can lead to death
   c. Signs and symptoms include shortness of breath, puffy eyes, edema, polyuria, moist crackles (rales), and acute weight gain.
   d. Causes include unmonitored IVs, kidney failure, and prolonged hypoventilation.

IV. IV Fluid Composition

A. Types of IV Solutions

1. Five basic types to create desired effects inside the body
2. Isotonic solutions
   a. Normal saline (0.9% sodium chloride)
   b. Almost the same osmolarity (concentration of sodium) as serum and other body fluids
   c. Expand the contents of intravascular compartments without shifting fluid to or from other compartments or changing cell shape
   d. Lactated Ringer's (LR) solution is generally used in the field for patients who have lost large amounts of blood. It contains lactate, which is metabolized in the liver to form bicarbonate.
   e. D_5W (5% dextrose in water) is a unique type of isotonic solution that becomes hypotonic when the dextrose is metabolized in the body.
3. Hypotonic solutions
   a. Osmolarity less than that of serum
   b. Dilute serum, pulling water from the vascular compartment into the interstitial fluid compartment causing cells to swell
   c. Hydrate the cells while depleting the vascular compartment (dialysis recovery or hyperglycemic conditions)
   d. Used to cause a sudden fluid shift from the intravascular space to the cells, leading to cardiovascular collapse and increased intracranial pressure
4. Hypertonic solutions

a. Osmolarity higher than that of serum
b. Pull fluid and electrolytes from the intracellular and interstitial compartments into the intravascular compartment
c. Stabilize blood pressure, increase urine output, and reduce edema
d. Rarely used in the prehospital setting
e. High concentration of proteins that have the same effect as sodium

5. Crystalloid solutions
   a. Dissolved crystals (salts or sugars) in water
   b. Best choice for prehospital care of injured patients who need body fluid replacement
   c. 3-to-1 replacement rule: 3 mL of isotonic crystalloid solution is needed to replace 1 mL of patient blood.
   d. Cannot carry oxygen
   e. Given to maintain perfusion but not to raise blood pressure to the patient's normal level (dilutes blood volume)
6. Colloid solutions
   a. Contain molecules (usually proteins) that are too large to pass out of the capillary membranes and remain in the vascular compartment
   b. Very high osmolarity
   c. Draw fluid from the interstitial and intracellular compartments into the vascular compartments
   d. Work well in reducing edema
   e. Could cause dramatic fluid shifts and are rarely used in the prehospital setting
7. Oxygen-carrying solutions
   a. The best fluid to replace lost blood is whole blood.
   b. On occasion, O-negative blood (universally compatible blood type) may be used outside a hospital setting.
   c. Synthetic blood substitutes are being researched and field tested.

V. IV Techniques and Administration

A. Overview

1. Intravenous means within a vein.
2. Intravenous (IV) therapy involves cannulation of a vein with a catheter to access the patient's vascular system.
   a. One of the most invasive techniques you will perform as a paramedic
3. Peripheral vein cannulation involves cannulating veins of the periphery (veins that can be seen or palpated).
4. The most important point to remember is to keep the IV equipment sterile.

B. Assembling Your Equipment

1. To avoid delays and IV site contamination, gather and prepare all your equipment before you attempt to start an IV.

C. Choosing a Solution

1. Identify the needs of the patient.
   a. Is the patient's condition critical?
   b. Is the patient's condition stable?
   c. Does the patient need fluid replacement?
   d. Will the patient need medications?
2. Usually limited to two isotonic crystalloids
   a. Normal saline
   b. LR solution
3. Each IV solution bag is wrapped in a protective sterile plastic bag and is guaranteed to remain sterile until the posted expiration date. Once the wrap is torn and removed the IV solution must be used within 24 hours.
4. Two ports
   a. Injection port for medication
   b. Access port for connecting the administration set

D. Choosing an Administration Set

1. An administration set moves fluid from the IV bag into the patient's vascular system.
2. Piercing spike
3. Drip sets
   a. A number on the package indicates the number of drops it takes for a milliliter of fluid to pass through the orifice into the drip chamber.
   b. Microdrip allows 60 gtt (drops) per milliliter (mL) through the needlelike orifice inside the drip chamber (ideal for medication administration or pediatric fluid delivery).
   c. Macrodrip sets allow 10 or 15 gtt/mL through a large opening between the piercing spike and the drip chamber (best for rapid fluid replacement).
4. Preparing an administration set
   a. Verify the expiration date of the solution and check for solution clarity.
   b. Prepare to spike the bag with the administration set.
5. Skill Drill 8-1 Preparing an Administration Set
   a. Remove the rubber pigtail found on the end of the IV bag by pulling on it. The bag is still sealed and will not leak until the piercing spike punctures this port. Remove the protective cover from the piercing spike. (Remember, this spike is sterile.) (Step 1)
   b. Slide the spike into the IV bag port until you see fluid enter the drip chamber. (Step 2)
   c. Allow the solution to run freely through the drip chamber and into the tubing to prime the line and flush the air out of the tubing. (Step 3)
   d. Twist the protective cover on the opposite end of the IV tubing to allow air to escape. Do not remove this cover yet, because the cover keeps the tubing end sterile until it is needed. Let the fluid flow until air bubbles are removed from the line before turning the roller clamp wheel to stop the flow. (Step 4)

e. Go back and check the drip chamber; it should be only half-filled. The fluid level must be visible to calculate drip rates. If the fluid level is too low, squeeze the chamber until it fills; if the chamber is too full, invert the bag and the chamber and squeeze the chamber to empty the fluid back into the bag (Step 5). Hang the bag in an appropriate location with the end of the IV tubing easily accessible.

6. Other administration sets
   a. Blood tubing is a macrodrip administration set that is designed to facilitate rapid fluid replacement by manual infusion of multiple IV bags or IV and blood replacement combinations (dual piercing spikes).
   b. Volutrol is a microdrip set used for pediatric patients and certain geriatric patients that allows you to fill a 100- or 200-mL calibrated drip chamber with a specific amount of fluid and administer only that amount to avoid fluid overload.

E. Choosing an IV Site

1. Select the most appropriate vein for IV catheter insertion.
2. Avoid areas of the vein that contain valves (may be recognized as small bumps located in the vein).
3. Criteria
   a. Locate the vein section with the straightest appearance.
   b. Choose a vein that has a firm, round appearance or is springy when palpated.
   c. Avoid areas where the vein crosses over joints.
   d. Avoid edematous extremities and any extremity with a dialysis fistula or on the side a mastectomy was done.
4. Start distally, work proximally.
   a. If the distal site ruptures or infiltrates, you can move up the extremity to the next appropriate site.
5. Large protruding arm veins can be deceiving.
   a. Often roll from side to side during a cannulation attempt
   b. Apply manual traction to lock it in position.

F. Choosing an IV Catheter

1. Should reflect the purpose of the IV, the age of the patient, and the location for the IV
2. The most common types are over-the-needle catheters and butterfly catheters.
   a. An over-the-needle catheter is a Teflon catheter inserted over a hollow needle.
   b. A butterfly catheter is a hollow, stainless steel needle with two plastic wings to facilitate its handling.
   c. Through-the-needle catheters are plastic catheters inserted through a hollow needle (rarely used in the prehospital setting).
   d. Tables 8-1 and 8-2 list the advantages and disadvantages of over-the-needle and butterfly catheters, respectively.
3. Select the largest diameter catheter that will fit the vein you have chosen or that will be the most appropriate and comfortable for the patient.
4. Contaminated stick

a. The paramedic punctures his or her skin with the same catheter that was used to cannulate the vein of a patient

G. Inserting the IV Catheter

1. Each paramedic has a unique technique to insert an IV.
2. Two considerations apply to any technique.
   a. Keep the beveled side of the catheter up when inserting the needle in a vein.
   b. Maintain adequate traction on the vein during cannulation.
3. Apply a constricting band above the site you have chosen for insertion to allow blood to fill the veins.
   a. Creates additional vascular pressure to engorge the veins with blood
   b. Snug enough to significantly diminish venous flow but not enough to hamper arterial flow
   c. Left in place only long enough to complete the insertion, obtain blood samples (if needed), and attach the line
   d. Penrose drain, a blood pressure cuff, or surgical hose
4. Prep the insertion site.
   a. Alcohol or iodine swab
   b. Apply gentle downward or lateral traction with your free hand.
   c. Establish an insertion angle of about 45º.
   d. Advance the catheter through the skin until the vein is pierced (flash of blood in the catheter flash chamber).
   e. Immediately drop the angle down to about 15º and advance the catheter a few more centimeters to ensure the catheter sheath is in the vein.
   f. Slide the sheath off the needle and into the vein (do not advance the needle too far because it can lacerate the vein).
   g. After the catheter is fully advanced, apply pressure to the vein just proximal to the end of the indwelling catheter, remove the needle, and dispose of it in a sharps container.

