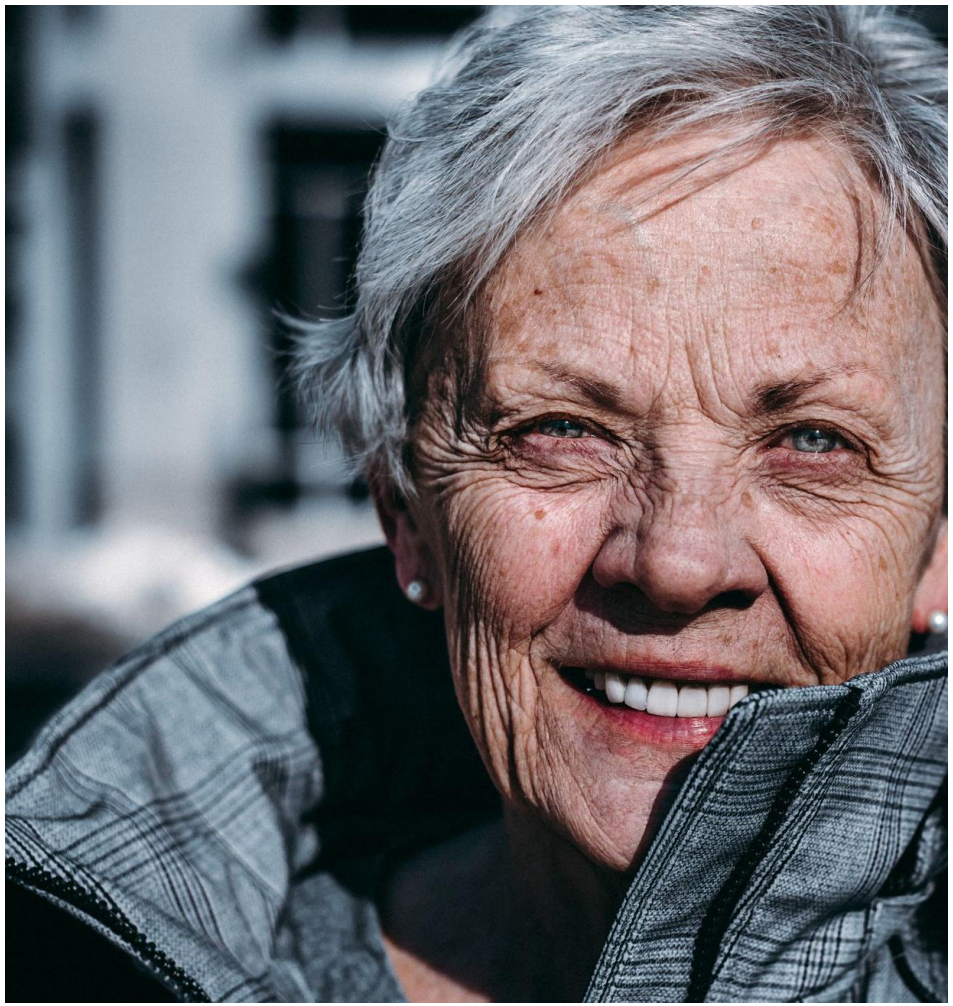
Advanced IV Course

Module 1: Peripheral VAD and Vessel Health Preservation

Case Study#1



- Nora: 80 years old admitted to Med unit from ER
  - Suspected septicemia 2ndary to UTI
  - Active, independent and started to develop 'flu-like' symptoms 3 days ago.

Vascular access

- Estimates show that 90% of these hospitalized patients will require peripheral intravenous (PIV) therapy during their admission, and 25% of these patients will go on to require a central venous access device (CVAD).
- Clinical indications include
- antibiotic therapy, pain management, chemotherapy, total parenteral
- nutrition, fluid and/or blood product administration, dialysis,
- apheresis blood draws and diagnostic imaging

(Raynak 2020, American College of Radiology, 2018; Deshmukh & Shinde, 2014; Ullman, Long, & Rickard, 2014; Weinstein & Hagle, 2014).

Vein Exhaustion

- Common occurrence in healthcare settings
- Hospital patients average two PVAD replacements over a 5-day course of infusion therapy (attempts not included)[4]
- Approximately 1:3 persons require more than one attempt for a success blood draw[5]
- Only 15% of all PVADs survive to 72 hours[6]
- Up to 71% of PVADs will require restart within 42 hours[6]
- 50-80% shown failure rates[7]

Primary Goal

One patient
One stick
One device

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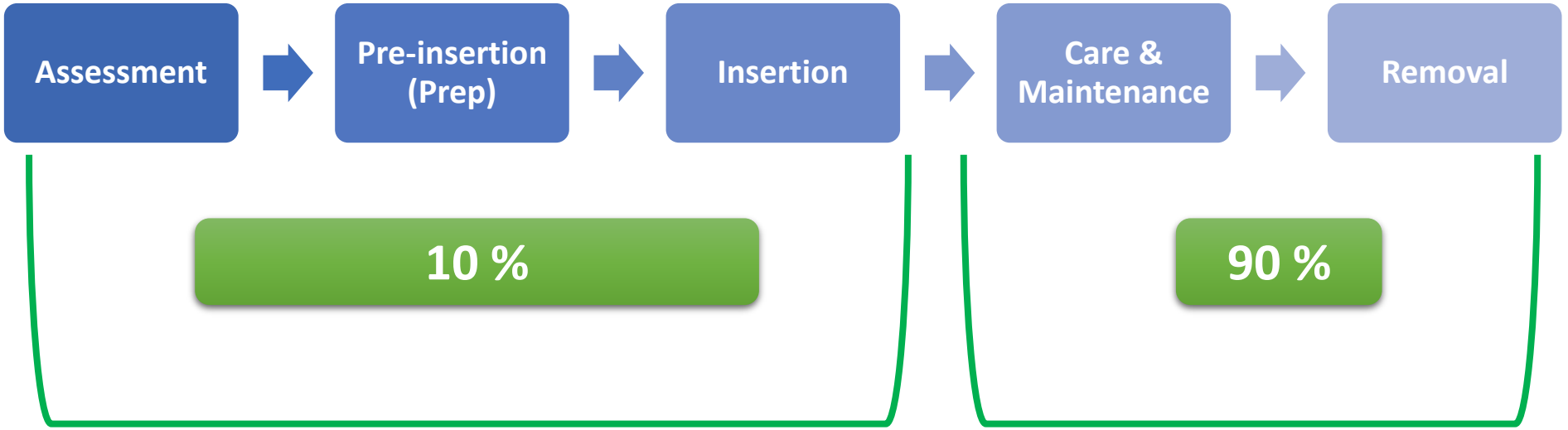
Life Cycle of a Vascular Access Device (VAD)



J. LeDonne, 2018

VAD Planning[2]

1. Use a systematic process to develop a patient-centric vascular access plan prior to or at onset of therapy that optimizes vessel preservation and guides device selection.
2. 2. Ensure VAD planning is an ongoing process throughout treatment.
3. 3. **Determine**: is vascular access is necessary or if an alternate route is appropriate (e.g., oral, sublingual, inhaled, nasal, transdermal, topical, subcutaneous)

4. **Select** the device that is the least invasive for the duration and type of therapy and promotes vessel preservation.

