Vascular Access

Objectives:

1. Examine the construction of the commonly used venous catheters.
2. Anatomical considerations regarding peripheral and central **venous access.**
3. Choice of catheter size.
4. Prepare and set-up an IV infusion set.
5. The choice of sites for placement of IV catheters.
6. What are the different sites suitable for **central venous catheter** and **arterial catheter placement**?
7. Universal precautions.
8. Indications and complications of central venous access
9. Indications and complications of arterial access

Important - Golden Note - Notes - 436 Notes

Medical Asepsis:

➔ Removal or destruction of disease causing organisms or infected material

1-Sterile technique (surgical asepsis) 2- Clean technique

Antiseptics and Disinfectants:

➔ Chemical agents used to kill or reduce the count of specific microorganisms
➔ Some chemical agents have antiseptic and disinfectant properties

Sometimes in the OR we use both alcohol and iodine at the same time .Iodine is bacteriostatic (reduce the no. of organisms doesn't kill the bacteria) and after applying it you have to wait for 5 mins . Alcohol is bactericidal (kills the bacteria) applied to kill the leftover microorganism on the skin.

Disinfectants:(e.g.: Bleach "clorox")

➔ Used on non-living objects
➔ Toxic to living tissue

Antiseptics: (e.g.: alcohol, iodine)

➔ Applied to living tissue
➔ More dilute to prevent cell damage

Universal Standard Precautions on Every Patient:

➔ Observe hand washing and gloving procedures to remove the bacteria physically. In both clean and sterile procedures. Wear gloves
➔ Face shields indicated during clean procedures like peripheral venous access.
➔ Sterile gowns plus above all for sterile procedures.like CVP or epidural insertion.

Types of IV catheters:

- Hollow needles
  - butterfly type
- Indwelling plastic catheter over hollow needle
- Indwelling plastic catheter inserted through a hollow needle
  - Intracath

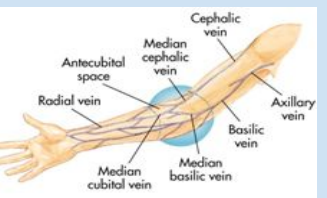
Needles

- Vary in length and gauge
- Larger gauge means smaller needle

The colors are universal.
18 gauge, 20 gauge for adults
22 gauge, 24 gauge for infants/pediatric

Peripheral IV Insertions

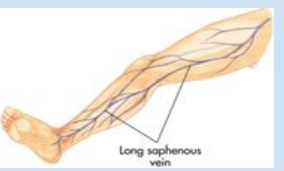
Sites :



- Common sites:
  - Hands and arms
  - Antecubital fossa (AC space)

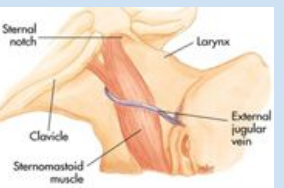
AC space : **Not** a routine site(not practical) ? It crosses the joint , flexion may destroy the cannula.

Catheters should not cross joints.



- Alternate sites:
  - Long saphenous veins
  - External jugular veins

Embolism and infection rates higher



- **Avoid sites** that have injury or disease:
  - Trauma
  - Dialysis fistula may destroy the AV fistula due to infection or thrombosis.
  - History of mastectomy(not absolute contraindication,but better to avoid) we remove lymph nodes. In case of extravasation it may not clear very easily or be more damaging .

