Learning Objectives

- Define total body water (TBW) and its two main compartments (intracellular fluid and extracellular fluid)
- Define osmosis and explain difference between isotonic, hypotonic, and hypertonic fluids in terms of osmotic pressure

Learning Objectives

- Discuss colloid solutions used in intravenous therapy: albumin and hetastarch (Hespan)
- Define hypertonic saline solutions
- Discuss electrolyte solutions used in intravenous (IV) therapy: calcium gluconate, sodium bicarbonate, insulin, and 5% dextrose
Learning Objectives

- Define drop factor, microdrip chambers, and macrodrip chambers
- List and discuss various appropriate sites for IV line insertion

Learning Objectives

- Demonstrate proper procedures for:
  - IV insertion
  - IV push
  - IV piggyback
  - IV infusion
  - Intraosseous infusion
- List complications of IV infiltration, catheter shear, and phlebitis

Introduction

- IV lines are inserted to administer IV fluids and provide access for rapid delivery of emergency medications
- Various types of IV fluids are used
- Human body is divided into 2 compartments
  - Intracellular fluid
  - Extracellular fluid
Introduction

- Dehydration
  - Loss of water from fluid space inside cells
  - As cell dehydrates, it begins to malfunction
  - Conditions that quickly develop should be quickly corrected, and conditions that develop slowly should be corrected slowly
  - When patient is evaluated at the hospital, physician calculates the patient’s free water deficit
  - Purpose of prehospital care is to start rehydrating patient

Body Fluid Compartments

- Most of the human body is composed of water
  - In adults, 45% to 65% of the body
  - In average man weighing 80 kg = 48 L

- Total body water (TBW)
  - Total amount of water in the body
  - Intracellular fluid (ICF)
    - Found inside cells
  - Extracellular fluid (ECF)
    - Found between cells and inside blood vessels
  - 2/3 of TBW is in the ICF, 1/3 in the ECF
    - Of the ECF, ¼ is found in interstitial fluid, ¼ in blood vessels
Body Fluid Compartments

- TBW
- Interstitial fluid
  - Space outside vascular space that is between cells
  - Example:
    - Blood vessels are pipes running alongside a brick wall
    - Volume inside pipes is intravascular space
    - Bricks are cells of the body
    - Volume of bricks is the intracellular volume
    - Mortar between bricks is the interstitial space
    - Mortar and volume of pipes both comprise the ECF
Body Fluid Compartments

- Water is able to move freely from one compartment to the other
  - Compartments are separated by membranes that water can move freely across
  - Concentration of particles in the body compartment drives movement of fluids

- Particles can be dissolved in salt or body protein
  - Cannot pass across membranes separating body compartments
  - Key particle: the electrolyte sodium
  - Particles that cannot pass freely across a membrane act as magnets for fluid
  - Osmosis
    - When particles are trapped on one side of a membrane that is permeable to water, water will move toward the higher concentration of particles
Body Fluid Compartments

- When "water" (D5W), which is free of any particles, is added to one compartment, it is freely distributed to various body fluid compartments in proportion to their % of TBW.
  - Example: If 1000 mL of water is administered as an IV bolus, it will be distributed as:
    - ICF (2/3 of TBW) = 666 mL
    - ECF (1/3 of TBW) = 333 mL
      - Extracellular fluid (3/4 of ECF) = 250 mL
      - Intravascular fluid (1/4 of ECF) = 83 mL

Body Fluid Compartments

- Large volume of distribution
  - IV fluid that distributes throughout several body compartments
  - Improves patient's intravascular and extravascular volume
  - IV fluids must get to the intended site of action to achieve desired effect
  - If intention is to increase intravascular volume, you must choose fluid that provides maximal expansion of intravascular space
Body Fluid Compartments