H. Securing the Line

1. Tape the area so that the catheter and tubing are securely anchored in case of a sudden pull on the line.
2. Tear the tape before you start the IV, because you will need one hand to stabilize the site while you tape the IV.
3. Double back the tubing to create a loop that will act as a shock absorber if the line is pulled accidentally.
4. Cover the insertion site with sterile gauze, and secure it with tape.
5. Avoid circumferential taping around any extremity.
6. Skill Drill 8-2: Obtaining Vascular Access
   a. Choose the appropriate fluid, and examine the bag for clarity and expiration date. Make sure that no particles are floating in the fluid and that the fluid is appropriate for the patient's condition.

b. Choose the appropriate drip set, and attach it to the fluid. A macrodrip set (eg, 10 gtt/mL) should be used for a patient who needs volume replacement; a microdrip set (eg, 60 gtt/mL) should be used for a patient who needs a medication route.
c. Fill the chamber by squeezing it (Step 1).
d. Flush or "bleed" the tubing to remove any air bubbles by opening the roller clamp (Step 2). Make sure no errant bubbles are floating in the tubing.
e. Tear the tape before venipuncture, or have a commercial device available (Step 3).
f. Apply gloves before making contact with the patient. Palpate a suitable vein (Step 4). Veins should be "springy" when palpated. Stay away from areas that are hard when palpated.
g. Apply the constricting band above the intended IV site (Step 5). It should be placed approximately 6" to 10" above the intended site.
h. Clean the area using aseptic technique. Use an alcohol pad to cleanse in a circular motion from the inside out. Use a second alcohol pad to wipe straight down the center (Step 6).
i. Choose the appropriately sized catheter, and twist the catheter to break the seal. Do not advance the catheter upward, because this may cause the needle to shear the catheter. Examine the catheter and discard it if you discover any imperfections (Step 7). Occasionally you will find "burrs" on the edge of the catheter.
j. Insert the catheter at an angle of approximately 45º with the bevel up while applying distal traction with the other hand (Step 8). This traction will stabilize the vein and help to keep it from "rolling" as you stick.
k. Observe for "flashback" as blood enters the catheter (Step 9). The clear chamber at the top of the catheter should fill with blood when the catheter enters the vein. If you note only a drop or two, you should gently advance the catheter further into the vein.
l. Occlude the catheter to prevent blood leaking while removing the stylet (Step 10). Place the thumb of the hand not holding the catheter over the end of the catheter that is currently situated inside the vein to prevent blood running out when you remove the needle. With practice, you will be able to feel the catheter.
m. Immediately dispose of all sharps in the proper container (Step 11).
n. Attach the prepared IV bag (Step 12).
o. Remove the constricting band (Step 13).
p. Open the IV line to ensure fluid is flowing and the IV is patent. Observe for any swelling or infiltration around the IV site (Step 14). If the fluid does not flow, check whether the constriction band has been released. If infiltration is noted, immediately stop the infusion and remove the catheter while holding pressure over the site to prevent bleeding.
q. Secure the catheter with tape or a commercial device (Step 15).
r. Secure IV tubing and adjust the flow rate while monitoring the patient (Step 16).

I. Changing an IV Bag

1. Do not allow an IV fluid bag to become completely depleted of fluid (25 mL left).
2. Two important points
   a. Replacing the bag is a sterile process.

b. Never allow the administration set to become depleted of fluid; always ensure that some fluid remains in the drip chamber and tubing of the set (prevents air from entering the patient's vein).

3. Steps
   a. Stop the flow of fluid from the depleted bag by closing the roller clamp.
   b. Prepare the new IV bag by removing the pigtail from the piercing spike port. Inspect the new bag of IV fluid for clarity and discoloration and to ensure that the expiration date has not passed.
   c. Remove the piercing spike from the depleted bag and insert it into the port on the new bag. Do not touch the piercing spike of the administration set.
   d. Ensure that the drip chamber is appropriately filled, and then open the roller clamp and adjust the fluid rate accordingly.

J. Discontinuing the IV Line

1. Shut off the flow with the roller clamp.
2. Peel back the tape toward the IV site.
3. As you get closer to the site and the catheter, stabilize the catheter while you loosen the remaining tape.
4. Do not remove the IV tubing from the hub of the catheter.
5. Fold a 4" x 4" piece of gauze and place it over the site, holding it down while you pull back on the hub of the catheter.
6. Gently pull the catheter and the IV line from the patient's vein while applying pressure to control bleeding.

VI. External Jugular Vein Cannulation

A. External Jugular Vein (EJ vein)

1. Runs downward and obliquely backward behind the angle of the jaw until it pierces the deep fascia of the neck just above the middle of the clavicle
2. Fairly large and usually easy to cannulate
   a. Because it is so near the surface of the skin, it rolls if the vein is not appropriately anchored.
   b. Very near other vessels (carotid artery) that may be damaged during cannulation
3. Exhaust all other means of cannulating a peripheral vein before attempting cannulation of the EJ vein. (Risks include puncturing the carotid artery, a rapidly expanding hematoma if infiltration occurs, and air embolism.)
4. Steps
   a. Place the patient in a supine, head-down position to fill the jugular vein. Turn the patient's head to the side opposite the intended venipuncture site. Always feel carefully for a pulse before cannulating an external jugular vein. It is imperative not to pierce the carotid artery.
   b. Appropriately cleanse the venipuncture site.
   c. Occlude the jugular vein with your finger, distal to the catheter insertion site, to facilitate backflow of blood; this will allow the vein to become more visible.

d. Align the catheter in the direction of the vein, with the point aimed toward the shoulder on the side of the venipuncture.
e. Make the puncture midway between the angle of the jaw and the midclavicular line. Stabilize the vein by placing a finger lightly on top of it just above the clavicle.
f. Proceed as described for cannulation of a peripheral vein. Do not let air enter the catheter once it is in the vein.
g. Tape the line securely but do not put circumferential dressings around the neck.

VII. Factors Affecting IV Flow Rates

A. Perform the following checks.

1. Check the IV fluid.
   a. Thick, viscous fluids such as blood products and colloid solutions infuse slowly and may be diluted to help speed delivery.
   b. Cold fluids run more slowly than warm fluids. If possible, warm IV fluids before administering them in a cold environment.
2. Check the administration set.
   a. Macrodrips are used for rapid fluid delivery.
   b. Microdrips deliver a more controlled flow.
3. Check the height of the IV bag.
   a. The IV bag must be hung high enough to overcome gravity. Hang it as high as possible.
4. Check the type of catheter used.
   a. The larger the diameter of the catheter (the smaller the number), the more fluid can be delivered.
5. Check the constricting band.
   a. Do not leave the constricting band on the patient's arm after completing the IV.

VIII. Potential Complications of IV Therapy

A. Local IV Site Reactions

1. Most local reactions require that you discontinue the IV and reestablish the IV in the opposite extremity.
2. Infiltration
   a. The escape of fluid into the surrounding tissue, which causes a localized area of edema
   b. Causes include the IV passing completely through the vein and out the other side; the patient moving excessively; the tape used to secure the IV becoming loose or dislodged; and the catheter being inserted at too shallow an angle and entering only the fascia surrounding the vein.
   c. Signs and symptoms include edema at the catheter site, continued IV flow after occlusion of the vein above the insertion site, and patient complaints of tightness and pain around the IV site.

d. If it occurs discontinue the IV and reestablish it in the opposite extremity or in a more proximal location on the same extremity. Apply direct pressure over the swollen area to reduce further swelling or bleeding into the tissue.

3. Thrombophlebitis
   a. Inflammation of the vein
   b. Most frequently caused by lapses in aseptic technique
   c. Commonly encountered in patients who abuse drugs as well as in patients who are receiving long-term IV therapy in a hospital or hospice setting
   d. Manifested by pain and tenderness along the vein and redness and edema at the venipuncture site
   e. Stop the infusion and discontinue the IV at that site. Warm compresses applied to the site may provide some relief.
   f. Far better to prevent than to treat it
   g. Prevention methods include using a povidone-iodine preparation to scrub and disinfect the skin over the venipuncture site, then doing a final wipe with an alcohol swipe (make sure the site is dry before initiating the venipuncture); always wearing gloves when doing a venipuncture; after inserting the catheter, covering the puncture site with a sterile dressing; and anchoring the catheter and tubing securely to prevent motion of the catheter within the vein.
4. Occlusion
   a. Physical blockage of a vein or catheter
   b. Flow rate insufficient to keep fluid moving out of the catheter tip such that blood enters the catheter and a clot may form
   c. The first sign is a decreasing drip rate or the presence of blood in the IV tubing.
   d. Positional IV site causes fluids to flow at different rates depending on the position of the catheter within the vein causing occlusion.
   e. May occur if IV bag nears empty and the patient's blood pressure overcomes the flow, causing fluid backup in the line
5. Skill Drill 8-3: Determining Whether an IV Is Viable
   a. Select and assemble a sterile 10-mL syringe and large gauge needle (Step 1).
   b. Select an injection port near the IV site, and swab it with an alcohol wipe.
   c. Depress the plunger of the syringe, and insert the syringe into the port (Step 2).
   d. Pinch the line between the IV site and the port, and pull back on the plunger to draw clean IV fluid from the bag (Step 3).
   e. Once the syringe is full, leave it in place, switch your hand from the tubing between the port and the IV site to between the port and the IV bag, and pinch the line.
   f. Gently apply pressure to the plunger to disrupt the occlusion and reestablish flow.
   g. If flow is reestablished, ensure that the line is free and the rate is sufficient.
   h. If the occlusion does not dislodge, discontinue IV and reestablish it in the opposite extremity or at a proximal location in the same extremity (Step 4).
6. Vein irritation
   a. Patients who have this problem often complain immediately that the solution is bothering them (ie, tingling, stinging, itching, and burning).
   b. Observe the patient closely in case an allergic reaction to the fluid develops.

c. Usually caused by a too-rapid infusion rate
d. If redness develops at the IV site, discontinue the IV and save the equipment for later analysis. Reestablish the IV in the other extremity with new equipment in case the old equipment contained unseen contaminants.

