THE UNIVERSITY OF JORDAN

Vascular access

Dr Ahmed Shahin

Content

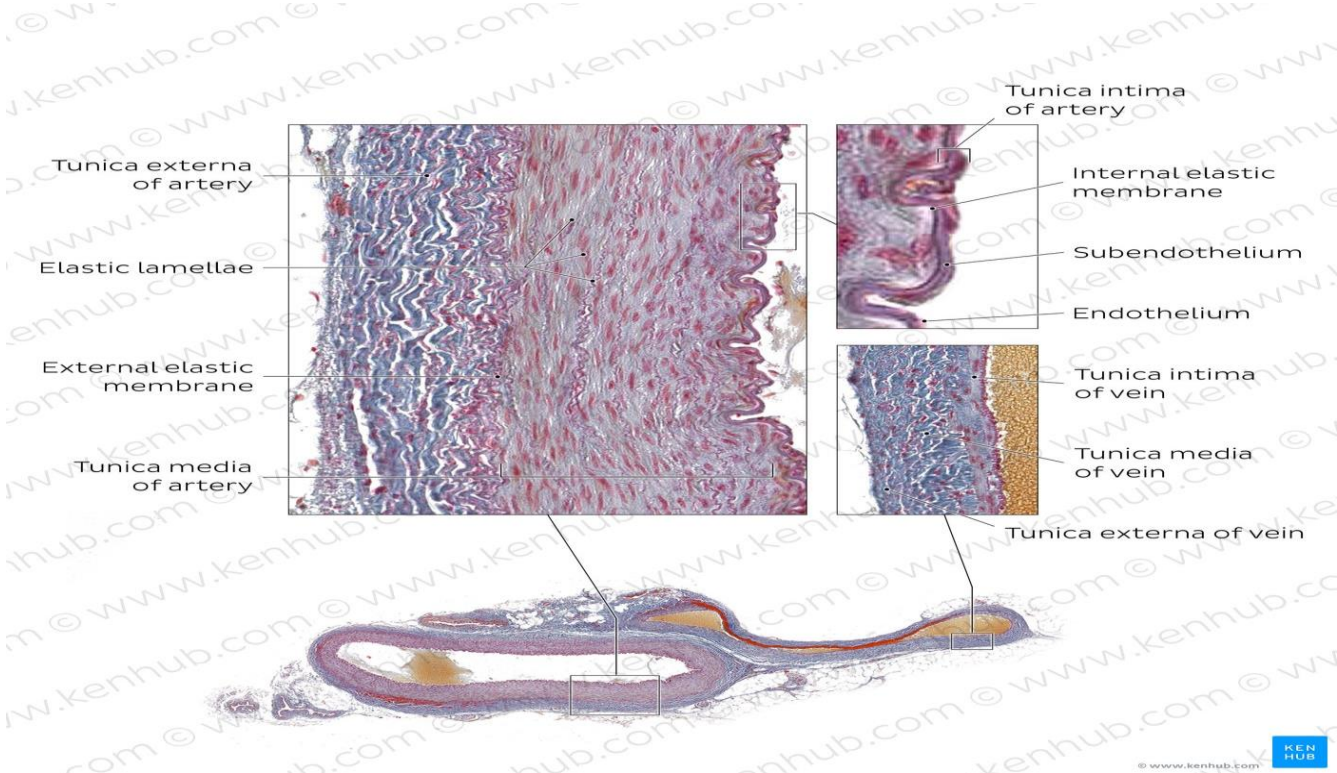
- Introduction
- Peripheral intravenous access.
- Central venous access.
- Arterial line.

Introduction

- Fundamental components of the cardiovascular system.
- Deliver blood cells, nutrients, oxygen, and pharmacological agents to tissue.
- Removal of cellular byproducts, carbon dioxide, and toxic chemicals from the tissue.
- ‘Port’ to the body with quick onset.

Histology

- Vasculature system is separated into macro vasculature and microvasculature.
- The macro vasculature being any vessel observable with the naked eye, and the microvasculature being vessels that are less than 100 microns.
- LIMA
  - Lumen
  - Intima (Squamous endothelial cells)
  - Media (Myocytes in arteries)
  - Adventitia (Externa) ‘vessels of vessels’
    ‘nerves of vessels’



Peripheral Intravenous access

Objectives

Having completed the IV cannulation workshop you will be able to:

- Describe the basic anatomy and physiology of the superficial veins of arms and hands.
- Assemble required equipment for IV cannulation.
- Perform a successful IV cannulation on the training arm.

Anatomy and physiology

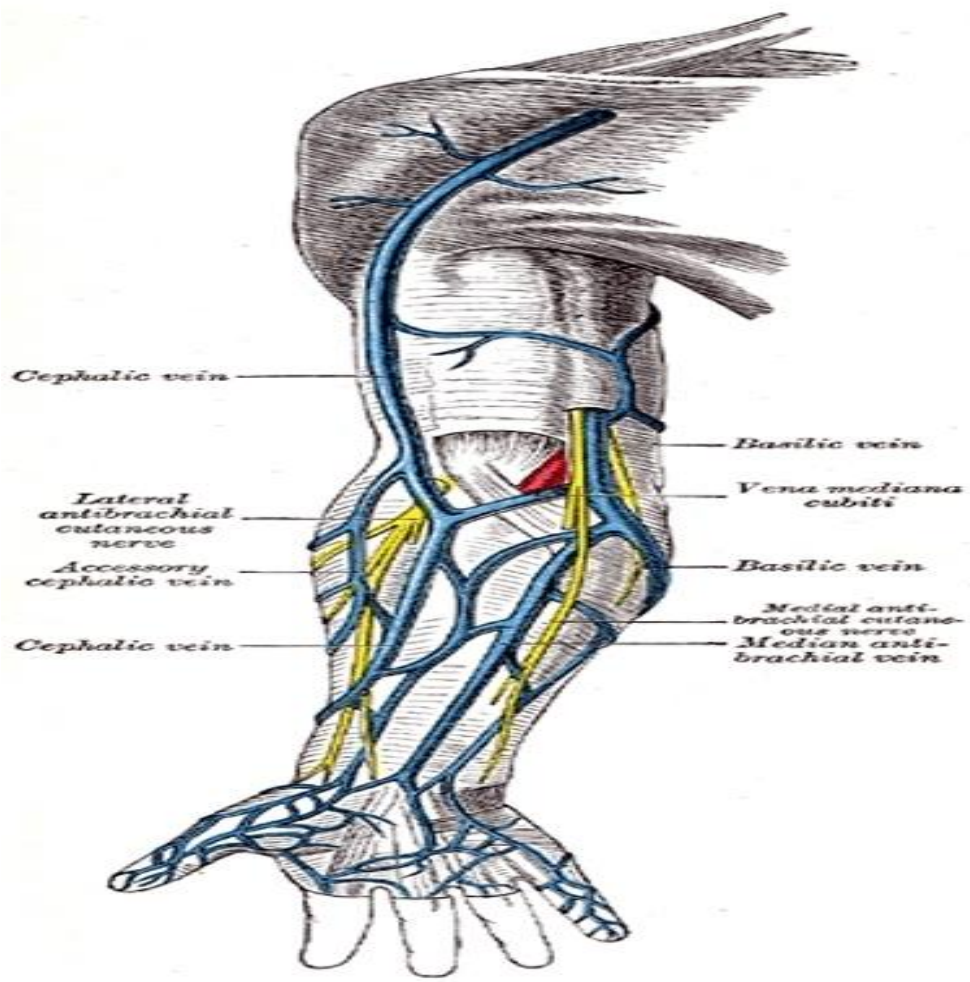
- 2/3rds of TBV (no myocytes) (capacitance vessels), deoxygenated.
- Small veins have a diameter of 0.1mm to 1mm.
- Thin-walled, fibrous, have a large diameter, and low pressure.
- Some veins contain valves to regulate the one-way flow to the heart (usually lower limbs).
- Skeletal muscles pump influences venous return.

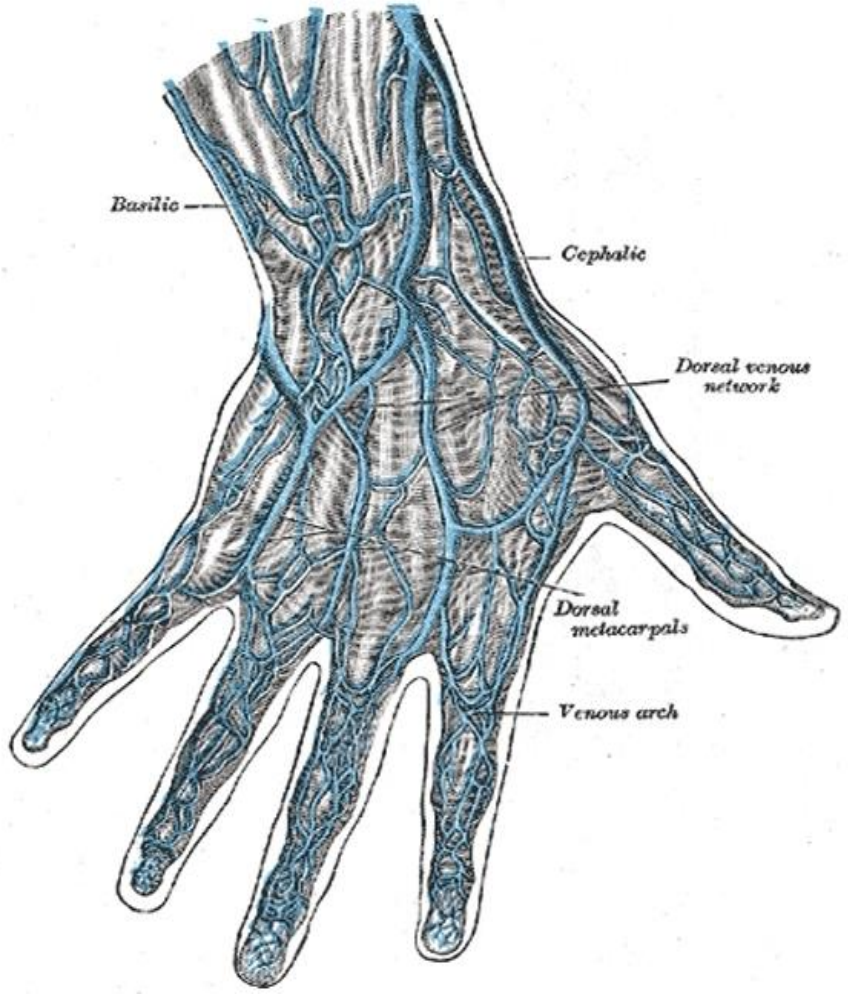
Anatomy and physiology cont.

Major veins of the arm

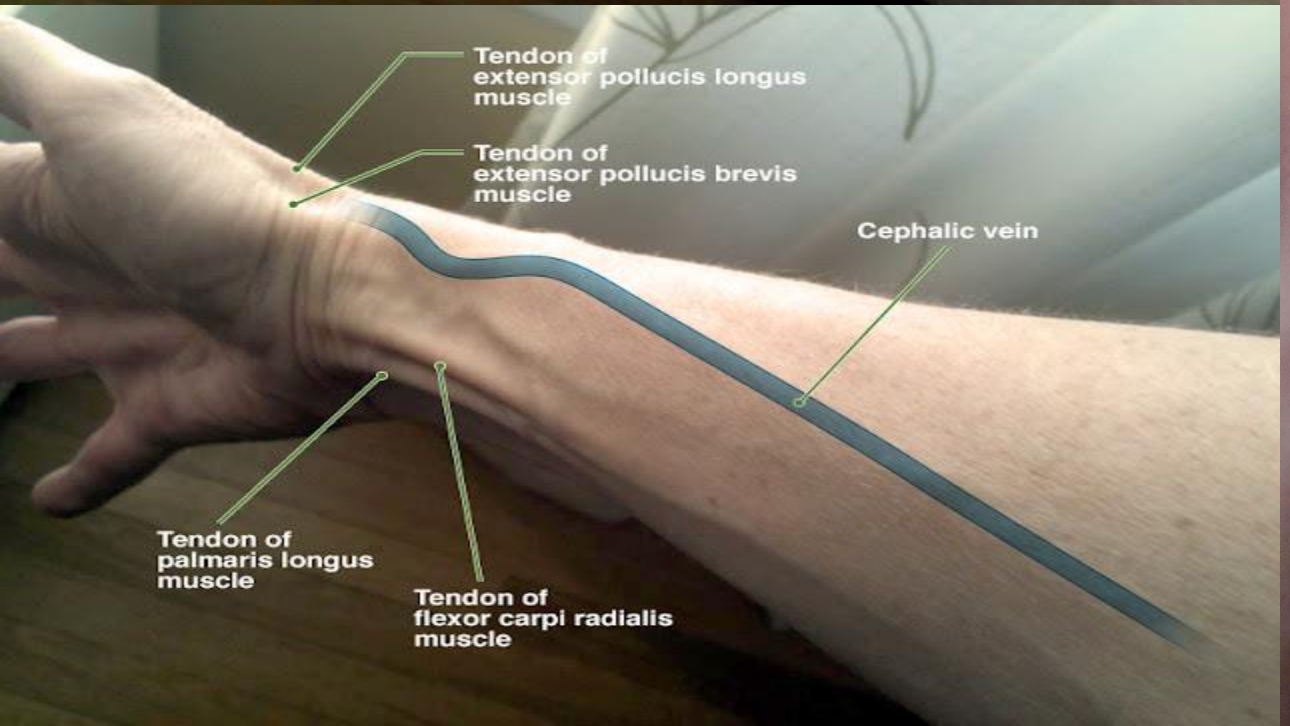
- Dorsum of the hand.
- Cephalic vein.
- Basilic vein.
- Antecubital vein (Cubital Fossa).