- Large volume of distribution
  - When treatment goal is fluid resuscitation, a smaller volume of distribution is more efficient
    - By decreasing distribution volume, a greater proportion of fluid remains in vascular space
  - Infusion of fluids containing particles reduces distribution volume
    - Limiting movement of particles limits volume of distribution
      - More fluid remains in vascular space

- Isotonic fluids
  - Have same sodium concentration as body water
  - Normal saline and Ringer lactate solution
    - Salt and electrolytes serve as particles
    - Their sodium concentration approximates that of extracellular space
    - Intracellular space is excluded

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**Extracellular fluid (ECF):**
- 2/3 total body water (TBW) = 1000 mL
- Intravascular fluid = 1/3 of the ECF = 333 mL
- Interstitial fluid = 2/3 of the ECF = 667 mL

**Intracellular fluid (ICF):**
- 1/3 TBW = 333 mL
- Salt particles cannot exceed 10 mL
Predicting distribution of various types of IV fluids is possible to determine optimal fluid to administer.

Example: patient is dehydrated and has depleted intravascular volume.

- The fluid this patient receives should provide some expansion of intravascular volume and fluid in intracellular space.
- Good choice of IV fluid would be 0.45% normal saline.
  - Replaces fluid in vascular space.
  - Not much fluid in intracellular space.

Volume expansion

- Intravascular volume is often depleted by illness/injury.
  - Restoration required to reestablish perfusion to vital organs and tissues.
- Decreased volume results in decreased cardiac output.
  - Results in decreased \( O_2 \) delivery.
  - Patient needs fluid that maximally expands intravascular volume.

For any amount of blood loss, at least 3x amount of crystalloid is required to increase intravascular volume to compensate.

- Large volume of distribution of IV fluids causes fluids to shift/leak out of vascular space to interstitial and intracellular spaces.
- For large amounts of blood loss that produce symptoms of hypovolemia, amount of required volume replacement is beyond that of most EMS protocols.
Body Fluid Compartments

- After period of blood loss, body responds by attempting to autoresuscitate
  - Shift fluid from both intracellular space and interstitial space into intravascular space
    - Cells can become dehydrated and malfunction
  - Acute blood loss: intravascular fluid replacement needs to occur within minutes to prevent multiple organ failure
    - Excessive resuscitation can result in edema and pulmonary complications

Body Fluid Compartments

- Crystalloids
  - IV fluids in which sodium is primary particle that controls volume distribution
  - Most common: Ringer lactate solution and normal saline
  - Movement of water through fluid compartments is controlled by osmosis
  - Trapped particles do not attract the movement of water

Body Fluid Compartments

- Crystalloids
  - Water moves from compartment of lower concentration to compartment of higher concentration
    - As water moves into compartment, concentration of trapped particles decreases
      - Diluted by newly added water
Body Fluid Compartments

- **Crystalloids**
  - Water continues to move down concentration gradient until a difference in concentration between two compartments no longer exists
  - Particles in solution that attract water and exert osmotic pressure are sodium and serum proteins (albumin)

Body Fluid Compartments

- **Crystalloids**
  - **Isotonic**
    - Fluids that have = osmotic pressure with body under normal conditions
    - Contain sodium and other electrolytes that closely mimic concentration of ECF
  - **Hypotonic**
  - **Hypertonic**
  - Crystalloid solutions use electrolytes to provide osmotic pressure

Body Fluid Compartments

- **Colloid solutions use complex molecules for osmotic pressure**
  - Proteins
  - Complex sugars
Body Fluid Compartments

- Hypovolemia
  - Causes:
    - Bleeding
    - Burns
    - Vomiting
    - Diarrhea
    - Diabetic ketoacidosis
    - Bowel obstruction

Healthy individual has capacity to compensate for intravascular volume loss.
- By the time patient shows signs of hypovolemia, assume significant volume loss.
- In case of acute blood loss, a 70-kg patient will lose more than 30% of blood volume before exhibiting hypotension.