7. Hematoma
   a. Accumulation of blood in the tissues surrounding an IV site, often resulting from vein perforation or improper catheter removal
   b. Blood can be seen rapidly pooling around the IV site (tenderness and pain).
   c. Patients with a history of vascular diseases (including diabetes) and patients taking certain medications can have a predisposition to vein rupture or to hematoma development.
   d. If it occurs, stop and apply direct pressure to help minimize the bleeding.
8. Nerve, tendon, or ligament damage
   a. Improper identification of anatomic structures around the IV site
   b. Selecting an IV site near joints increases the risk for perforation of these structures.
   c. Sudden and severe shooting pain and numbness or tingling in the extremity
   d. Immediately remove the catheter and select another IV site.
9. Arterial puncture
   a. Risk is especially high when cannulating an external jugular vein.
   b. Bright red blood will spurt back into the catheter.
   c. Immediately withdraw the catheter and apply direct pressure over the puncture site for at least 5 minutes or until the bleeding stops.
   d. Always check for a pulse in any vessel you intend to cannulate.

B. Systemic Complications

1. Can evolve from reactions or complications associated with IV insertion
   a. Usually involve other body systems and can be life-threatening
2. Allergic reactions
   a. Often minor
   b. Anaphylaxis is possible and must be treated aggressively.
   c. Unexpected sensitivity to an IV fluid or medication
   d. Patient presentation depends on the extent of the reaction (itching, shortness of breath, edema of the face and hands, urticaria, bronchospasm, and wheezing).
   e. Discontinue IV and remove the solution, leave the catheter in place as an emergency medication route, attach a saline lock, and notify medical control immediately.
3. Pyrogenic reactions
   a. Pyrogens are foreign proteins capable of producing fever.
   b. Characterized by an abrupt temperature elevation (as high as 106ºF) with severe chills, backache, headache, weakness, nausea, and vomiting
   c. The reaction usually begins within 30 minutes after the IV infusion has been started.
   d. Stop the infusion immediately, start a new IV in the other arm with a fresh infusion solution, and remove the first IV.
4. Circulatory overload

a. Healthy adults can handle as much as 2 to 3 extra liters of fluid without compromise.
b. Complications occur when the patient has cardiac, pulmonary, or renal dysfunction.
c. The most common cause in the prehospital setting is failure to readjust the drip rate after flushing an IV line immediately after insertion.
d. Signs and symptoms include dyspnea, jugular vein distention, and hypertension; crackles (rales) are often heard when evaluating breath sounds; acute peripheral edema can also be an indicator.
e. Slow the IV rate and raise the patient's head to ease respiratory distress; administer high-flow oxygen, and monitor vital signs and breathing adequacy.

5. Air embolus
   a. Any air introduced into the IV line can be dangerous.
   b. Proper flushing of an IV line will help eliminate the likelihood of air emboli.
   c. Respiratory distress with unequal breath sounds, cyanosis, shock, loss of consciousness, and respiratory arrest
   d. Place the patient on his or her left side with the head down to trap any air inside the right atrium or right ventricle, administer 100% oxygen, and rapidly transport to the closest appropriate facility.
6. Vasovagal reactions
   a. Anxiety concerning needles or the sight of blood causing vascular dilation, leading to a drop in blood pressure and collapse
   b. Symptoms include anxiety, diaphoresis, nausea, and syncopal episodes.
   c. Place the patient in shock position, apply high-flow oxygen, monitor vital signs, and establish an IV in case fluid resuscitation is needed.
7. Catheter shear
   a. Part of the catheter is pinched against the needle and the needle slices through the catheter, creating a free-floating segment
   b. The catheter segment can then travel through the circulatory system and possibly cause a pulmonary embolus.
   c. Treatment involves surgical removal of the shear.
   d. If you suspect a shear, place the patient in a left lateral recumbent position with his or her legs down and head up to try to keep the catheter shear out of pulmonary circulation.
   e. Catheter hubs are radiopaque (appear white in an x-ray) to aid in diagnosing this problem.
   f. Never rethread a catheter.
   g. Symptoms include sudden dyspnea, shortness of breath, and possibly diminished breath sounds.

IX. Obtaining Blood Samples

A. At the Time of the IV

1. Equipment needed
   a. 15- or 20-mL syringe
   b. 18- or 20-gauge needle

c. Self-sealing blood tubes

2. Blood tube tops usually come in red, blue, green, and lavender, and should be filled in that order.
   a. Red-topped tubes contain no additives and are intended to clot if blood typing is needed.
   b. Blue-topped tubes contain the preservative EDTA and are used to help determine a patient's prothrombin time and partial thromboplastin time.
   c. Green-topped tubes are filled with heparin to prevent clotting and are used to evaluate the patient's electrolyte and glucose levels.
   d. Lavender-topped tubes are filled with sodium citrate and are used for a complete blood count, including hematocrit and hemoglobin values.
3. After the IV catheter is in place, occlude the catheter and remove the constricting band. Attach a 15- or 20-mL syringe to the hub of the IV catheter and draw the necessary amount of blood.
4. Detach the syringe, attach the IV tubing, and begin infusion.
5. Attach an 18- or 20-gauge needle to the syringe, fill the blood tubes with the necessary amounts, and immediately dispose of the syringe and needle in a puncture-proof sharps container.

B. Without an IV

1. Obtain a blood sample using a cylindrical device that attaches to an 18- or 20-gauge sampling needle (Vacutainer).
   a. Apply a constricting band, and locate a suitable vein—typically, the antecubital vein. Follow body substance isolation (BSI) precautions.
   b. Prep the vein as you would when you start an IV—use an alcohol prep or iodine swab, and cleanse the area in a circular motion, starting from the inside and working your way out.
   c. Insert the needle (already attached to the Vacutainer) into the vein.
   d. Remove the constricting band, and insert blood tubes into the Vacutainer to obtain the necessary amount of blood.
   e. Remove the needle from the vein, and apply direct pressure.
   f. Dispose of the needle in a puncture-proof sharps container.
   g. Label all tubes with patient's name, the date, the time, and your name as soon as possible to avoid mixing tubes with those of another patient.
2. Gently turn the tubes back and forth to mix the anticoagulant and blood evenly (don't shake the red-topped tube).
3. Tubes must be at least three-fourths full.

X. Intraosseous Infusion

A. Overview

1. Intraosseous means "within the bone."
2. Technique of administering fluids, blood and blood products, and medications into the intraosseous space of a long bone, usually the proximal tibia

3. Intraosseous (IO) space collectively comprises the spongy cancellous bone of the epiphyses and the medullary cavity of the diaphysis.
    a. Noncollapsible vein
    b. Quickly absorbs IV fluids and medications and rapidly gets them to the central circulation
4. Historically used for children younger than 6 when IV access could not be obtained within 3 attempts or 90 seconds
    a. Approved by the US Food and Drug Administration as an alternative means of establishing vascular access in critically ill or injured adults

B. Equipment for IO Infusion

1. Manually inserted IO needles
    a. Original devices for establishing IO access in children
    b. Solid boring needle (trocar) inserted through a sharpened hollow needle
    c. Pushed into the bone with a screwing, twisting, action
    d. The solid needle is removed, leaving the hollow needle in place, and the IV tubing is attached to this catheter.
    e. Require full and careful immobilization
2. F.A.S.T.1 (First Access for Shock and Trauma)
    a. First IO device approved for use in adults (not used in children)
    b. Placement in the sternum is allowed by an infusion tube and subcutaneous portal, an introducer, a target/strain relief patch, and a protective dome.
    c. Sternum placement is based on the ease of locating the manubrium and the easier penetration than other bones.
3. EZ-IO
    a. Hand-held battery-powered driver to which a special needle is attached
    b. Used to insert an IO needle into the proximal tibia of adults and children when IV access is difficult or impossible to obtain
    c. Different sized needles for adults and children
4. Bone Injection Gun (BIG)
    a. Spring-loaded device
    b. Used to insert an IO needle into the proximal tibia of adult and pediatric patients
    c. Comes in adult and pediatric sizes

C. Performing IO Infusion

1. Requires proper anatomic landmark identification
2. The flat bone of the proximal tibia (most commonly used site) is located medial to the tibial tuberosity (bony protuberance just below the knee).
3. Skill Drill 8-4 IO Infusion
    a. Check the selected IV fluid for proper fluid, clarity, and expiration date. Look for discoloration and for particles floating in the fluid. If found, discard the bag and choose another bag of fluid.

b. Select the appropriate equipment, including an IO needle, syringe, saline, and extension set (Step 1). A three-way stopcock may also be used to facilitate easier fluid administration.
c. Select the proper administration set. Connect the administration set to the bag. Prepare the administration set. Fill the drip chamber and flush the tubing. Make sure all air bubbles are removed from the tubing.
d. Prepare the syringe and extension tubing.
e. Cut or tear the tape. This can be done at any time before the IO puncture.
f. Take BSI precautions (Step 2). This must be done before IO puncture.
g. Identify the proper anatomic site for IO puncture (Step 3). When using the BIG in an adult, go 2 cm from the tibial tuberosity toward the inner leg, and then 1 cm up toward the knee. When using the EZ-IO, go down 2 cm from the patella to the tibial tuberosity, then 1 cm toward the inner leg. It is important to avoid penetrating the epiphyseal (growth) plate in children. When using the BIG in a child, go 1 to 2 cm from the tibibal tuberosity toward the inner leg, and then 1 cm down toward the foot.
h. Clean the site appropriately. Follow aseptic technique by cleansing in a circular manner from the inside out.
i. Perform the IO puncture by first stabilizing the tibia, then placing a folded towel under the knee, and finally holding in a manner to keep your fingers away from the site of puncture.
j. Insert the needle at a 90º angle to the leg. Advance the needle with a twisting motion until a "pop" is felt (Step 4). Unscrew the cap, and remove the stylet from the needle (Step 5).
k. Attach the syringe and extension set to the IO needle. Pull back on the syringe to aspirate blood and particles of bone marrow to ensure proper placement.
l. Slowly inject saline to ensure proper placement of the needle. Watch for extravasation, and stop the infusion immediately if it is noted. It is possible to fracture the bone during insertion of the IO. If this happens, you should remove the IO and switch to the other leg.
m. Connect the administration set and adjust the flow rate as appropriate (Step 6). Fluid does not flow as rapidly through an IO catheter as through an IV line; therefore, crystalloid boluses should be given with a syringe in children and a pressure infuser device in adults.
n. Secure the needle with tape, and support it with a bulky dressing. Stabilize the place in the same manner that an impaled object is stabilized. Use bulky dressings around the catheter, and tape securely in place. Be careful not to tape around the entire circumference of the leg, as this could impair circulation and potentially result in compartment syndrome (Step 7).
o. Dispose of the needle in the proper container.