Anatomy and Physiology cont.

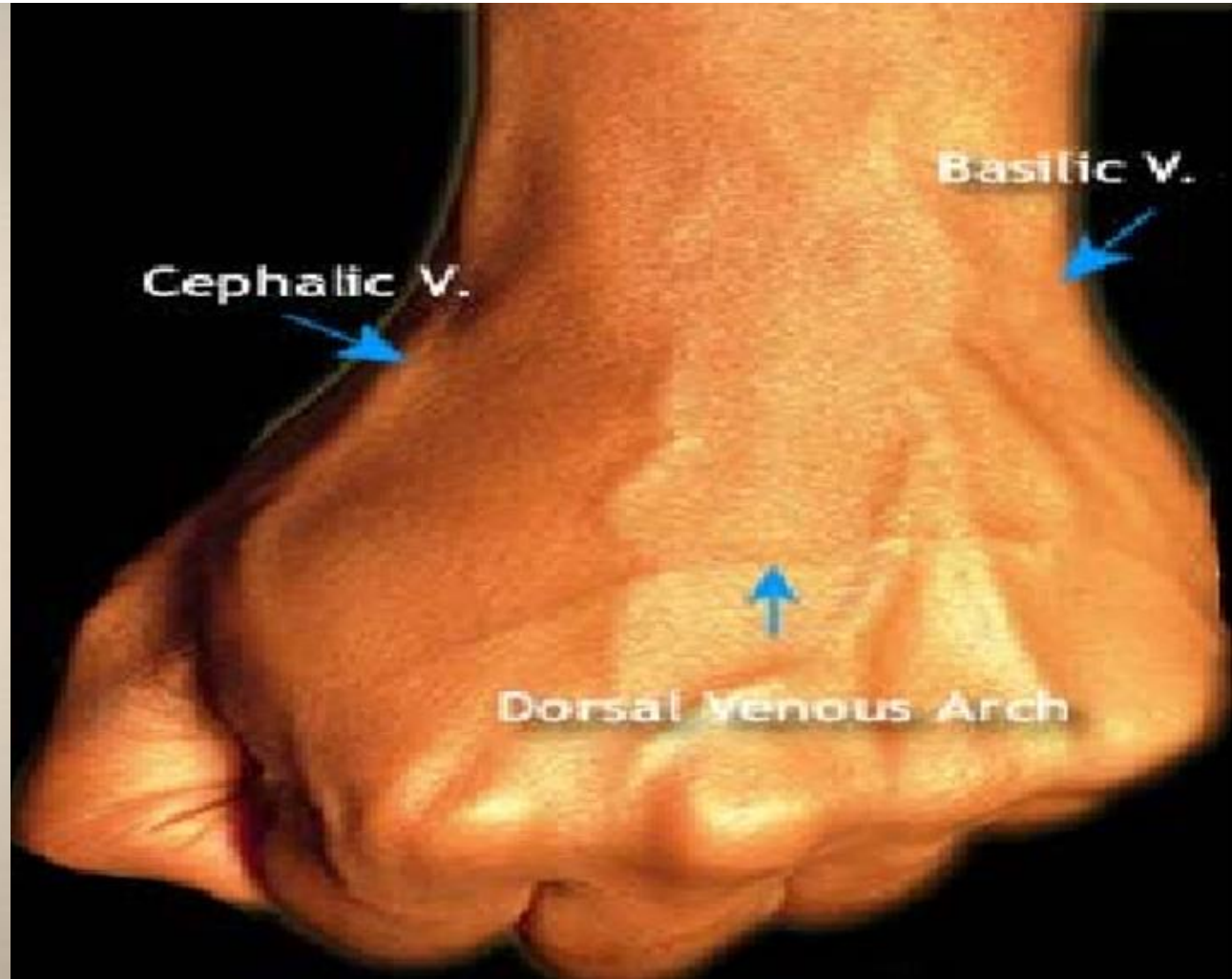




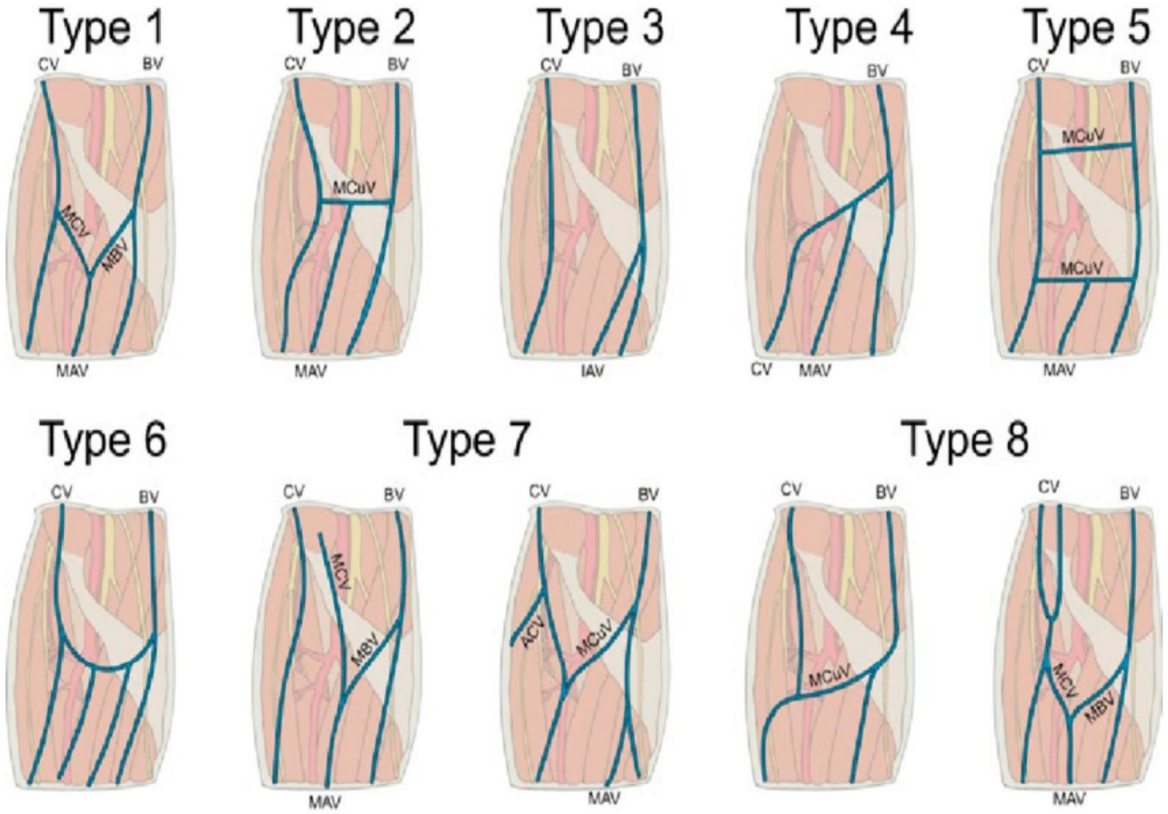

Cephalic vein

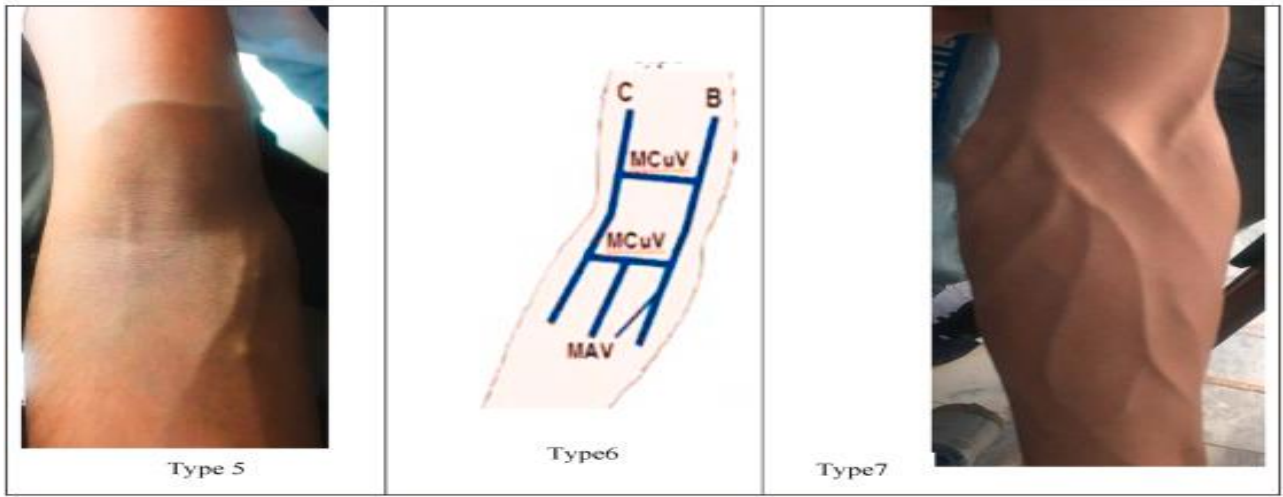

Tendon of extensor pollucis longus muscle
Tendon of extensor pollucis brevis muscle
Cephalic vein
Tendon of palmaris longus muscle
Tendon of flexor carpi radialis muscle