Delivery of IV Fluids

- Rapid fluid losses require rapid replacement
  - Typical fluid bolus in adult = 1000 mL (1 L) administered in a 15- to 60-min period
  - Typical fluid bolus in a child = 10 to 20 mL/kg
  - For rapid fluid administration in adult, use two large-bore IV catheters, either 14 or 16 gauge
    - Size of catheter has profound effect on rate at which IV fluids can be given
Delivery of IV Fluids

- Colloid solutions
  - Contain large molecules that have preference for vascular space
  - 3:1 rule
    - Paramedics should administer 3x the volume of crystalloid for a given loss of blood volume
    - Underestimates extravascular fluid shifts

Delivery of IV Fluids

- Colloids and hypertonic fluids provide greater volume expansion with less fluid administered
  - Albumin can expand intravascular volume by 80% of infused volume
    - Under normal conditions, 30% to 40% is in intravascular space
    - 50% to 60% is in interstitial space
    - Intravascular half-life: 16 hours
    - 2 hours after infusion, 90% remains in intravascular space
    - Capable of recruiting water into intravascular space

Delivery of IV Fluids

- Colloids and hypertonic fluids provide greater volume expansion with less fluid administered
  - Hetastarch can increase intravascular volume by 100% of infused volume
    - After 36 hours, 33% of infused volume remains in intravascular space
Delivery of IV Fluids

- Hypertonic saline solutions
  - Have concentration greater than isotonic concentration of 0.9%
  - Typical solutions are 3%, 5%, or 7% saline
    * 3 to 5x higher sodium concentration than standard normal saline
    * Higher concentration of sodium pulls more volume into vascular space
    * Some solutions use particles other than sodium to make hypertonic fluid

Delivery of IV Fluids

- Electrolytes
  - Paramedics must treat electrolyte disorders that have clinical manifestations
  - Most electrolyte disorders are not immediately life threatening and can wait for lab test confirmation, except hyperkalemia

Delivery of IV Fluids

- Electrolytes
  - Hyperkalemia
    * May occur with renal failure
    * Presenting symptoms include:
      - GI symptoms of nausea, abdominal pain, diarrhea
      - Initially peaked T waves
      - Widening of QRS complex
      - Depression of ST segment
Delivery of IV Fluids

- Electrolytes
  - Hyperkalemia
    - Causes:
      - Burns
      - Crush injuries
      - Diabetic ketoacidosis
      - Severe infections
    - Left untreated, can progress to heart block and cardiac arrest
    - Treatment objectives:
      - Protect heart from effects of hyperkalemia
      - Hide potassium inside cells
    - Administer 1 g 10% calcium gluconate
      - Does not alter serum level of potassium
    - To hide potassium, must be shifted from extracellular space into intracellular space
      - Administer sodium bicarbonate, 50% dextrose, and insulin
      - Sodium bicarbonate rapidly shifts potassium into cells within minutes of administration and lasts up to 12 hours
      - Insulin (10 U regular insulin) allows additional potassium to be hidden inside cells
      - Dextrose (2.5 g) is given with insulin to prevent hypoglycemia
Delivery of IV Fluids

- Electrolytes
  - Hypokalemia
    - Low serum concentration of potassium
    - Cannot diagnose without lab blood test
    - Result of chronic medical conditions:
      - Reduced dietary intake of potassium
      - Chronic diuretic therapy
      - Diarrhea
      - Short bowel syndrome
      - Vomiting
      - Burns

Delivery of IV Fluids

- Electrolytes
  - Hypokalemia
    - Paramedics must rely on symptoms
      - Muscle weakness
      - Abdominal distention
      - Constipation
      - T waves tend to flatten and progress to AV block and cardiac arrest

Delivery of IV Fluids

- Electrolytes
  - Hypokalemia
    - Potassium infusion in the field is unlikely
      - May transport patient from one facility to another who is receiving a potassium infusion
    - Potassium in chronic and nonemergent conditions is provided with oral supplements
Delivery of IV Fluids

