MEDAVIE HealthEd ÉduSanté

VASCULAR ACCESS

Advanced Care Paramedicine

Module: 04
Section: 08

MEDAVIE HealthEd ÉduSanté

Vascular Access

IV FLUIDS

Fluids

- Types:
  - Crystalloids
  - Colloids

Crystalloids

- Solutions with dissolved crystals in water
- May contain electrolytes (Na, K, Ca, Cl) but lack the large proteins and molecules found in colloids
- Classified according to their “tonicity”
  - Hypotonic
  - Isotonic
  - Hypertonic
- Can equilibrate more quickly between vascular and extravascular spaces
  - 2/3 of crystalloid fluid leaves vascular space $\leq$ 1 hr
  - 3 mL of crystalloid replaces 1 mL of blood

Hypertonic and Hypotonic Solutions

- Hypertonic solutions
  - Higher osmotic pressure than body cells
    - 7.5% saline
- Hypotonic solutions
  - Lower osmotic pressure than body cells
    - Distilled water
    - 0.45% sodium chloride (0.45% NaCl)

Isotonic Solutions

- Lactated Ringer's solution
- Normal saline
- Glucose-containing solutions (e.g., D_5W)
  - Dextrose is readily used up leaving only the water to affect the space

Colloids

- Solutes in the form of large proteins or other similarly sized molecules
  - So large that they cannot pass through the walls of the capillaries and onto the cells
- Remain within blood vessels longer
- Can significantly increase the intravascular volume
  - May be beneficial in the short term, continual movement in this direction can cause the cells to lose too much water and become dehydrated
- Colloids are useful in maintaining blood volume
- Examples
  - Whole blood, Fresh or frozen Plasma, Packed RBC's
  - Human serum Albumin
  - LMW Hydroxyethyl starch (Pentaspan)
  - HMW Hydroxyethyl starch (Hetaspan)
  - Dextran

Colloids

- Advantages
  - Less edema
  - Less volume administered
  - Less thermal load effect for given level of plasma volume expansion
  - Volume administer stays in intravascular space longer

- Disadvantages
  - Decreased hemoglobin
  - Dilution of plasma proteins (Dextrans, HES)
  - Dilution of coagulation factors (PT, PTT)
  - Pulmonary edema (due to changes in osmotic pressures)
  - Allergic reaction

Theory of Fluid Flow

- Flow of fluid through catheter (Poiseuille's Law)
  - Directly related to diameter (to the fourth power)
  - Inversely related to length

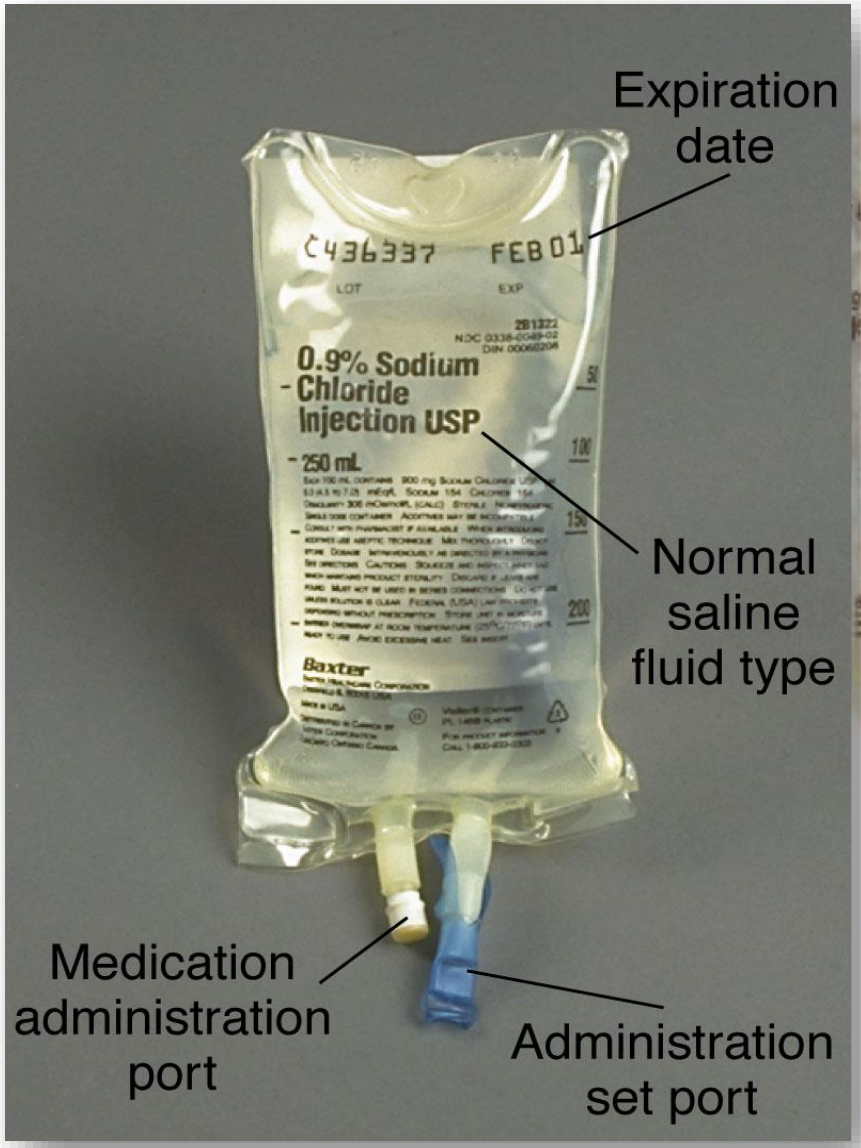
- Also affect fluid flow:
  - Diameter and length of tubing
  - Size of vein
  - Viscosity and temperature of fluid
    - Viscosity is affected by temperature
    - Warm fluids flow faster

Q	Flow rate
P	Pressure
r	Radius
η	Fluid viscosity
l	Length of tubing

$$Q = \frac{\pi \mathrm{P} r^4}{8 \eta l}$$

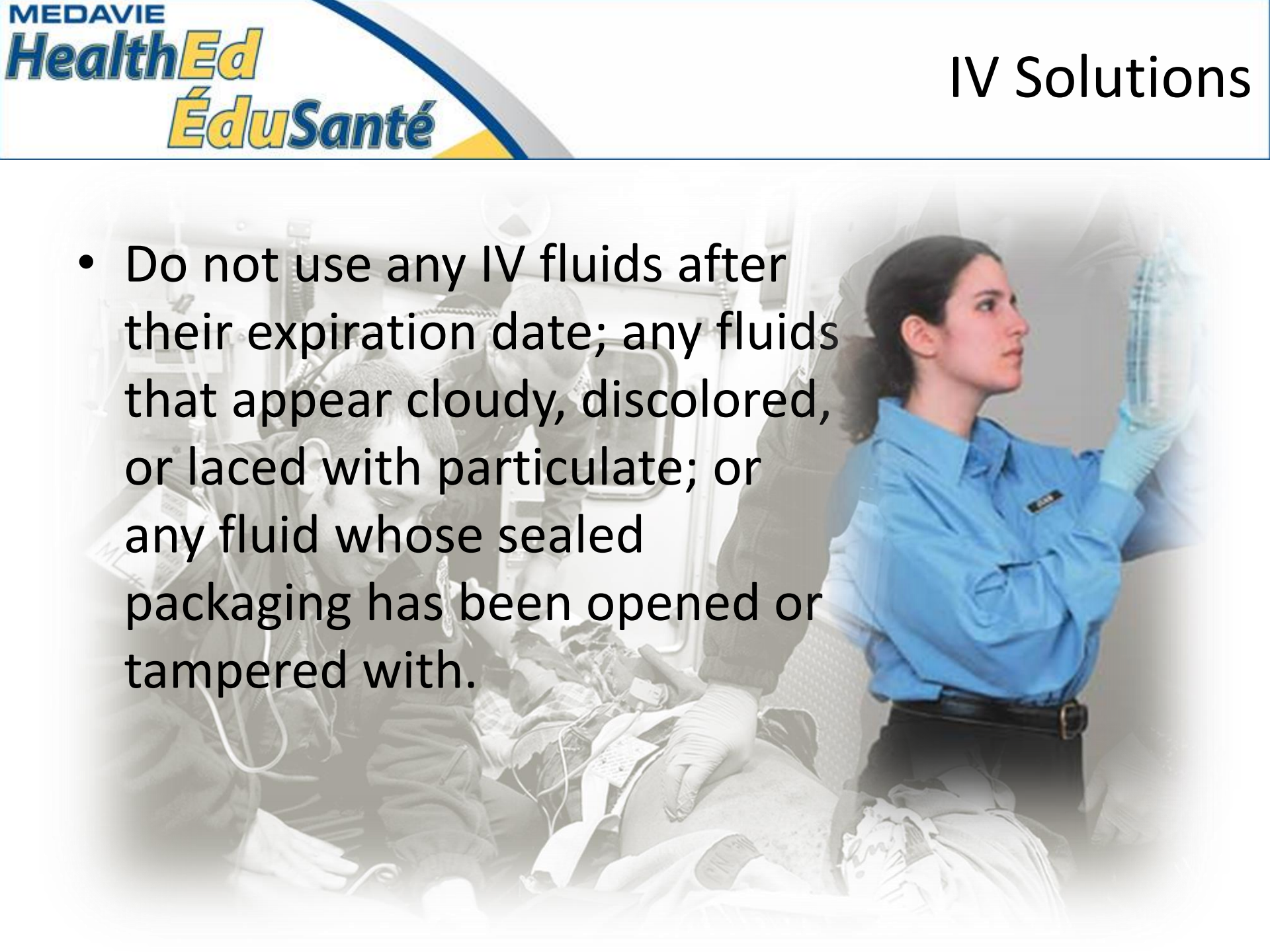
MEDAVIE HealthEd ÉduSanté

IV Solution Containers



IV Solutions

- Do not use any IV fluids after their expiration date; any fluids that appear cloudy, discolored, or laced with particulate; or any fluid whose sealed packaging has been opened or tampered with.