A patient-centric vascular access plan is paramount for vessel health.[8]

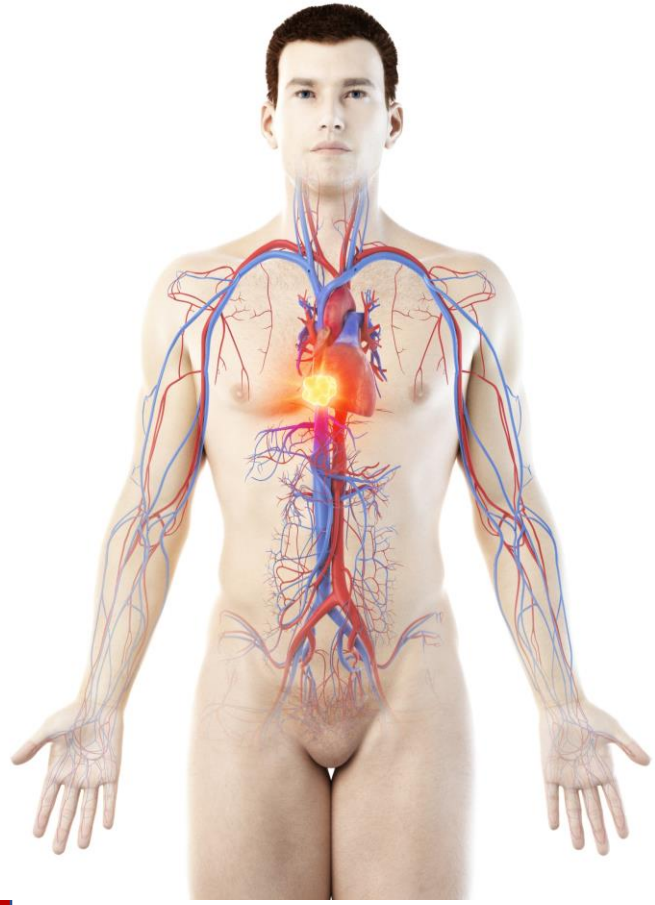







Clinical used with permission from Karen Laforet

Vessel Health



- Vessel Health Preservation (VHP) is the awareness and conscious effort to reduce the amount of trauma associated with vascular access.[1-3] It is a systematic approach to improve patient safety and patient outcomes[2] by:
  - Improving consistency and quality of staff education & training
  - Reducing vascular access complications (phlebitis, infiltration, thrombosis, infection

VEINS are a finite resource!

Key Elements in Vessel Health [3,8]

1. VAD Planning

Patient-centric plan prior to start of the therapy.

2. Device selection

Least invasive device, smallest gage catheter, right inserter, insertion technique.

3. Device Insertion

HCP skill, site selection, access to resources, insertion protocols, training, competency.

4. Infection Control

At all touchpoints for the life of the device.

5. Device Care and Maintenance

Daily assessment for site, VAD function, necessity, dressing, etc.

6. Monitoring & Evaluation

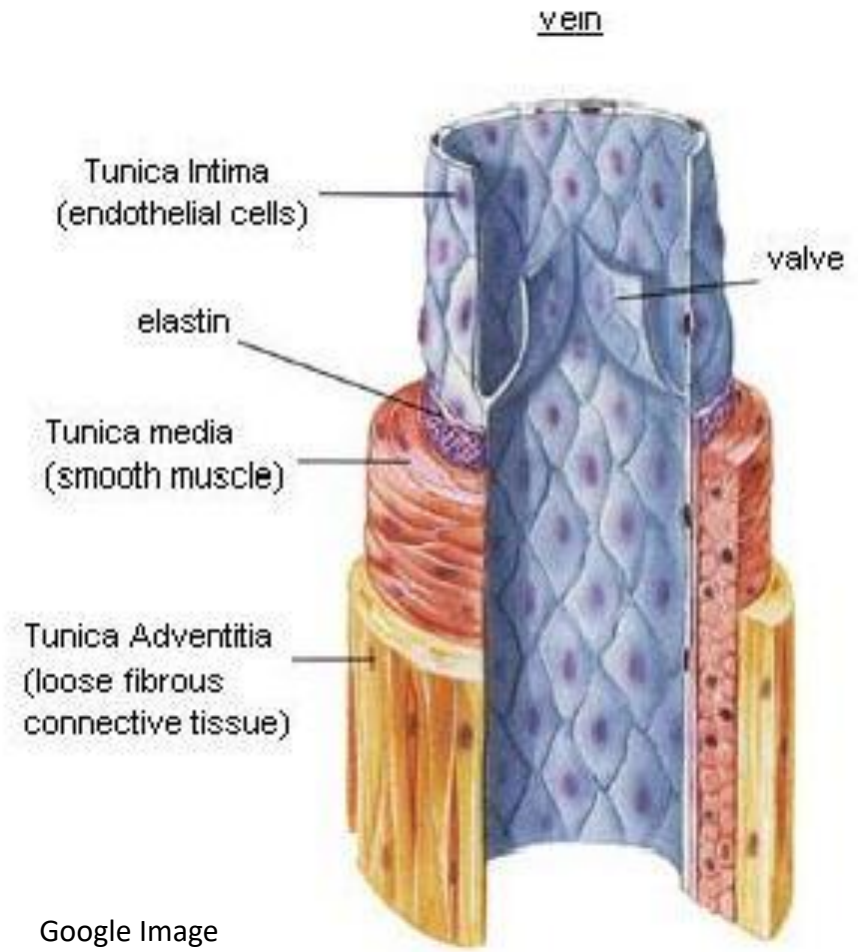
Complication rates (infection, failed attempts, VAD failure), safe competency, education.

Vein Anatomy and Physiology

Endothelium (also known as tunica intima) is a single layer of cells, half the thickness of Scotch™ tape and stretches for thousands of kilometers.

Functions

- Release of nitric oxide (vessel size)
- Cell slipperiness
- Repels blood clot formation
- Vessel protection