- Electrolytes
  - Hypokalemia
    - IV potassium administration is potentially dangerous
    - Too-vigorous replacement leads to hyperkalemia
    - Should always be diluted and slowly administered
    - Administered only to patients with adequate renal function and good urine output
    - Should not be administered to dehydrated patients
    - IV fluids with supplemental potassium should not contain more than 40 mEq/L of potassium
    - Rate of administration should not exceed 20 mEq/hr

- Other common electrolyte disorders:
  - Hypocalcemia
  - Hypercalcemia
  - Hypomagnesemia
  - Hypermagnesemia
  - Hypophosphatemia
  - Hyperphosphatemia
  - Paramedics rarely treat any of these conditions without lab blood tests

IV Therapy: Equipment and Administration

- Starting IV lines requires practice and patience

- Equipment
  - PPE: eye protection and gloves
  - Catheters
    - Composed of hub and catheter shaft
    - Have plastic catheter that fits over needle
**IV Therapy: Equipment and Administration**

- **Administration sets**
  - IV fluid bag
  - Drip chamber
  - Roller clamp
  - Administration port

- **Drip chamber**
  - Compartment immediately below IV bag where IV fluid drips at predetermined volume
  - Can control volume and rate of administration
  - Allow provider to count number of drops over period and calculate rate of fluid

- **Drop factor**
  - Number of drops into chamber required to administer 1 mL of fluid
  - Microdrip
    - Administer 60 gtt/mL
    - Number of drops counted per minute = rate of infusion in mL/hour
    - Used with adrenergic agents and cardiac antiarrhythmics
    - Used with children sensitive to large amounts of IV fluids
IV Therapy:
Equipment and Administration

- Administration sets
  - Drip chamber
    - Macro-drip
      - Variety of sizes
    - Drip factors of 10, 12, 15, and 20 gtt/mL

- Administration sets
  - Drip chamber
    - Volume-control chambers
      - Used to control amount of fluids delivered (see Fig. 5-7)
      - Can be inserted between drip chamber and IV bag
      - Can set maximal amount of fluid to be infused by filling chamber from IV
      - Once emptied, patient cannot receive any more fluid

IV Therapy:
Equipment and Administration

- Administration sets
  - Drip chamber
    - Macro-drip
      - Variety of sizes
    - Drip factors of 10, 12, 15, and 20 gtt/mL
IV Therapy: Equipment and Administration

- Administration sets
  - Y-tubing
    - Used in patients who require volume expansion and possibly transfusion of blood products
    - For trauma patient, start IV line with Y-tubing and hang normal saline
    - Transfusion of blood can be started as soon as blood is available

- IV Therapy: Equipment and Administration
  - IV fluids infused without an infusion pump use force of gravity
    - Must be frequently verified as flowing at intended rate
    - Factors affecting drip rate:
      - Height of IV bag
      - Position of extremity with IV
      - Coiling of IV tubing

- Indication for starting IV line determines rate of fluid administration
  - Serves as vehicle to allow rapid administration of medications as patient's condition dictates
  - Fluid rate is often referred to as TKO (to keep open) or KVO (keep vein open)
  - KVO rate
    - Can be achieved with a microdrip set running at 30 to 50 gtt/min
    - Failure to infuse some fluids slowly can result in the IV line clotting
IV Therapy: Equipment and Administration

■ Trauma
  ▶ IVs are started for rapid administration of fluids or blood to expand intravascular volume
  ▶ Running fluids wide open means opening roller clamp all the way
  ▶ To increase rate of delivery, paramedic can place IV bag in pressure bag or have someone manually squeeze bag of fluids

IV Therapy: Equipment and Administration

■ Trauma
  ▶ Rate that fluid can flow through a tube is determined by laws of physics:
    • \( \frac{(\text{Change in pressure}) \times \text{radius}^4}{\text{length of the catheter}} \)
    ▶ Increasing change in pressure by increasing height of bag, adding a pressure bag, or manually squeezing increases rate of delivery
    ▶ Increasing length of tubing by adding tubing actually decreases rate