Peripheral IV Procedure:

1. **Explain** procedure
2. Assemble **equipment** Clean procedure (hand washing + non-sterile gloves)
3. **Inspect fluid** for contamination appearance, and expiration date
4. **Prepare** infusion set
   - Attach infusion set to bag of solution
5. **Clamp tubing and squeeze reservoir on infusion set until it fills half way**
6. **Open clamp and flush air from tubing**
7. **Close clamp**
8. **Maintain aseptic technique** IV drip
9. **Select catheter:**
   - Large-bore catheter used for fluid replacement > 14 to 16 gauge
   - Smaller bore catheter used for "keep open" lines > 18 to 20 gauge

10. **Prepare other equipment**
11. Put on **gloves**
12. Select **site**
13. Apply **tourniquet above** antecubital space To cause the veins to engorge (more prominent)
14. **Prepare site**
15. **Cleanse area with alcohol or iodine wipes** (per protocol)
    - Check for iodine allergy

16. **Stabilize vein**
17. **Apply pressure** and tension to point of entry
18. **Bevel** of the **needle** : up in **adults** - may be down in **infants** and **children**
19. **Pass needle through skin into vein from side or directly on top**
20. **Advance needle** and catheter about **2 mm** past point where blood return is seen in hub of needle

21. **Slide catheter over needle and into vein**
22. **Withdraw needle** while stabilizing catheter
23. Lock in protective sheath if present
24. Apply pressure on proximal end of catheter to stop escaping blood
25. Obtain blood samples if needed
26. **Release tourniquet**
27. Attach IV tubing
28. Open tubing clamp and allow fluid infusion to begin at prescribed flow rate
29. **Cover puncture site dressing**
30. Antibiotic ointment if indicated by protocol
31. Anchor tubing To prevent dislodgement
32. Secure catheter
33. **Document procedure**
34. **Monitor flow**

Local Complications:

- Pain and irritation
- Infiltration and extravasation
- Phlebitis
- Thrombosis and thrombophlebitis
- Hematoma formation
- Venous spasm
- Vessel collapse
- Cellulitis
- Nerve, tendon,ligament, and limb damage

Infiltration

Happens in the time of the procedure or later on .

Causes:

- Dislodgement of catheter or needle cannula during venipuncture
- Puncture of vein wall during venipuncture
- **Extravasation:** Leakage of solution into surrounding tissue from insertion site. very fatal and serious complication causing swelling and may lead to compression of the vessels "it's like compartment syndrome" pt may lose his/her arm, and sometimes they may require fasciotomy.
- Poor vein or site selection
- Irritating solution inflamed vein intima
- Improper cannula size
- High delivery rate or pressure
- Poorly secured IV

Signs and Symptoms:

- Cool skin around IV site Bc it's a cool solution
- Swelling at IV site
  - With or without pain
- Sluggish or absent flow
- Infusion flows when fluid is pushed forcefully
- No backflow of blood into IV tubing when clamp is fully opened and solution container is lowered below IV site

Management:

- ➔ Lower fluid reservoir to check for presence of backflow of blood into the tubing
  - ◆ Absence of backflow suggests infiltration
- ➔ discontinue IV infusion
- ➔ Remove needle or catheter
- ➔ Apply a pressure dressing to the site
- ➔ Choose new site
- ➔ Initiate IV therapy with new equipment
- ➔ Document If you aren't there someone else can follow up

Central Venous Access:

To get access to the big veins

- ➔ Requires special training not routine procedure
- ➔ Authorization from medical direction
- ➔ Not for rapid fluid replacement in pre-hospital setting
- ➔ Within scope of paramedic practice in some EMS systems
- ➔ Prepare as for peripheral veins (Sterile procedure) Hand washing , sterile glove , sterile gown , mask

common sites include: MCQs

- ➔ Femoral vein To get access to IVC
- ➔ Internal jugular vein to get access to SVC
- ➔ Subclavian vein to get access to SVC