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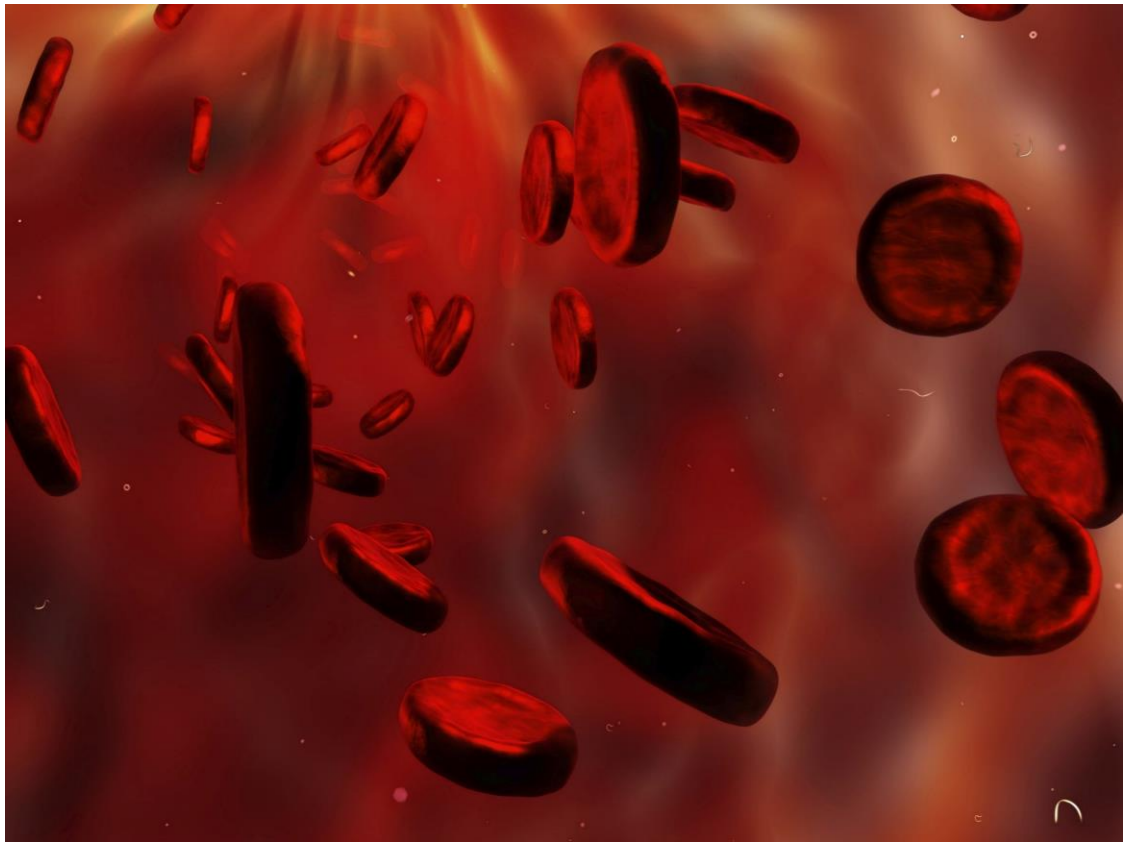
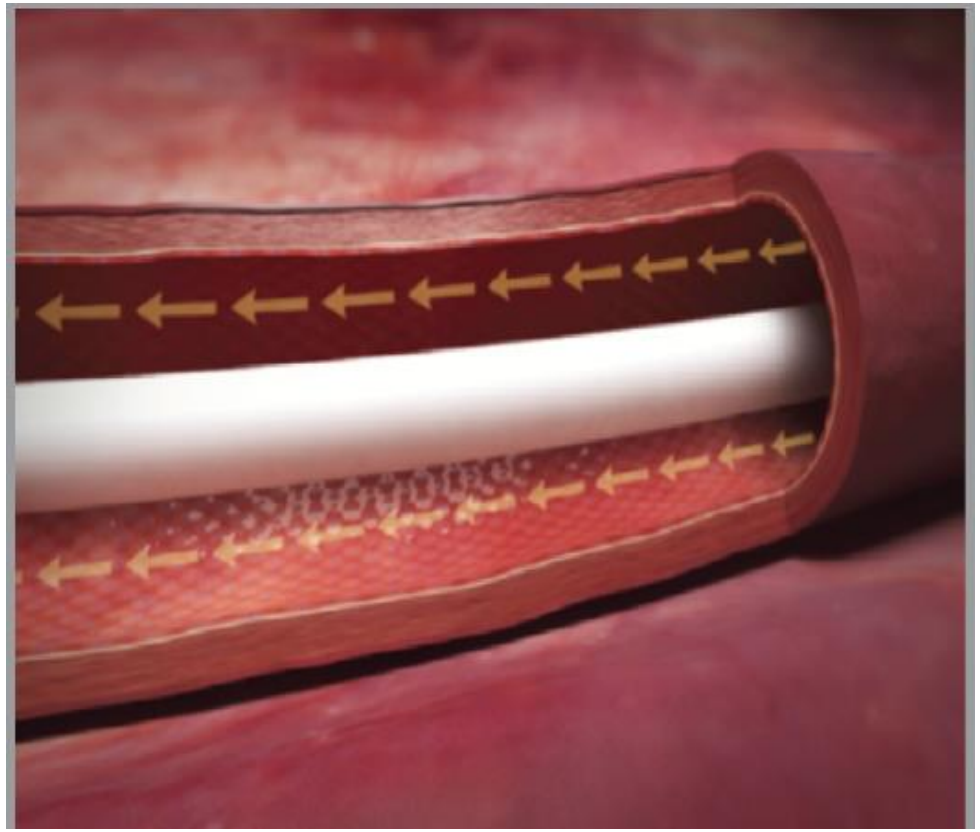
Pathology of the ‘Stick’

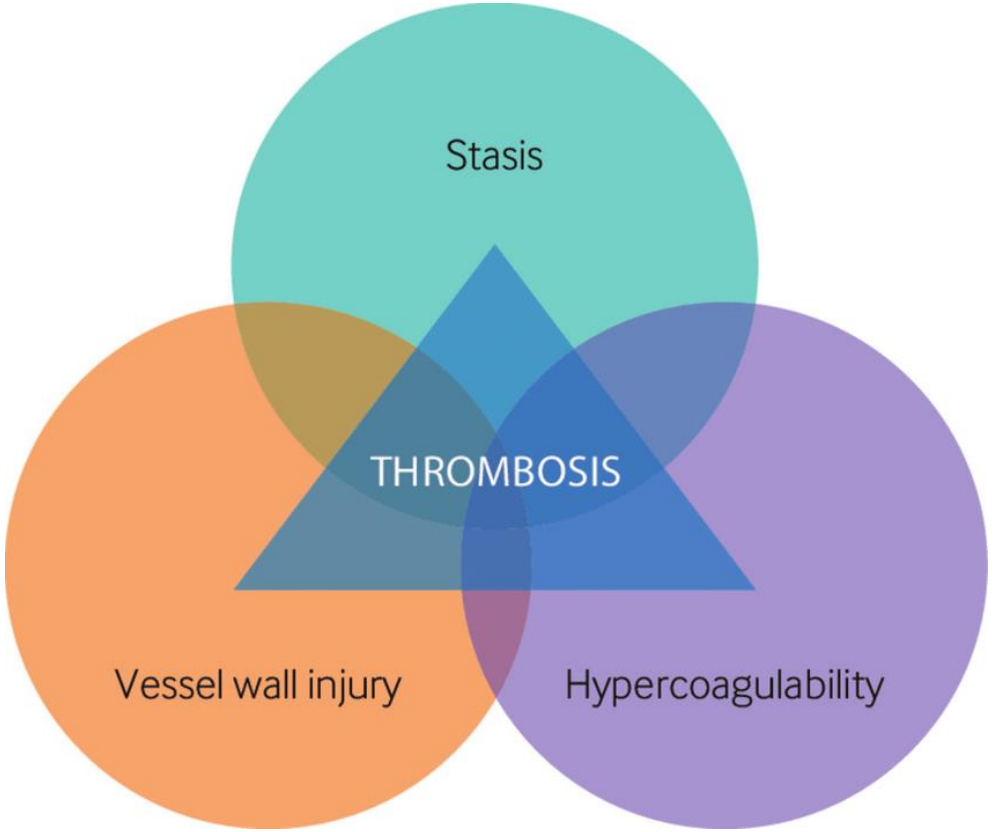


- The trauma of the ‘stick’ releases platelets, WBCS and coagulation cascade[5]
  - Endothelium ↑ tackiness
  - Blood flow reduced
- Continued “poking” and “fishing”
  - Increased inflammation
  - Scar tissue develops
  - Loss of elasticity = sclerosis

Vessel Preservation / Reducing Vessel Depletion



Spencer, T. & Mahoney, K., 2017[11]