IV Therapy: Equipment and Administration

■ In helicopters and mobile intensive care units, paramedics may encounter a variety of infusion pumps
  ▶ Advantages
    • Able to directly enter rate of infusion
    • Allows entry of patient’s weight and desired dose of medication
    • Allows user to set a volume to be delivered, and will stop infusion after delivery
Site selection and preparation

- Most commonly inserted in veins of hands and arms
- With trauma or shock, place in larger vein of antecubital fossa
- In less critical cases, choose most distal aspect of extremity

- Avoid starting IV in dominant hand or injured extremity
- Avoid IVs in lower extremities of adults
- In children, insertion into dorsal aspect of foot or scalp is common
- Alcohol or povidone iodine is most commonly used to prepare site
IV Therapy: Equipment and Administration

• Procedures
  ➢ IV assembly
    • Equipment needed:
      ➢ IV solution
      ➢ IV tubing

• Procedure:
  ➢ Observe universal precautions
  ➢ When possible, explain to patient what procedure you are performing and why
  ➢ Select appropriate fluid
  ➢ Remove cover from both IV part of IV bag of fluids and spike on IV tubing drip chamber

• Procedure:
  ➢ Insert spike of tubing drip chamber into IV tubing part of bag
  ➢ Open roller clamp on IV tubing to flush IV fluid though tubing
  ➢ After tubing has been flushed, disese roller clamp or set fluid infusion rate as prescribed
IV Therapy: Equipment and Administration

Procedures
- IV assembly with volume control (volutrol)
  - Equipment needed:
    - IV solution
    - IV tubing with volutrol

Procedure:
- Observe universal precautions
- Confirm patient has no allergies to medication
- When possible, explain to patient what procedure you are performing and why
- Select appropriate IV fluid and spike bag in same way you would for a regular IV
- Connect and hang the drip set
- Open flow clamp above chamber
- Cannulate the vein, connect IV tubing, and set drip rate by using flow regulation clamp below volume chamber
- Monitor fluid in chamber at all times
IV Therapy: Equipment and Administration

- Procedures
  - IV assembly with volutrol
    - Procedure:
      - When volume regulation chamber is almost empty, reassess patient’s condition and lung fields to determine whether procedure should be continued as premeasured infusion or in TKO format.
      - Document medication, dose, route, needle size, and time in the PDR.
      - Evaluate patient for desired effects of medication and any adverse effects.

- Procedures
  - Peripheral IV access
    - Equipment needed:
      - Alcohol or povidone-iodine (Betadine) prep
      - Tourniquet
      - IV catheter
      - IV tubing
      - IV solution
      - Adhesive tape or dressing to secure IV line
      - Sharps
      - PPE

- Procedures
  - Peripheral IV access
    - Procedure:
      - Observe universal precautions.
      - Confirm patient has no allergies to medication.
      - When possible, explain what procedure you are performing and why.
      - Position patient to stabilize extremity where IV is to be inserted with pillows or cot that is easily accessible.
IV Therapy: Equipment and Administration

**Procedures**

- **Peripheral IV access**
  - **Procedure:**
    - Ensure all IV tubing and equipment are assembled and flushed, and all materials required for securing and dressing the catheter are immediately available
    - Determine location for IV catheter placement
    - Apply tourniquet several inches proximal to proposed IV site
    - Prepare area

- **Procedure:**
  - Hold needle in your dominant hand at a 30° angle, with needle bevel up
  - Insert needle through skin approximately ½ to 1 inch distal to site where it will enter vein
  - As you slowly advance needle through the skin, reduce angle to approximately 15° while advancing through soft tissues into the vein
  - Once needle has entered into the vein, blood will flow back into hub of the needle