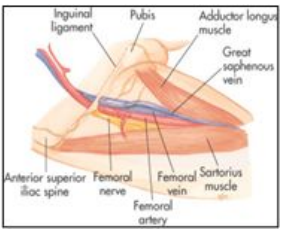
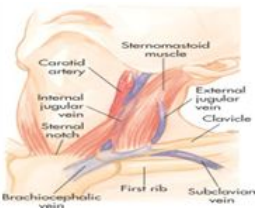
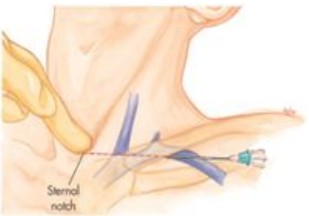
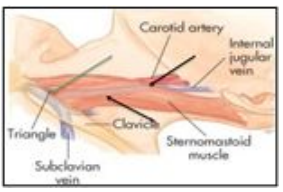
Axillary and antecubital veins As well depending on the kit you are using

External jugular vein is not used as an access

Success depends on:

- ◆ Patient's body position
  Ex:IJV is normally collapsed (low pressure ? Above the heart) what to do?lower the pt head so the vein will engorge.
- ◆ Knowledge of anatomy
- ◆ Familiarity with the procedure and equipment

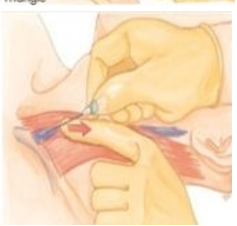
Types of central venous access:

Vein	Anatomy	Cannulation
Femoral vein	 VAN Feel the pulse(artery) and go **medial** it is the femoral **vein** **lateral** is the femoral **nerve**	
Subclavian Vein	 Under (posterior) to the medial third of the clavicle	
Internal jugular Vein	**Anatomy :** It descends in the carotid sheath lateral to the internal carotid artery. and then **lateral** to the **common Carotid artery.** Usually between the heads of the sternocleidomastoid muscle.	

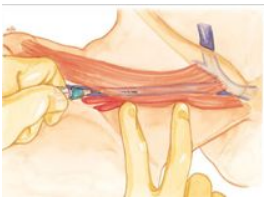
Cannulation MCQ

Posterior approach: high Approach
(direction of needle insertion to the **contralateral** nipple)
Risk of : Puncturing vertebral artery
Injury to cervical plexus

Central approach: near the apex of the lungs.
Risk of:Pneumothorax
Air embolism
Which are fatal complications



Anterior approach: its higher approach
(direction of needle insertion to the **ipsilateral** nipple)
Risk of: Carotid puncture
Extravasation
if you go deep may lead to Vertebral artery puncture.



Central Venous Access:

Advantages/ indications :	➔ Available when peripheral vessels collapse (or the veins are already being used) ➔ Access to central pressure measurement (In-hospital procedure) check volume status ➔ Safer vasopressor administration if the patient is on inotrope (eg, epinephrine or norepinephrine) if given peripherally it will take time to go to the central circulation and you might not get the proper response or any response ➔ Administration of irritant fluids (eg, Bicarbonate, potassium solution, all chemotherapy)
Disadvantages 	➔ Excessive time for placement ➔ Sterile technique if not it might end up with sepsis ➔ Special equipment ➔ Skill deterioration ➔ High complication rate ◆ Pneumothorax*, arterial injury, abnormal placement *a serious complication you may puncture the apex of the lungs) ➔ Chest x-ray should be obtained immediately especially for SVC ➔ Can't initiate during other patient care activities ➔ Not generally considered to be a useful prehospital technique ➔ Lower flow rates than peripheral IV
Complications	➔ Femoral vein: (Local complications, Systemic complications) ➔ Internal jugular and subclavian veins: (Local complications, Systemic complications)

Systemic Complications	➔ Contamination and infection ➔ Hypersensitivity reactions ➔ Sepsis ➔ Speed shock For example any drug causes histamine release if you use it in diluted form from the peripheral vein it goes slowly so histamine release won't be immediate to cause hypotension, vasodilation and bronchospasm. But when you give it in central vein it will enter the central circulation immediately and be circulated to the whole body and causes shock like condition. ➔ Emboli (blood clot, air, and catheter)