D. Potential Complications of IO Infusion

1. When done properly, relatively low complication rate
2. Same potential complications associated with IV therapy
3. Extravasation occurs when the IO needle does not rest in the IO space.
   a. Rests outside the bone
   b. IV fluid will collect in the soft tissues.

c. Should be suspected if the infusion does not run freely or if the site rapidly becomes edematous
d. Discontinue the infusion immediately and reattempt insertion in the opposite leg.
e. Could result in compartment syndrome

4. Osteomyelitis
   a. Inflammation of the bone and muscle caused by an infection
   b. Fewer than 0.6% of IO insertions
5. Growth plate damage
   a. Failure to identify the proper anatomic landmark
   b. Potentially results in long-term bone growth abnormalities in children
6. Through-and-through insertion
   a. Needle passes through both sides of the bone
   b. To avoid this, stop inserting the needle when you feel a pop.
   c. If you feel a "pop, pop," you have likely passed the needle through both sides of the bone.
   d. Remove the needle and attempt insertion on the opposite extremity.
7. Pulmonary embolism
   a. Particles of bone, fat, or marrow find their way into the systemic circulation and lodge in a pulmonary artery.
   b. Suspect if the patient experiences acute shortness of breath, pleuritic chest pain, and cyanosis

E. Contraindications to IO Infusion

1. Cannulation of a peripheral vein remains the preferred route for administering IV fluids and medications.
2. If the bone intended for IO cannulation is fractured
3. Osteoporosis
4. Osteogenesis imperfecta (congenital disease resulting in fragile bones)
5. Bilateral knee replacements

XI. Calculating Fluid Infusion Rates

A. Flow Rate

1. Adjust according to patient's clinical condition or as directed by medical control
2. You must know the following:
   a. The volume to be infused
   b. The period over which it is to be infused
   c. The properties of the administration set you are using—how many drops per milliliter (gtt/mL) it delivers
3. Calculation
   a. Gtt/min = (volume to be infused x gtt/mL of administration set) ÷ total time of infusion in minutes

XII. Medication Administration

A. Overview

1. Must have a thorough understanding of how the medication will affect the human body—negatively and positively
   a. Mechanisms of action, indications, contraindications, side effects, routes of administration, pediatric and adult doses, and antidotes for adverse reactions
2. The first rule of medication is *primum non nocere*: "The first thing (is) to do no harm."
3. Basic math for pharmacology to calculate appropriate medication dose
   a. Quickly and accurately calculate medication doses to maximize the chance for a positive patient outcome.

B. Mathematical Principles used in Pharmacology

1. The metric system
   a. Decimal system based on multiples of 10
   b. Prefixes indicate the fraction of the base being used, from smallest to largest; they include micro-, milli-, centi-, and kilo-.
2. Weight and volume conversion
   a. Convert larger units of weight and volume to smaller ones, and the reverse.
   b. Weight conversion is simply a matter of multiplying or dividing by 1,000.
   c. The volume conversion formula is the same.
3. Converting pounds to kilograms
   a. Pounds (apothecary) to kilograms (metric)
   b. Some medications are based on body weight in kilograms.
   c. Divide the patient's weight in pounds by 2.2 or divide the patient's weight by 2 and subtract 10%.
4. Other systems of measurement
   a. Apothecary system (ounces and grains)
   b. Household system (drops, teaspoons, tablespoons, and cups)
   c. Fahrenheit and Celsius (centigrade) temperature scales
   d. To convert Fahrenheit to Celsius subtract 32, then multiply by 0.555 (5/9).
   e. To convert Celsius to Fahrenheit multiply by 1.8 (9/5), and then add 32.

C. Calculating Medical Doses

1. Desired dose
   a. Amount of drug the physician orders you to give a patient
   b. May be a standard dose or a specific number of micrograms, milligrams, or grams per kilogram of body weight
2. Drug concentrations
   a. The total weight of the drug contained in a specific amount of volume
   b. To administer a drug, you must know the weight of the drug that is present in 1 mL.
   c. Total weight of the drug ÷ total volume in milliliters = weight per milliliter

   d. Trickier when the label of the drug lists the concentration as a percentage (grams present in 100 mL)
3. Volume to be administered
   a. Calculate how much volume is needed to give the amount of the drug ordered.
   b. Desired dose (mg) ÷ concentration of drug on hand (mg/mL) = volume to be administered

D. Weight-Based Drug Doses

1. One extra step: conversion of the patient's weight in pounds to kilograms

XIII. Calculating the Dose and Rate for a Medication Infusion

A. Non–weight-based medication infusions

1. May need to begin a continuous infusion to maintain a therapeutic blood level of the drug to prevent a recurrence of the condition
2. Usually ordered to be administered over a specific period (usually per minute)
3. Determine the concentration.
4. Determine the amount of volume to infuse per minute.
5. Determine how many drops per minute (gtt/min) at which to set the IV flow rate.

B. Weight-based medication infusions

1. Before determining the concentration, amount to infuse per minute, and how many drops per minute, you must determine the desired dose based on the patient's weight.

XIV. Pediatric Drug Doses

A. Methods

1. Length-based measures
2. EMS field guide with tables or charts specific to pediatric patients

XV. Medical Direction

A. Overview

1. Medication administration is governed by your local protocols and/or online medical direction.
   a. Standing orders
   b. Online (direct) medical control

B. Paramedic's Responsibility Associated With Drug Orders

1. Make sure the base physician understands the situation. The decision to order the administration of any given drug is complex, involving such considerations as the

patient's age, weight, clinical status, allergy history, concomitant medical problems, and other drugs he or she may be taking. Thus it is critical that you obtain and communicate complete and accurate information about the patient to enable the physician to make prudent and correct decisions about drug administration.

2. Make sure you understand the physician's orders clearly. If the orders are unclear or seem—on the basis of your knowledge—to be in error, ask the physician to repeat the order. Do not assume that the doctor is infallible, especially at 3:00 am.
3. Always repeat any orders, word for word, back to the physician before administering a medication, to confirm that you received and understood the order accurately. In the repetition, state the name of the drug, the dose, and the route by which it is to be given. As a paramedic, you are just as responsible for the administration of the drug and its possible consequences as the physician giving the order, so be absolutely certain which drug is to be administered, in what dose, and by which route. If your partner does not hear the exchange of information, you should repeat the order to him or her as an additional safety measure.
4. If the patient is conscious, or if there is another reliable source of information, confirm that the patient is not allergic to the drug that has been ordered.
5. Read the label carefully as you take the vial or syringe from its box and again before you give the drug. Note the drug concentration printed on the label and the drug's date of expiration.
6. Check for defects in the vial, preloaded syringe, or ampule, and make sure that the fluid inside is not cloudy, discolored, or precipitated. Check whether the container itself appears to be cracked or damaged. If the medication looks suspicious in any way, do not use it.
7. If you have orders to administer more than one drug, make sure that the drugs are compatible. Some drugs will not mix with others. For example, if sodium bicarbonate is mixed with calcium chloride, calcium carbonate, an insoluble precipitate, will form in the solution. Should any cloudiness occur after a drug has been injected into IV tubing, clamp the tubing immediately and replace it with a new administration set.
8. Notify the physician when the medication has been administered.
9. Monitor the patient for possible adverse side effects.
10. Dispose of the syringe and needle safely. Do not try to recap the needle, because the likelihood is quite high of sticking yourself in the process; rather, dispose of the needle and syringe in a sharps container.

C. The "Six Rights" of Drug Administration

1. Before giving any drug, review the "six rights" of medication administration.
   a. Right patient
   b. Right drug
   c. Right dose
   d. Right route
   e. Right time

f. Right documentation

2. If you did not document it, you did not do it.
   a. Name of the drug
   b. Dose of the drug
   c. Time you administered the drug
   d. Route of administration
   e. Your name or the paramedic who administered the drug
   f. Patient's response to the medication, whether positive or negative

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XVI. Local Drug Distribution System

A. Medication Check

1. All medications must be checked to ensure that they are not expired or damaged and that they are readily available in the right quantity.
2. You are responsible for documentation and security of all controlled substances carried on your ambulance, including accounting for all controlled substances that were wasted.