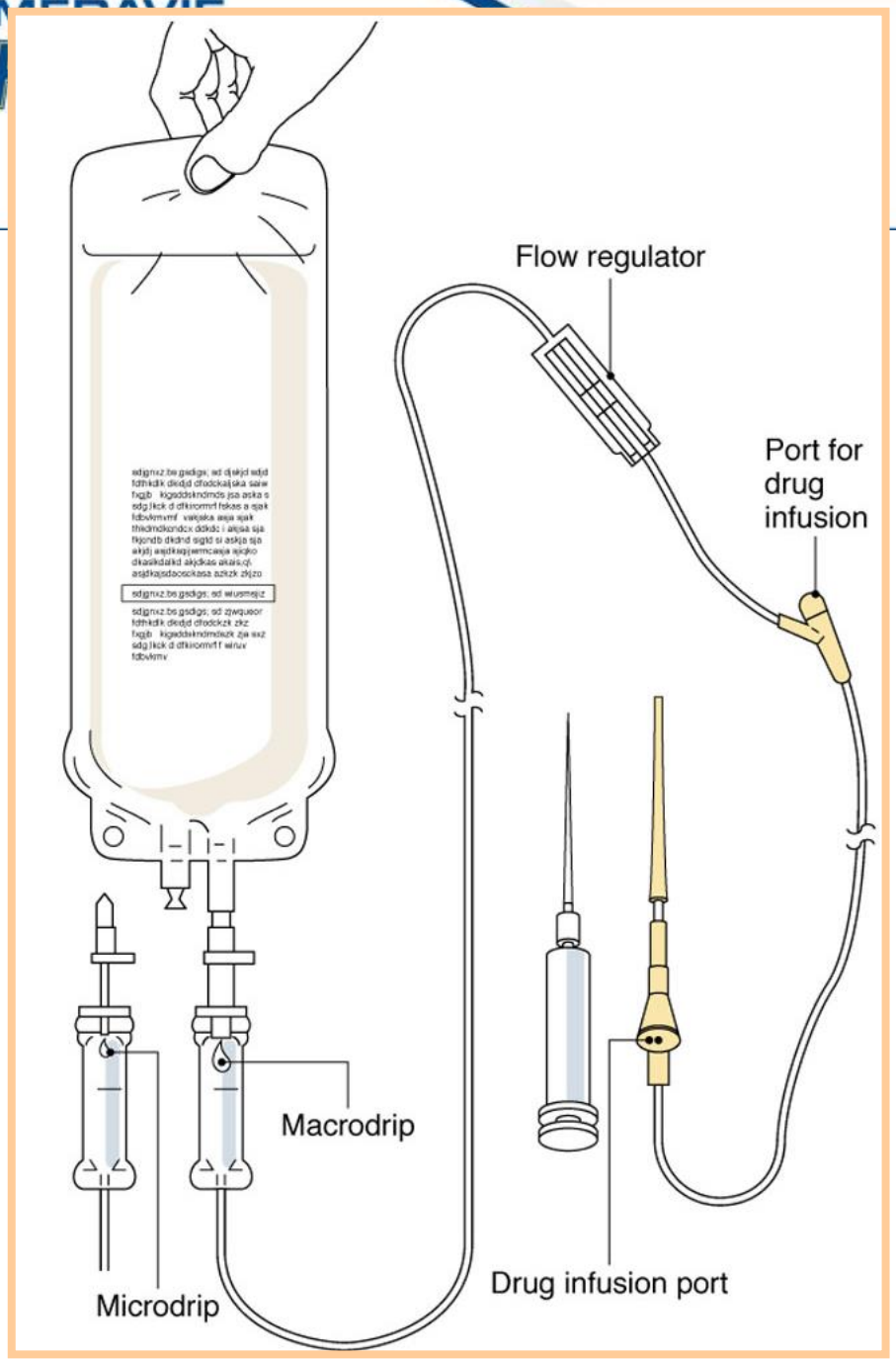
IV Administration Sets

- Macrodrip
  - 10 to 20 gtts = 1 ml, for giving large amounts of fluid.
- Microdrip
  - 60 gtts = 1 ml, for restricting amounts of fluid.
- Blood tubing
  - Has a filter to prevent clots from blood products from entering the body.
- Measured volume
  - Delivers specific volumes of fluids.

IV Administration Sets

- IV extension tubing
  - Extends original tubing.
- Electromechanical pump tubing
  - Specific for each pump.
- Miscellaneous
  - Some sets have a dial that can set the flow rates.

Macrodrip and Microdrip Administration Sets



MEDAVIE HealthEd ÉduSanté

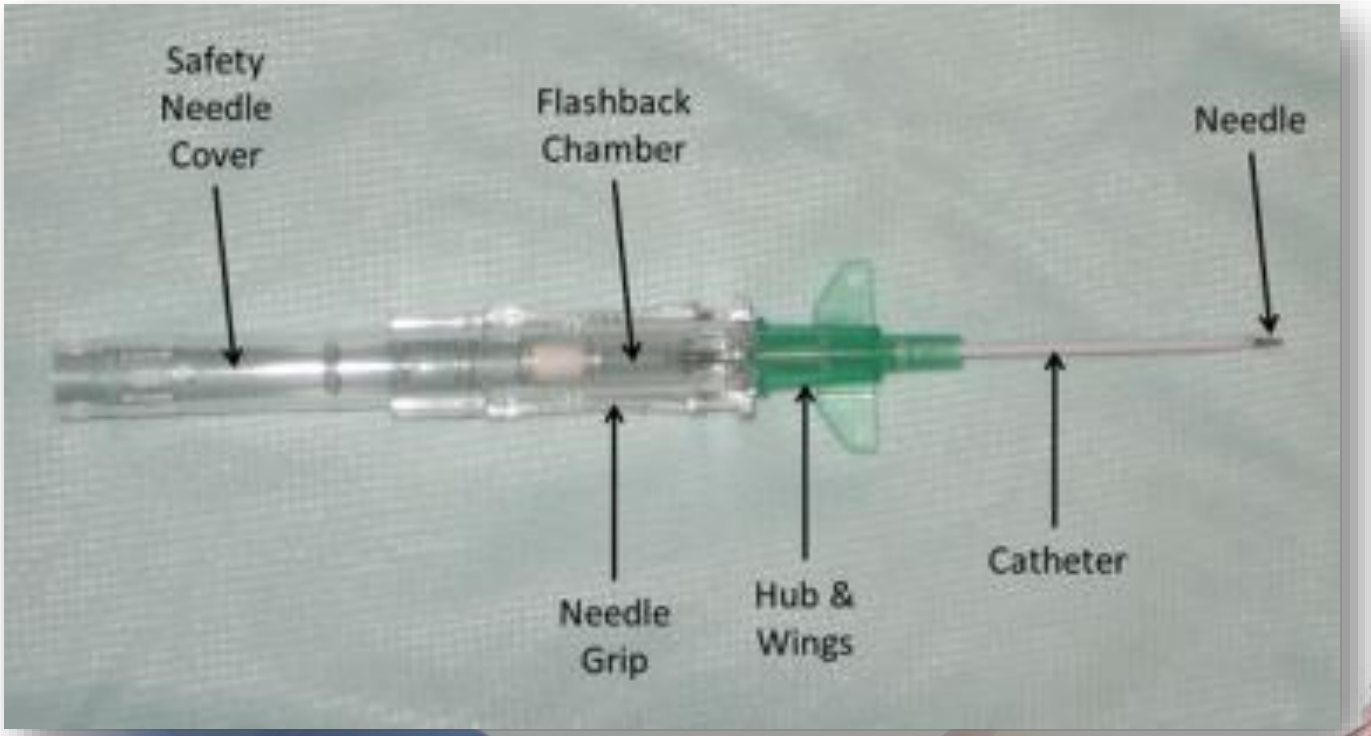
Measured Volume Administration Set

Intravenous Cannulas

- Over-the-needle catheter
- Hollow-needle catheter
- Plastic catheter inserted through a hollow needle

