VYGON

Anatomy and Physiology as it relates to Peripheral Intravenous Central Catheters (PICCs)

Anatomy and Physiology

Content

At the end of this session you should be able to:

- Describe the structure of veins
- Discuss which arm veins are suitable for device placement
- Discuss flow dynamics and relate them to vascular access device placement

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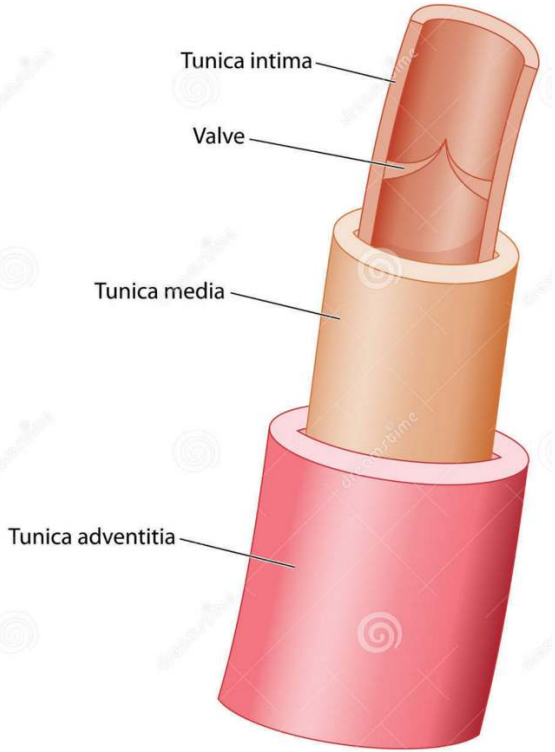
Layers of the Vein

- The **tunica intima is the** innermost layer of the vein. It is made up of one layer of endothelial cells The endothelial cells are in direct contact with the blood flow.
- The **tunica media** is the middle layer of the walls of arteries and veins. It is composed of smooth muscle and elastic fibers.
- The outermost coat, or **tunica adventitia**, is a tough layer consisting mainly of collagen fibres that act as a supportive element



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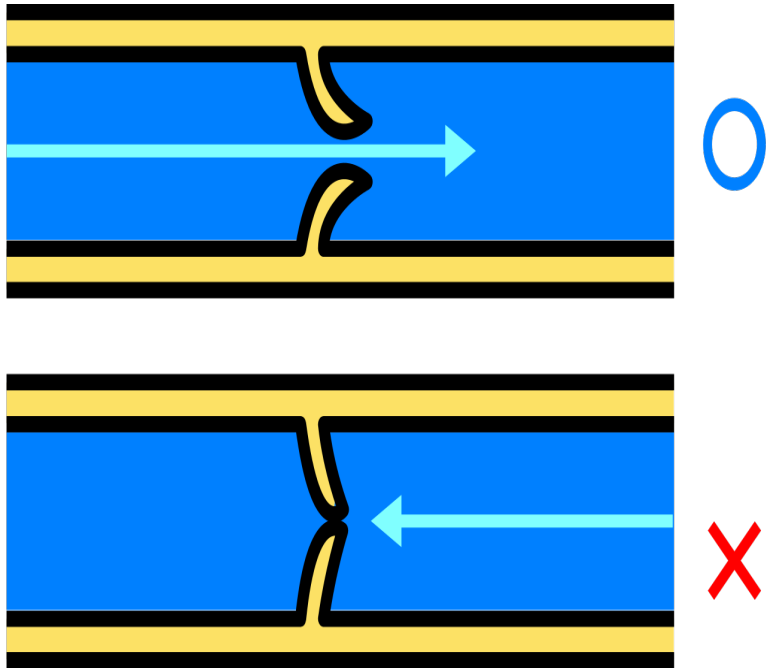
Valves

Valves are present in most veins except in the head, vena cava, very in small veins.

The purpose of valves is to allow unidirectional flow of blood back to the heart and prevent pooling in the peripheral circulation.

Difficulty can be encountered when threading wires / catheters passed the valves.