- **Procedure:**
  - While securing catheter with one hand, release tourniquet and connect hub of the catheter to preassembled tubing set
  - Secure catheter in place with tape or adhesive dressings
  - Document medication, dose, route, needle size, and time in the PCR
  - Evaluate patient for desired effects of medication and any adverse effects
IV Therapy: Equipment and Administration

**Procedures**

- After IV line has been established, providers can deliver medications directly into circulatory system
- IV push
  - Involves using syringe connected to injection port of IV line
  - Rapidly administers medications
  - Slowly empty syringe over period of several minutes

**Procedures**

- Injection ports
  - Areas placed along IV tubing where provider can inject contents of a syringe into IV line
- Preloaded syringe
  - Must assemble syringe by removing yellow caps on the ends of the two pieces, then screwing the two pieces together

**Procedures**

- Prefilled tubes
  - Glass syringes or tubes that are rapidly screwed in a plastic or metal tube
- Medications not supplied in preloaded syringes are provided in vials or ampules
  - Must transfer medication into a syringe
  - Vials
  - Ampules
IV Therapy: Equipment and Administration

Procedures
- Withdrawing medication from a vial
  - Procedure:
    - Observe universal precautions
    - Verify drug order
    - Confirm patient has no allergies to medication
    - When possible, explain what procedure you are performing and why

- Procedure:
  - Peel back aluminum lid of vial to expose rubber diaphragm
  - Wipe rubber diaphragm with an alcohol wipe
  - Fill syringe with volume of air equal to amount of medication desired
  - With bevel of the needle facing you, insert needle into the vial and inject air from syringe
  - Load medication from vial into syringe
  - When withdrawing medication from vial for use by IM or Sub-Q routes, place new needle on syringe before administering medication
IV Therapy: Equipment and Administration

- Procedures
  - Assembly of a preloaded syringe
    - Equipment needed:
      - Medication in preloaded syringe
      - Sharps
    - Procedure:
      - Observe universal precautions
      - Verify drug order
      - Confirm patient has no allergies to medication
      - When possible, explain what procedure you are performing and why
    - Procedure:
      - Calculate volume of medication to be administered
      - Remove protective cap from barrel and cartridge
      - Screw cartridge into barrel
      - Push in plunger to expel air
IV Therapy:
Equipment and Administration

Procedures

- Withdrawing medication from an ampule
  - Equipment needed:
    - Ampule of medication
    - 2 pieces of 4 x 4 gauze
    - Syringe
    - Filtered needle for drawing medication into the syringe
    - Needle for injection
    - Sharps

- Procedure:
  - Observe universal precautions
  - Verify drug order
  - Confirm patient has no allergies to medication
  - When possible, explain what procedure you are performing and why
  - Shift all medication into lower portion of ampule by tapping the top half of ampule
  - Hold ampula between your hands by wrapping it with two pieces of gauze
  - In one hand, hold top of ampule in a piece of gauze
  - With other hand, hold lower portion of glass ampule
  - Break top off ampula by bending it away from you
  - Use a filtered needle to draw medication into the syringe to prevent any glass shards from being drawn up
IV Therapy: Equipment and Administration

- Procedures
  - IV drug administration
    - Equipment needed:
      - Alcohol prep
      - Medication loaded in a syringe
      - Needle for the syringe
      - Sharps
      - PPE
  - Procedure
    - Observe universal precautions
    - Verify drug order
    - Confirm patient has no allergies to medication
    - When possible, explain what procedure you are performing and why
    - Locate medication port of IV line and wipe it clean with alcohol
    - Clamp or pinch IV tubing above site of medication port
    - Insert needle of syringe through diaphragm of medication port
    - Gently pull back plunger on syringe until you see small flow of blood in IV tubing
**IV Therapy: Equipment and Administration**

**Procedures**

- **IV drug administration**
  - **Procedure**
    - Inject medication into IV line at rate appropriate for medication.
    - Once all medication has been injected, remove needle from medication port, uncapse IV tubing, and dispose the needle and syringe into sharps container.
    - Document medication, dose, route, needle size, and time in the PCR.
    - Evaluate patient for desired effects of medication and any adverse effects.