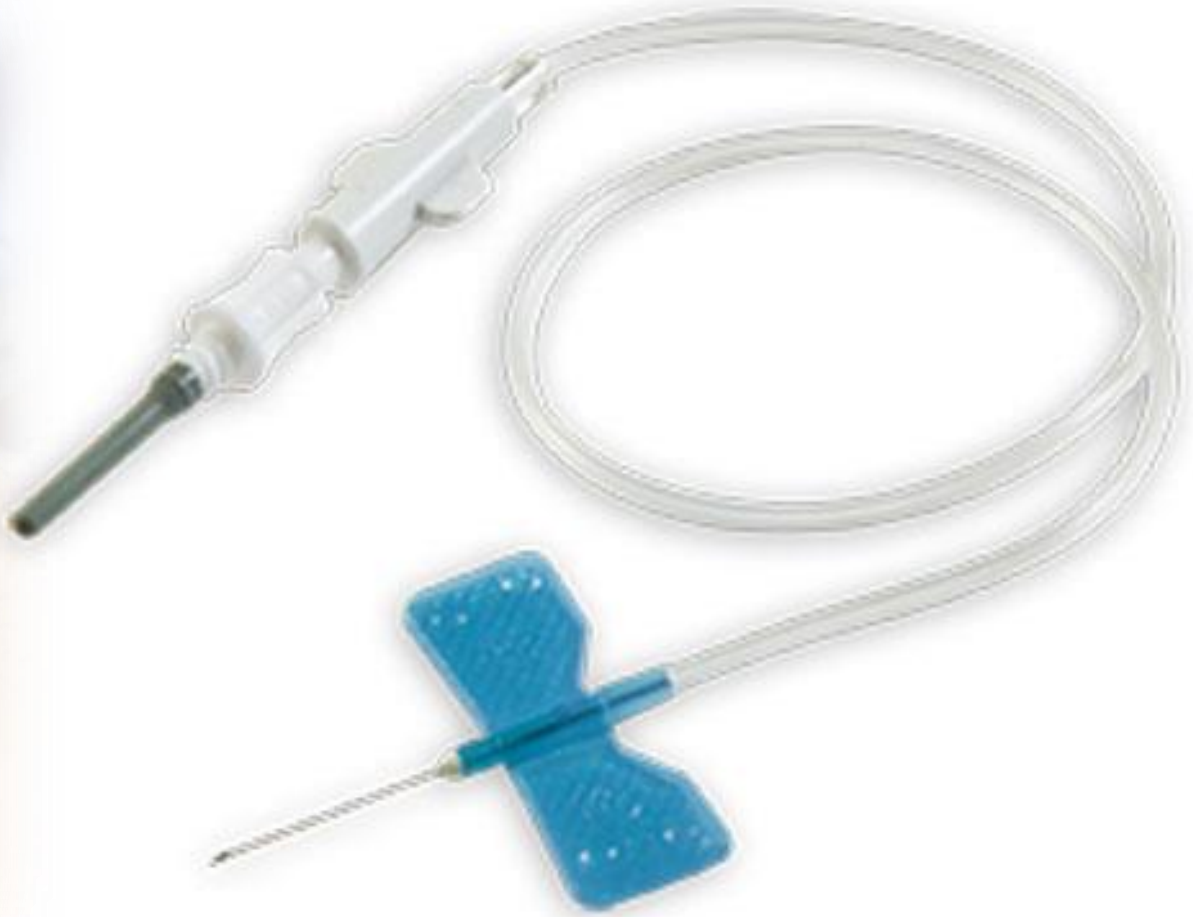
MEDAVIE HealthEd ÉduSanté

Over-the-Needle Catheter

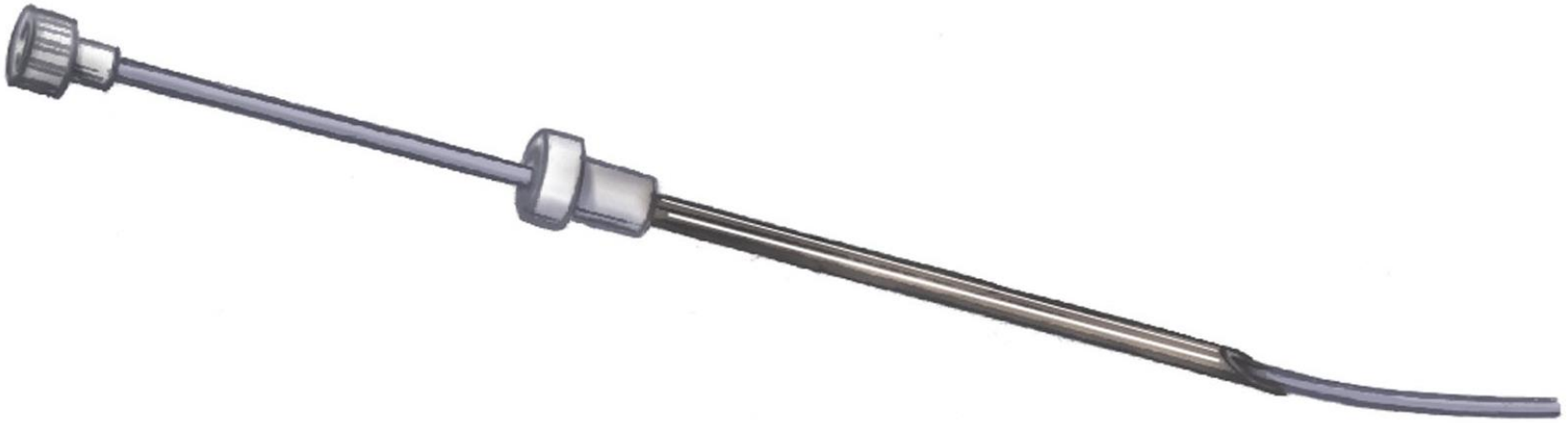


MEDAVIE HealthEd ÉduSanté

Hollow-Needle Catheter



Catheter Inserted Through the Needle



MEDAVIE HealthEd ÉduSanté

Vascular Access

PERIPHERAL IV ACCESS

Intravenous (IV) Access

- Indications
  - Fluid and blood replacement
  - Drug administration
  - Obtaining venous blood specimens for lab analysis
- Types
  - Peripheral venous access
  - Central venous access

Contraindications

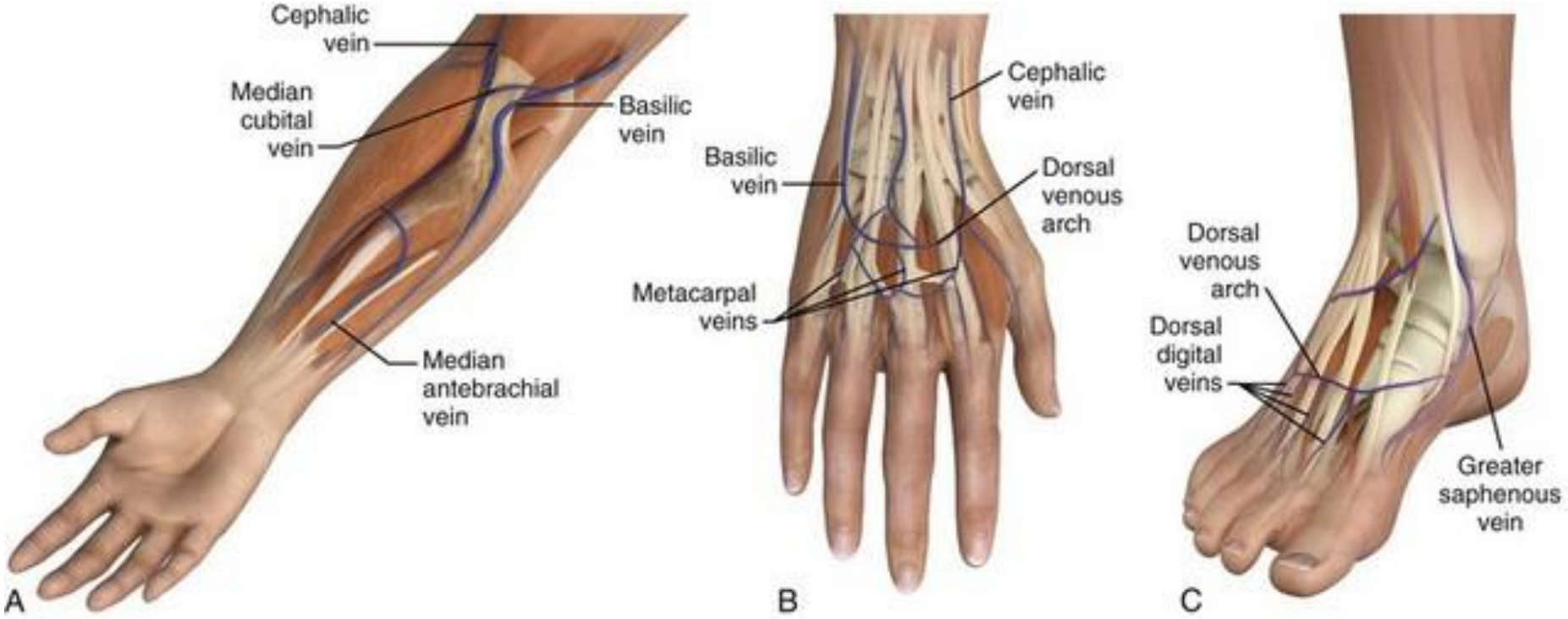
- Distal to a fracture site in a limb
- Through damaged or abraded skin
  - Burns may be an exception if there is no other accessible site
- In an arm affected by a radical mastectomy, edema, blood clot or infection
- In an arm with a fistula for dialysis or a peripherally inserted control catheter (PICC Line)

Where do we cannulate?