Surface Anatomy of the dorsal venous arches



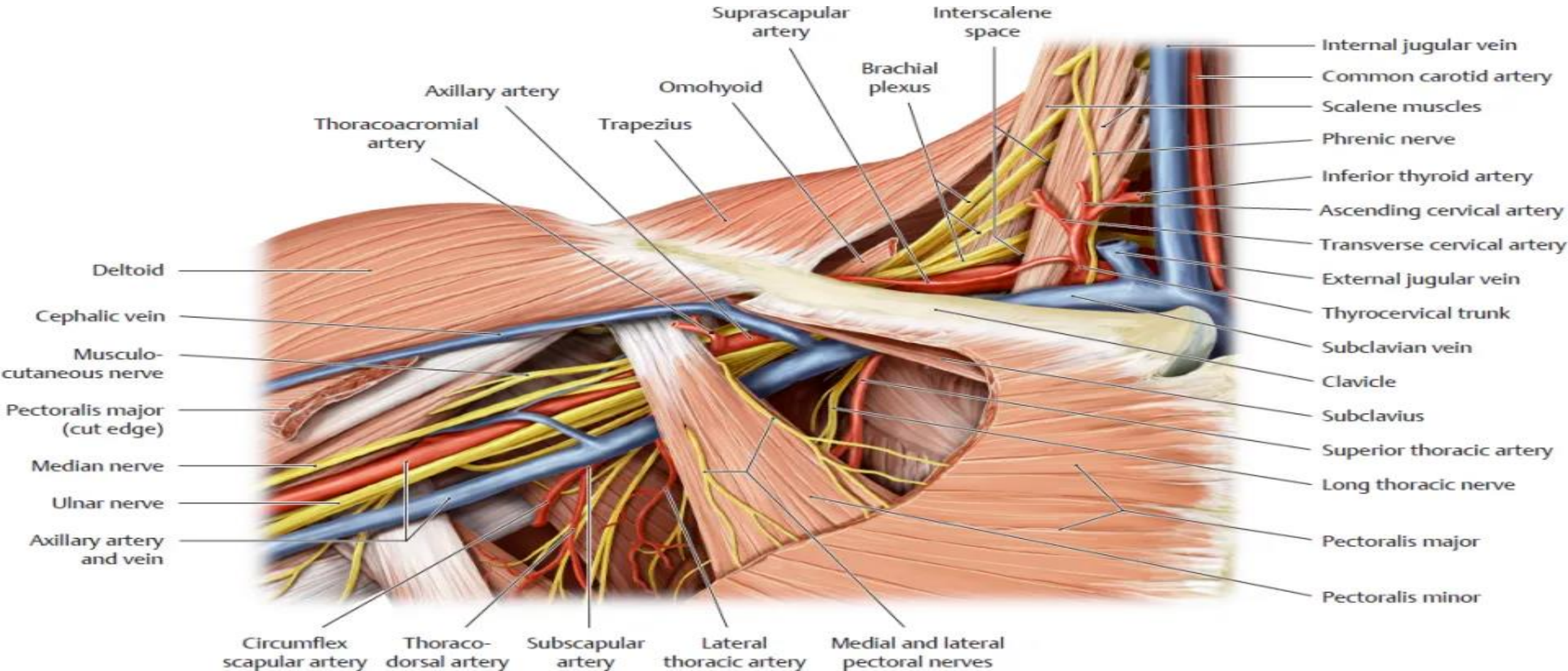
Cubital Fossa



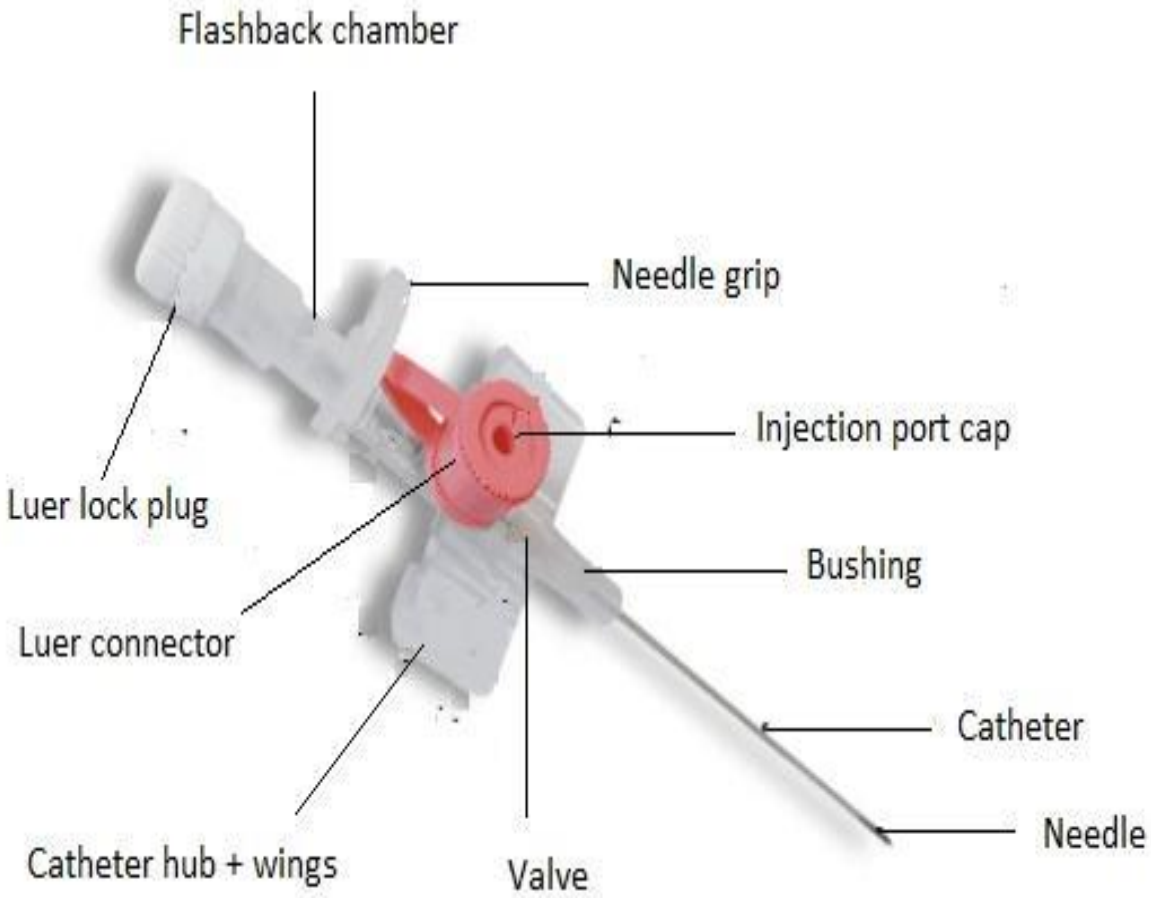


The venous patterns of the cubital fossa. CV = cephalic vein; BV = basilic vein; MAV = median antebrachial vein; MCuV = median antecubital vein; MBV = median basilic vein; MCV = median cephalic vein; ACV = accessory cephalic vein.

Termination of upper limb veins

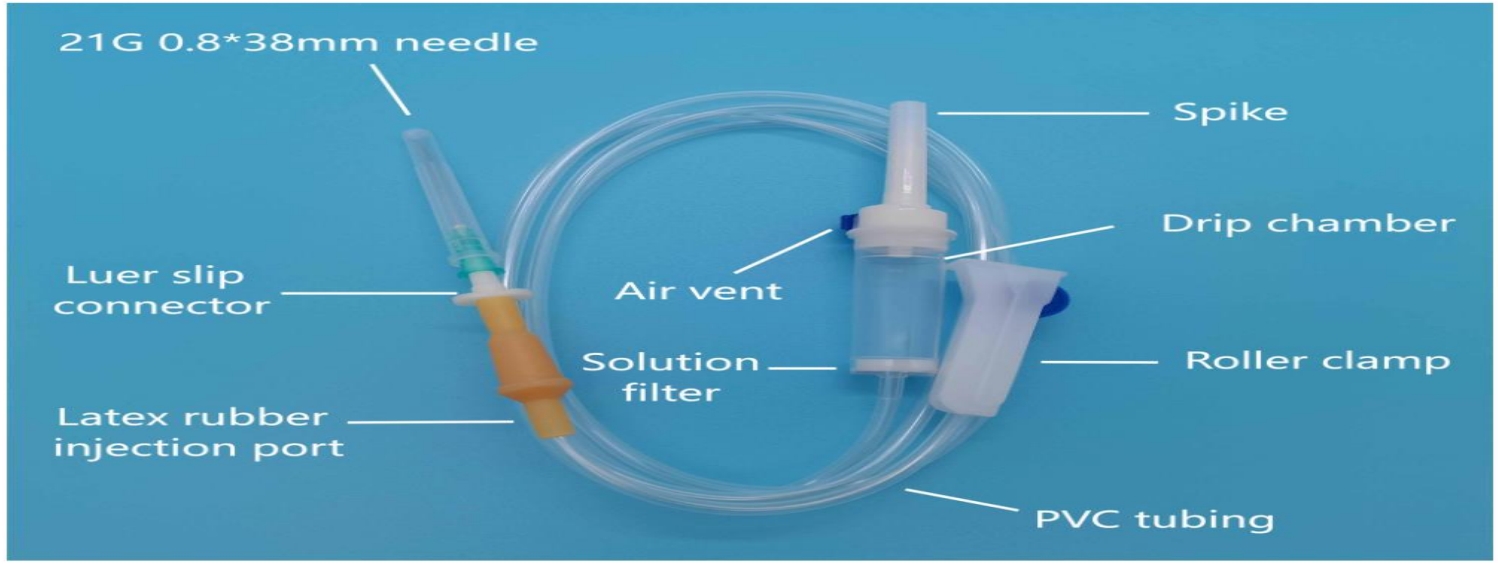


Parts of Cannula



IV fluid set up

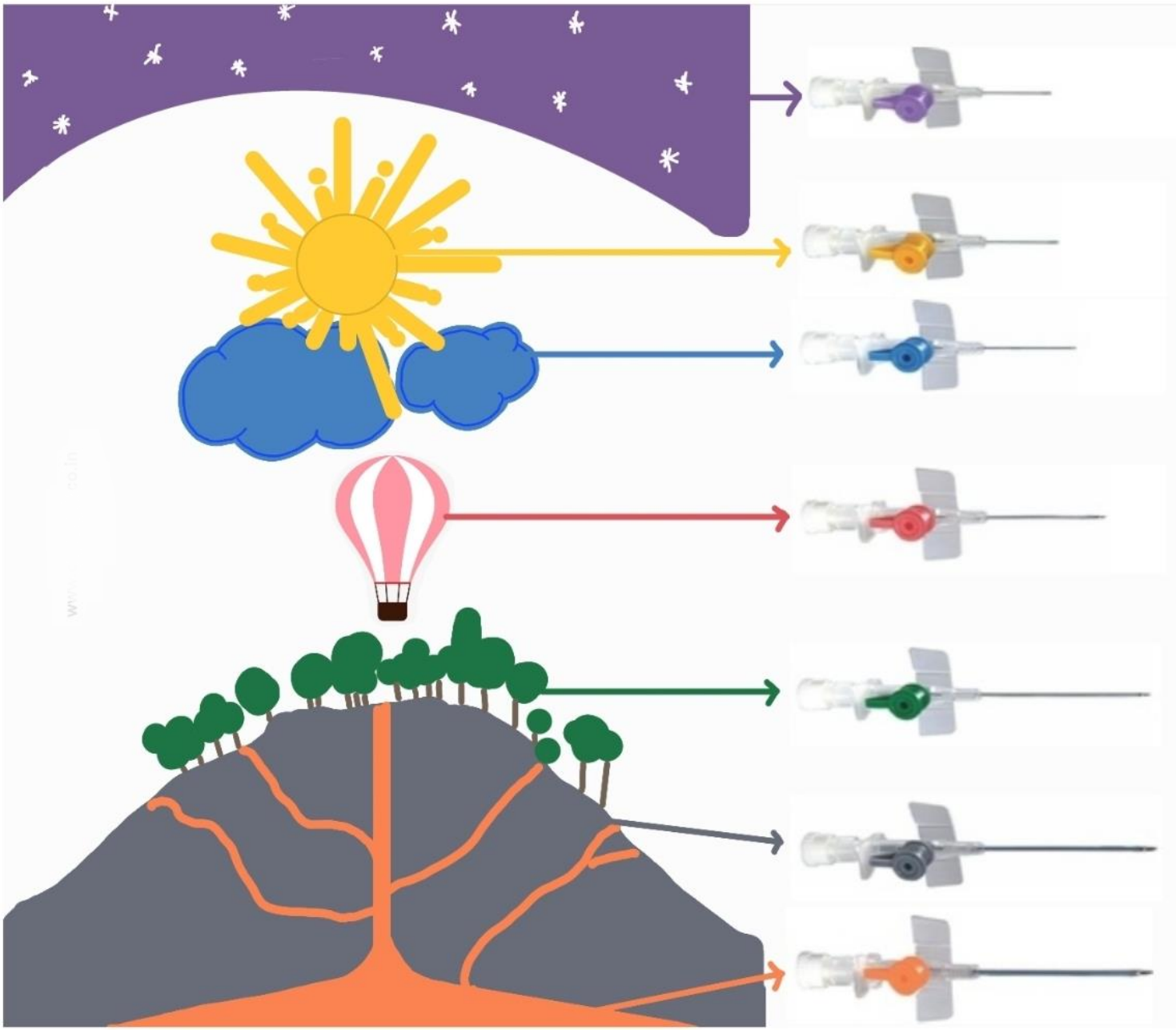
IV set parts and uses



IV set full form

1. **Plastic spike with protector cap**
2. **Air vent**
3. **Solution filter**
4. **Drip chamber**
5. **Flow regulator**
6. **Injection site**
7. ***Luer lock connector***
8. **Cap**
9. **Needle**
10. **Tube**