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Irritant / Vesicant Drugs

- Certain medications can cause damage to the vein intima if delivered peripherally
- Vesicant and irritant drugs should be used with caution
- Drug with an osmolarity of over 800 should be used with caution.
- Irritant and vesicant drugs can cause chemical phlebitis and extravasation and thrombophlebitis
- Think about the delicate vein intima
- A central venous catheter should be considered for such drugs

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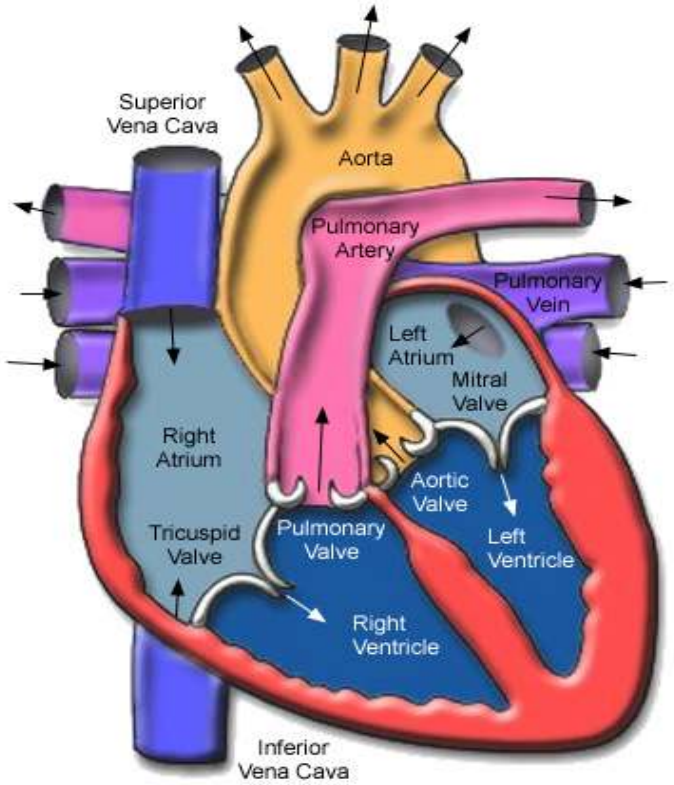
Central Venous Catheter

Definition: ***A catheter with a tip terminating in a large central vein (SVC, SVC/RA Junction, IVC or RA)'***

- Central line or Acute Central Venous Catheter
- PICC
- Tunnelled Cuffed Catheter 'Hickman type'
- Totally Implanted Port
- Midline (Tip terminates in the peripheral veins so is NOT a central venous catheter)



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Midlines and PICCs

Entry sites

- Both midlines and PICCs are inserted via the veins in the antecubital fossa or the higher deeper veins of the arm

- These veins are the basilic, brachial or cephalic

- All of these veins provide a route to the auxiliary vein then subclavian vein finally reaching the superior vena cava and right atrium

Moureau (2014)

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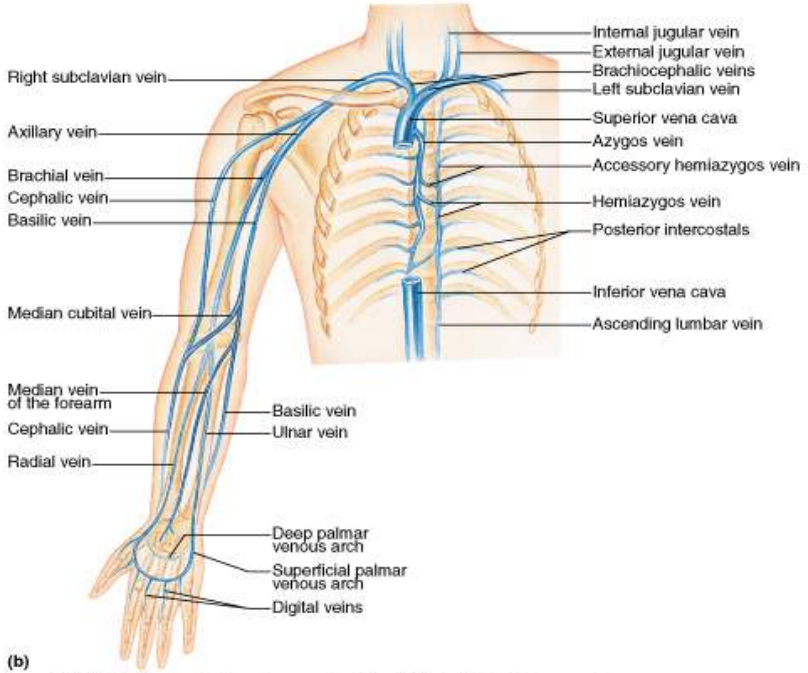
Basilic Vein

The basilic vein is the first choice for insertion

- Originates on the ulnar or medial side of the forearm and ascends on the posterior surface of the arm.
- Just before reaching the elbow, it travels to the front of the arm where it joins the median cubital vein.
- The basilic vein joins the brachial vein becoming the axillary vein near the armpit.