Spencer, T. & Mahoney, K., 2017[11]

Veins of the Upper Extremities

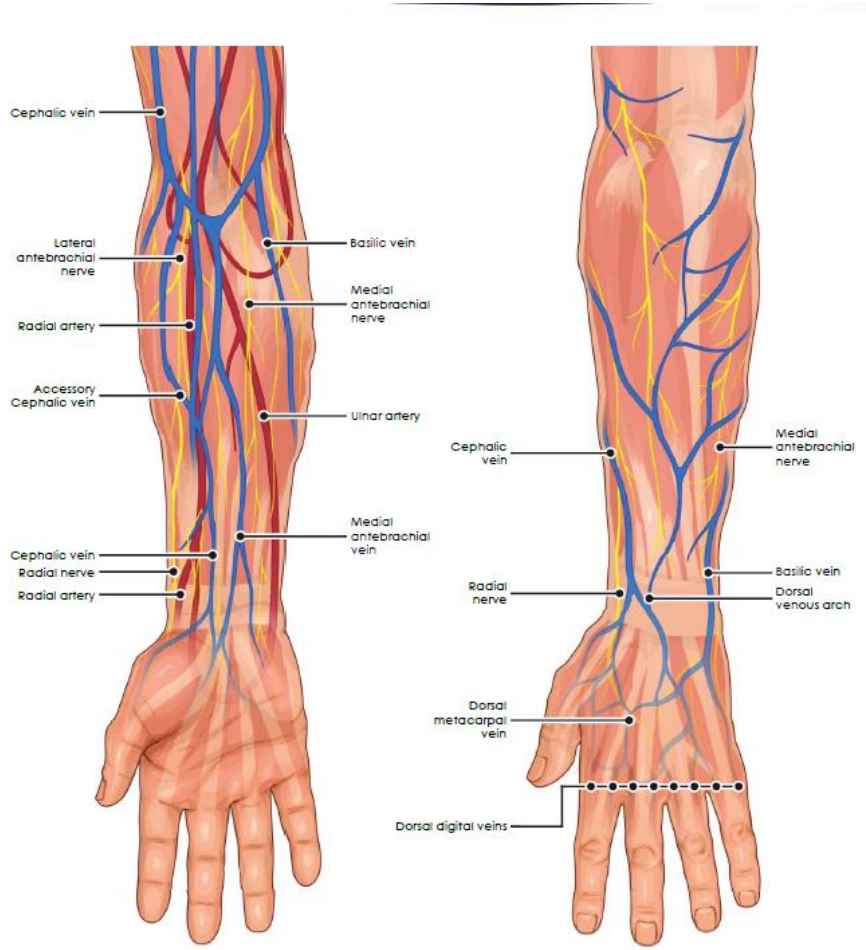
- Cephalic Vein
- Begins at radial aspect of wrist
- Access anywhere along entire length

- Medial Cephalic Vein
- Joins the Cephalic below the elbow bend

- Basilic Vein
- Originates from the ulnar side of the metacarpal veins and runs along the medial aspect of the arm.

- Medial Basilic Vein
- Empties into the Basilic vein running parallel to tendons, so it is not always well defined.

- BEWARE of Radial Artery/Nerve
- 10 cm from wrist for insertion



CVAA Resource Centre

		Radius of Vessel (mm)[4]	Length (CM)	Actual Diameter	Approx. mL/Min.
Cephalic		3^4	38 cm	2-4 mm	81
Basilic		4^4	24 cm	4-6 mm	256
Axillary		8^4	13 cm	16 mm	4,096
Subclavian		9.5^4	6 cm	19 mm	8,145
SVC		12.5^4	7 cm	20 mm	24,414

Courtesy of Teleflex

PVAD Selection Recommendations

- Accessible peripheral vein in the upper extremity for short-term therapy (< 7 days)
- Infusate osmolarity of continuous solutions/medications < 600 Osm/L. Exception:
  - Immunoglobulin
- Use with caution for pH < 5 - > 8
- Known vesicant/irritants infused intermittently will need frequent, ongoing clinical assessment
- Monitor for vein depletion and repeated failed peripheral access
- Midlines are a PVAD that may be used for ≤ 4 weeks.
- Osmolarity of continuous solution and/or medication < 900 Osm/L for short-term duration (e.g., < 7 days)
- Use same precaution re pH as PVAD

Examples of PVAD appropriate infusions/meds

- Hydration (Lactated Ringers, 0.9%NaCl, 5%DW & 0.9%NaCl
- Pain management
- Antibiotics: (certain ones)
- Biologics (certain ones)

Infusate / Medication Risk Assessment[8]

High-risk medications for PVAD:

- Continuous vesicant chemotherapy or intermittent/irritant cyclicals
- Osmolarity > 600 Osm/L (exception immunoglobulin)
- pH extremes (e.g. pH <5 or > 9)
- Duration of therapy > 7 days
- Speed of infusion
- Medication dilution
- Viscosity

CVAD Selection Recommendations

- When suitable peripheral access is unavailable
- Long term therapy consider implanted or tunneled CVAD
- Osmolarity of continuous solution and/or medication > 900 Osm/L (e.g., parenteral nutrition)
- Vesicant infusions: long-term, intermittent, cyclical or continuous

Recognizing Patients Likely to have DVA[10]

- Veins: non-palpable, not visible, "tiny" (>2mm diameter)
- History of multiple attempts
  - "I don't have any veins" or, "they can't find my veins"
- Chronic disease: Diabetes, Sickle cell anemia, vascular pathology
- Age (younger and older)
- Acute trauma or burns
- History of IV drug-use
- Fluid status

Incorporate validated peripheral vein or DiVA Assessment tool to determine patient-centric VAD plan.

Peripheral Vein Assessment			
Grade	**Vein Quality**	**Definition of Vein Quality**	**Insertion Management**
1	**Excellent**	4-5 palpable, easily visible veins suitable for cannulation	PVAD may be inserted by trained/authorized HP
2	**Good**	2-3 palpable, easily visible veins suitable for cannulation	PVAD may be inserted by trained/authorized HP
3	**Fair**	1-2 palpable, easily visible veins suitable. Veins may be scarred or difficult to find. Requires vasodilation techniques to locate	PVAD may be inserted by an trained & experienced HP. Visualization technology (Infrared or ultrasound) may be required.
4	**Poor**	NO palpable or visible veins. Located using infrared or ultrasound viewing	PVAD inserted by an HP experienced in cannulation. Use infrared, ultrasound or transillumination or other aids.
5	**None Identifiable**	NO palpable or visible veins	PVAD not appropriate. Consider alternate routes for administration

Adapted from UK Vessel Health and Preservation Framework (2016). https://nivas.org.uk/contentimages/main/TFX-VHP-Poster-V10-FINAL.pdf

Device Insertion

- Use Aseptic protocols established for CVADs AND PVADs.
- Take time to prepare patient for insertion:
  - Choose best site location–avoid flexion areas
  - Vein dilation, relaxation, hydration, etc.
  - Insert the right device in the right vein for the prescribed therapy
- Trained and validated competent inserter (PVAD & CVAD)
  - PVAD, Extended dwell and CVAD

Device Insertion

- Ensure protocols are in place for patients with difficult access to support HCP to **not** attempt insertion beyond their skill and competency.[8] Consider vein visualization technology for all patients at risk for all VAD insertions (Peripheral, Midline, PICC)
- Utilize VAD insertion bundles
- Advocate and lobby for designated specialists for patients with difficult vascular access (DVAs)[8]

VAD Insertion Attempts

Restrict attempts to a maximum of two for any one inserter with a total maximum number of attempts to four.[8]

If the HCP isn't 80% confident they can find a vein, they should not attempt an insertion.[1,3]

Each failed attempt results in permanent damage to a vessel.