IV Cannula Gauge Sizes & Color Code -VISUAL MNEMONIC



COLOR	GAUGE	Flow Rate	Recommended Use
VIOLET	26	13mL/min	Elderly & Neonates
YELLOW	24	20mL/min	Very Fragile veins, Elderly & Pediatric patient
BLUE	22	36mL/min 31 mL/min	Chemotherapy Infusions, elderly and pediatrics.
PINK	20	60mL/min 54 mL/min	" Multipurpose IV " For medications & Hydration.
GREEN	18	90ml/min 85 mL/min	Blood Transfusion. Large volume Infusion
GREY	16	180mL/min	Trauma, Surgery, Large volume Infusion.
ORANGE	14	240mL/min	Massive trauma

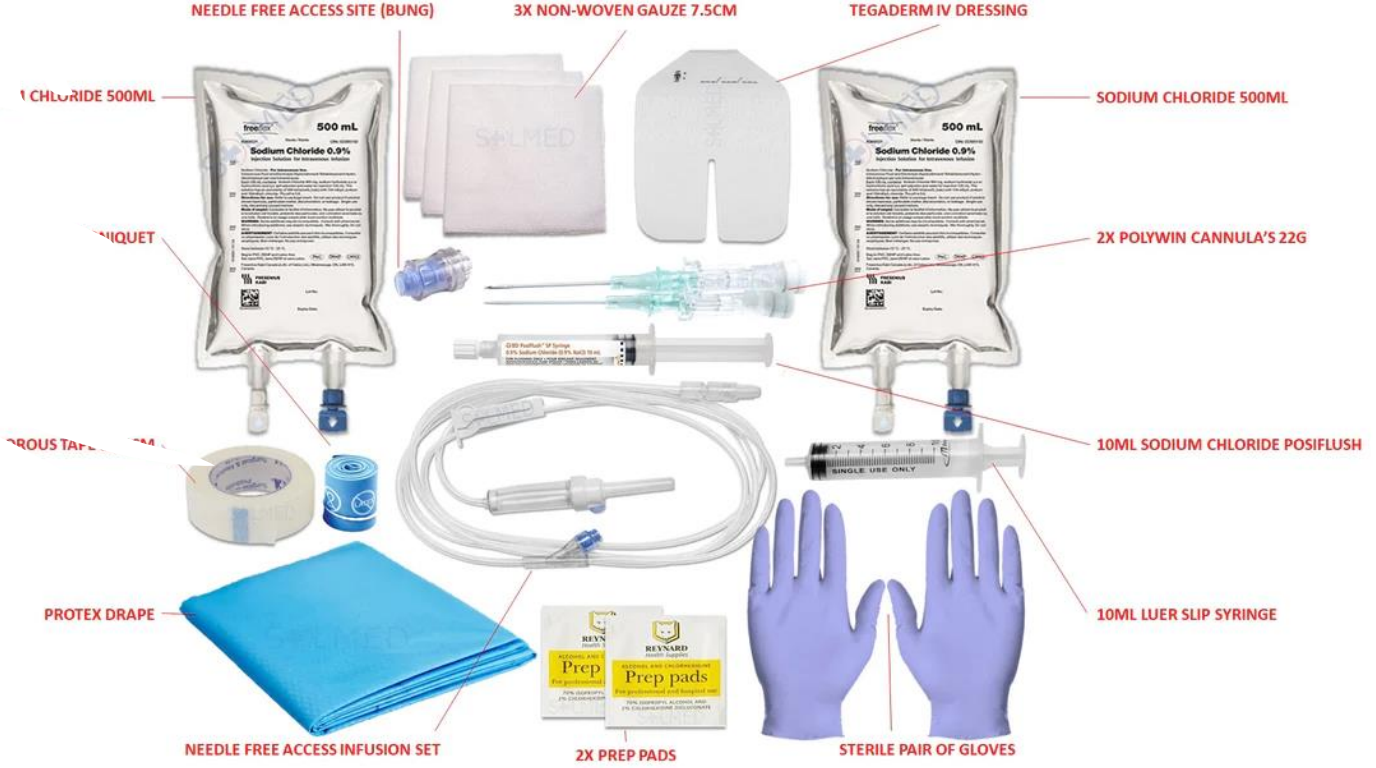
Hagen–Poiseuille equation

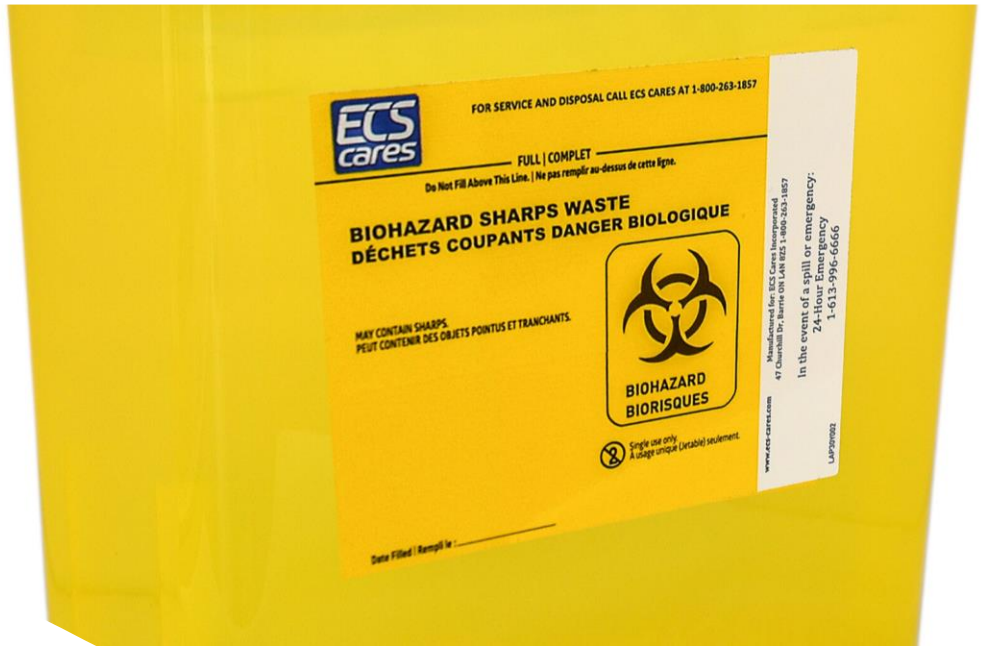
Q	Flow rate
P	Pressure
r	Radius
η	Fluid viscosity
l	Length of tubing

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

Equipment

- Cannula size depending on need
- Alcoholic chlorhexidine
- Tourniquet
- Dressing (Tegaderm)
- Gloves
- Sharp container
- Giving set and prescribed IV fluids
- Syringe 10ml with 0.9% Normal saline
- Fluid balance sheet



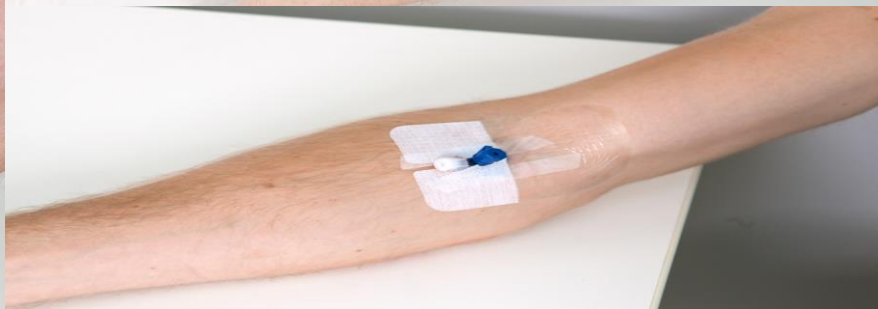


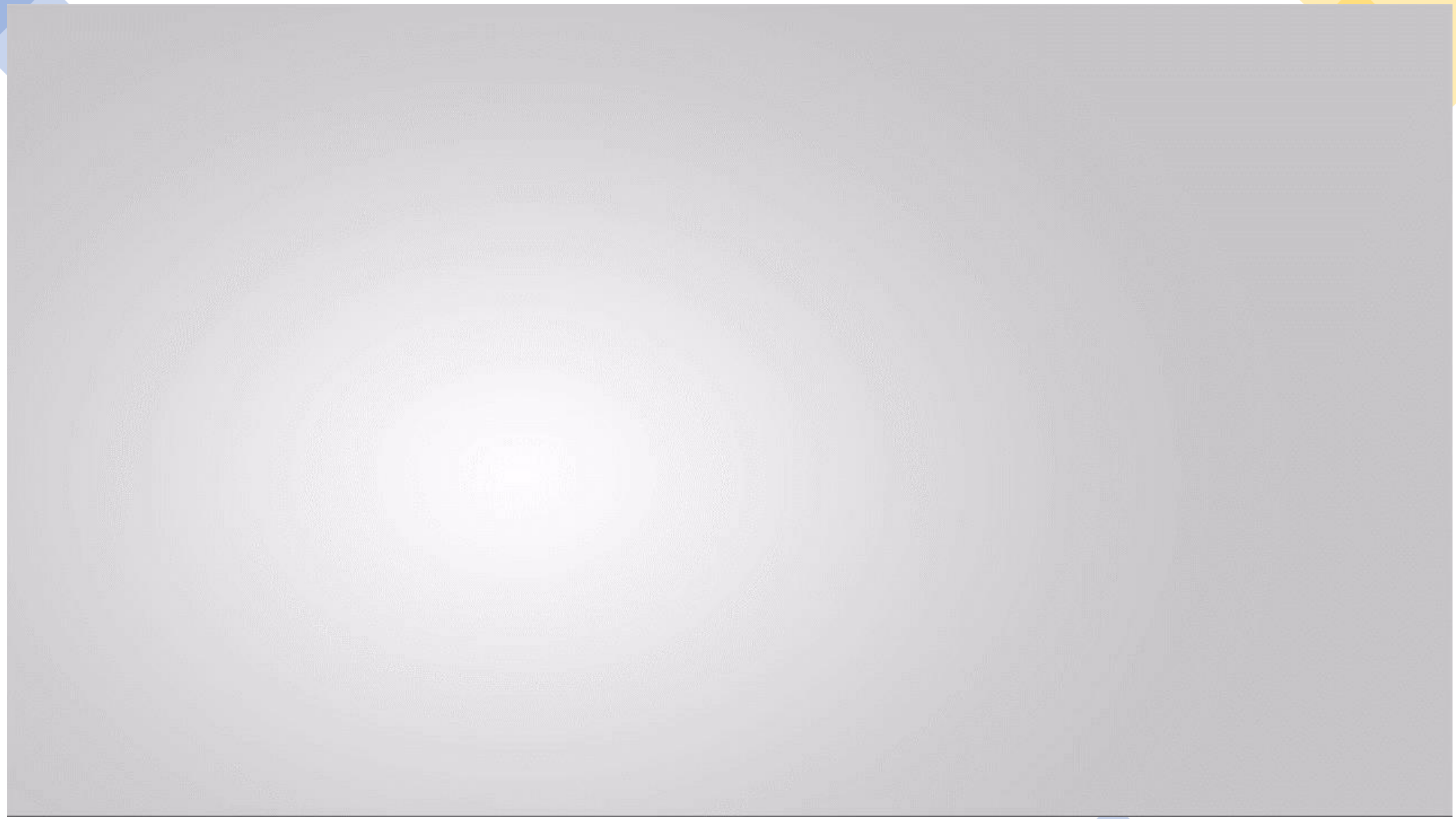










Central venous access

Objectives

Having completed the central venous access workshop, you will be able to:

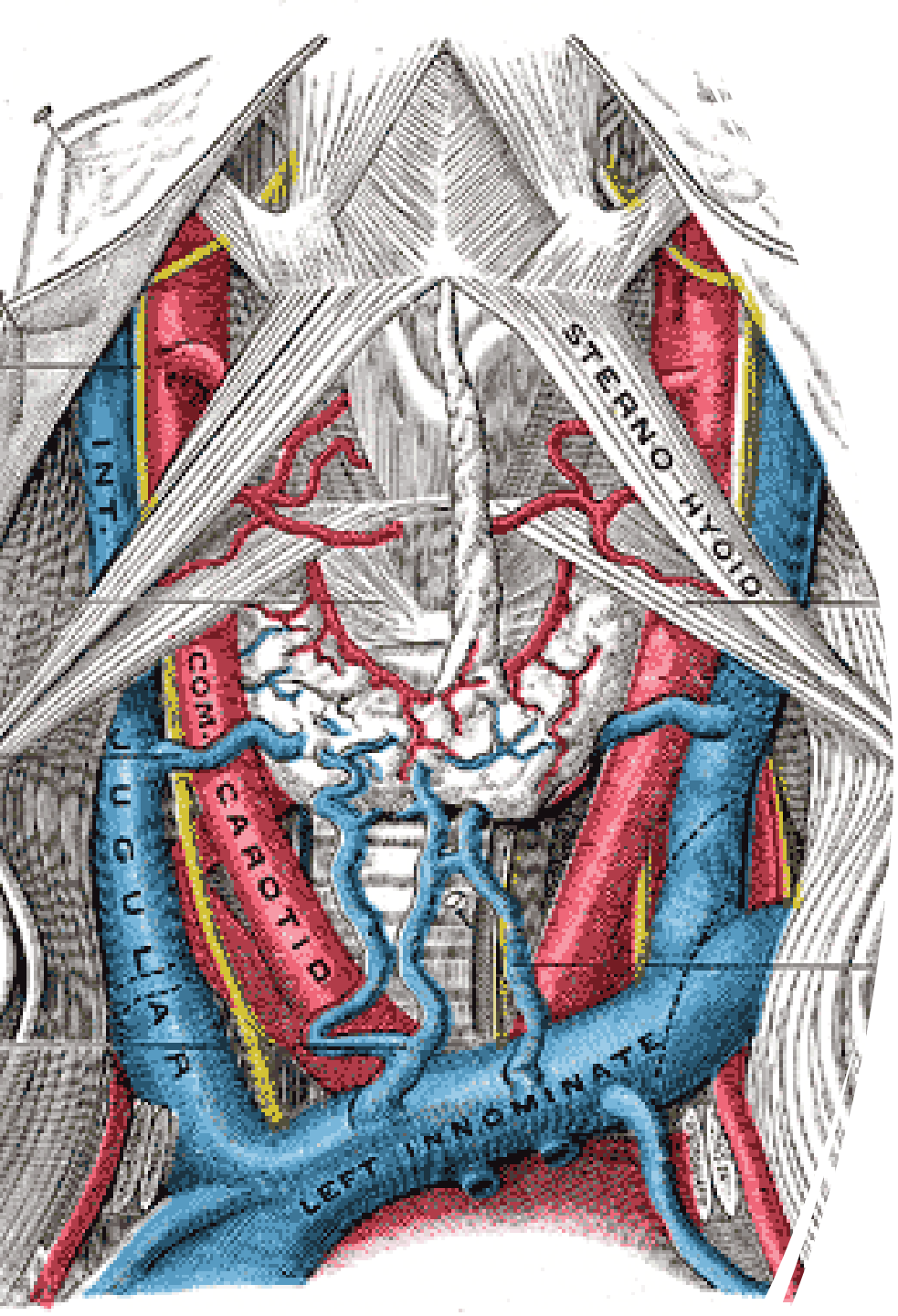
- Describe the applied anatomy of the central veins.
- Recognize indications for central line insertion.
- Identify equipment needed for central line insertion.
- Identify central venous pressure waveform.

Anatomy

- What is a central vein? one near the centre of the circulation (heart)
- Central vein to be catheterized has to be ‘big with fast-flowing blood’.

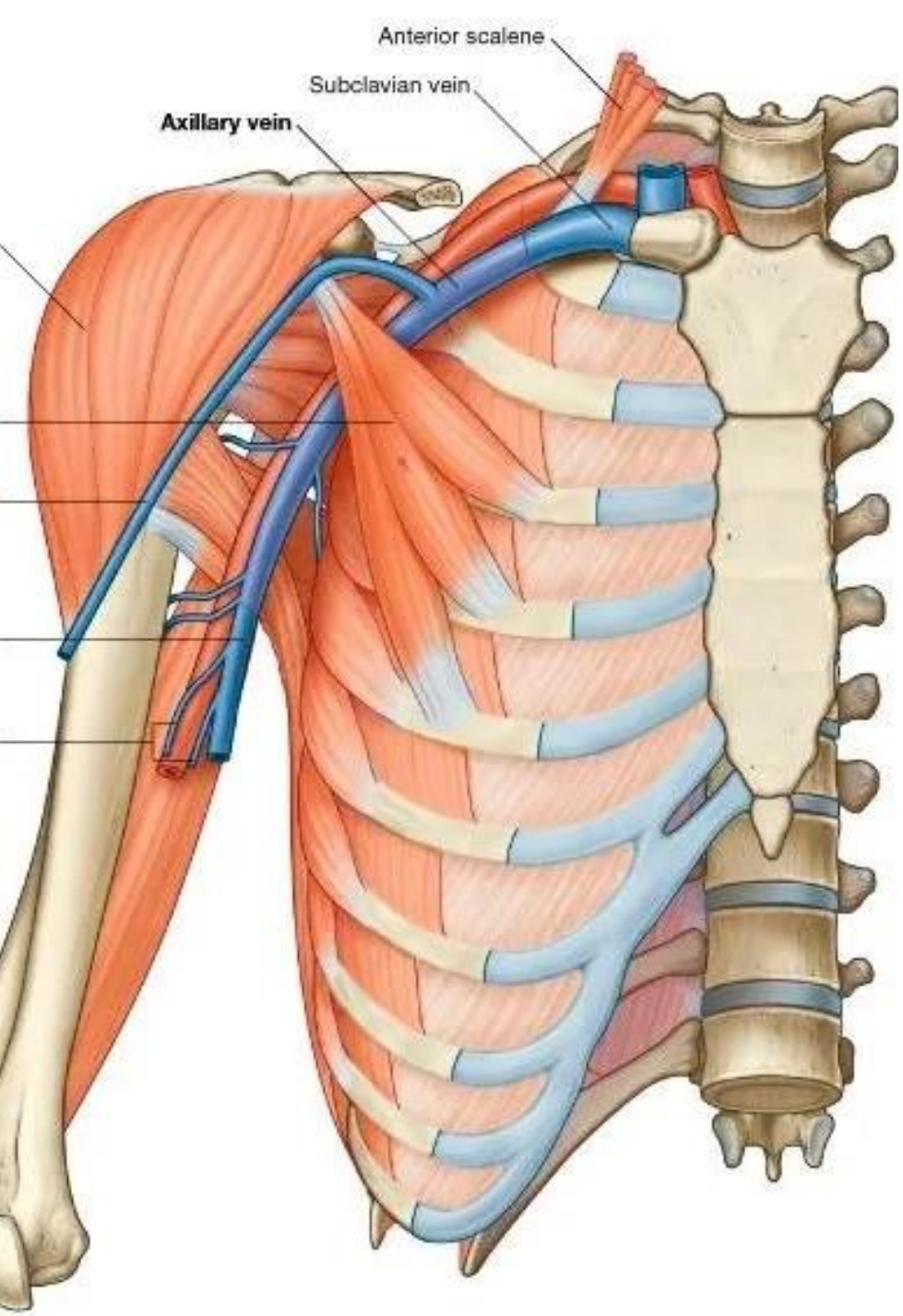
- SVC, the brachiocephalic veins, the subclavian veins, the IVC, the external and common iliac veins.

- SVC → IJV.
- External iliac vein → Femoral vein.
- Subclavian vein → directly.