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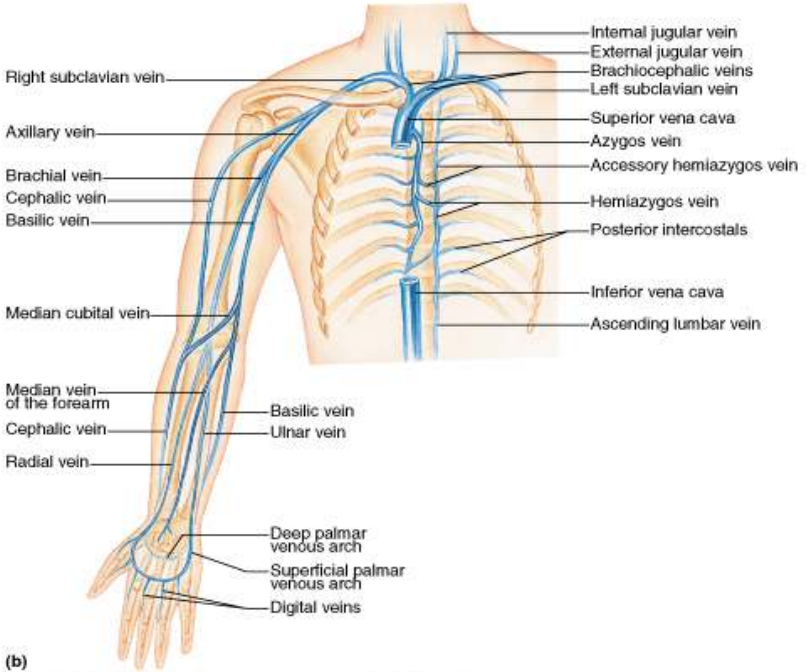
Brachial Vein

- Begins where the radial and ulnar veins join
- At this point, the brachial veins join the basilic vein to form the axillary vein.
- The brachial veins accompany the brachial artery and median nerve

*Ultrasound Guidance is advised for this approach



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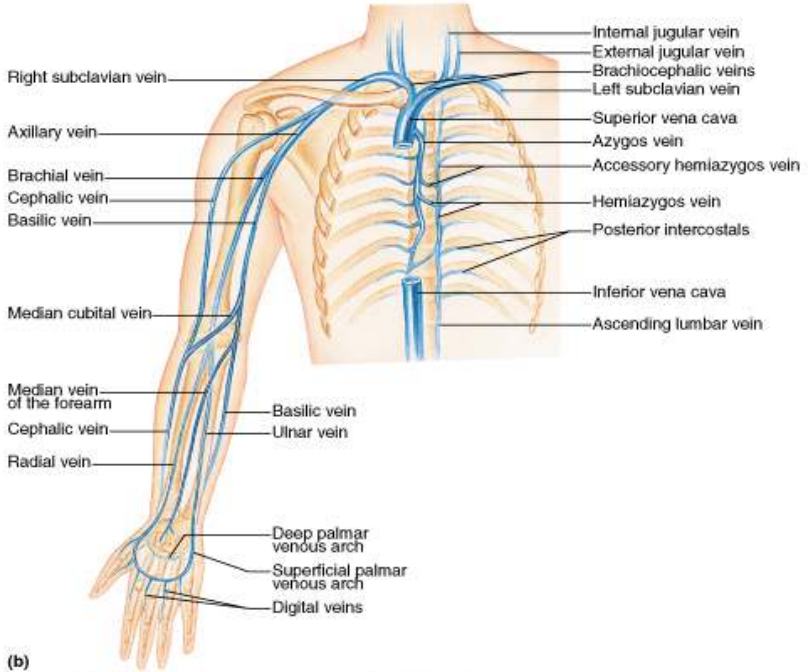
Cephalic Vein

- The cephalic vein originates on the radial or lateral side of the forearm near the thumb.
- The cephalic vein is smaller than the basilic vein and may be tortuous.
- PICCs inserted into the cephalic vein have a higher incidence of mechanical phlebitis.



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Basilic vein:

- Preferred vein as it provides the most direct route. Blood flow is greater than the cephalic.