Air embolism

- ➔ Uncommon but can be fatal
- ➔ Air enters the bloodstream through catheter tubing
- ➔ Risk greatest with catheter in central circulation
- ➔ Negative pressure may pull air in but in positive pressure ventilation the chance of getting air embolism is low. When the patient is breathing while in inhalation the negative pressure is generated in the thorax if the catheter tip is open the air will be sucked and goes to SVC and end in the heart> block pulmonary artery > right ventricle is unable to pump blood > shock like condition. Cannot pump blood adequately to the lungs and left side
- ➔ Air can enter circulation
  - ◆ During catheter insertion
  - ◆ If tubing is disconnected
- ➔ If enough air enters the heart chamber:(depends on how much air and the speed of the air)
  - ◆ Blood flow is impeded.
  - ◆ Shock develops

Signs and symptoms:

- ➔ Hypotension
- ➔ Cyanosis
- ➔ Weak and rapid pulse
- ➔ Loss of consciousness
- ➔ Desaturation
- ➔ Sudden arrhythmia
- ➔ Sudden drop in etCO2

*rule out other causes like ig the patient is trauma case suspect bleeding

Management:

- ➔ Close the tubing
- ➔ Turn patient on left side with head down it will shift the bobble from pulmonary artery to the apex of the heart so the blood will start flowing.
- ➔ Check tubing for leaks
- ➔ immediately Administer 100% Oxygen and stop nitrous oxide if given
- ➔ Notify medical direction stop the procedure until the patient gets settle

Indwelling Vascular Devices:

- ➔ Heparin or saline lock
- ➔ Single-, dual-, and triple- lumen catheters

Venous access insertion:

US guided IV insertion

US guided CVC insertion

Arterial line placements:

- ➔ Provide Continuous BP monitoring
- ➔ Arterial blood sampling

Arterial line placement indications	➔ Continuous arterial BP monitoring beat to beat change- more accurate than NIBP (non invasive blood pressure monitoring) ➔ Inability to use indirect BP monitoring (eg, in patients with severe burns or morbid obesity) can not rely on cuffs ➔ Frequent blood sampling ICU ➔ Frequent arterial blood gas sampling ➔ In major vascular surgeries, cardiac surgeries and neurosurgeries. And in critical patients like ischemic heart disease. ➔ ICU patients for monitoring and frequent blood sampling	
Contraindications for arterial line	➔ Absolute ◆ Absent pulse ◆ Thromboangiitis obliterans (Buerger disease) ◆ Full-thickness burns over the cannulation site ◆ Inadequate circulation to the extremity ◆ Raynaud syndrome ◆ Any Peripheral vascular disease* ◆ Old DM	➔ Relative: ◆ Anticoagulation ◆ Atherosclerosis ◆ Coagulopathy ◆ Inadequate collateral flow ◆ Infection at the cannulation site ◆ Partial-thickness burn at the cannulation site ◆ Previous surgery in the area ◆ Synthetic vascular graft

*Patients with peripheral vascular disease because they don't have very good collateral circulation so, if you put arterial in radial artery and the collateral is insufficient you may end up with loss of hand or ischemic changes to the supplying area.

Technical Considerations:	
	◆ Not entirely without risks ◆ Requires appropriate knowledge of the anatomy and procedural skills. ◆ Arterial line placement is considered a safe ◆ major complications that is below 1%. ◆ Common site of cannulation • radial • Ulnar • Brachial and axillary • posterior tibial • Femoral • dorsalis pedis arteries

Allen test

To know if the upper limb is properly vascularised, hence to know if its safe or not

- ➔ The Allen test is a worldwide used test to determine whether the patency of the radial or ulnar artery is normal.
- ➔ It is performed prior to radial cannulation or catheterization.
- ➔ The test is used to reduce the risk of ischemia to the hand.
- ➔ Instruct the patient to clench his or her fist OR hand tightly.
- ➔ Using your fingers, apply occlusive pressure to both the ulnar and radial arteries, to obstruct blood flow to the hand.
- ➔ While applying occlusive pressure to both arteries, have the patient relax his or her hand, and check whether the palm and fingers have blanched. If this is not the case, you have not completely occluded the arteries with your fingers