Inserter Knowledge, Skill and Competency

"The skill level of the inserter needs to match the difficulty of the patient's vascular access."[8]

Clinical studies have shown that initial peripheral intravenous (PIV) insertion success rates are higher in nurses who are specifically trained in infusion therapy (91%) than in staff nurses who have not received specialized training, or those who do not routinely place IV catheters (53%–65%) (Jacobson, 2005,; Lininger, 2003; Cosentino, 1984).

Determine vascular access needs according to:[2]

a) Intended frequency and duration of therapy
b) Prescribed therapy (e.g., osmolarity, pH, vesicant, and irritant properties)
c) History of vascular access and comorbidities (e.g., renal status)
d) Age and developmental stage
e) Anatomy
f) Activities
g) Skin integrity
h) Patient's preferences and lifestyle
i) Available resources for VAD care and maintenance.

- Identify risks and benefits associated with each type of VAD
- Determine the minimum number of lumens required for the plan of care
- Determine if a VAD designed with power injection capabilities is needed

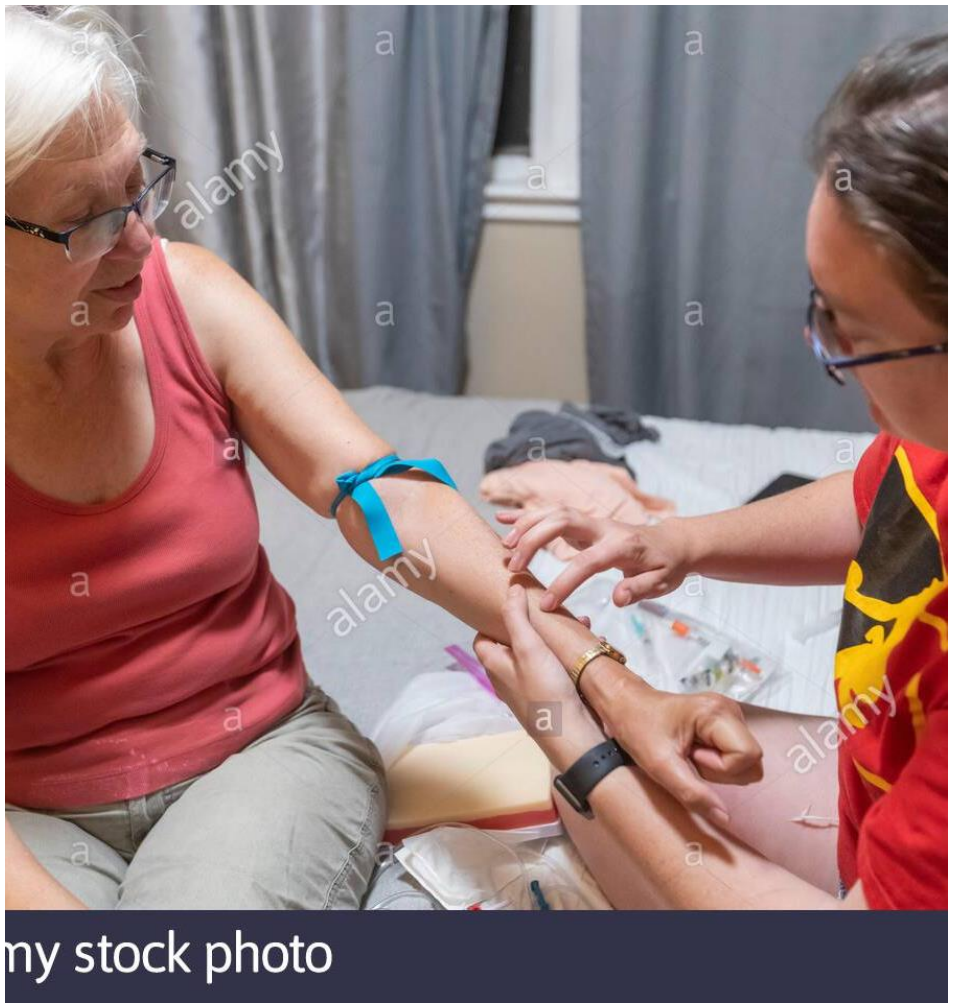
Principles of site selection

- Catheter/Vein Ratio
- Hemodilation and hemodilution (Dilution of infusate)
- Vessel preservation
- Location
  - When would you use the hand vs the forearm? (there are exceptions)
    - A TRUE emergency (person is to die in the next 90 sec)
- Just because the vein is large doesn't mean you put in a large cannula

"If you want an IV to fail, put it in the elbow or the hand"

(J LeDonne)

Physiological Response to IV insertion attempts



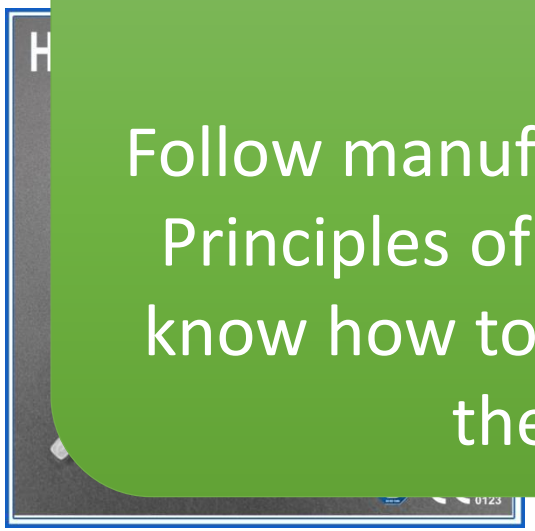
Fear activates the sympathetic nervous system resulting in peripheral vasoconstriction

Most patients experience some degree of distress & sympathetic activation after the first failed attempt making subsequent attempts increasingly difficult (Lenhardt et al., 2002).

KNOW the PVAD(s) being used in your organization.

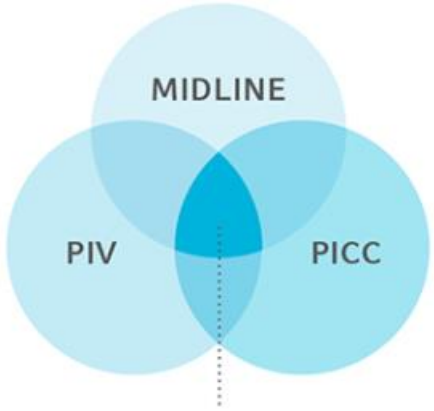
Follow manufacturer's instructions for use (IFU)

Principles of insertion stay the same. Need to know how to thread the cannula in—and keep the needle out of the vein

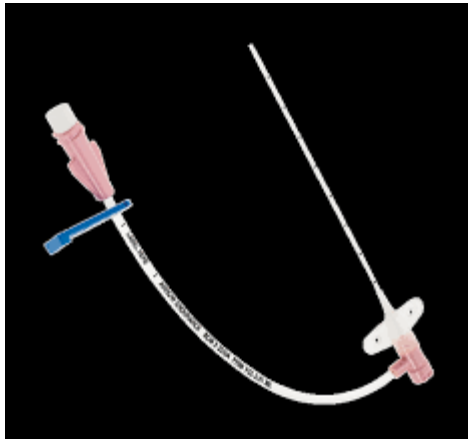


Long PVAD/Extended Dwell

- Longer length
- Shown to extend time in situ
- Valuable for heavier/thicker arms
- Requires additional skills for insertion
- Recommended to sue Ultrasound placement.