Cephalic vein:

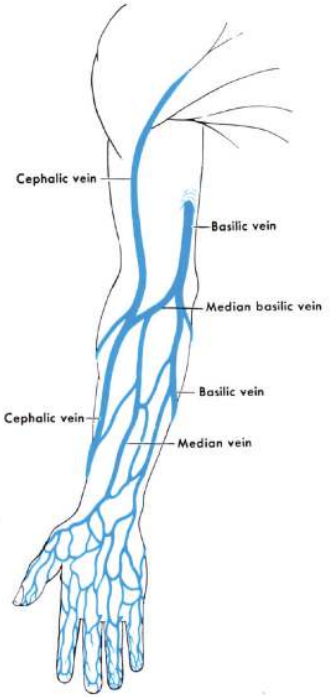
- Route to SVC more tortuous, typically small in size.
- Adequate for EDC and Midlines

Brachial Vein:

- Brachial bundle

Veins of the ACF should be avoided as associated with mechanical phlebitis

Ultrasound guidance and a Modified Seldinger Technique allows placement in the deeper veins of the upper arm



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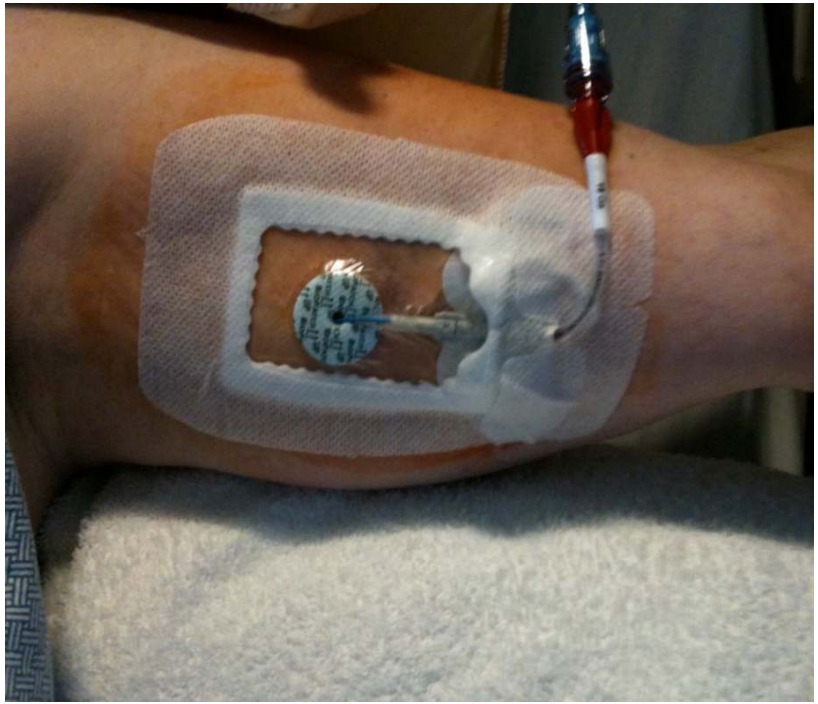
Upper Arm Basilic Vein Insertion sites - Dawson (2011)



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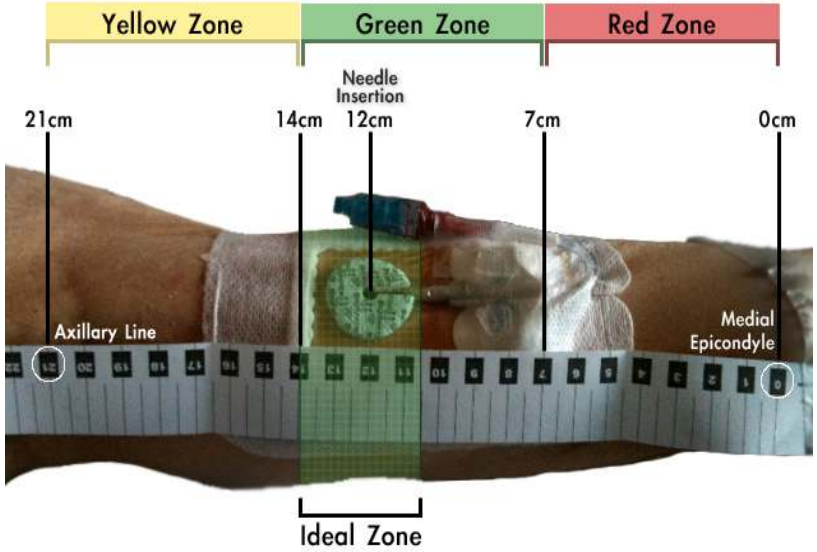
ZIM Insertion Method - Dawson (2011)

In this method the arm is separated into color zones: Red, Green and Yellow.

Yellow: The axillary area will generally have more moisture and hair follicles than the middle third.

Red: This area houses smaller veins which are more superficial and affected by elbow joint motion.