Negative

Positive

Release the occlusive pressure on the ulnar artery

- Positive modified Allen test:
  - hand flushes within 5-15 seconds it indicates that the ulnar artery has good blood flow; this normal flushing of the hand is considered to be a positive test.
- Negative modified Allen test
  - If the hand does not flush within 5-15 seconds, it indicates that ulnar circulation is inadequate or nonexistent; in this situation, the radial artery supplying arterial blood to that hand should not be punctured. You may lose the hand if done

Anatomic Consideration:

- Radial Artery:
  - Originates in the cubital fossa from the brachial artery
  - At the wrist, the radial artery sits proximal and medial to the radial styloid process and just lateral to the flexor carpi radialis tendon.

- Femoral Artery:
  - Originates at the inguinal ligament from the external iliac artery
  - Medial to the femoral nerve and lateral to the femoral vein and lymphatics.

Arterial line placement

Equipment

- Sterile gloves, gauze, and towels
- Chlorhexidine or povidone-iodine skin preparation solution
- 1% Lidocaine needle
- 5-mL syringe
- Appropriate-sized cannula for artery Scalpel (No. 11 blade)
- Non-absorbable suture (3-0 to 4-0)
- Adhesive tape or strips
- Sterile non-absorbable dressing
- Three-way stopcock
- Pressure transducer kit
- Pressure tubing
- Arm board of appropriate size for the patient (eg, neonate, pediatric, adult)
- Needle holder
- Intravenous (IV) tubing T-connector

Patient preparation

- Unconscious patient may not be a problem
  - Anesthesia/ Sedation is not required.
- Conscious patient
  - provided LA -lidocaine 1%
- Uncooperative patient
  - sedation or general anesthesia may be required.

Positioning:

- The patient is placed in the supine position.
- The arm is placed up on a flat surface in neutral position, with the palm up and the wrist adequately exposed.
- The wrist is dorsiflexed to 30-45° and supported in this position with a towel or gauze under its dorsal aspect.

Most commonly used methods:

- ➔ Catheter over needle
- ➔ Catheter over wire (including direct Seldinger and modified Seldinger techniques)

5 steps for Seldinger techniques:

1. get access to the artery with the needle ⟶ blood will come out
2. Put the wire into the needle
3. Remove the needle
4. once the needle is removed put the catheter over the wire and place it to the artery

Sometimes we need an extra step: dilators before inserting a thick catheter

5. Remove the wire

Catheter over needle technique	Radial artery cannulation (Seldinger).
	➔ Advancement of catheter over guide wire. 

Complications of arterial line

- Common:
  - Temporary radial artery occlusion (19.7%)
  - Hematoma/bleeding (14.4%)
- Less common:
  - Localized catheter site infection (0.72%), The risk increases with the length of time the catheter is in place
  - Hemorrhage (0.53%)
  - Sepsis (0.13%)
  - Permanent ischemic damage (0.09%)
  - Pseudoaneurysm formation (0.09%)

Quiz

1. Which one is serious complication of central line?
   a. Sepsis
   b. Arterial injury
   c. Pneumothorax

2. The allen test is used the patency of which artery?
   a. Ulnar
   b. Femoral
   c. Median

3. What vein is not used for central line access?
   a. Subclavian vein
   b. External jugular vein
   c. Internal jugular vein

4. What is the anatomical position of the femoral vein?
   a. Medial to femoral nerve
   b. Lateral to femoral artery
   c. Medial to femoral artery

5. Which of the following is an absolute contraindication for arterial line?
   a. Partial thickness burn
   b. Raynaud syndrome
   c. Atherosclerosis

Answers:
1:C / 2:A / 3:B / 4:C / 5:B

Thank You

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