- Hand
- Forearm
- Neck
- Foot

MEDAVIE HealthEd ÉduSanté

Peripheral IV Access Sites



Vein Selection

- Based on:
  - Condition
  - Location
  - Purpose
  - Duration

Equipment Required

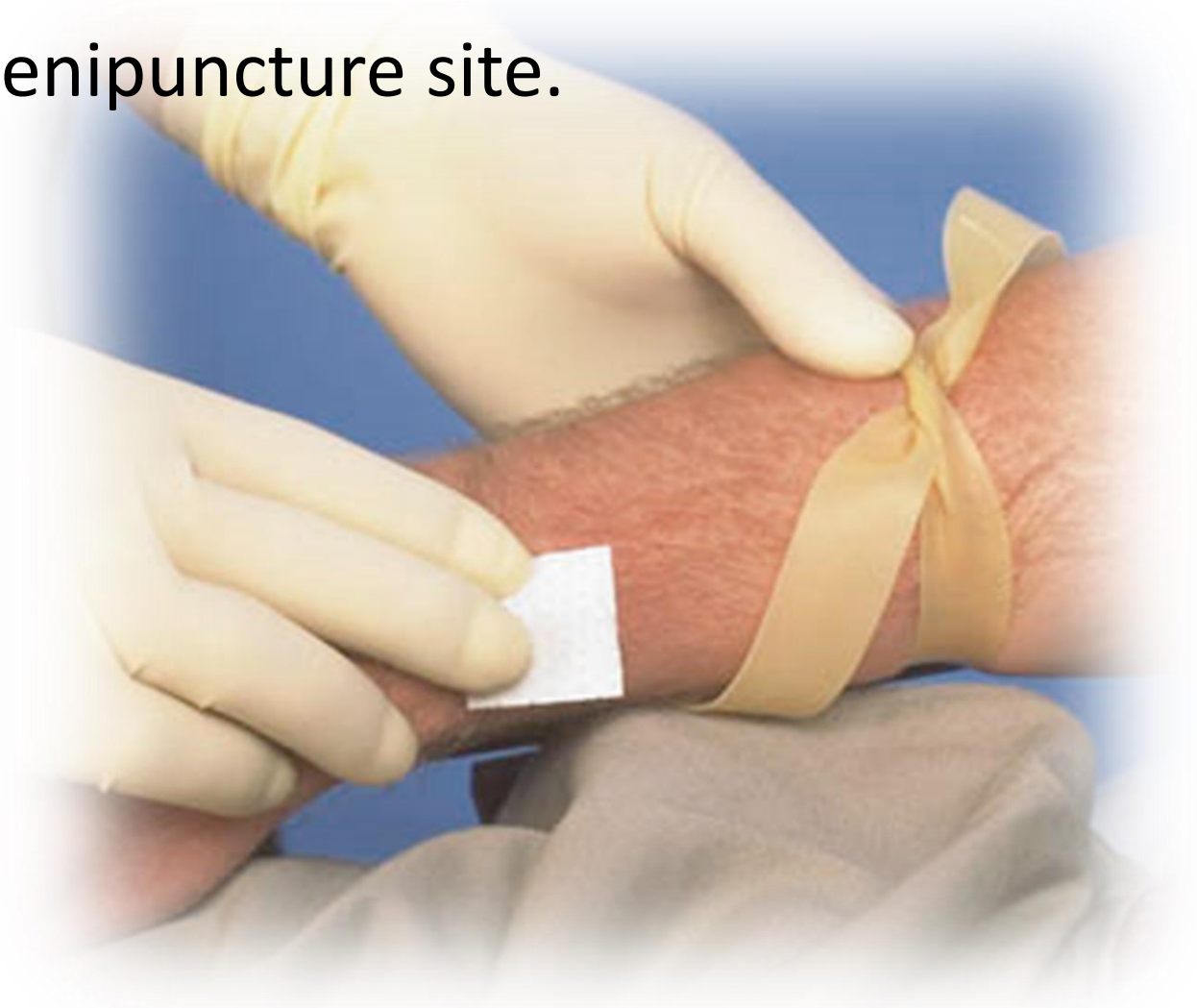
- Solution
- Administration set
- IV cannula
- Tourniquet
- Alcohol swab
- Gloves
- Sharps bin
- Op site and gauze
- Tape
- If performing a Lock
  - Lock, syringe and saline

Peripheral IV Access

- Place the constricting band.

Peripheral IV Access

- Cleanse the venipuncture site.



Peripheral IV Access

- Insert the intravenous cannula into the vein.

Peripheral IV Access

- Withdraw any blood samples needed.

Peripheral IV Access

- Connect the IV tubing

Peripheral IV Access

- Secure the site.

Peripheral IV Access

- Label the IV solution bag.

Changing an IV Bag or Bottle

- Prepare the new bag or bottle.
- Occlude the flow from depleted bag or bottle.
- Remove spike from depleted bag or bottle.
- Insert spike into the new IV bag or bottle.
- Open the clamp to appropriate flow rate.

Fluid Replacement

- Blood
  - Replaced at a ratio of 3:1 of IV fluid to blood being replaced

- Minimum daily requirements
  - 1st 10 kg 100 ml/hr
  - 2nd 10 kg 50 ml/hr
  - 3rd 10 kg 20 ml/hr
  - 4th 10 kg 10 ml/hr
  - 5th 10 kg 10 ml/hr
    - Usually does not exceed 190 ml/hr

  - Example 50 kg patient
    - 100 ml/hr + 50 ml/hr + 20 ml/hr + 10 ml/hr + 10 ml/hr = 190 ml/hr

MEDAVIE HealthEd ÉduSanté

IV Access

Complications

- Local complications
  - Hematomas
  - Infiltration
  - Necrosis
  - Thrombophlebitis

- Systemic complications
  - Pulmonary edema
  - Speed shock
  - Pyrogenic reaction
  - Pulmonary embolism
    - blood
    - Air
  - Catheter shear

Local - Hematomas

- Causes:
  - Punctured vein
- Symptoms:
  - Bruising
  - Tenderness
  - Swelling
- Preventative actions:
  - Proper techniques

Local - Infiltration

- Causes:
  - Poor insertion techniques
  - Improper taping
  - Over active patient
  - IV slows or stops
- Symptoms:
  - Swelling or hardness
  - Feeling of coldness
  - Leaking at the site
- Preventative actions:
  - Armboards, proper taping
  - Routine checks of IV flow and site

Local - Necrosis

- Causes:
  - Irritation of tissues from infiltrated drug or fluid
- Symptoms:
  - Swelling, tenderness
  - Inflammation or bruising
- Preventative actions:
  - Routine checks
  - Report any changes

Local - Thrombophlebitis

- Causes:
  - Trauma to endothelium from chemical means
- Symptoms:
  - Pain, redness, swelling along infected vein
  - Generalized symptoms such as fever, malaise, rapid pulse
- Preventative actions:
  - Avoid insertion over joint
  - Select veins with adequate blood flow for infusions of hypertonic solutions

Systemic – Pulmonary Edema

- Causes:
  - Circulatory overload from too rapid infusion when patient has impaired renal or cardiac function
- Symptoms:
  - JVD, ↑BP, ↑Resps, dyspnea, agitation
- Preventative actions:
  - Watch rate
  - Oxygen, sit pt upright
  - Slow IV and contact OLMC

Systemic – Speed Shock

- Causes:
  - IV running to rapidly
  - Rapid injection of a drug
- Symptoms:
  - ↓BP, rapid pulse
  - Labored resps, cyanosis
  - Faint, ↓LOC
- Preventative actions:
  - Use controlled volume infusion set
  - Upon initiation, ensure free flowing prior to rate adjustment

Systemic – Pyrogenic Reaction

- Causes:
  - Contaminated IV solutions
- Symptoms:
  - Symptoms generally occur after IV begun
  - ↑temp, chills, headache, N/V, circulatory collapse
- Preventative actions:
  - Check IV fluids for cloudiness and particles
  - Use fresh open IV's

Systemic – PE (Blood/Embolus)

- Causes:
  - Unfiltered blood
  - Partially dissolved drug
  - Particulate matter in IV solution
- Symptoms:
  - Dyspnea, cyanosis, pain, anxiety, tachycardia, tachypnea
- Preventative actions:
  - Infuse blood through filter
  - Dissolve drugs completely
  - Use good judgment when syringing IV's

Systemic – PE (Air)

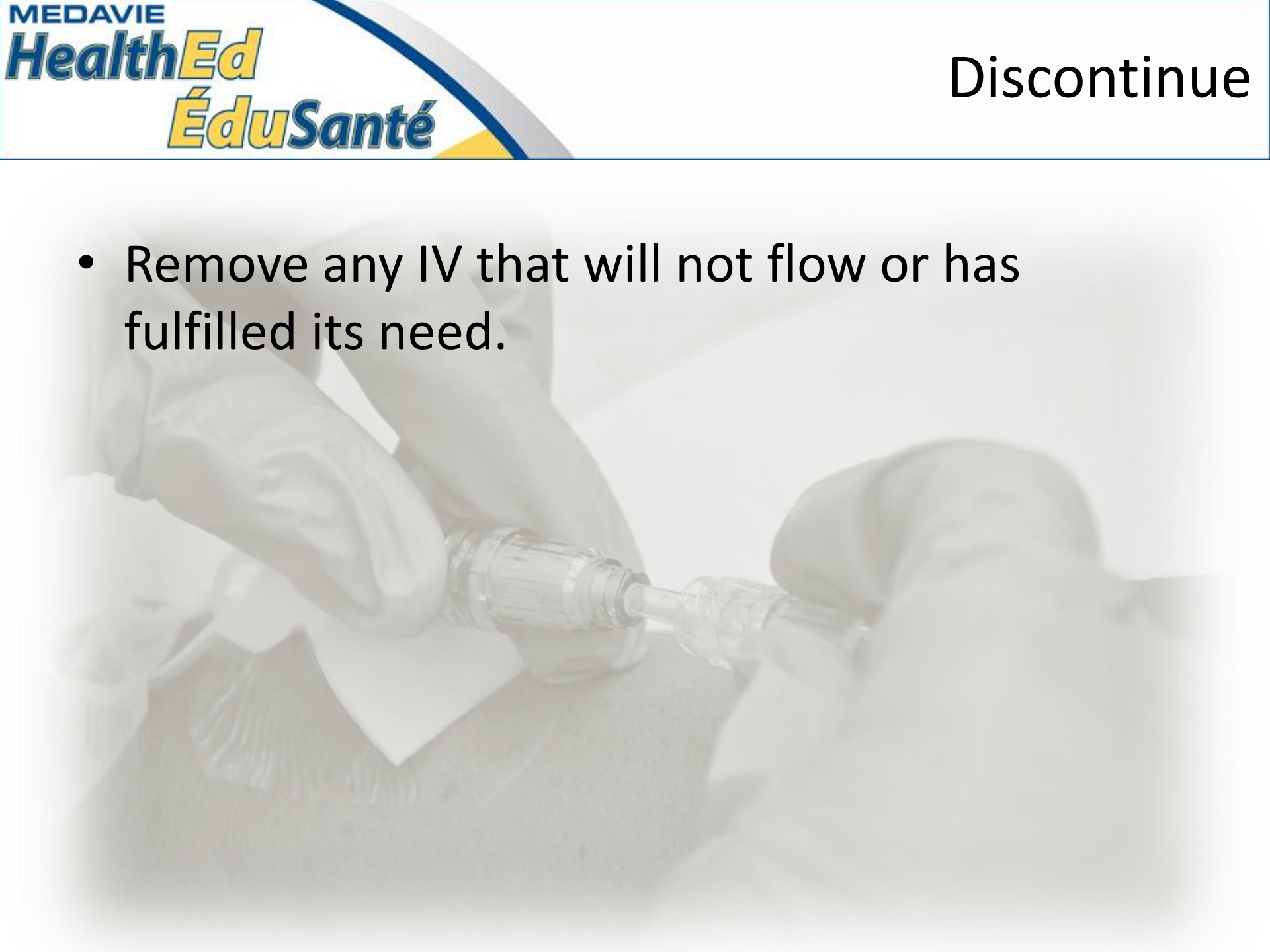
- Causes:
  - Failure to clear tubing of air
  - Allowing air to enter the system
- Symptoms:
  - Cyanosis, ↓BP, weak, tachycardia, ↓LOC, non-specific chest or ABD pain
- Preventative actions:
  - Don’t let IV run dry
  - Clear tubing properly
  - Check syringe prior to injecting
  - If occurs place pt on left side and contact OLMC

Troubleshooting

- If blood begins to flow back in the IV tubing
  - Check location of the bag to insure it is in a gravity flow location
  - Insure all valves are open
  - If continues, reassess site and assure arterial cannulation has not occurred
- If your IV does not run…
  - Start at the top, work your way back to the patient
  - Is the bag empty?
  - Check the IV set clamps to insure they are open
  - Check tubing for kinks
  - Check site for any problems
    - Blood backing up
    - Infiltration
  - Do you need to flush the site
  - Is your tourniquet still one!