Arrow® Endurance™ Extended Dwell System



Veins to avoid

- Sclerotic or highly visible veins (tend to roll)
- In areas of flexion
- Damaged by previous use (phlebitis, blown, infiltration)
- Knotted or tortuous
- Compromised skin integrity (inflammation, bruising etc)
- In an extremity that is edematous, compromised or injured.
- AVOID arm with an AV fistula

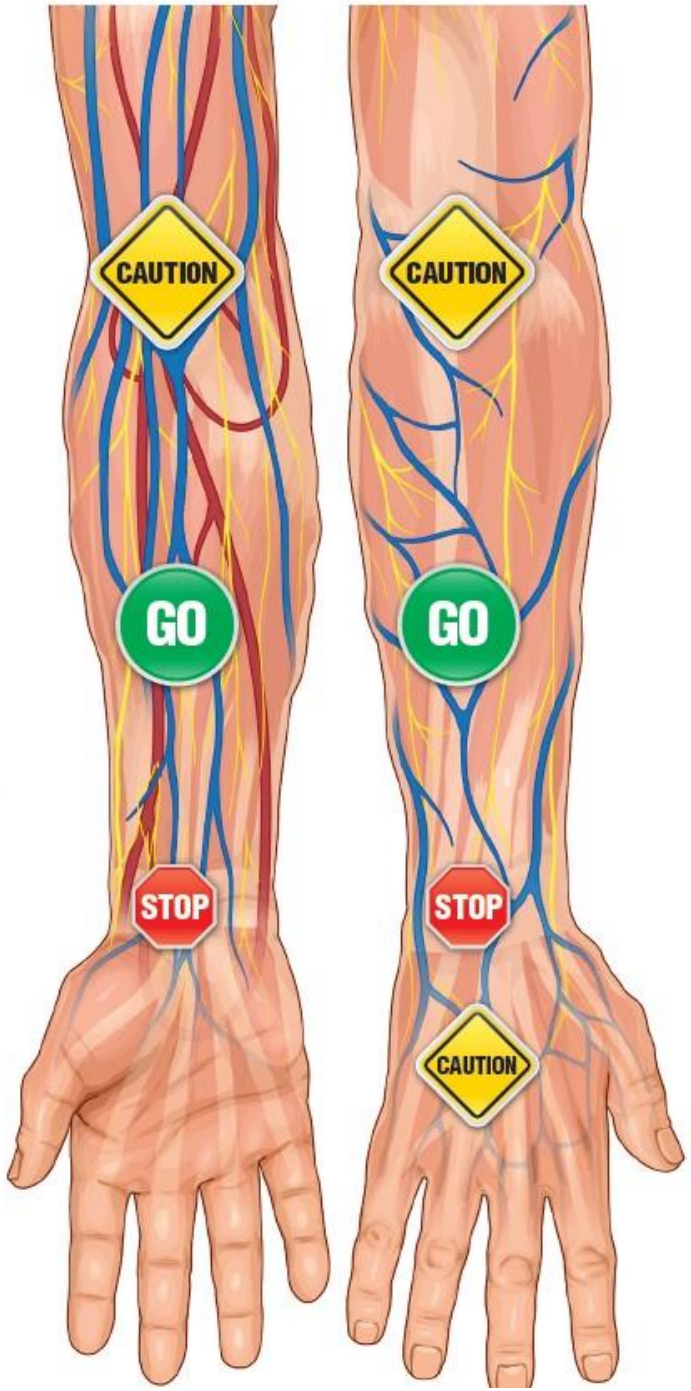
Photo courtesy K. Laforet. Used with permission

Do not use:

- Areas of flexion (e.g., wrist, ACF), except in trauma or emergency situation (to avoid nerve damage and depletion of antecubital veins)
- Chest wall, digits, or breast
- Lower legs, except in non-walking children
- Insertion areas that are painful on palpation or with veins that are obviously compromised (e.g., thrombosis, redness, cording, bruising, infiltration, phlebitis, engorgement)
- Extremity with arteriovenous (AV) fistula/graft site
- Affected extremity after extravasation for subsequent VAD insertion until symptoms are resolved

VAD Selection

- Determine the appropriate type of VAD:
  a) Use device with minimum number of lumens
  b) b) Always select the smallest gauge catheter that will accommodate the prescribed therapy WHY?
  c) Consider use of a 22-gauge PVAD for most infusion therapies.
  d) Consider using longer length PVAD for insertion using ultrasound or other vein illuminating technology.



CVAA Education
Resource Poster

Locate and Stabilize

Confidently enter the vein–don't hesitate or 'drag' when inserting or threading the catheter.

Troubleshooting

- Angle: don't dive bomb–keep it around 30°
- Got blood flashback then none? May have gone too deep with the needle or may be against the vein wall. Adjust if you can– do NOT fish
- Unable to thread the cannula? See above
- Can't find a vein? If you are unable to palpate a vein after trying all techniques (next slide), consider infrared, illumination or ultrasound to assist. Keep in mind these vein visualization technologies require additional training for competency.

Enhancing Venous Prominence

- Reduce angle of insertion in elderly patients (or others) with sunken veins
- Apply pressure over vein to displace adipose tissue for obese patients
- Anchor veins: pull skin taut (hang arm off side of the bed)
- Infants (< 1 yr) insert with bevel down
- Relaxation techniques
- Warm the limb
- Hydrate
- Transillumination

Additional techniques

- Distraction techniques
- Topical anesthetics provide analgesia within 30 – 45 min beforehand
- Eutectic lidocaine/prilocaine cream (EMLA)
- Amethocaine gel (Ametop)
- Vapocoolant spray

Flushing & Locking PVAD

- Aspirate for blood return prior to administering medications & prior to each infusion
- After each infusion- clear medication from the PVAD lumen using 0.9%NaCl to flush
- If resistance is met or no blood return do not forcibly flush the catheter
  - WHY? May flush in a clot ; could cause an embolism
- Use push-pause technique when flushing
- Luer-off syringe & close clamp

Dressings

- Maintain a sterile dressing on VADs, …to protect the site and stabilize and secure the catheter
- Assess skin integrity with each dressing change
- Select a sterile transparent film dressing as the preferred dressing (to allow for continuous observation and assessment)
- Use a sterile gauze or absorbent dressing if the patient is diaphoretic or if the site is bleeding or draining until appropriate for a sterile transparent film dressing.
  - Consider the use of alternate dressings or products for site condition
- Consider use of hemostatic agents (to control bleeding & reduce need for additional dressing changes)
- Avoid placement of products that are not designated for vascular access over the insertion/exit site, unless clinically required

Protect skin integrity

- Apply sterile skin barrier solution prior to applying adhesive securement device or dressing.
- Verify all solutions and/or medications & components used are compatible
- Use aseptic technique (including sterile gloves) or aseptic no-touch technique (ANTT) for application of dressing & securement
- Perform skin antisepsis

  a)Limit use of a tackifier (e.g., gum mastic, tincture of Benzoin) to aid in dressing/device integrity and enhance adherence for select patients at risk for dressing/device failure.