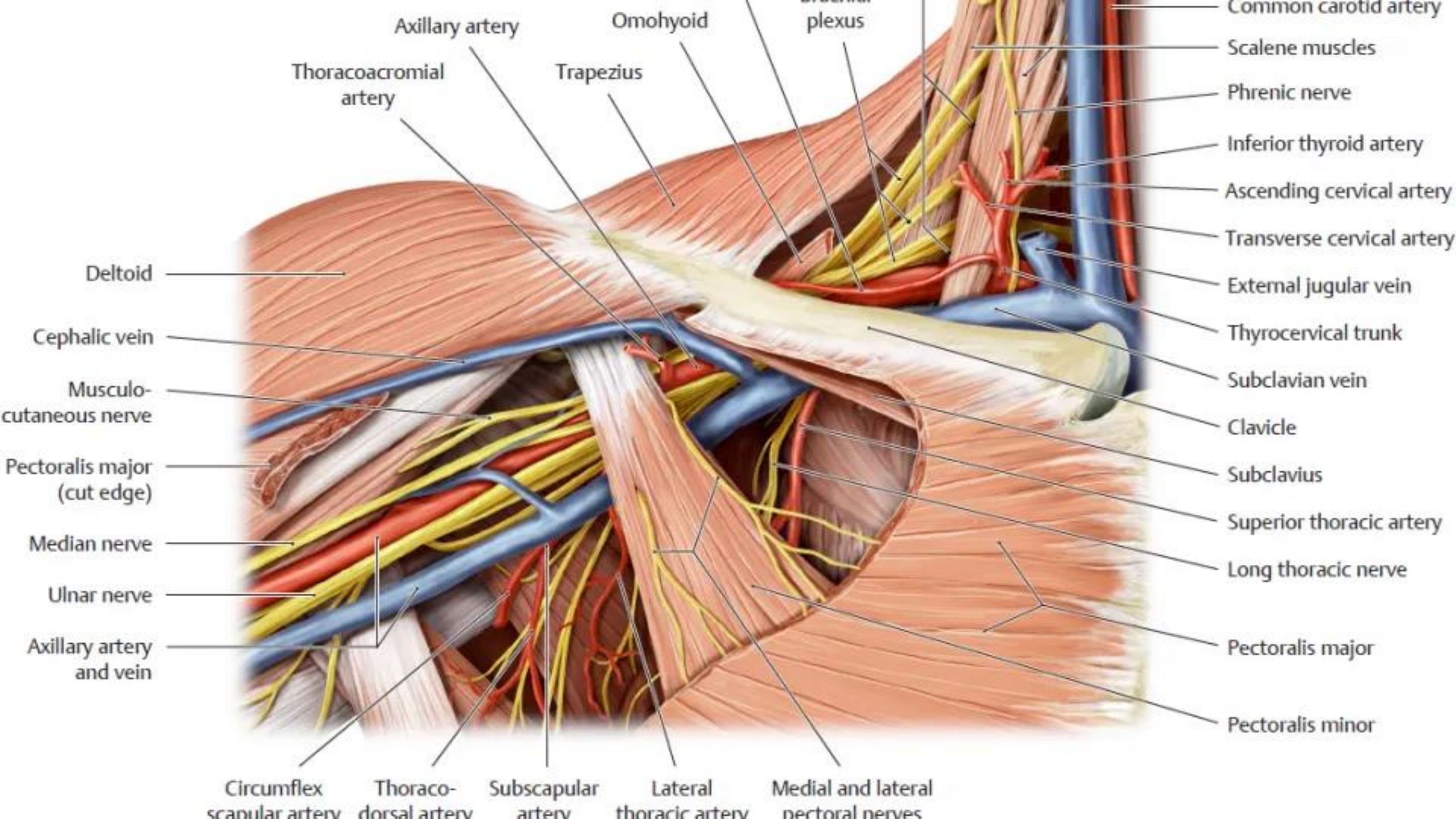
Anatomy of the IJV

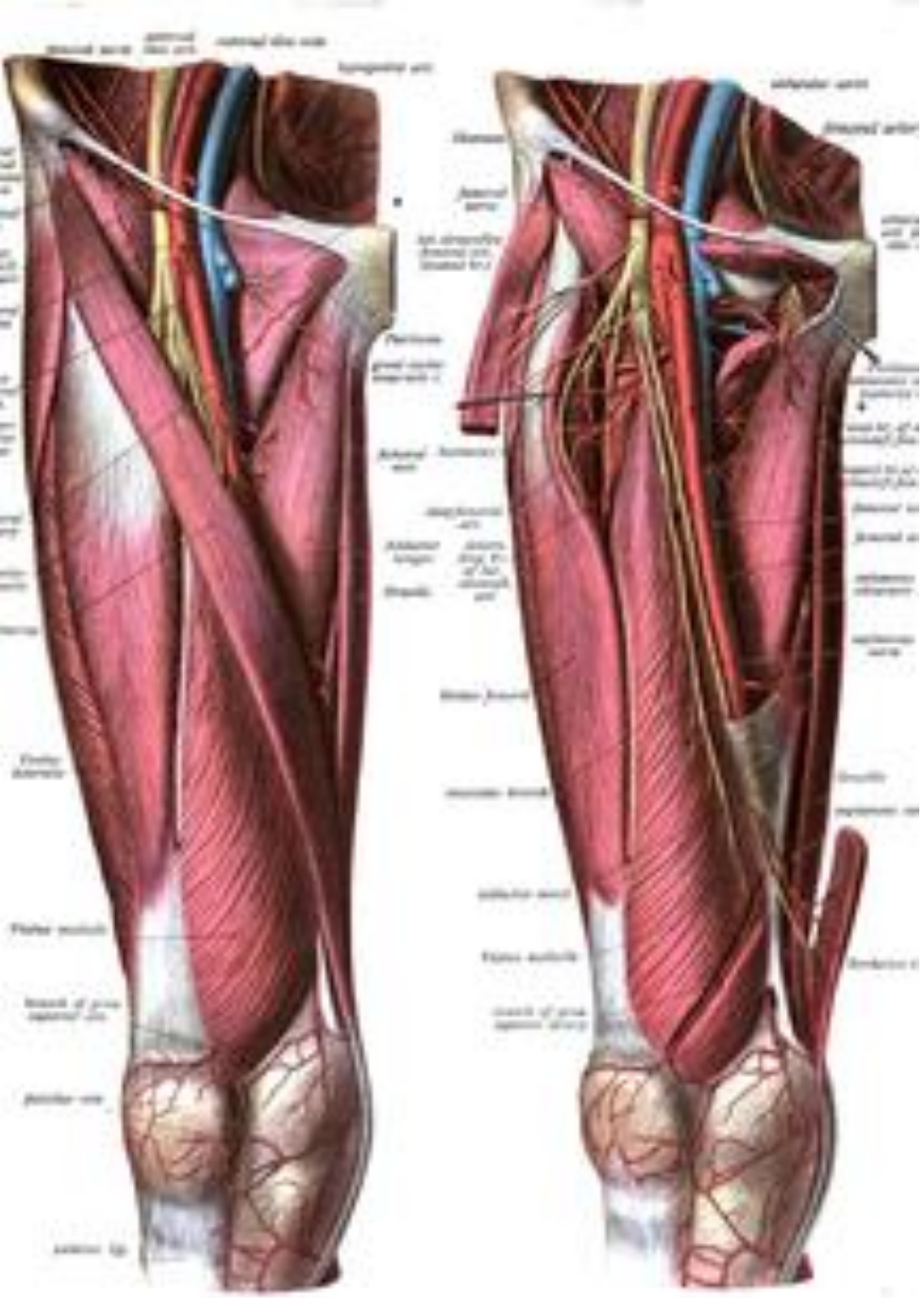
- Brain, superficial regions of the face, and neck.
- It arises in the posterior cranial fossa and exits the cranium through the jugular foramen, located at the base of the skull.
- Descends in the Carotid sheath, accompanied by the vagus nerve posteriorly and the common carotid artery anteromedially.
- Combines with the subclavian vein to form the brachiocephalic or innominate vein.



Anatomy of the SCV

- Runs under the clavicle and anterior to the SC artery.
- Direct continuation of the axillary vein.
- Renamed as the subclavian vein once it passed the lateral border of the first rib.
- Combines with the IJV to form the brachiocephalic or innominate vein.
- The two brachiocephalics will form the SVC.


Axillary artery
Omohyoid
plexus
Common carotid artery
Thoracoacromial artery
Trapezius
Scalene muscles
Phrenic nerve
Inferior thyroid artery
Ascending cervical artery
Transverse cervical artery
Deltoid
External jugular vein
Cephalic vein
Thyrocervical trunk
Musculo-cutaneous nerve
Subclavian vein
Clavicle
Pectoralis major (cut edge)
Subclavius
Superior thoracic artery
Median nerve
Long thoracic nerve
Ulnar nerve
Axillary artery and vein
Pectoralis major
Pectoralis minor
Circumflex scapular artery
Thoraco-dorsal artery
Subscapular artery
Lateral thoracic artery
Medial and lateral pectoral nerves



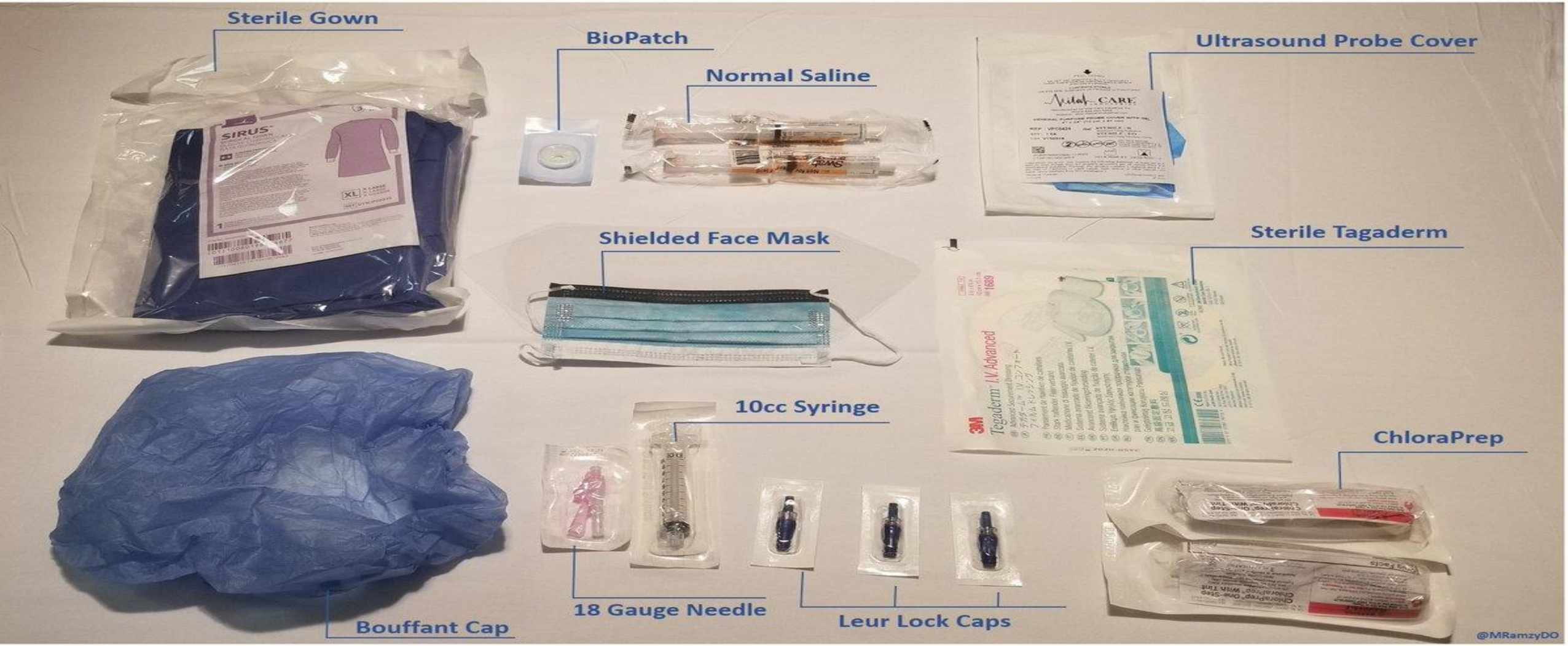
Anatomy of the Femoral vein

- Direct continuation of the popliteal vein.
- begins at the adductor hiatus, courses proximally through the adductor canal into the femoral triangle.
- Passes posterior to the inguinal ligament as the external iliac vein → common iliac vein → IVC.
- V A N

Indications for central venous access?

- Central venous pressure monitoring
- Large volume fluid resuscitation
- Infusion of highly osmolar fluids and drugs
- Right heart catheterization
- Difficult peripheral IV access
- Placement of transvenous pacemaker
- Hemodialysis

Equipment


Sterile Gown
BioPatch
Normal Saline
Ultrasound Probe Cover
Shielded Face Mask
Sterile Tagaderm
10cc Syringe
ChloraPrep
Bouffant Cap
18 Gauge Needle
Leur Lock Caps
@MRamzyDO

Central catheter

Central catheter

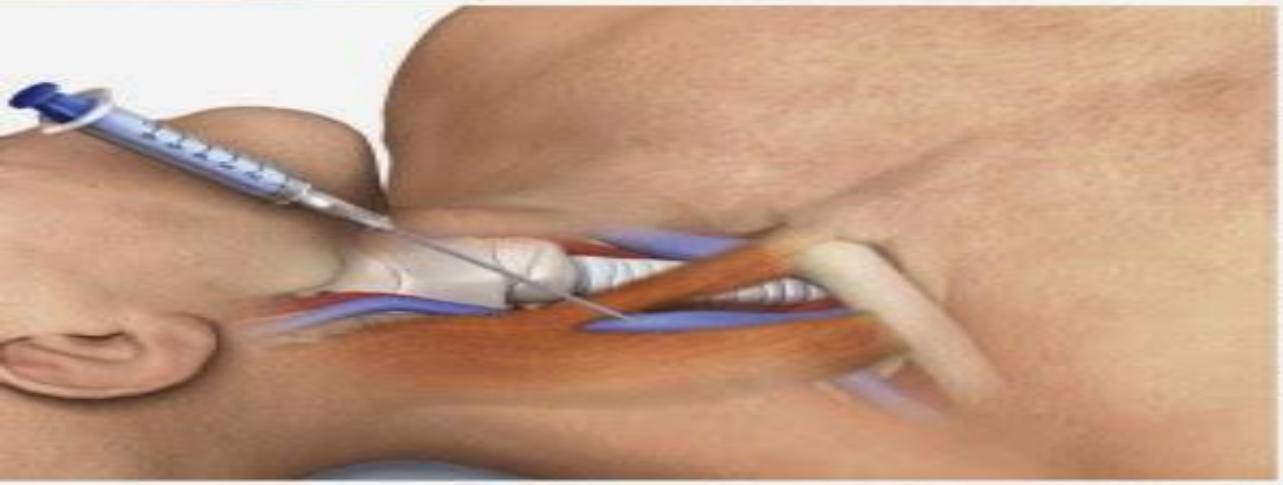
ANTERIOR APPROACH

Insert needle along the medial edge of the sternocleidomastoid, 2–3 fingerbreadths above the clavicle.

Entry angle = 30° to 45°.

Aim towards the ipsilateral nipple.

Note: Palpate the carotid artery during venipuncture. The artery may be slightly retracted medially.



CENTRAL APPROACH

Insert needle at the apex of the triangle formed by the heads of the sternocleidomastoid muscle and the clavicle.

Entry angle = 30°.

Aim towards the ipsilateral nipple.

Note: Estimate the course of the IJ vein by placing three fingers lightly over the carotid artery as it runs parallel to the vein. The vein lies just lateral to the artery, albeit often minimally so.

POSTERIOR APPROACH

Insert needle at the posterior (lateral) edge of the sternocleidomastoid, midway between the mastoid process and the clavicle.

Entry angle = 45°.

Aim towards the suprasternal notch.

Note: Avoid the external jugular vein, which crosses the posterior SCM border. During needle advancement, apply pressure to the SCM to lift the body of the muscle. The vein is usually reached at a depth of 7 cm.