XVII. Medical Asepsis

A. Overview

1. Practice of preventing contamination of the patient by using aseptic technique
2. Sterilization of equipment, antiseptics, or disinfectants

B. Clean Technique Versus Sterile Technique

1. Some of the equipment has been sterilized for patient safety.
   a. Medication packaged using sterile technique
   b. Destruction of all living organisms; achieved by using heat, gas, or chemicals
2. Examples of medical asepsis include handwashing, wearing gloves, and keeping equipment as clean as possible.
3. You must always make a conscious effort to prevent contamination.

C. Antiseptics and Disinfectants

1. Antiseptics are used to cleanse an area before performing an invasive procedure.
   a. Capable of destroying pathogens, but not toxic to living tissues
   b. Isopropyl alcohol (rubbing alcohol) and iodine are the two most common antiseptics
2. Disinfectants are toxic to living tissues.
   a. Never use them on a patient.
   b. Use only on nonliving objects (inside of the ambulance, laryngoscope blades, and other nondisposable equipment
   c. Virex, Cidex, and Microcide

XVIII. BSI Precautions and Contaminated Equipment Disposal

A. Body Substance Isolation

1. Treat any body fluid as being potentially infectious.
    a. Many patients who harbor infectious diseases may be asymptomatic and/or unaware that they are infected.
2. Minimum BSI precautions include:
    a. Wearing gloves and protective eyewear (goggles, face shield)
    b. If blood spattering is possible, full facial protection is indicated.
3. According to the Centers for Disease Control and Prevention, handwashing is the most effective way to prevent the spread of disease.

B. Disposal of Contaminated Equipment

1. After an IV catheter needle has penetrated a patient's skin it is contaminated.
    a. Accidental needlesticks are the most common route for disease transmission in the health care setting.
    b. Sharps are any contaminated item that can cause injury (IV needles and catheters, broken ampules or vials, and anything else that can penetrate or lacerate the skin).
2. Immediately dispose of all sharps in a puncture-proof sharps container that bears a biohazard logo.
    a. Readily available
    b. Two in the back of the ambulance
    c. Smaller sharps container in your jump kit
    d. See Table 8-5.

XIX. Enteral Medication Administration

A. Overview

1. Enteral route refers to any route in which medication is absorbed through some portion of the gastrointestinal tract.

B. Oral Medication Administration

1. Capsules, time-released capsules, lozenges, pills, tablets, elixirs, emulsions, suspensions, and syrups
2. Absorbed at a slow rate from the stomach and intestines
    a. Rarely given in the prehospital setting
3. Follow these steps when administering an oral medication:
    a. Take BSI precautions.
    b. Determine the need for the medication based on patient presentation.
    c. Obtain a focused history and physical exam, including any drug allergies.
    d. Follow standing orders, or contact medical control for permission.

e. Check the medication to be sure it is the right medication, it is not cloudy or discolored, and its expiration date has not passed.
f. Determine the appropriate dose. If using a liquid medication, pour the desired amount into a calibrated cup.
g. Instruct the patient to swallow the medication with water, if administering a pill or tablet.
h. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient.

C. Gastric Tube Medication Administration

1. Gastric tubes are occasionally inserted in the prehospital setting to decompress the stomach.
   a. Also provides a route for enteral medication administration
2. Skill Drill 8-5: Administering Medication via the Gastric Tube
   a. Take BSI precautions.
   b. Confirm proper gastric tube placement. Attach a 60-mL cone-tipped syringe to the gastric tube and slowly inject air as you or your partner auscultates over the epigastrium (Step 1). To further confirm proper placement, withdraw on the plunger of the syringe and observe for the return of gastric contents in the tube. Leave the gastric tube open to air.
   c. Draw up 30 to 60 mL of normal saline into the syringe, and irrigate the gastric tube (Step 2). If you meet resistance, ensure that the tube is not kinked.
   d. Draw up the appropriate amount of medication, and slowly inject it into the gastric tube (Step 3).
   e. Inject 30 to 60 mL of normal saline into the gastric tube following administration of the medication (Step 4). This will ensure that the tube is flushed and the patient has received the entire dose of the medication.
   f. Clamp off the proximal end of the gastric tube (Step 5). Do not attach the gastric tube to suction because this will result in the removal of medication from the stomach. Monitor the patient for adverse reactions. Repeat the medication dose if indicated.

D. Rectal Medication Administration

1. Certain drugs may be administered rectally if you are unable to establish IV or IO access.
   a. Diazepam (Valium) for pediatric patients
2. Medication absorption is rapid and predictable.
3. A suppository is a drug mixed in a firm base that melts at body temperature and is shaped to fit the rectum.
4. Follow these steps to administer a drug via the rectal route:
   a. Take BSI precautions.
   b. Determine the need for the medication based on patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies.
   d. Follow standing orders, or contact medical control for permission.

e. Determine the appropriate dose, and check that the medication is the right medication, there is no cloudiness or discoloration, and the expiration date has not passed.
f. When inserting a suppository, use a water-soluble gel for lubrication. Insert the suppository approximately 1" to 1 1/2" into the rectum.
g. For medication in liquid form some modifications are needed. You may use a nasopharyngeal airway or a small endotracheal tube as your delivery device.
h. Lubricate the end of the nasal airway or endotracheal tube with a water-soluble gel, and gently insert it approximately 1" to 1 1/2" into the rectum.
i. Instruct the patient to relax and not to bear down.
j. With a needleless syringe, gently push the medication through the tube.
k. Once the medication has been delivered, remove and dispose of the tube or syringe in an appropriate container.
l. Monitor the patient's condition, and document the medication given, the route, time of administration, and response of the patient.

XX. Parenteral Medication Administration

A. Overview

1. Any route other than the gastrointestinal tract
2. Absorbed into the central circulation more quickly and at a more predictable rate

B. Syringe and Needles

1. Most syringes come prepackaged in color-coded packs with a needle already attached.
2. Syringes consist of a plunger, body or barrel, flange, and tip.
3. Syringe selection is based on the volume of the medication that you will administer.
4. Hypodermic needle lengths vary from 3/8" to 2" for standard injections.
   a. Gauge refers to the diameter (18–26).
   b. The smaller the number, the larger the diameter.
   c. Smaller gauge needles are used for subcutaneous injections; larger gauge needles are used for intramuscular and IV injections.
5. The proximal end of the needle, or hub, attaches to the standard fitting on the syringe, while the distal end of the needle is beveled.

C. Packaging of Parenteral Medications

1. Ampules
   a. Breakable glass containers designed to carry a single dose of medication
2. Skill Drill 8-6: Drawing Medication From an Ampule
   a. Check the medication to be sure that the expiration date has not passed and that it is the correct drug and concentration.
   b. Shake the medication into the base of the ampule. If some of the drug is stuck in the neck, gently thump or tap the stem (Step 1).

c. Using a 4" x 4" gauze pad or an alcohol prep, grip the neck of the ampule and snap it off. Drop the stem in the sharps container (Step 2).
d. Insert the needle into the ampule without touching the outer sides of the ampule. Draw the solution into the syringe, and dispose of the ampule in the sharps container (Step 3).
e. Hold the syringe with the needle pointing up, and gently tap the barrel to loosen air trapped inside and cause it to rise (Step 4). Press gently on the plunger to dispel any air bubbles (Step 5).
f. Recap the needle using the one-handed method.

3. Vials
   a. Small glass or plastic bottles with a rubber stopper top
   b. For a single-dose vial, you will draw up the entire amount; for multiple-dose vials, you should draw up only the amount needed.
   c. Once you remove the cover from a vial, it is no longer sterile.
   d. Some medications will need to be diluted using drug reconstitution (injecting the sterile water from one vial into the vial containing powder).
4. Skill Drill 8-7: Drawing Medication From a Vial
   a. Check the medication to be sure that the expiration date has not passed and that it is the correct drug and concentration (Step 1).
   b. Remove the sterile cover, or clean the top with alcohol if the vial was previously opened.
   c. Determine the amount of medication you will need, and draw that amount of air into the syringe (Step 2). Allow a little extra room to expel some air while removing air bubbles.
   d. Invert the vial, and insert the needle through the rubber stopper into the medication. Expel the air in the syringe into the vial and then withdraw the amount of medication needed (Step 3).
   e. Once you have the correct amount of medication in the syringe, withdraw the needle from the vial and expel any air in the syringe (Step 4).
   f. Recap the needle using the one-handed method (Step 5).
5. Prefilled syringes
   a. Packaged in tamper-proof boxes
   b. Either separated into a glass drug cartridge and a syringe or preassembled, prefilled syringes
   c. Designed for ease of use

D. Intradermal Medication Administration

1. Small amount of medication into the dermal layer just beneath the epidermis
2. Avoid areas that contain superficial blood vessels to minimize the risk of systemic medication absorption.
   a. Anterior forearm or upper back
3. Slow rate of absorption and minimal systemic distribution
4. Follow these steps:
   a. Take BSI precautions.

b. Determine the need for the medication based on patient presentation.
c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
d. Follow standing orders, or contact medical control for permission.
e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount to give for the correct dose.
f. Advise the patient of potential discomfort while explaining the procedure.
g. Assemble and check equipment needed: alcohol preps and a 1-mL syringe with a 25- to 27-gauge, 3/8" or 1" needle. Draw up the correct dose of medication.
h. Cleanse the area for administration using aseptic technique.
i. Pull the skin taut with your nondominant hand.
j. Insert the needle at a 10º to 15º angle with the bevel up.
k. Slowly inject the medication while observing for the formation of a wheal, or small bump, which indicates that the medication is collecting in the intradermal tissue.
l. Remove the needle. Immediately dispose of the needle and syringe in the sharps container.
m. Monitor the patient's condition, and document the medication given, route, administration time, and response of the patient.