Green: This zone is a more ideal area to search for vein access, ideally the upper half of the Green Zone or Ideal Zone (IZ).



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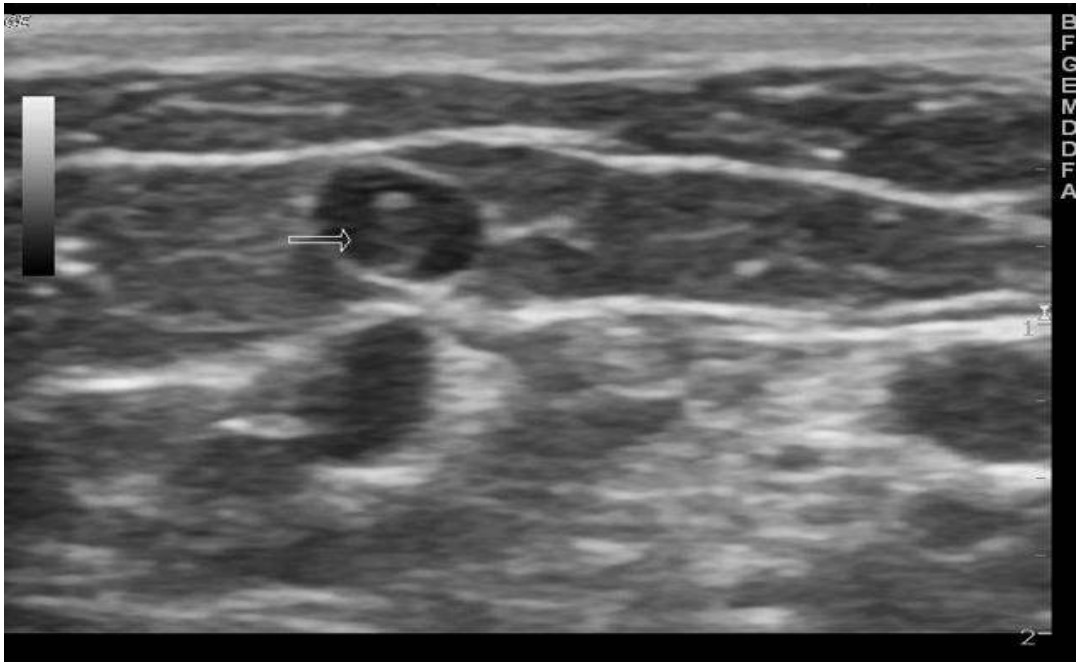
Physiology of Blood Flow and Thrombosis Risk



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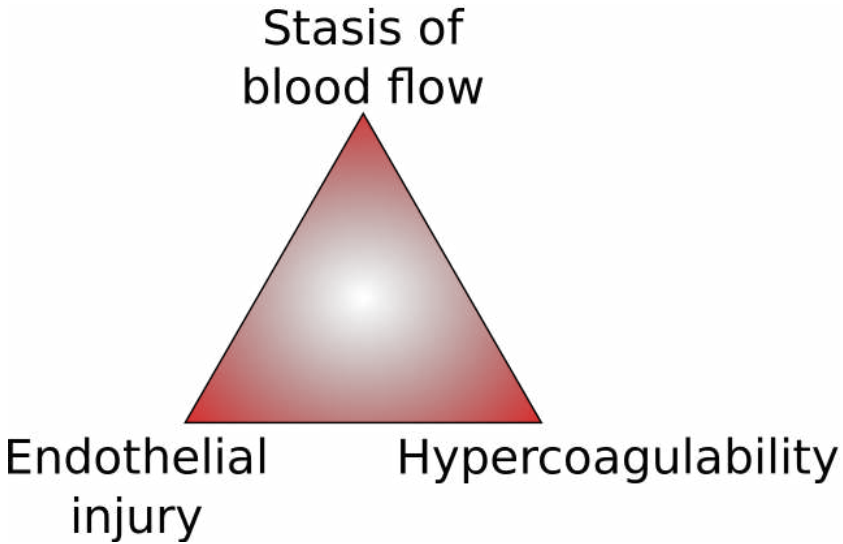
Virchow's Triad - Dickson (2009)

- Flow dynamics plays a key role in the 3rd component of Virchow's triad as we slow the flow within the vessel by at least 50% when we place a catheter within it.

- The tip position is also important as if in a narrow vein (innominate or distal SCV) risk of thrombosis is increased.