CENTRAL LINE PREP

Steps 1 & 2

Wear hat and mask then perform a surgical scrub of forearms and hands

Put on surgical gown and double-glove

Step 3

Assistant attaches velcro fasteners

Step 4

Operator hands tag to assistant

Step 5

Operator turns around anti-clockwise

Step 6

Operator pulls gown-tie from tag which is being held by assistant

Step 7

Operator ties gown

Step 8

Prime Central Line with Saline

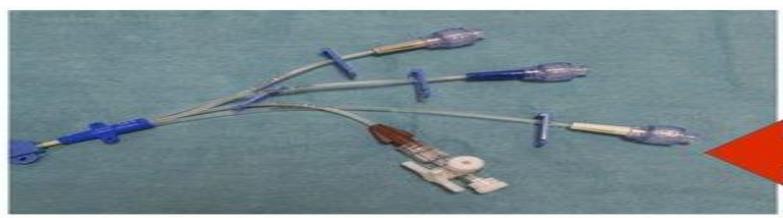
Place bioconnectors on grey, white and blue ports & close these lines

Step 9

Leave brown line open

attach primed 3-way connector AFTER line sited

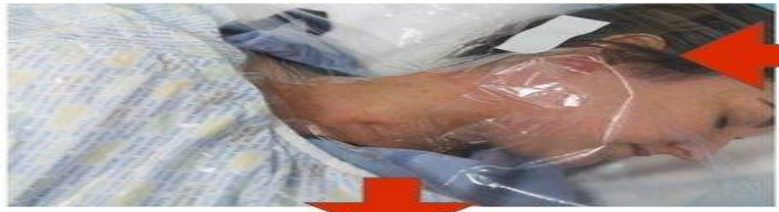
Guidewire has to feed through this line



Step 10

Use chloraprep to clean skin - pink colour indicates the large area to be cleaned

Step 11



Place central line drape over patient

rectangular opening exposes the area of interest

Step 12

Patient needs to be fully covered (use ENT drapes in addition to central line drape)

Bring trolley to head of bed as shown

Position ultrasound machine in line-of-sight

Steps 13&14

Assistant places probe inside cover as shown

ensure sterility at all times

Hold ultrasound probe cover as shown and drop gel inside

Step 15

Operator grasps probe as shown

Step 16

Operator pulls probe cover to length

Step 17

Secure probe cover with elastic band

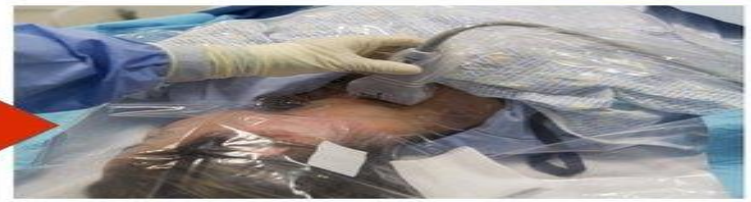
Step 18

More sterile gel can be placed on top of probe

Step 19

YOU ARE NOW READY TO PROCEED WITH CENTRAL LINE PLACEMENT

First step is to find the vein with ultrasound



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Seldinger Technique (Catheter over guidewire)

CENTRAL LINE PLACEMENT

Step 1

Remove outer pair of gloves to remain sterile for line placement

Ensure that wire runs freely on wheel as will need to be sited one-handed

Tilt bed head-down 10-15^0 and anaesthetise skin for insertion

Step 2

Find vein with ultrasound

lateral to carotid - typically larger and collapsible

Use needle & syringe provided and advance at 30-40^0 to skin withdrawing as you advance until flashback

Flatten needle and advance another 0.5cm ensuring continued flashback

Step 3

Hold needle still and remove syringe

Initially cover end of needle with thumb to prevent blood loss

Could take blood cultures at this stage (peripheral)

Feed wire through needle

Approx 10-15cm

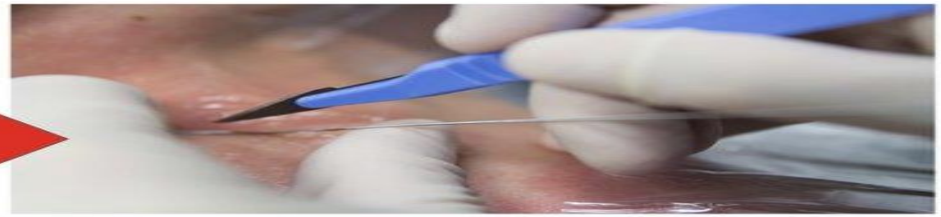
Step 4

Hold wire still and remove needle over wire

Step 5

Use scalpel to make a small incision at skin where wire enters

Have sharp end facing upwards



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Step 6

Feed dilator over guide wire
Keep hold of wire at all times

Step 7

Advance dilator through skin with twisting motion
Insert only far enough to dilate skin and soft tissue and not the vein itself

Step 8

Remove dilator keeping wire still
Feed central line over wire
Advance until tip about 2cm from skin then feed wire back out of skin until end protrudes beyond brown port of central line
Hold wire still and advance central line through skin to a depth of approx 12cm
Central line can be pulled-back but NOT advanced after wire removed

Step 9

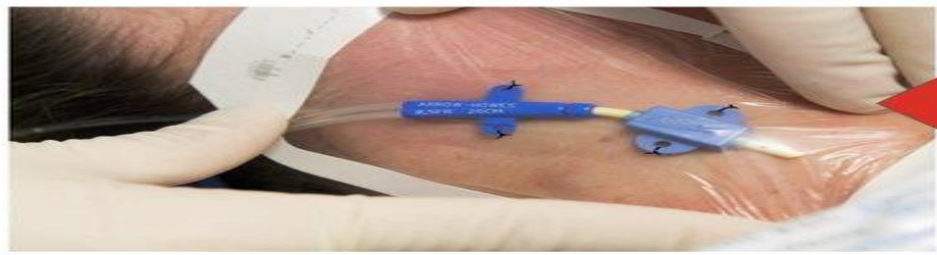
Attach hub ☆ to line and stitch into place
More local anaesthetic may be required
Stitch both hubs
Ensure ties are loose and skin not being 'pinched'

Step 10

Dry the skin well around the line

Step 11

Secure in place with a clear adhesive dressing



ORDER A CHEST XRAY PRIOR TO USE

GRI ED 2017

Ultrasound Guided Central Venous Catheterization
Internal Jugular Vein Transverse Approach

SonoSite

CVP waveform

RA/CVP Waveform Interpretation

'a' wave (end diastole)
right atrial (RA) contraction

Lost in atrial fibrillation/flutter

↑ 'a' wave in tricuspid/pulmonic stenosis and pHTN due to ↑ resistance to forward flow

"Cannon" 'a' waves in junctional rhythm, V-tach, 3° block from RA contraction against closed tricuspid valve (TV) generating large reflection wave back into RA

'c' wave (early systole)
TV cusps bulging into RA

Tricuspid regurgitation (TR) causes fusion of 'c' and 'v' waves with blunting of 'x' descent

'v' wave (late systole)
rapid filling of RA

↑ 'v' wave in TR (reaches RVSP) from regurgitant jet ↑ RA pressure

'x' descent (mid systole)
RA relaxation

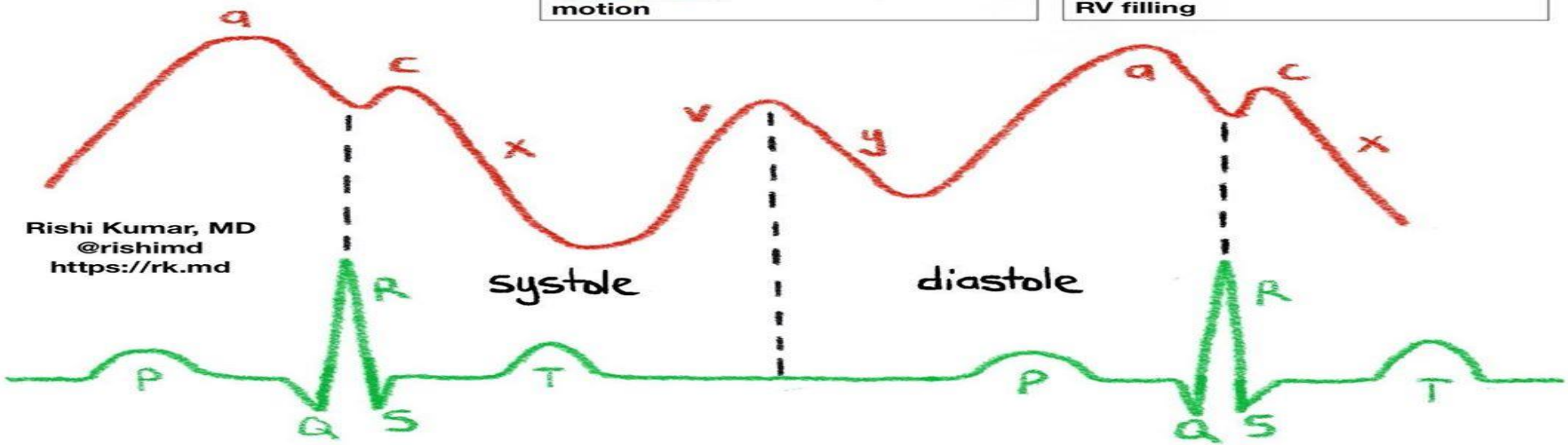
↑ 'x' descent in constrictive pericarditis

↓ 'x' descent with TR as this jet ↑ RA pressure. Suggests RV dysfunction due to ↓ apical motion

'y' descent (early diastole)
early ventricular filling

↑ 'y' descent in constrictive pericarditis

↓ 'y' descent in tamponade due to pericardial fluid pressure impairing caval inflow to RA and RV filling

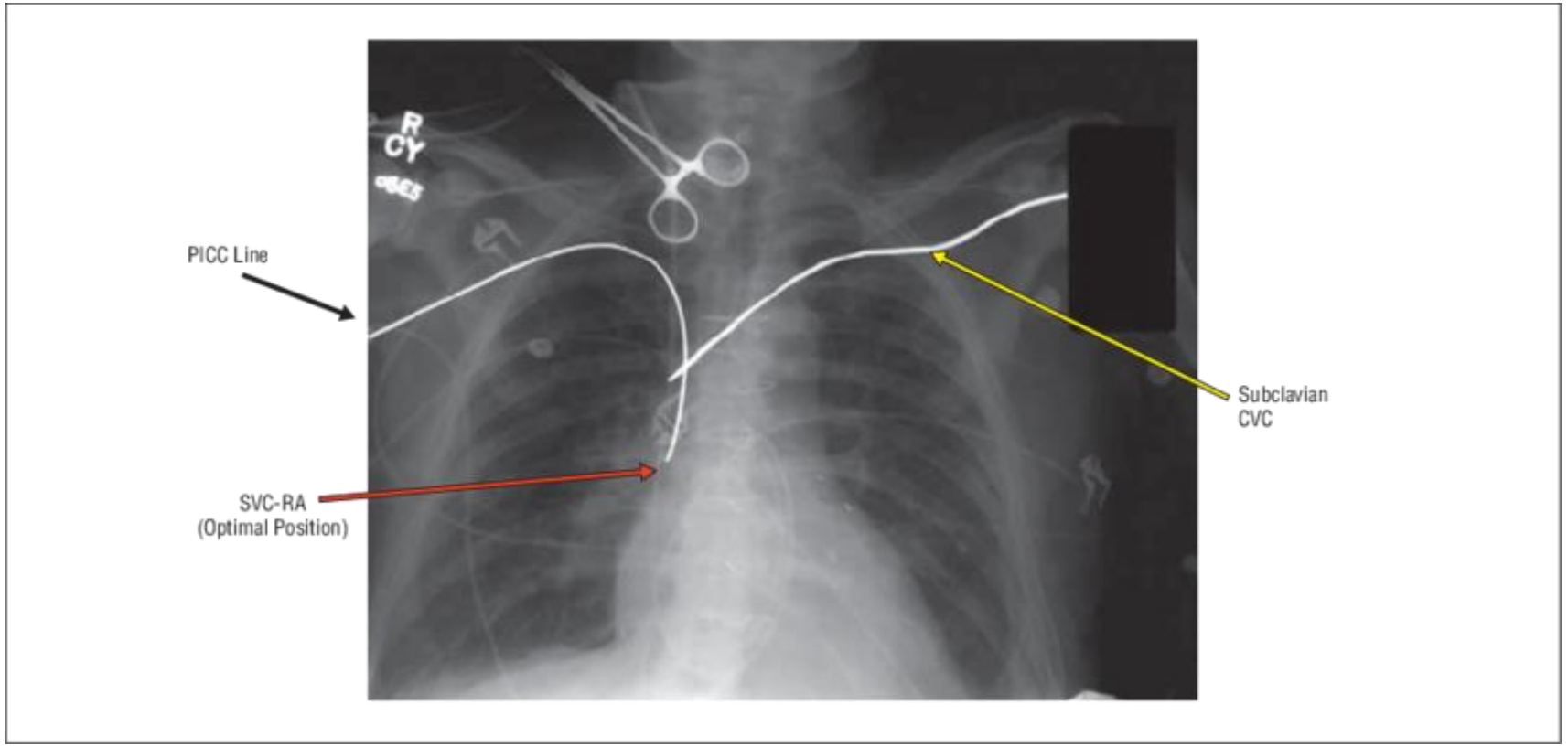


Position of the central line in the SVC

The ideal position of the tip of the central line should be checked after the insertion by chest x-ay. It will also rule out the presence of pneumothorax.