- **IV piggyback**
  - Secondary infusions attached to primary infusion line.
  - Medication is added to smaller bag of IV fluid and slowly infused through medication port of main IV line.
  - Many IV medications are administered during projected period of 30 minutes to hours.
  - Smaller IV bag containing medication is then connected by injector port into main IV line.

- **IV infusion (piggyback)**
  - **Equipment**
    - Alcohol prep
    - Medication
    - Syringe
    - Needle
    - Small bag of compatible IV fluids (100 or 250 mL)
    - IV tubing
    - Medication label
    - Sharps
IV Therapy: Equipment and Administration

Procedures

- IV infusion (piggyback)
  - Procedure:
    - Observe universal precautions
    - Verify drug order
    - Confirm patient has no allergies to medication
    - When possible, explain what procedure you are performing and why

- To prepare medication, draw it into a syringe by techniques previously explained
- Wipe injection port of smaller bag of IV fluids being used for piggyback infusion with alcohol
- Inject medication into IV bag
- Mix solution by shaking IV bag

- Label bag with medication label
- Document medication, dose, route, needle size, and time in the PCR
- Evaluate patient for desired effects of medication and any adverse effects
IV Therapy: Equipment and Administration

- Procedures
  - Attaching infusion solution to primary IV line
    - Equipment needed:
      - Alcohol prep
      - Medication
      - Syringe
      - Needle
      - Small bag of compatible IV fluids
      - IV tubing
      - Medication label
      - Sharps

- Procedure:
  - Observe universal precautions
  - Verify drug order
  - Confirm patient has no allergies to medication
  - When possible, explain what procedure you are performing and why

  - Wipe clean the medication port of IV line with alcohol
  - Clamp IV tubing of primary line
  - Place needle of line containing piggyback medication through diaphragm of medication port above site of medication port
  - Infuse medication into primary IV line at rate appropriate for particular medication
IV Therapy: Equipment and Administration

- Procedures
  - Attaching infusion solution to primary IV line
    - Procedure:
      - Hang smaller IV bag containing medication given by piggyback infusion at level higher than bag used for primary IV infusion
      - Once infusion of medication is complete, remove piggyback infusion and unclamp tubing of primary IV line
      - Document medication, dose, route, needle size, and time in the PCR
      - Evaluate patient for desired effects of medication and any adverse effects

- Procedures
  - Intraosseous (IO) infusions
    - Placement of needle set into highly vascular intramedullary space of bone and infusion of fluids or medications into this space
    - In cases of hypovolemic shock, veins often collapse, making access with IV catheters difficult or impossible
    - Fluids, blood, and medications administered through an IO line can be delivered to central circulation by this route as rapidly as through peripheral or central venous catheters
IV Therapy: Equipment and Administration

- Procedures
  - IO infusions
    - Most common site: proximal tibia
      - Flat nature and lack of extensive overlying muscle and soft tissue
    - To locate, palpate proximal tibia immediately below knee and feel for marked bump in the bone
    - Medial to tibial tuberosity on anteromedial portion of the bone
    - Avoid placing needle in an injured extremity

- Devices used to gain access
  - Jamshidi intraosseous needle is most widely used
  - Some use manual application
  - Some use spring-loaded devices
  - Electrical drills
  - EZ-IO device
IV Therapy: Equipment and Administration

- Procedures
  - IO infusions
    - In adults, sternum is occasionally used as IO infusion site
      - Thin and flat
      - Contains high proportion of red marrow
      - Easy to penetrate
      - Less likely to be fractured
      - Close to central circulation
      - Recommended insertion site is manubrium, 1.6 cm below sterna notch
      - Must use specifically designed device for sterna applications