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PICC Size and Incidence of Thrombosis

Evans et al (2010) observed that increasing catheter size is associated with increased DVT risk

- 0.4% symptomatic thrombosis rate for 4F PICCs
- 8.8% symptomatic thrombosis rate for 6F PICCs)
- 0.6% with single-lumen catheters
- 2.9% with double lumen and
- 8.8% with triple lumen

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Continued:

- 3-year, prospective, observational study, which showed that an increase in the use of single-lumen PICCs combined with use of smaller 5F triple-lumen PICCs was associated with significant decrease in the rate of PICC-related thrombosis (Evans et al, 2013)

- In a retrospective analysis, Grove et al (2000) showed no thrombosis for PICCs <3F and 9.8% rate of thrombosis for 6F PICCs
- Vein diameter should be know before device insertion

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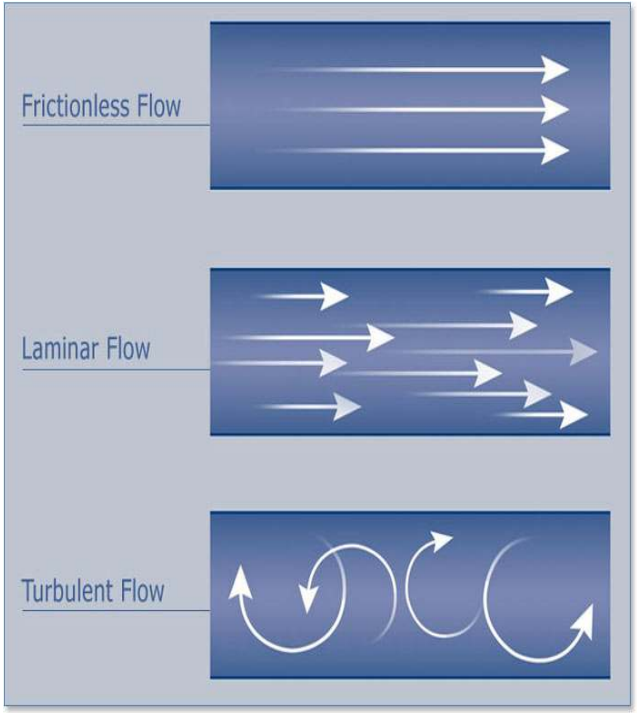
Flow Dynamics

Vein	Initial Flow	2 Fr		4 Fr		6 Fr		8 Fr	
Cephalic (4 mm)	10	5	48%	3	28%	1.5	14%	0.5	0.5%
Brachial (5 mm)	25	13	53%	9	36%	6	22%	3	12%
Basilic (6 mm)	52	29	56%	21	41%	15	28%	9	18%
Axillary (8 mm)	164	100	61%	79	48%	62	38%	47	28%
Subclavian (10 mm)	400	256	64%	212	53%	175	44%	143	36%



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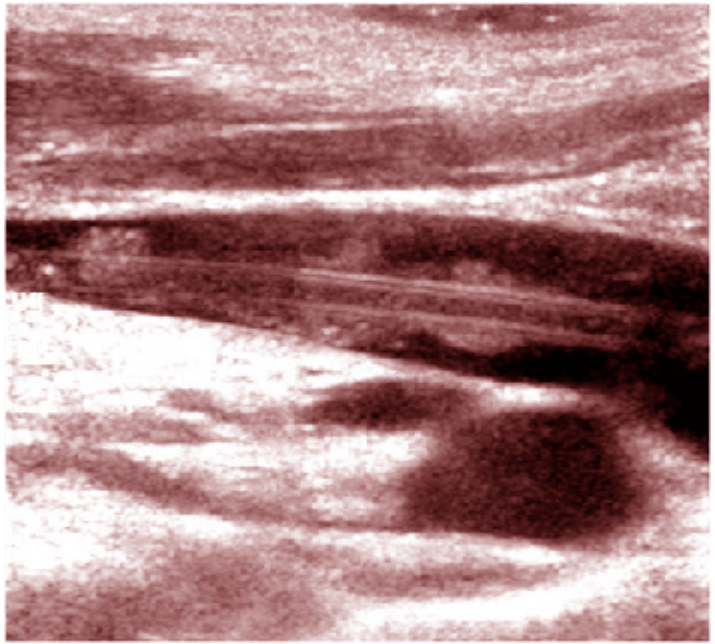
Vein to Catheter Ratio

- Vein lumen size should be measured using ultrasound

- The vein to catheter ratio should be around 3:1 or at the minimum 2:1 (Nifong, 2011, Sharp, 2015, Spencer and Mahoney, 2017)