Ideal position (whether IJV or SCV) is junction of SVC and RA.

PICC: peripherally inserted central line



Complications

Table 5. Complications of central venous catheterization		
Immediate	Infectious	None
	Mechanical	Arterial puncture Haemorrhage Intra-arterial placement of catheter Haemothorax Pneumothorax Arrhythmia Injury of thoracic duct Cardiac tamponade
	Thrombo-embolic	Air embolism Guidewire embolism
Delayed	Infectious	Colonization of catheter Catheter-related bloodstream infection
	Mechanical	Erosion or perforation of vessel Fracture and embolism of catheter Venous stenosis Cardiac tamponade
	Thrombo-embolic	Air embolism Catheter-related thrombus Pulmonary embolism

Arterial catheter

ASA Standards for monitoring

- Oxygenation
- Ventilation
- Circulation
- Temperature

- Circulation: ECG, HR, and ABP (5 minutes), but sometimes you need invasive blood pressure measurement → arterial line

Indication

- Severe hypotension
- Surgeries with expected swinging of blood pressure
- Major surgery with expected major blood loss
- Frequent blood sampling (ICU). Ex. DKA, Hyponatremia ….etc

Insertion

- Most common site: radial artery at wrist
- Less common: dorsal pedis, brachial, femoral
- Seldinger technique vs cannula insertion

VYGON

Leadercath Arterial

Setting High Standards to Reduce Line Infection

Safe

Simple

Successful

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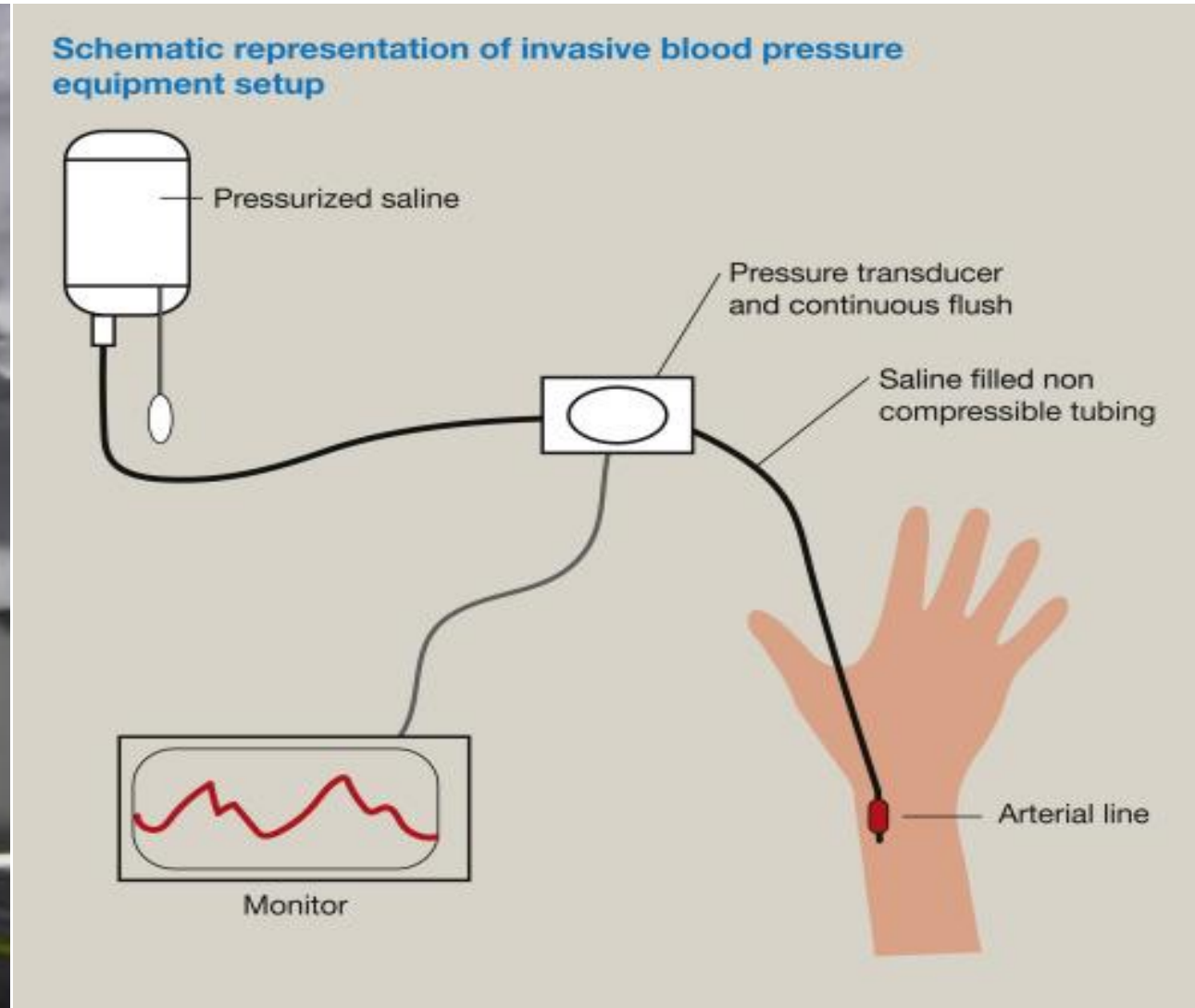
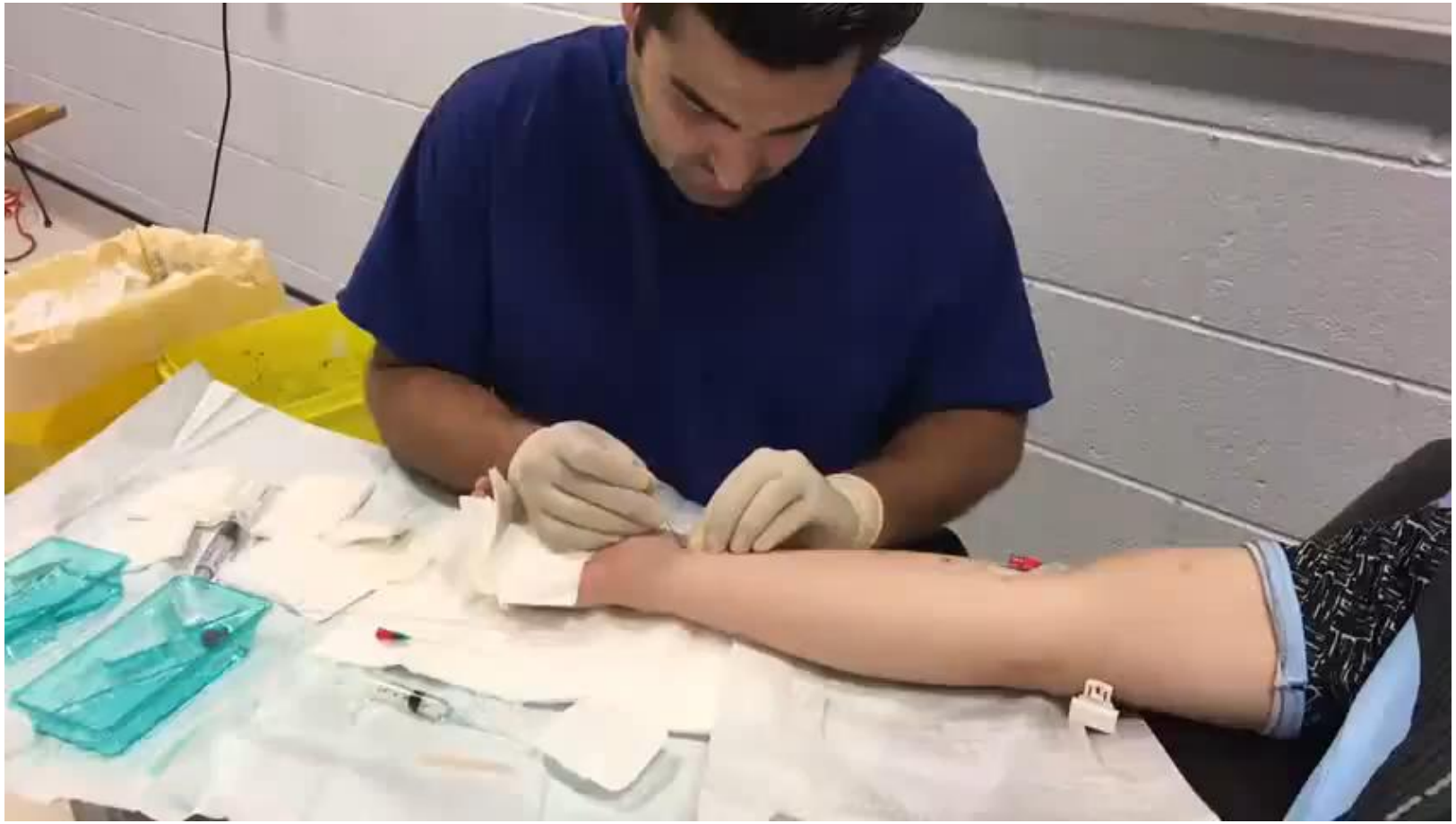
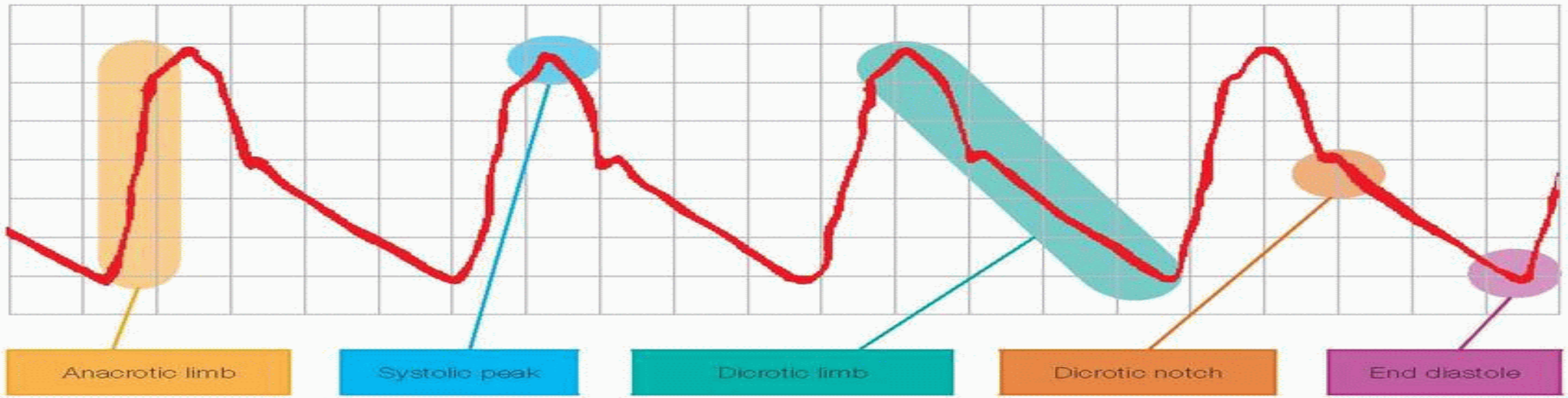
www.vygon.co.uk

Invasive Arterial Blood Pressure (IABP) Monitoring





Normal arterial waveform



The *anacrotic limb* marks the waveform's initial upstroke, which occurs as blood is rapidly ejected from the ventricle through the open aortic valve into the aorta.

Arterial pressure then rises sharply, resulting in the *systolic peak*—the waveform's highest point.

As blood continues into the peripheral vessels, arterial pressure falls and the waveform begins a downward trend, called the *dicrotic limb*. Arterial pressure usually keeps falling until pressure in the ventricle is less than pressure in the aortic root.

When ventricular pressure is lower than aortic root pressure, the aortic valve closes. This event appears as a small notch on the waveform's downside, called the *dicrotic notch*.

When the aortic valve closes, diastole begins, progressing until aortic root pressure gradually falls to its lowest point. On the waveform, this is known as *end diastole*.

Thank You