  b) Apply sterile barrier solution each time prior to tackifier

PVAD Stabilization

Clinical Rationale

- Preserve the integrity of the access device
- Minimize catheter movement at the hub
- Pistoning is the movement of the catheter in and out of the insertion site
- Prevent catheter dislodgement

Stabilization Products

- Transparent semi-permeable membrane dressings
- Tape
- Padded arm board or splint if catheter in an area of flexion
- Apply in order to allow visual site inspection
- Should help minimize complications & maintain device patency

DiVAs–Recap

- Pick your IV site–don't attempt unless you are sure
- Don't just look–feel!
- Use solid traction: if you hold the skin taut, 99% of the time the veins will not roll
- Use a shallow angle–remember…if you get a brief flash, then none before advancing catheter–angle is too steep…lower it..no need to dive bomb
- Catheter forward: needle back
- Give yourself permission to let the bad ones go
- Assess veins with tourniquet in place and with tournie in the right location–consider BP cuff
- WARM the arm
- HYDRATE–recommend asking patients to drink at least 1L fluid before appt
- Don't forget there's a patient attached to the vein!

Alternative routes

- Oral rehydration therapy (ORT)
- MDs believe that infusion therapy is less time-consuming and more effective than ORT, though this is not always the case (Walsh 2008)
- Subcutaneous Administration (Hypodermoclysis)
  - Research supports HDC as effective as Infusion therapy (Barreto Annes, 2020)
  - Agitated patients may also tolerate subcutaneous fluid infusions better than IV with less agitation during infusions (37%) than during IV (80%) (O'Keeffe & Lavan, 1996).

Hypodermoclysis (HDC) Advantages

- Advanced nursing skills are not required to start or maintain the infusion
- May be administered in the home or in other settings where IV therapy is not readily available or easily or safely to use
- It is "vein-sparing": it avoids some local complications of IV therapy (e.g., dislodgement, discomfort associated with IV cannulation, thrombophlebitis, sepsis)
- There are many potential subcutaneous injection sites, and if a limb is chosen, immobilization is not necessary
- Subcutaneous lines can be inserted and maintained in relatively pain-insensitive areas of the body (e.g., thigh, upper arm); reducing discomfort
- Can be stopped and restarted at any time without risk of clotting
- May be more cost effective or cost-neutral

Indications

- Hydration (As effective in treating mild-moderate dehydration as IV (Barreto Annes, 2020)
- Pain management
- Medication delivery (opioids, antiemetics, anticholinergics, antipsychotics, benzodiazepines [Dickman, 2017])

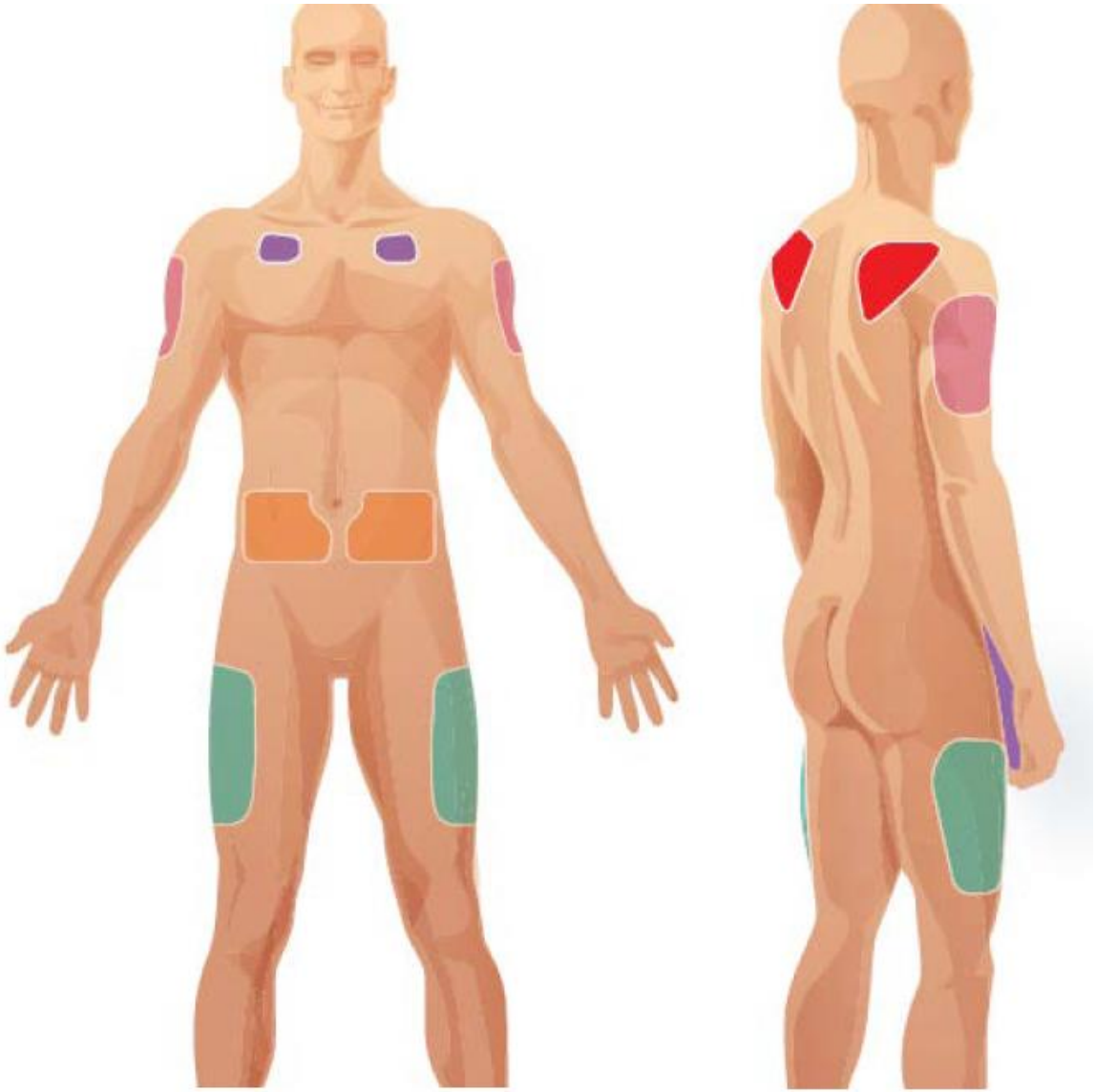
Dehydration scale (2020)

- In addition to clinical assessment of signs & symptoms of dehydration (Chart next page), classification more commonly used is 0 - +3 scale:
- 0 = no dehydration
- +1 = mild dehydration (BP & lab values within normal limits (WNL)
- +2 = moderate dehydration (various symptoms/signs present, lab values abnormal [BUN: Creatinine ratio ≥25]
- + 3 = severe dehydration (clinical symptoms present, Na >150 mEq/L, Osmolarity >300, BUN: Creatinine ratio > 25)