Discontinue

- Remove any IV that will not flow or has fulfilled its need.



MEDAVIE HealthEd ÉduSanté

Vascular Access

PERIPHERAL INTRAVENOUS ACCESS IN AN EXTERNAL JUGULAR VEIN

External Jugular

- Place the patient in a supine or Trendelenburg position.

External Jugular

- Turn the patient's head to the side opposite of access and cleanse the site.

External Jugular

- Occlude venous return by placing a finger on the external jugular just above the clavicle.

External Jugular

- Point the catheter at the medial third of the clavicle and insert it, bevel up, at a 10°–30° angle.

External Jugular

- Enter the jugular while withdrawing on the plunger of the attached syringe.

MEDAVIE HealthEd ÉduSanté

Vascular Access

INTRAVENOUS ACCESS

WITH A MEASURED VOLUME ADMINISTRATION SET

Prepare the tubing

- OSCAR
  - Open
  - Squeeze
  - Close
  - And
  - Release

Open and Squeeze

- Open the uppermost clamp and fill the burette chamber with approximately 20 ml of fluid.
- Squeeze the drip chamber to fill (no more then ½ full)

- Close the uppermost clamp and open the flow regulator.

MEDAVIE HealthEd ÉduSanté

Vascular Access

INTRAVENOUS ACCESS
WITH BLOOD TUBING

- Insert the flanged spike into the spike port of the blood and/or normal saline solution.

- Squeeze the drip chamber until it is one third full and blood covers the filter.

- Attach blood tubing to the intravenous cannula or into a previously established IV line.

- Open the clamp(s) and/or flow regulator(s) and adjust the flow rate.

MEDAVIE HealthEd ÉduSanté

Vascular Access

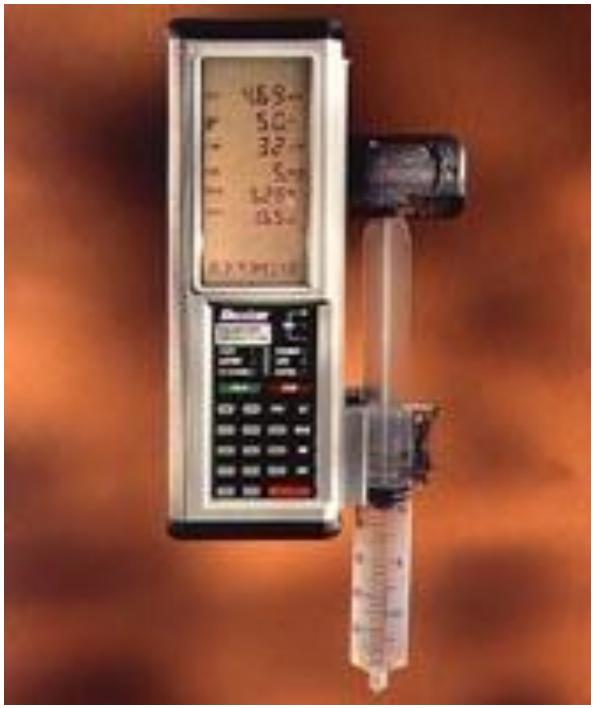
PUMPS

Electromechanical Infusion Devices

- Infusion controllers
- Infusion pumps

Infusion Pump

Syringe-Type Infusion Pump



MEDAVIE HealthEd ÉduSanté

Vascular Access

IV CALCULATIONS

Calculating flow rates

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ (\frac{gtts}{ml})}{Time\ to\ be\ infused\ (min)}$$

Drip Set (gtts/ml)	Drops to achieve 1 ml of solution	Factor
10 (macro)	10	6
15	15	4
20	20	3
60 (micro)	60	1

Calculations

- Your patient is to receive 1000 ml of normal saline (NS) over a 12 hour period using a microdrip (60 gtt/ml) administration set. The formula will now look like this:

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ (\frac{gtts}{ml})}{Time\ to\ be\ infused\ (min)}$$

$$= \frac{1000\ ml\ X\ 60\ gtts/ml}{720\ min}$$

$$= 83.33\ gtts/min$$

Now add medications

- A physician orders 2 mg/min of Lidocaine to your patient. She orders 2 g of lidocaine to be added to 500 ml NaCL. Using a 60 gtt/ml set, calculate the gtt/min.

Calculation

Step 1: Calculate the concentration of the drug in the solution

$$[\,] = \frac{Mass}{Volume}$$

$$= \frac{2.0\ g}{500\ ml}$$

$$= \frac{2000\ mg}{500\ ml}$$

$$= 4\ mg/ml$$

Step 2: Calculate the Desired Dose of the medication needed

$$Dose = \frac{Want}{Have} \times Volume$$

$$= \frac{2.0\ mg/min}{2000\ mg} \times 500\ ml$$

$$= \frac{1000\ mgml/min}{2000\ mg}$$

$$= 0.5\ ml/min$$

Calculation

Step 3: Calculate the Drip Rate based on the calculated Desired Dose

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ (\frac{gtts}{ml})}{Time\ to\ be\ infused\ (min)}$$

$$= \frac{0.5\ ml\ X\ 60\ gtts/ml}{1\ min}$$

$$= 30\ gtts/min$$

A Variation to the Same

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ (ml) \times Ordered\ \left(\frac{mg}{min}\right) X\ Drip\ Set\ (\frac{gtts}{ml})}{On\ Hand\ (mg)}$$

$$= \frac{500\ ml \times 2\ \frac{mg}{min} X\ 60 \frac{gtts}{ml}}{2000\ mg}$$

$$= 30\ gtts/min$$

Calculation #9

- Your pt is a 40 y/o, 220 lb male who is one week post operative bowel surgery, released from hospital 3/7 ago, responsive but lethargic. His SaO_2 is 95% on RA, HR 124 Reg and Weak, BP 70/40.
- Your interventions of airway management and a bolus of NaCl and have not shown a hemodynamic change. The CPG requires the ACP to begin an infusion of dopamine.
- The medication is provided in a premixed bag containing 800 mg of drug in 500 ml of saline.
- What is the concentration of the medication and at what drip rate should it be administered to achieve the dose of 5 µg/kg/min using a micro drop set?

MEDAVIE HealthEd ÉduSanté

Vascular Access

IO INFUSIONS

Intraosseous Infusion

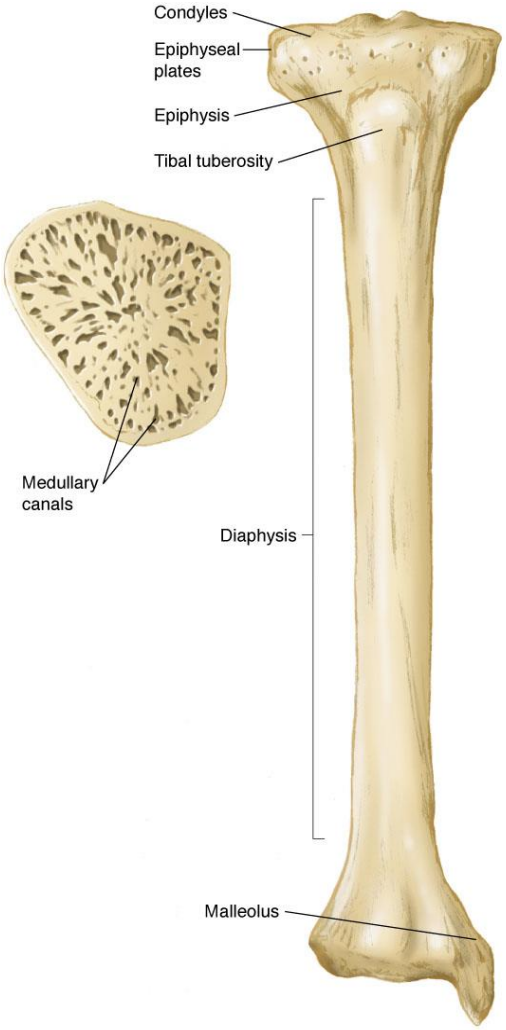
- A rigid needle is inserted into the cavity of a long bone.
- Used for critical situations when a peripheral IV is unable to be obtained.
- Initiate after 90 seconds or three unsuccessful IV attempts.