- IO infusion: tibial approach
  - Equipment needed:
    - Alcohol or chlorhexidine prep
    - IO needle set
    - 10-mL syringe
    - IV tubing
    - Bag of IV compatible fluids
    - Several rolls of gauze
    - Tape
    - Sharps
    - PPE
IV Therapy:
Equipment and Administration

Procedures
- IO infusion: tibial approach
  - Procedure:
    - Observe universal precautions
    - Verify drug order
    - Confirm patient has no allergies to medication
    - When possible, explain what procedure you are performing and why

- Identify site of insertion
- Prepare insertion site with either alcohol or chlorhexidine
- Make sure that angle of needle set insertion is 90° to the bone
- Advance needle set with back-and-forth screwing motion
- Confirm proper placement of the catheter

- Attach preassembled administration set to IO catheter
- Secure IO line in place with bulky dressings
- Document medication, dose, route, needle size, and time in the PCR
- Evaluate patient for desired effects of medication and any adverse effects
IV Therapy: Equipment and Administration

- Procedures
  - IO infusion: sterna approach for FAST1 IO infusion system
    - Equipment needed:
      - Alcohol or povidine-iodione prep
      - IO needle
      - 10-mL syringe
      - IV tubing
      - Bag of IV compatible fluids
      - Several rills of gauze
      - Tape
      - Sharps
      - PPE

- Procedure:
  - Locate patient’s manubrium and prepare the site with aseptic solution
  - Use index finger to align target patch with patient’s sternal notch
  - Place target patch
  - Place introducer into target zone on patch, perpendicular to the skin
  - Firmly push on introducer to insert infusion tube into correct site and to right penetration depth
IV Therapy: Equipment and Administration

• Procedures
  ➢ IO infusion: sterna approach for FAST1 IO infusion system
    Procedure:
    ➢ Pull introducer straight back, exposing infusion tube and two-part support sleeve, which falls away
    ➢ Verify correct placement by observing marrow entering infusion tube
    ➢ Connect IV solution and tubing to infusion tube on patch, and adjust flow rate

• Procedures
  ➢ IO infusion: sterna approach for FAST1 IO infusion system
    Procedure:
    ➢ Place protective dome over site by pressing firmly over target patch to engage Velcro fastening
    ➢ Document medication, dose, route, needle size, and time in the PCR
    ➢ Evaluate patient for desired effects of medication and any adverse effects

IV Therapy: Equipment and Administration

• Complication of IV therapy
  ➢ IV therapy has potential complications
    • Infiltration
      ➢ Occurs when tip of the catheter dislodges from lumen of the vein
      ➢ Fluid then delivered to soft tissues around vein
      ➢ Can result in tissue destruction and necrosis at site of infiltration
      ➢ Signs: fluid no longer freely drips, pain and swelling at the IV site
IV Therapy: Equipment and Administration

- Complication of IV therapy
  - IV therapy has potential complications
    - Infiltration
      - Treatment: discontinue IV, start new IV either proximal to infiltration or in another extremity
      - Hand and foot infiltration can cause damage to underlying and adjacent structures
      - Elevate affected area
      - Examine vascular, motor, and sensory function
      - If medication infiltration is suspected, immediately report to medical direction

- Complication of IV therapy
  - Catheter shear
    - Occurs when segment of catheter breaks off
    - Is either retained in vein or embolizes through venous system
    - Can occur when provider tries to pull catheter back over needle
    - Typically when blood return appears while starting an IV
    - Severed catheter can float away in vein to site more proximal in limb or heart and lungs
    - Can require retrieval by surgery or angiography

- Complication of IV therapy
  - Phlebitis
    - Inflammation of the vein
    - Manifests as pain, redness, edema
    - Thrombophlebitis
    - Suppurative thrombophlebitis
    - Infection
    - Infected phlebitis
IV Therapy: Equipment and Administration

Questions?