E. Subcutaneous Medication Administration

1. Loose connective tissue between the dermis and the muscle layer
2. Upper arms, anterior thighs, and the abdomen
   a. Insulin
3. Skill Drill 8-8: Administering Medication via the Subcutaneous Route
   a. Take BSI precautions.
   b. Determine the need for the medication based on patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   d. Follow standing orders, or contact medical control for permission.
   e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount and concentration for the correct dose (Step 1).
   f. Advise the patient of potential discomfort while explaining the procedure.
   g. Assemble and check equipment needed: alcohol preps and a 3-mL syringe with a 24- to 26-gauge needle. Draw up the correct dose of medication (Step 2).
   h. Cleanse the area for the administration (usually the upper arm or thigh) using aseptic technique (Step 3).
   i. Pinch the skin surrounding the area, advise the patient of a stick, and insert the needle at a 45º angle.
   j. Pull back on the plunger to aspirate for blood. The presence of blood in the syringe indicates you may have entered a blood vessel. In such a case, remove the needle, and hold pressure over the site. Discard the syringe and needle in the sharps container. Prepare a new syringe and needle, and select another site.

k. If there is no blood in the syringe, inject the medication and remove the needle. Immediately dispose of the needle and syringe in the sharps container (Step 4).
l. To disperse the medication through the tissue, rub the area in a circular motion with your gloved hand.
m. Properly store any unused medication.
n. Monitor the patient's condition, and document the medication given, route, administration time, and response of the patient (Step 5).

F. Intramuscular Medication Administration

1. Penetrating a needle through the dermis and subcutaneous tissue and into the muscle layer
   a. Allows for a larger volume of medication (up to 5 mL) than the subcutaneous route
2. Common sites for injection
   a. Vastus lateralis muscle: the large muscle on the lateral side of the thigh
   b. Rectus femoris muscle: the large muscle on the anterior side of the thigh
   c. Gluteal area: the buttocks, specifically the upper lateral aspect of either side
   d. Deltoid muscle: the muscle of the upper arm that covers the prominence of the shoulder
3. Skill Drill 8-9: Administering Medication via the Intramuscular Route
   a. Take BSI precautions.
   b. Determine the need for the medication based on patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   d. Follow standing orders, or contact medical control for permission.
   e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount and concentration for the correct dose (Step 1).
   f. Advise the patient of potential discomfort while explaining the procedure.
   g. Assemble and check equipment needed: alcohol preps and a 3- to 5-mL syringe with a 21-gauge, 1" or 2" needle. Draw up the correct dose of medication (Step 3).
   h. Cleanse the area for administration (usually the upper arm or hip) using aseptic technique (Step 3).
   i. Stretch the skin over the cleansed area, advise the patient of a stick, and insert the needle at a 90º angle.
   j. Pull back on the plunger to aspirate for blood. The presence of blood in the syringe indicates you have entered a blood vessel. In such a case, remove the needle, and hold pressure over the site. Discard the syringe and needle in the sharps container. Prepare a new syringe and needle, and select another site.
   k. If there is no blood in the syringe, inject the medication and remove the needle. Immediately dispose of the needle and syringe in the sharps container (Step 4).
   l. To disperse the medication through the tissue, rub the area in a circular motion with your gloved hand (Step 5).
   m. Store any unused medication properly.
   n. Monitor the patient's condition, and document the medication given, route, administration time, and response of the patient.

G. IV Bolus Medication Administration

1. Places the drug directly into the circulatory system
   a. Fastest route of medication administration
   b. No room for error
2. Many services use needleless systems to provide protection against needlesticks.
   a. The syringe simply screws into the injection port of the administration set.
3. Bolus is a single dose.
4. Skill Drill 8-10: Administering Medication via the Intravenous Bolus Route
   a. Take BSI precautions.
   b. Determine the need for the medication based on the patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   d. Follow standing orders, or contact medical control for permission.
   e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount and concentration for the correct dose.
   f. Explain the procedure to the patient and the need for the medication.
   g. Assemble needed equipment, and draw up medication. Expel any air in the syringe. Draw up 20 mL of normal saline to use as a flush for the medication.
   h. Cleanse the injection port with alcohol, or remove the protective cap if using the needleless system (Step 1).
   i. Insert the needle into the port, and pinch off the IV tubing proximal to the administration port. Failure to shut off the line will result in the medication taking the pathway of least resistance and flowing into the bag instead of into the patient.
   j. Administer the correct dose of the medication at the appropriate rate. Some medications must be administered very quickly, whereas others must be pushed slowly to prevent adverse effects (Step 2).
   k. Place the needle and syringe into the sharps container.
   l. Unclamp the IV line to flush the medication into the vein. Allow it to run briefly wide open, or flush with a 20 mL bolus of normal saline.
   m. Readjust the IV flow rate to the original setting (Step 3).
   n. Properly store and label any unused medication.
   o. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient.
5. Saline locks are used for patients who don't need IV fluid but may need medication therapy.
   a. Take BSI precautions.
   b. Determine the need for the medication based on patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   d. Follow standing orders, or contact medical control for permission.

e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount and concentration for the correct dose.
f. Explain the procedure to the patient and the need for the medication.
g. Assemble needed equipment, and draw up the medication. Draw up 20 mL of normal saline to use as a flush for the medication.
h. Cleanse the injection port with alcohol, or remove the protective cap if using the needleless system.
i. Insert the needle into the port while holding it carefully, or screw the syringe onto the port.
j. Pull back slightly on the syringe plunger, and observe for blood return. If blood appears, slowly inject the medication, watching for infiltration. If resistance is felt, or if the patient complains of any discomfort, discontinue administration immediately. A new site will need to be established.
k. Place the needle and syringe into the sharps container.
l. Clean the port, and insert the needle with the syringe containing the flush.
m. Flush the saline lock, and place the needle in the sharps container.
n. Store any unused medication properly.
o. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient.

6. Adding medication to an IV bag
   a. Check the fluid in the IV bag for clarity or discoloration, and ensure that the expiration date has not passed.
   b. Check the drug name on the ampule, vial, or prefilled syringe. Check the concentration of the drug it contains.
   c. Compute the volume of the drug to be added to the IV bag. Draw up that amount in a syringe.
   d. Cleanse the medication injection port on the IV bag with an alcohol swab.
   e. Inject the desired volume of medication into the IV bag by puncturing the rubber stopper on the medication injection port.
   f. Withdraw the needle, and dispose of the needle and syringe in the sharps container. Agitate the IV bag gently to ensure that the added drug is well mixed in the solution.
   g. Label the IV bag with the name of the medication added, the amount added, the concentration of the medication in the IV bag, the date and time, and your name.
   h. Attach the IV administration set, and prepare the IV bag as discussed earlier in this chapter.
7. Electomechanical infusion pumps
   a. Medication maintenance infusion
   b. Allows you to set the parameters of medication administration
   c. Safety features

H. IO Medication Administration

1. Critically ill or injured children and adults when IV access is difficult or impossible to obtain
2. Large syringe to infuse the fluid

3. Pressure infuser device should be used when infusing fluids in adults.
4. Skill Drill 8-11: Administering Medication via the IO Route
    a. Take BSI precautions.
    b. Determine the need for medication based on patient presentation.
    c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
    d. Follow standing orders, or contact medical control for permission.
    e. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed, and determine the appropriate amount and concentration for the correct dose.
    f. Explain the procedure to the patient and/or parent and the need for the medication.
    g. Assemble needed equipment, and draw up the medication. Also draw up 20 mL of normal saline for a flush (Step 1).
    h. Cleanse the injection port of the extension tubing with alcohol, or remove the protective cap if using the needleless system (Step 2).
    i. Insert the needle into the port, and clamp off the IV tubing proximal to the administration port. This is usually managed with a three-way stopcock. Failure to shut off the line will result in the medication taking the pathway of least resistance and flowing into the bag instead of into the patient.
    j. Administer the correct dose of the medication at the proper push rate. Some medications must be administered very quickly, whereas others must be pushed slowly to prevent adverse effects (Step 3).
    k. Place the needle and syringe into the sharps container.
    l. Unclamp the IV line to flush the medication into the vein. Flush with at least a 20 mL bolus of normal saline.
    m. Readjust the flow rate to the original setting.
    n. Store any unused medication properly.
    o. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient (Step 4).

I. Percutaneous Medication Administration

1. Applied and absorbed through the skin and mucous membranes
    a. Absorption predictable
2. Transdermal medication administration
    a. Surface of the skin
    b. Take BSI precautions.
    c. Determine the need for the medication based on patient presentation.
    d. Obtain a focused history and physical exam, including any drug allergies and vital signs.
    e. Follow standing orders, or contact medical control for permission.
    f. Check the medication patch or cream to ensure that it is the correct one and that the expiration date has not passed, and determine the amount for the correct dose.
    g. Explain the procedure to the patient and the need for medication.
    h. Clean and dry the area of the skin where the medication will be applied.

i. Apply the medication to the area in accordance with the manufacturer's specifications.
j. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient.