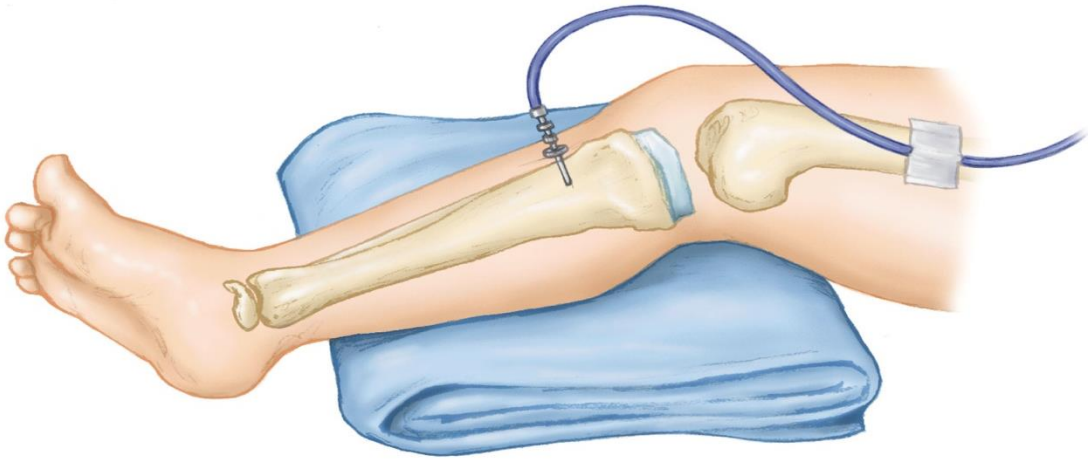
Indications

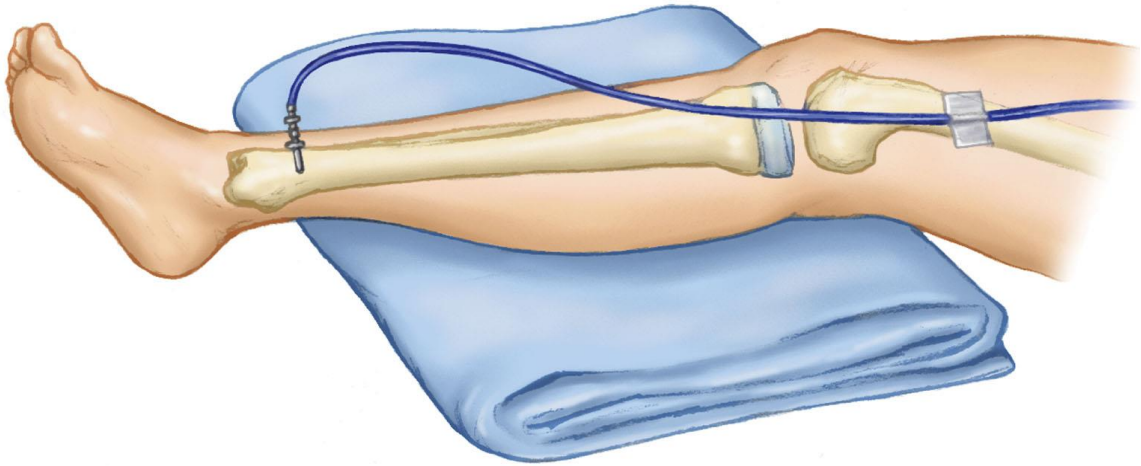
- Children less than 6 years old.
  - Shock, cardiac arrest or status seizure.
  - Unable to start peripheral line after one attempt; peripheral IV is always attempted first, intraosseous second.
  - If on visual inspection unable to see good peripheral vein, go straight to intraosseous (IO) infusion

MEDAVIE HealthEd ÉduSanté

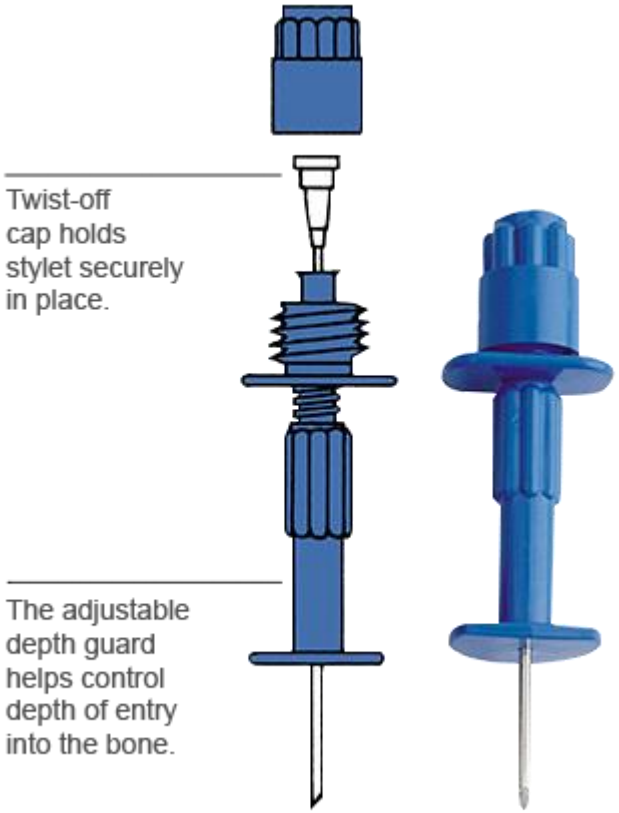
Pediatric and adult IO needle placement sites.







Intraosseous Needles



Illinois IO Needle

EZ-IO System

Interosseous

- Prepare the equipment
- Select the appropriate site
- Clean the site
- Make the puncture

Interosseous

- Aspirate to confirm proper placement.

Interosseous

- Connect the IV fluid tubing.

Interosseous

- Secure the needle appropriately.
- Adjust flow rate accordingly.

- Administer the medication. Monitor the patient for effects.

IO Complications

- Fracture
- Infiltration
- Growth plate damage
- Complete insertion
- Pulmonary embolism
- Infection
- Thrombophlebitis
- Air embolism
- Circulatory overload
- Allergic reaction

Contraindications

- Fracture to tibia or femur on side of access
- Osteogenesis imperfecta
  - Congenital bone disease resulting in fragile bones
- Osteoporosis
- Establishment of a peripheral IV line

MEDAVIE HealthEd ÉduSanté

Vascular Access

PRINCIPLES IN PHLEBOTOMY

Why is phlebotomy performed ?

- To obtain venous blood samples to determine/obtain:
  - Blood composition
  - Electrolyte levels
  - Substance levels
  - Blood cultures

Equipment required

- Blood Bottles
- Vacutainer holder
- Cannula
- Tourniquet
- Alcohol swab
- Gloves
- Sharps Bin
- Gauze
- Tape

MEDAVIE HealthEd ÉduSanté

Blood Tubes

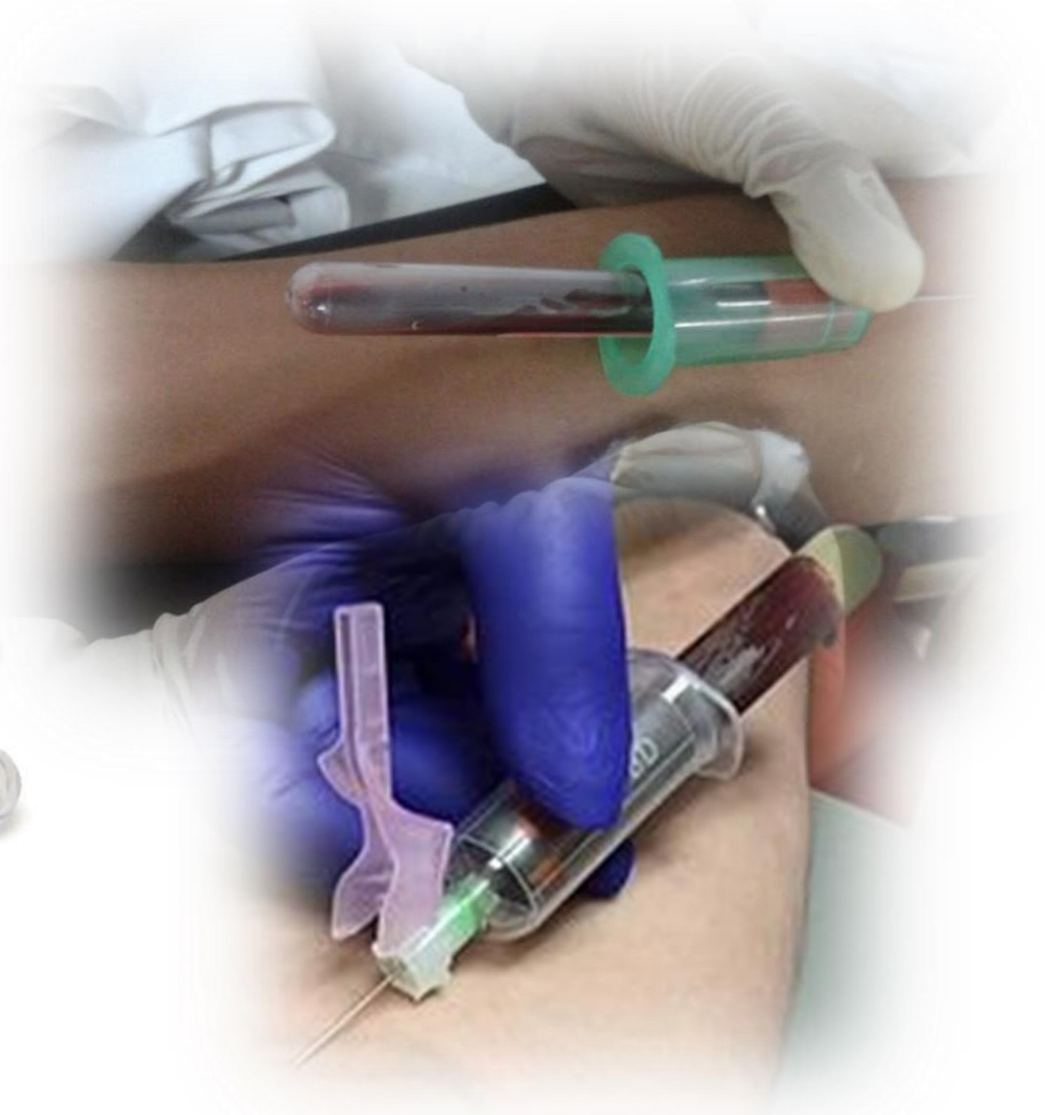
MEDAVIE HealthEd ÉduSanté

Blood Tubes

Order #	Tube Colour	Collection Tube	Purpose
1	Aerobic/Anaerobic	Blood Cultures	
2	Light Blue	Sodium Citrate Tube	sodium citrate as an anticoagulant - coagulation studies
3	Red	Serum Tube	contains no anticoagulant - serum for selected chemistry tests, clotted blood for immunohematology
4	Gold	SST Gel Separator Tube	contain a special gel that separates blood cells from serum, as well as particles to cause blood to clot quickly
5	Light Green	PST Gel Separator Tube with Heparin	Contains lithium heparin for plasma separation
6	Dark Green	Heparin Tube	contains sodium heparin - used for collection of heparinized plasma or whole blood for special tests
7	Lavender	EDTA Tube	EDTA as an anticoagulant - used for most hematological procedure
8	Grey	Fluoride Tube	contains potassium oxalate as an anticoagulant and sodium fluoride as a preservative - used to preserve glucose in whole blood and for some special chemistry tests