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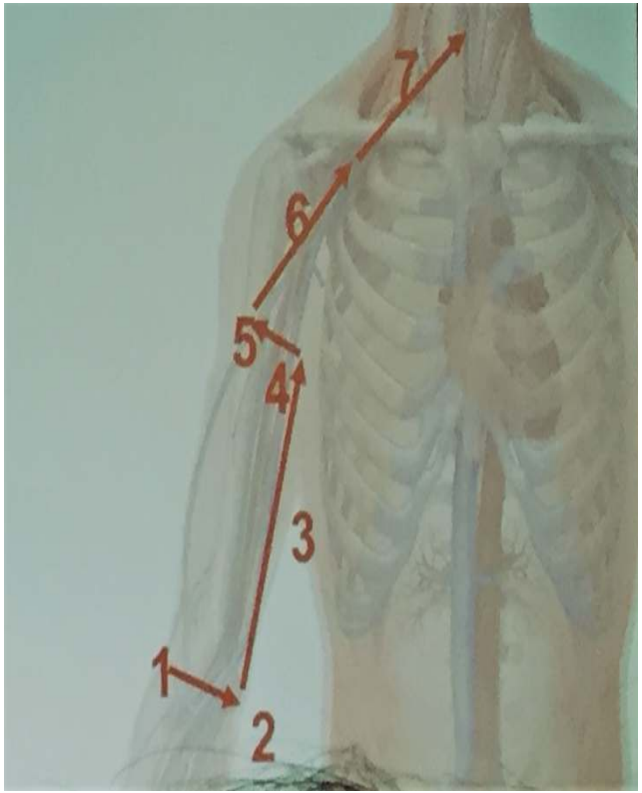
The RaPeVA Protocol

Visualisation of the following vessels in succession

1. Elbow: Cephalic vein
2. Elbow: Brachial vein & artery
3. Basilic vein bicipital humeral groove
4. Mid arm: Neurovascular bundle (brachial vein, artery & nerve)



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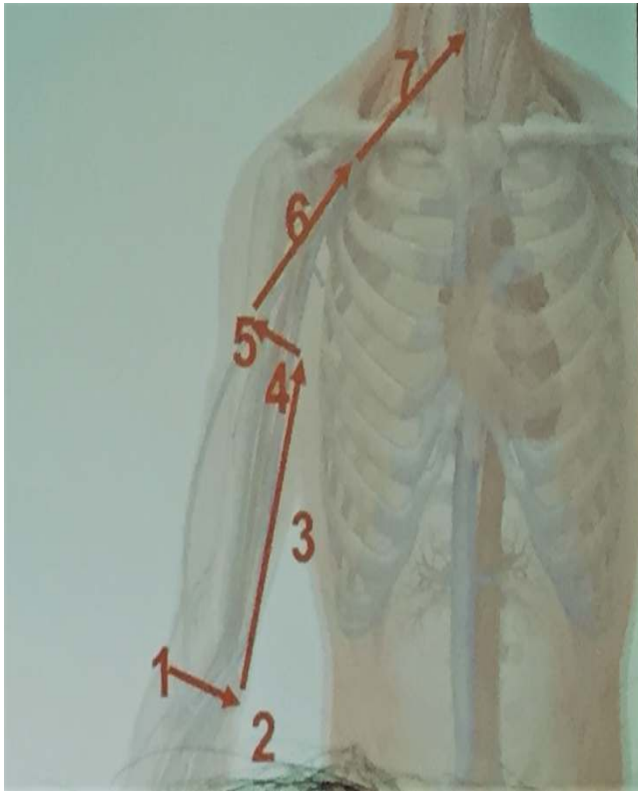
The RaPeVA Protocol

Visualisation of the following vessels in succession

5. Mid arm: Cephalic vein
6. Axillary and cephalic veins, infraclavicular area
7. Subclavian, internal jugular and innominate veins, supraclavicular