3. Sublingual medication administration
   a. Under the tongue
4. Skill Drill 8-12: Administering Medication via the Sublingual Route
   a. Take BSI precautions.
   b. Determine the need for medication based on patient presentation.
   c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   d. Follow standing orders, or contact medical control for permission.
   e. Check the medication to ensure that it is the correct one and that its expiration date has not passed, and determine the appropriate amount for the correct dose.
   f. Ask the patient to rinse his or her mouth with a little water if the mucous membranes are dry (Step 1).
   g. Explain the procedure, and ask the patient to lift his or her tongue. Place the tablet or spray the dose under the tongue, or ask the patient to do so.
   h. Advise the patient not to chew or swallow the tablet, but to let it dissolve slowly.
   i. Monitor the patient's condition, and document the medication given, route, administration time, and response of the patient (Step 2).
5. Buccal medication administration
   a. Between the cheeks and gums
   b. Take BSI precautions.
   c. Determine the need for the medication based on patient presentation.
   d. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   e. Follow standing orders, or contact medical control for permission.
   f. Check the medication to ensure that it is the correct one and that its expiration date has not passed, and determine the appropriate amount for the correct dose.
   g. Explain the procedure to the patient and the need for the medication.
   h. Place the medication in between the patient's cheek and gum, or ask the patient to do so.
   i. Advise the patient not to chew or swallow the tablet, but to let it dissolve slowly.
   j. Monitor the patient's condition, and document the medication given, route, administration time, and response of the patient.
6. Ocular medication administration
   a. Drops or ointments for pain relief, allergies, drying of the eyes, or infections
   b. Take BSI precautions.
   c. Confirm that the medication is prescribed to the patient.
   d. Place the patient in a supine position, or have the patient place his or her head back and look up.

e. Without touching the eyeball, expose the conjunctiva by gently pulling down the lower eyelid.
f. Administer the required amount of medication on the conjunctival sac by using an eye dropper. Do not apply the medication directly on the eyeball.
g. Advise the patient to close his or her eyes for 1 to 2 minutes.
h. Document the medication name, dose, and administration time.

7. Aural medication administration
   a. Mucous membranes of the ear canal (mostly antibiotics, analgesics, and ear wax removal preparations)
   b. Take BSI precautions.
   c. Confirm that the medication is prescribed to the patient.
   d. Place the patient on his or her side with the affected ear facing up.
   e. Expose the ear canal by pulling the ear up and back (adults) or down and back (infants and children).
   f. Administer the medication in the appropriate dose with a medicine dropper.
   g. Document the medication name, dose, and administration time.
8. Intranasal medication administration
   a. Nasal spray for congestion or solutions to moisten the nasal mucosa
   b. Rapidly absorbed
   c. Mucosal atomizer device (MAD) that attaches to a syringe and allows you to spray (atomize) select medications into the nasal mucosa
   d. Take BSI precautions.
   e. Determine the need for the medication based on patient presentation.
   f. Obtain a focused history and physical exam, including any drug allergies and vital signs.
   g. Follow standing orders, or contact medical control for permission.
   h. Check the medication to ensure that it is the correct one, that it is not cloudy or discolored, and that the expiration date has not passed.
   i. Draw up the appropriate dose of medication in the syringe.
   j. Attach the mucosal atomizer device to the syringe.
   k. Explain the procedure to the patient (or to a relative if the patient is unconscious) and the need for the medication.
   l. Spray half of the medication dose into each nostril.
   m. Dispose of the atomizer device and syringe in the appropriate container.
   n. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient.

XXI. Medications Administered by the Inhalation Route

A. Nebulizer and Metered-Dose Inhaler

1. Respiratory emergencies
2. Oxygen, beta-2 agonist bronchodilators, ipratropium bromide (Atrovent)

3. A patient with a history of respiratory problems will usually have a metered-dose inhaler (MDI).
4. For more severe problems, liquid bronchodilators may be aerosolized in a nebulizer for inhalation.
5. Skill Drill 8-13: Administering a Medication via Small-Volume Nebulizer
    a. Take BSI precautions.
    b. Determine the need for an inhaled bronchodilator based on patient presentation.
    c. Obtain a focused history and physical exam, including any drug allergies and vital signs.
    d. Follow standing orders, or contact medical control for permission.
    e. Check the medication and its expiration date. Make sure that you have the right medication and that it is not cloudy or discolored (Step 1).
    f. If the medication is in a premixed package, add it to the bowl of the nebulizer. If it is not premixed, add the medication to the bowl and mix it with the specified amount of normal saline, usually 3 mL (Step 2).
    g. Connect the T piece with the mouthpiece to the top of the bowl, or the mask to the bowl, and connect it to the oxygen tubing.
    h. Set the flowmeter at 6 L/min to produce a steady mist (Step 3).
    i. With the MDI or hand-held nebulizer in position, instruct the patient on the proper way to breathe. Have the patient breathe as deeply as possible and hold his or her breath for 3 to 5 seconds before exhaling. Continue to coach the patient as needed.
    j. Monitor the patient's condition, and document the medication given, route, time of administration, and response of the patient to the medication (Step 4).
    k. Cardiac monitoring is essential when administering a beta agonist. If cardiac dysrhythmias are noted, stop the administration of the medication, administer high-flow oxygen, and contact medical control.

B. Endotracheal Medication Administration

1. If IV or IO access is unavailable, certain resuscitative medications can be administered down the endotracheal (ET) tube.
    a. You must administer 2 to 2.5 times the standard IV dose
    b. Only four medications (lidocaine, epinephrine, atropine, Narcan)
2. Administration
    a. Draw up the appropriate dose of the medication to be administered as your partner ventilates the patient. Dilute the appropriate dose of the medication in 10 mL of normal saline.
    b. Disconnect the bag-mask device from the ET tube, and rapidly instill the medication down the ET tube.
    c. Immediately reconnect the bag-mask device to the ET tube, and ventilate the patient briskly to facilitate passage of the drug down the trachea and into the lungs.

XXII. Rates of Medication Absorption

A. Overview

1. Rate directly related to route by which it is given
2. Table 8-6 summarizes various medication routes and their rates of absorption.

C. Summary

1. Fluids and electrolytes
2. IV fluid composition
3. IV techniques and administration
4. Potential complications
5. Obtaining blood samples
6. Medication administration

Answers to Multiple-Choice Questions

You and your partner are dispatched to an apartment complex because of a possible overdose. Law enforcement personnel are already present and radio you that the scene is secure. When you enter the apartment, you find the patient, a 30-year-old man, unconscious on the couch. With the assistance of law enforcement personnel, you and your partner quickly move the patient to the floor and perform initial assessment. The patient has sonorous respirations and a slow, weak radial pulse. There is no gross bleeding or evidence of trauma.

1. How will you treat this patient initially?
   A. Apply oxygen via a nonrebreathing mask.
   B. Suction his oropharynx for 15 seconds.
   C. Provide bag-mask ventilation and 100% oxygen.
   D. Manually open his airway and insert an airway adjunct.

Answer: D. The patient is unconscious with sonorous (snoring) respirations. This indicates that his tongue is partially obstructing his airway. Before you can clear his airway with suction (if needed) and assess his respiratory effort, you must open his airway. The quickest and most effective way to do so is to perform a head tilt–chin lift maneuver and insert an airway adjunct (ie, oral or nasal airway) to help maintain airway patency. If trauma is suspected or cannot be ruled out, use the jaw-thrust maneuver.

2. Your EMT-B partner assesses the patient's respirations and notes that they are slow and shallow. What should you direct him to do?
   A. Apply a nonrebreathing mask set at 15 L/min.
   B. Provide bag-mask ventilation and 100% oxygen.
   C. Assess the patient's oxygen saturation with a pulse oximeter.
   D. Help you prepare to perform immediate endotracheal intubation.

Answer: B. Slow, shallow (reduced tidal volume) respirations will not provide adequate alveolar minute volume. Therefore, you must direct your partner to begin providing bag-mask ventilation and 100% oxygen. Endotracheal intubation (if necessary) should not be performed until the patient is adequately preoxygenated. A nonrebreathing mask, which delivers passive oxygen, will be ineffective when oxygenating a patient with inadequate

tidal volume. Oxygen saturation should be assessed and monitored, but not before restoring an adequate respiratory rate and tidal volume with positive-pressure ventilation assistance.

3. Following additional assessment of the patient, you suspect a narcotic overdose. While your partner continues to manage the patient's airway, you prepare to establish vascular access. Which of the following statements regarding vascular access is *most* correct?

   A. You should immediately insert an IO catheter into the patient's proximal tibia.
   B. External jugular vein cannulation is preferred when patients are deeply unconscious.
   C. 5% dextrose in water (D_5W) is the fluid of choice for patients who may require volume expansion.
   D. The antecubital vein is the preferred vein to use when starting an IV on a critically ill or injured patient.

Answer: D. When emergency IV access is required, you should use the antecubital vein, which is located in the antecubital fossa of the anterior elbow. Relative to other extremity veins (eg, hand, forearm), the antecubital vein is typically the most visible and easily palpable. IO cannulation is indicated if IV access is extremely difficult or impossible to achieve. External jugular vein cannulation, because it is associated with greater risks (ie, carotid artery injury), should be performed only if other methods of vascular access have failed. The most appropriate IV solution to use in a critically ill or injured patient is an isotonic crystalloid (eg, normal saline, lactated Ringer's). Unlike D_5W, isotonic crystalloids remain in the vascular space for longer periods and can be used to expand circulating volume.

4. Which of the following IV catheters will allow you to deliver the greatest amount of volume in the shortest period?

   A. 14-gauge, 1¼" catheter
   B. 14-gauge, 2¼" catheter
   C. 16-gauge, 1½" catheter
   D. 18-gauge, 2¼" catheter

Answer: A. The IV catheter with the largest gauge (smallest number) and the shortest length will allow you to deliver the greatest amount of volume in the shortest period. A 14-gauge, 1¼" catheter will provide for more rapid fluid delivery compared with the other catheters listed in this question.