MEDAVIE HealthEd ÉduSanté

Vacutainer and Leur Lock



- Obtaining a blood sample with a 20 ml syringe

MEDAVIE HealthEd ÉduSanté

Leur Sampling Needle

Procedure

- Practice universal precautions:
  - Wear gloves when handling blood/body fluids.
  - Change gloves after each patient or when contaminated.
  - Wash hands frequently.
  - Dispose of items in appropriate containers.

Procedure

- Dispose of needles immediately upon removal from the patient's vein.
- Do not bend, break, recap, or re-sheath needles to avoid accidental needle puncture or splashing of contents.
- Clean up any blood spills with a disinfectant such as freshly made 10% bleach.

Procedure

- Position the patient.
- Apply tourniquet 3 - 4 inches above the selected puncture site.
- The patient should make a fist without pumping the hand.
- Select the venipuncture site.
- Prepare the patient's arm using an alcohol prep.

Selecting the Vein

Cleansing the site

Procedure

- Grasp the patient's arm firmly using your thumb to draw the skin taut and anchor the vein.
- The needle should form a 15 to 30 degree angle with the surface of the arm.

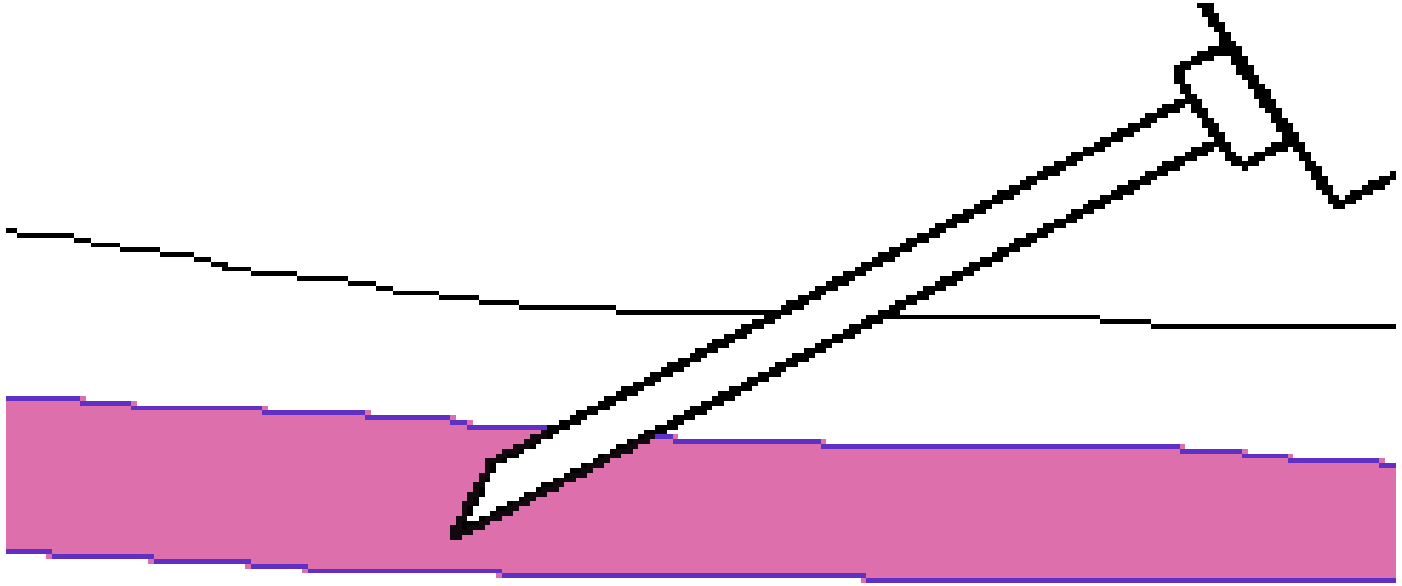
Inserting the needle

Procedure

- Swiftly insert the needle through the skin and into the lumen of the vein.
- Avoid trauma and excessive probing.

Procedure

Proper catheter placement



Obtaining the sample

Procedure

- When the last tube to be drawn is filling, remove the tourniquet.
- Remove the needle from the patient's arm using a swift backward motion.
- Press down on the gauze once the needle is out of the arm, applying adequate pressure to avoid formation of a hematoma.
- Dispose of contaminated materials/supplies in designated containers.

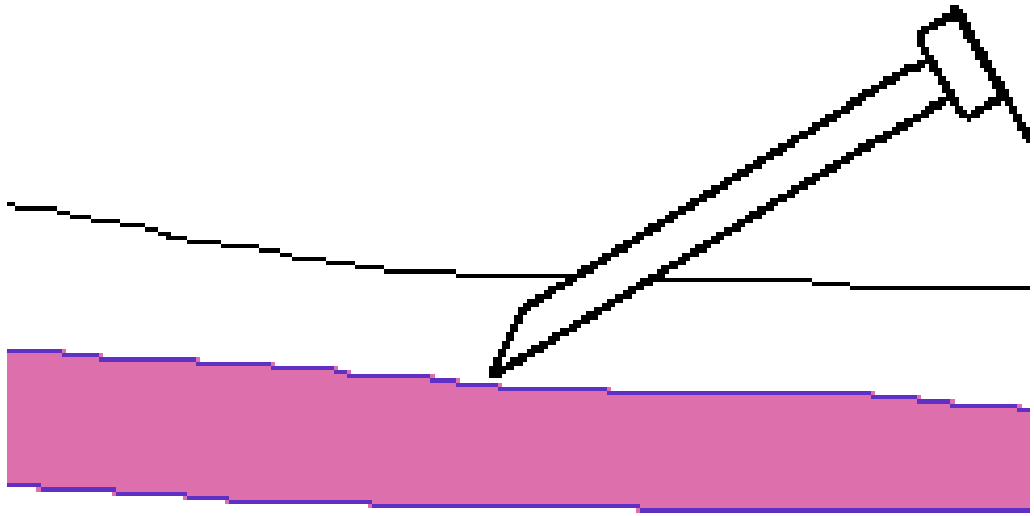
El completo

Troubleshooting

- What to do when blood doesn't flow, a hematoma occurs, or an artery is punctured

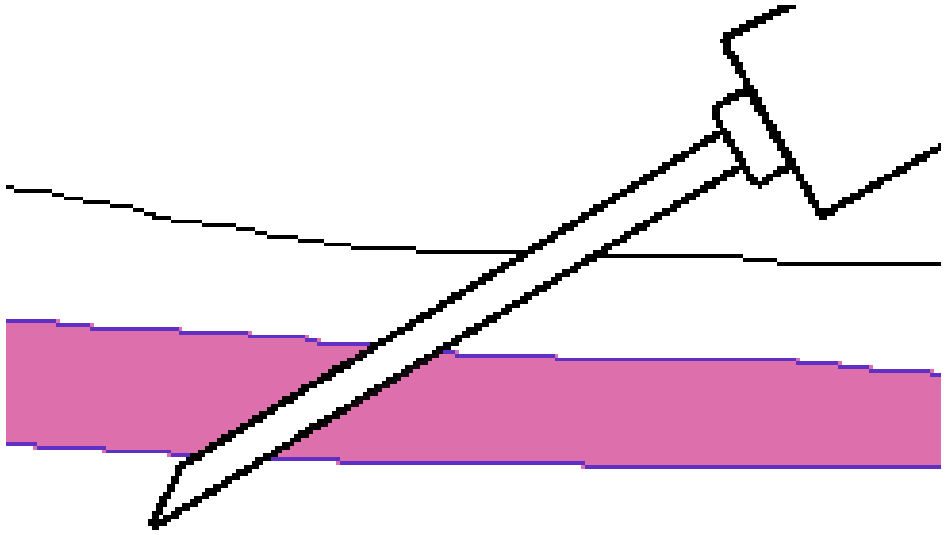
Troubleshooting

- No flow due to needle not in lumen
  - Insert needle further until “ pop ” felt and blood flows into collection tube