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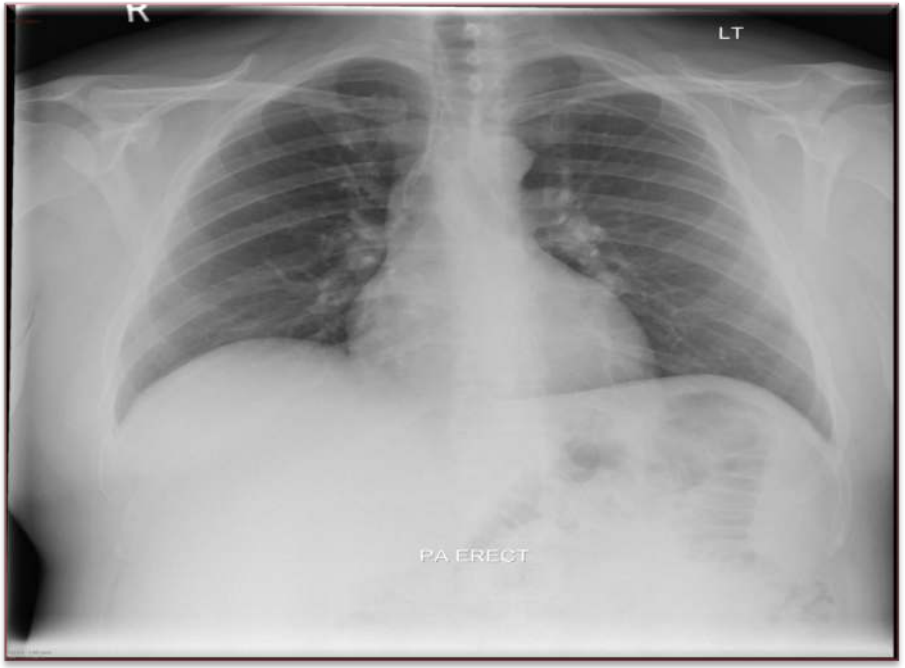
The Importance of Vascular Access Device Tip Position

The ideal catheter tip position is in the lower superior vena cava (SVC) / upper right atrium (Denton et al, 2016; Gorski, 2016; Bodenham, 2016)



The Association of Anaesthetists of Great Britain & Ireland

INS Infusion Nurses Society UK and Ireland

Royal College of Nursing

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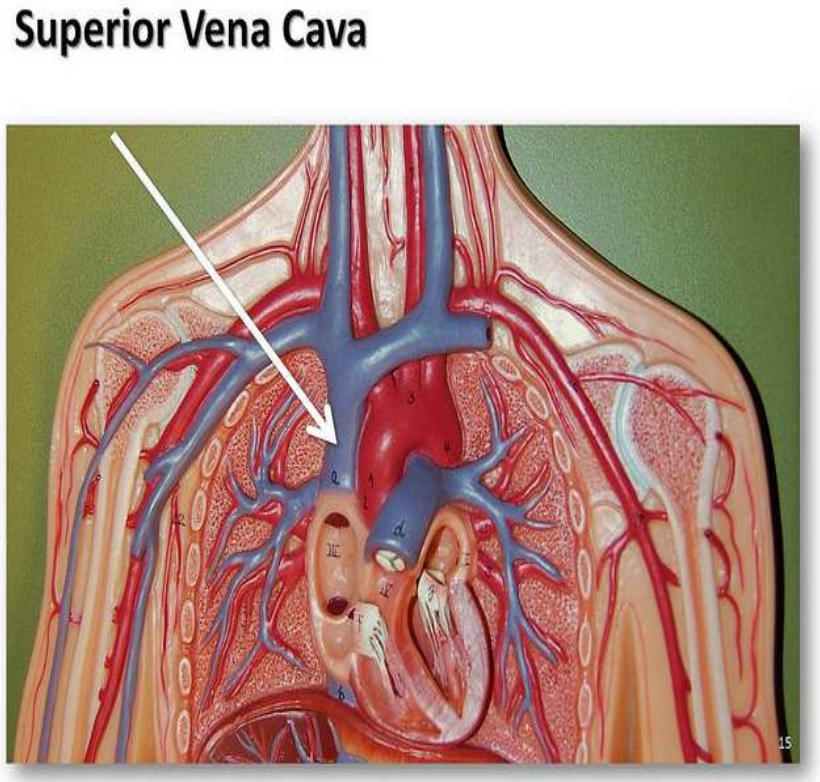
PICC Tip Positioning

- The arm veins eventually lead to the SVC /upper right atrium.
- To prevent inadvertent tip positioning in the Internal jugular vein. ECG tip location or fluoroscopy should be used.
- In addition, on feeding the catheter over the shoulder, the patient should be advised to turn their head to the side of placement and place their chin on the shoulder.



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Tip Positioning: Midline

- The point of insertion should be approximately 5cm above or below the antecubital crease (Griffiths, 2007).
- The tip of a midline should terminate prior to the auxiliary vein (before shoulder).
- There is a significant risk of venous thrombosis if placement is above the axillary line' (Gorski & Czaplewski, 2004).

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Conclusion

Assess	Fully assess both arms systematically to identify adequate veins for device placement
Aim	Aim for a mid upper arm placement
Measure	Measure vein to ensure adequate vein / catheter lumen ratio

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