5. Vascular access has been obtained. Your protocols call for the administration of naloxone (Narcan) in a dose of 2 mg. You have a prefilled syringe of naloxone that contains 10 mg in 5 mL. How many milliliters of naloxone will you administer to achieve the desired dose of 2 mg?

   A. 1 mL
   B. 2 mL
   C. 3 mL

D. 4 mL

Answer: A. To determine the concentration on hand, you must determine the number of micrograms, milligrams, or grams present in 1 mL. This is determined by dividing the total weight of the drug (µg, mg, g) by the total volume (mL, L) of the solution: 10 mg of naloxone contained in 5 mL equals a concentration on hand of 2 mg/mL (10 mg ÷ 5 mL = 2 mg/mL). You will administer 1 mL to achieve the 2 mg desired dose.

6. Compared with medications administered via the enteral route, parenteral medications:

   A. must be instilled through a gastric tube.
   B. can be delivered only by the IV route.
   C. do not pass through the gastrointestinal tract.
   D. reach the central circulation at a much slower rate.

Answer: C. In general, enterally administered medications, which pass through the gastrointestinal tract, reach the central circulation more slowly than those administered via the parenteral route. Enteral medication routes include the oral, gastric tube, and rectal routes. Parenteral medications are given through any route other than the gastrointestinal tract. Because they bypass the barrier of the gastrointestinal tract, they reach the central circulation faster than those administered via the enteral route. IV, IO, SC, IM, and sublingual routes are examples of parenteral medication routes.

7. Which of the following medication routes has the *slowest* rate of absorption?

   A. Intravenous
   B. Transdermal
   C. Subcutaneous
   D. Intramuscular

Answer: B. The transdermal route, which involves the topical administration of medications (ie, absorption across the barrier of the skin), has the slowest rate of absorption of those listed. The fastest route of medication absorption is the IV route; it has been shown to be as fast as the IV route. The IM route has a faster rate of absorption than the SC route.

8. Shortly after administering naloxone to your patient, the IV line infiltrates. You obtain a blood glucose reading of 40 mg/dL and must administer glucagon via the IM route. However, glucagon must be reconstituted before being administered. What does drug reconstitution involve?

   A. Administration of the drug during a period of at least 5 seconds.
   B. Delivering the medication in the form of a maintenance infusion.
   C. Diluting the drug with at least 5 mL of normal saline or sterile water.
   D. Adding diluent to the powdered form of the drug to make a solution.

Answer: D. In drug reconstitution, diluent (diluting solution) is added to the powdered form of a drug to make a solution for administration. Glucagon is supplied in two vials: one that contains diluent and one that contains powder (glucagon). The diluent is drawn

from the first vial and injected into the second vial, which contains the powder, to make a solution. Solu-Medrol is supplied in a single vial with a sterile rubber stopper that separates the chambers of the vial (ie, Mix-o-Vial). Its reconstitution involves pressing down on the top of the vial, which injects the diluent from the upper chamber into the powder in the lower chamber.

Challenging Questions

A 54-year-old male is found unconscious in his home by a close friend. The patient is unresponsive, is breathing slowly and shallowly, and is bradycardic. As your partner begins ventilation assistance with a bag-mask device and 100% oxygen, you find a bottle of hydrocodone—a potent narcotic analgesic—on an adjacent table. The prescription was filled 2 days prior and is now empty. According to the friend, the patient recently had bilateral knee replacements, and was prescribed the medication for pain relief. He further states that the patient has "emotional problems." Recognizing that the patient will require naloxone (Narcan), you attempt to establish a peripheral IV line, but are unsuccessful after several attempts. Your partner reports that she is not having difficulty with bag-mask ventilation.

9. Should you intubate this patient?

Rationale: Intubation should not be performed without adequately preoxygenating your patient for at least 2 to 3 minutes. If basic techniques can adequately manage the patient's airway and breathing, you should not be too hasty to intubate before administering Narcan to a patient who has overdosed on a narcotic; reversing the effects of the narcotic may only cause the patient to become noncompliant with the ET tube if his or her level of consciousness improves.

10 What alternate medication routes are available to administer the Narcan?

Rationale: Because your partner is able to adequately perform bag-mask ventilations, you should focus your initial efforts on identifying other routes by which you can administer Narcan—a narcotic antagonist that will reverse the CNS depressant effects of the narcotic and improve the patient's hemodynamic status. Generally, if IV access is difficult or impossible to obtain, the intraosseous (IO) route is preferred. However, IO cannulation is not an option in this patient because of his bilateral knee replacements. Unless your protocols allow for the placement of an IO cannula in the humeral head, there are only two other viable routes by which you can administer Narcan: intramuscularly and intranasally. Medications given via the intramuscular (IM) route have an onset of action of 10–20 minutes. Intranasal administration, however, has a faster onset of action owing to rapid medication absorption through the nasal mucosa. Intranasal medication administration involves the use of a mucosal atomizer device (MAD). The MAD attaches to the syringe and allows you to spray (atomize) medications into the nasal mucosa. When administering medications via the MAD, remember to *spray half of the medication dose into each nostril*; in this case, you should administer 1 mg of Narcan into each nostril. If the patient does not respond to a therapeutic dose of Narcan, you should be suspicious that he coingested another medication. In this case, you should consider intubation for definitive airway protection, depending on your transport time to the closest appropriate medical facility.

B. Points to Ponder

Time: 20 minutes
Individual/Small Group Activity/Discussion

This activity addresses the affective objectives of the chapter, allowing you to help students probe the more difficult situations that they face. Use this as an opportunity to allow them to express differences of opinion and approach, while directing them to be thorough and decisive in their answers. Encourage challenges.

Purpose

To allow students an opportunity to apply critical thinking analysis to a given case study.

Instructor Directions

1. Direct students to read the "Points to Ponder" scenario found in the Prep Kit at the end of Chapter 8.
2. You may wish to assign students to a partner or a group and direct them to review the discussion question at the end of the scenario and prepare a response. Facilitate a class dialogue centered on the discussion point.
3. You may also ask students to complete this activity on their own and hand in their comments on a separate piece of paper.
4. Personally review the scenario and discussion question based on your experience and knowledge as an emergency care professional. Develop your own key points for guiding this discussion.

Scenario

You and your partner are treating a 35-year-old man with a headache. The patient is conscious and alert and denies chest pain or shortness of breath. His blood pressure is 130/84 mm Hg, heart rate is 44 beats/min and regular, and respirations are 16 breaths/min and unlabored. Further assessment reveals that the patient's skin is pink, warm, and dry, and his lungs are clear to auscultation bilaterally. The cardiac monitor reveals sinus bradycardia at 40 beats/min. An IV line is established and set at a keep vein open (KVO) rate. As you are obtaining the patient's medical history, your paramedic partner administers 1 mg of atropine sulfate to the patient. Following administration of the atropine, the patient experiences tachycardia at a rate of 130 beats/min and becomes anxious and nauseous. However, his symptoms have resolved by the time you arrive at the hospital.

Analyze this situation and explain what happened.

Issues

Recognizing a Patient in Stable Versus Unstable Condition, Understanding the Need to Verify the "Six Rights" of Medication Administration, Documenting and Reporting a Medication Error.

Discussion

The patient in this scenario—whose condition is clearly stable—did not require the administration of atropine to treat his bradycardia. Your partner should have recognized that the patient's clinical presentation did not warrant the administration of a medication. Furthermore, he should have apprised you of his intentions before carrying them out, which would have allowed you to advise him that drug therapy was not indicated on the basis of the patient's hemodynamically stable condition. As a result of atropine administration, the patient experienced undesirable effects; although they resolved spontaneously, the situation could just as easily have become a disaster (eg, unstable tachycardia with hemodynamic compromise). This is a classic example of understanding when it is *not* appropriate to administer a drug. This situation must be thoroughly documented, including the effects that the drug had on the patient, and reported to the physician at the receiving facility. *Never* attempt to hide a medication error; doing so increases the risk to the patient, eliminates the opportunity to analyze the event and take action to help prevent future errors, and will expose you to legal issues.

II. Lesson Review

Time: 10 minutes

Discussion

Note: Facilitate the review of this lesson's major topics using the review questions as direct questions or overhead transparencies. Answers are found throughout this lesson plan. Each question includes a reference to the slide where the information is covered.

1. Total body water (TBW) comprises what percentage of total body weight? (Lecture II-A)
2. What is the primary intracellular cation? (Lecture II-B)
3. Shortness of breath, edema, polyuria, and crackles (rales) are signs of what condition? (Lecture III-F)
4. Lactated Ringer's and normal saline are classified as what type of solution? (Lecture IV-A)
5. For every 1 mL of patient blood loss, how many mL of a crystalloid are required for replacement? (Lecture IV-A)
6. What are the two common types of IV administration sets? (Lecture V-D)
7. What is the largest diameter of gauges of IV catheters used in the prehospital setting? (Lecture V-F)
8. When inserting an IV catheter, what should the initial angle at the point of entry be? (Lecture V-G)
9. An intraosseous infusion is indicated for what type of critically ill or injured patient? (Lecture X-A)
10. What are the "Six Rights" to drug administration? (Lecture XV-C)

III. Assignments

Time: 5 minutes
Lecture

1. Review all materials from this lesson and be prepared for a lesson quiz to be administered (date to be determined by instructor).
2. Read Chapter 9: *Human Development* for the next class session.