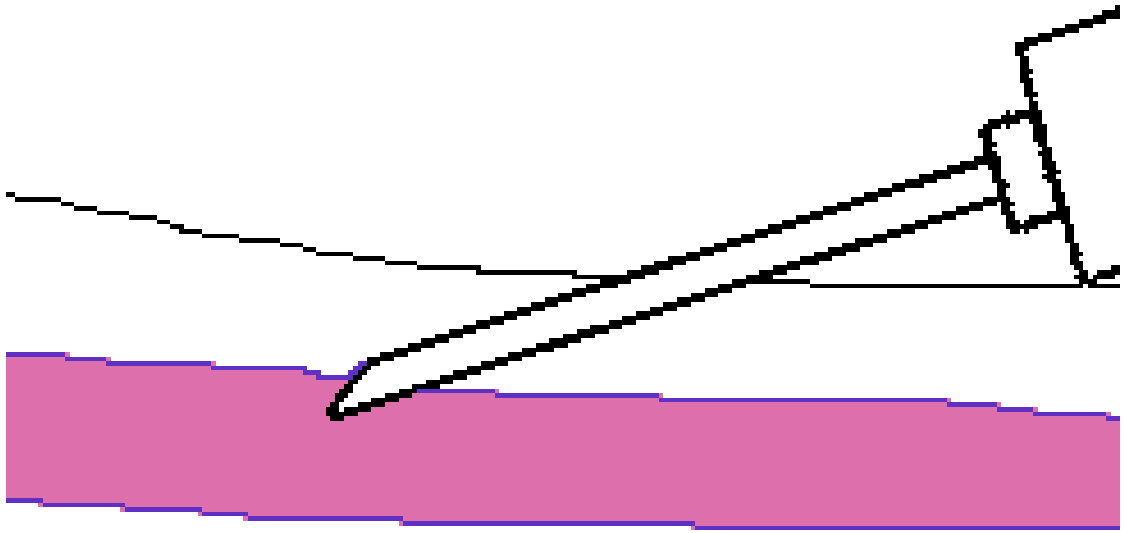
Troubleshooting

- Needle too far - lumen passed and needle in interstitial space
  - Withdraw slightly and retry blood collection



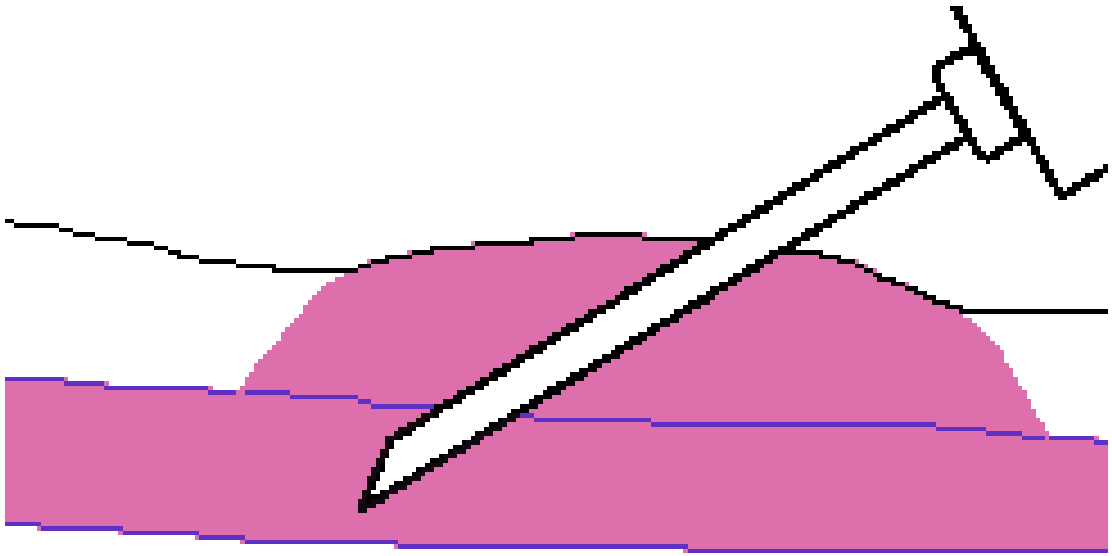
Troubleshooting

- Needle against wall of vessel
  - Reposition angle of needle



Troubleshooting

- Hematoma created
  - Release tourniquet
  - Withdraw needle
  - Apply pressure

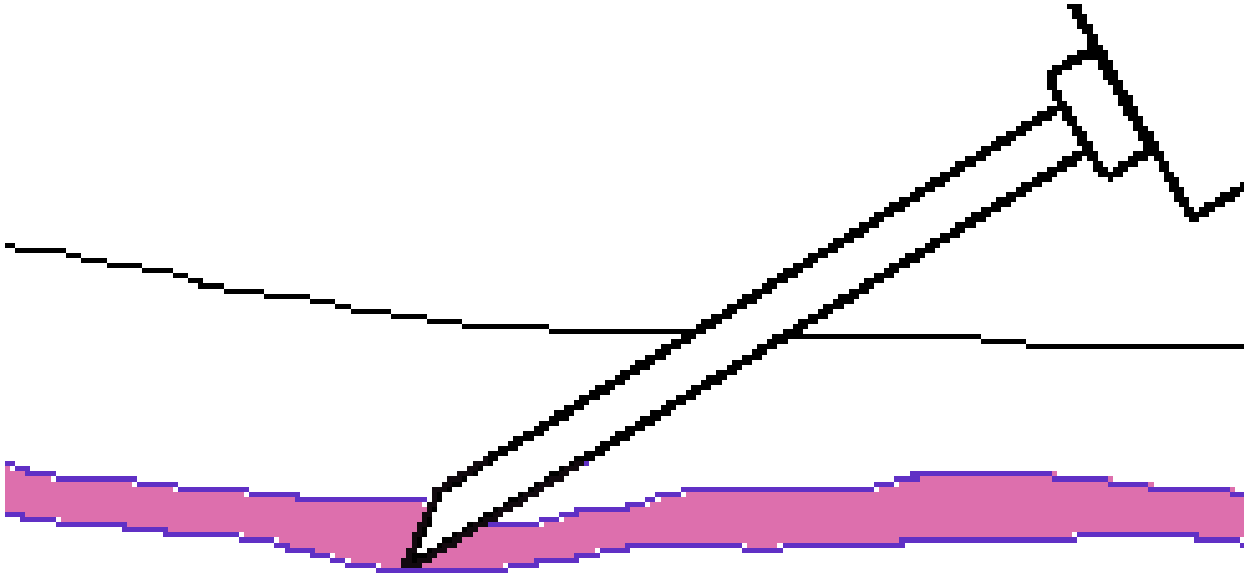


Preventing Hematomas

- Puncture only the uppermost wall of the vein
- Remove the tourniquet before removing the needle
- Use the major superficial veins
- Make sure the needle fully penetrates the upper most wall of the vein
  - Partial penetration may allow blood to leak into the soft tissue surrounding the vein by way of the needle bevel
- Apply pressure to the venipuncture site

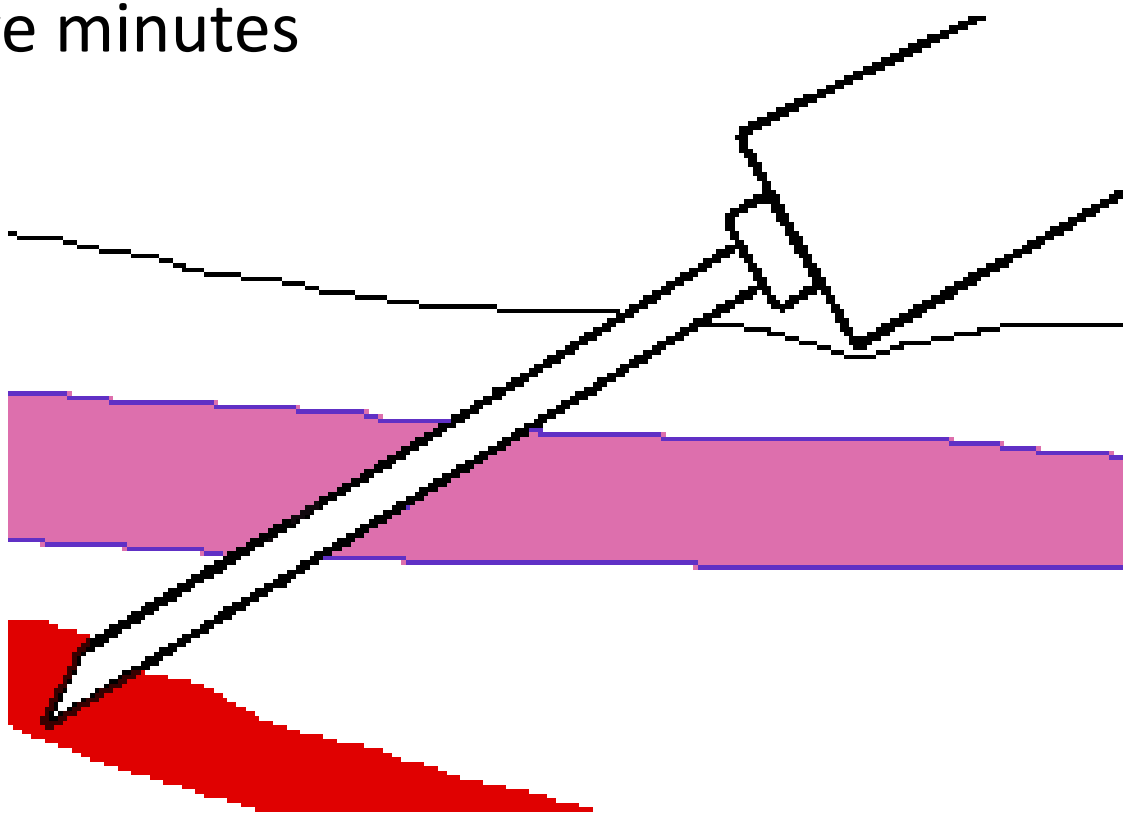
Troubleshooting

- Vein collapse
  - Re-secure tourniquet to increase venous swelling



Troubleshooting

- Arterial puncture
  - Withdraw needle and simultaneously apply pressure for five minutes



In hospital protocol

- Once blood is collected...
  - Label all appropriate tubes at the patient bedside.
  - Deliver / send all specimens promptly to the laboratory.

Needle stick procedure

- Remove your gloves and dispose of them properly.
- Squeeze puncture site to promote bleeding.
- Wash the area well with soap and water.
- Record the patient's name and ID number.

Needle sticks

- Follow institution's guidelines regarding treatment and follow-up.
- NOTE: The use of prophylactic zidovudine following blood exposure to HIV has shown effectiveness (about 79%) in preventing seroconversion