Indicators that correlated *best* with dehydration severity

- **Unrelated to patient age:**
- Tongue dryness ($P < 0.001$),
- Longitudinal tongue furrows ($P < 0.001$),
- Dryness of the mucous membranes of the mouth ($P < 0.001$),
- Upper body muscle weakness ($P < 0.001$),
- Confusion ($P < 0.001$),
- Speech difficulty ($P < 0.01$),
- Sunken eyes ($P < 0.01$). (Gross et al, 1992)

HDC sites



- Areas that have too little subcutaneous tissue
- 2” (5 cm) diameter around umbilicus
- Skin folds or clothing lines (i.e. waistline)
- Breast tissue
- Areas with bony prominences
- Tumor sites
- Sites that have been recently irradiated
- Sites with induration, inflammation or infection present
- Areas with lymphedema, edema or ascites
- Areas with broken skin, bruises, masses, abrasions, moles, burns or scar tissue
- Area in close proximity to central lines


Cleo® 90 Infusion Set
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Hyaluronidase-Augmented Subcutaneous Infusion

- Large subcutaneous fluid volumes may cause local edema and pain when the rate of administration exceeds the rate of aabsorption
- Way to manage this include:
  - Reducing the rate of infusion,
  - Change site of administration,
  - Add spreading agent such as hyaluronidase to the infusion mixture

- Using hyaluronidase accelerates absorption up to 3X.
- However, when administering subcutaneous fluids, volumes should be carefully titrated using physiologic and hemodynamic end-points to ensure systemic fluid overload doesn't occur
- Caution: know source (bovine or recombinant)

Alternative options

- PICC or Midline
- Interosseous

Discussion

When would you choose PICC vs Midline?

CVAA Guidelines 2019

Type of VAD	Selection Recommendations
PVAD	• Accessible peripheral veins in the upper extremity for duration of therapy (INS, 2016; RCN, 2016) [IC] • Short term duration of therapy (e.g., < 7 days) [ICVAA] • Osmolarity of continuous solutions and/or medications < 600 Osm/L for short-term duration (e.g., < 7 days) (exception: immunoglobulin) [ICVAA] • Extremes of pH; use with caution [ICVAA] • Intermittent vesicants/irritants. Ongoing clinical assessment needed for sequential or cyclical vesicants/irritants [ICVAA] • Monitor for vein depletion and repeated failed peripheral access [ICVAA]
Midlines	• Accessible peripheral vein in the upper extremity above antecubital fossa (ACF) (INS, 2016; RCN, 2016) [IC] • Duration of therapy < 4 weeks (INS, 2016; RCN, 2016) [IB] • Osmolarity of continuous solutions and/or medications < 900 Osm/L for short-term duration (e.g., < 7 days) [ICVAA] • Extremes of pH; use with caution [ICVAA]
CVAD (non-tunneled, PICC, tunneled, implanted vascular access device (IVAD))	• Suitable peripheral access is unavailable (INS, 2016) [IC] • Consider implanted or tunneled CVAD for long term therapy (epic3, 2014; INS, 2016) [IIC] • Osmolarity of solutions and/or medications > 900m/L (e.g., parenteral nutrition) (INS, 2016) [IC] • Continuous vesicant infusion > 60 minutes [ICVAA] • Consider long-term intermittent vesicant infusion (INS, 2016) [IC] • Consider CVAD for irritant infusions > 60 minutes or ongoing intermittent infusion [IICVAA]

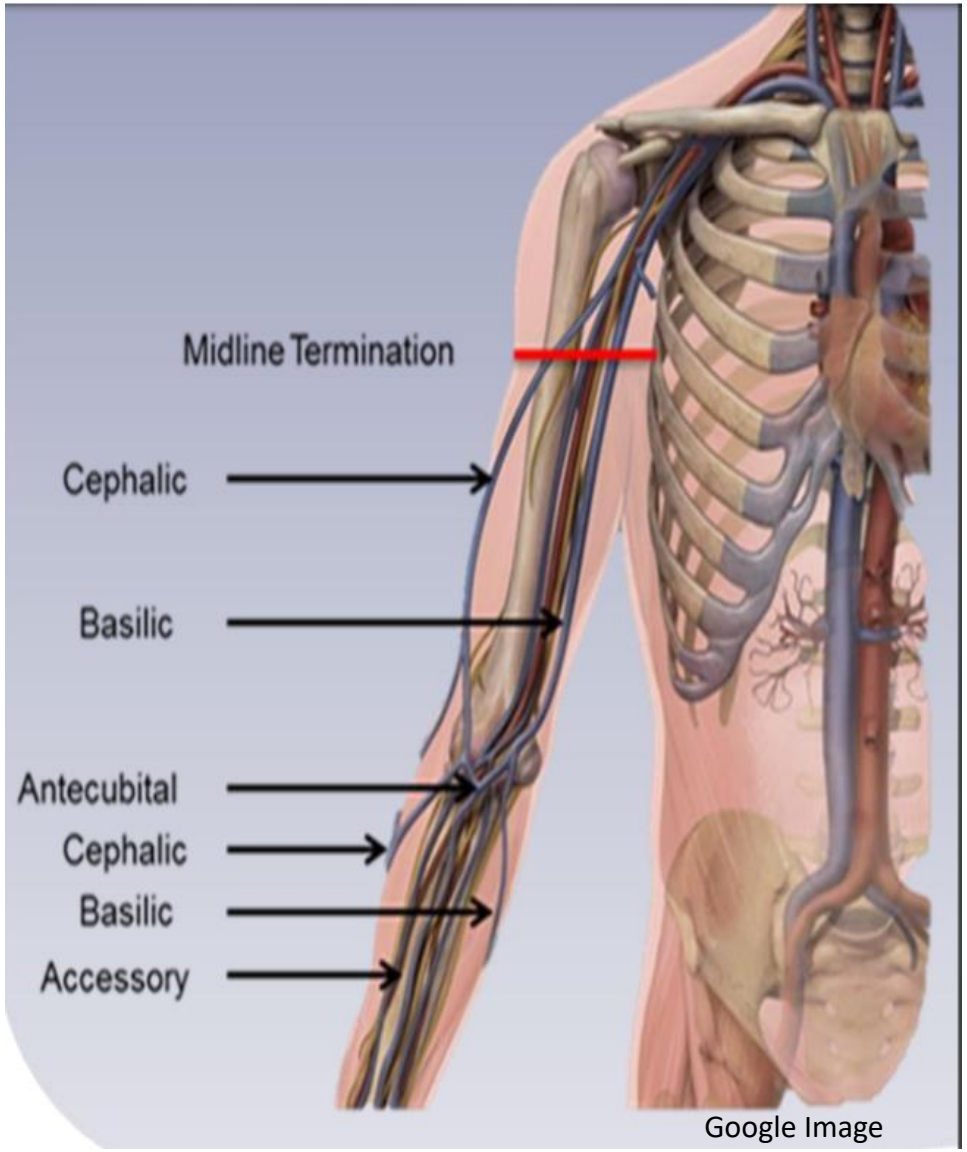
PVAD: Midline Catheters

PVAD's with the tip terminating in the Basilic, cephalic or brachial vein distal to the shoulder–level with axilla

- Single or double lumen
- 1.9 Fr - 5 Fr (adults); 22-24 g for pediatric catheters
- Polyurethane or silicone material

Initiated above or below the Antecubital Fossa in one of the following

- Basilic
- Cephalic
- Median Cephalic
- Brachial Veins



Midline Precautions and Contraindications

- Patients with:
  - history or at risk of thrombosis
  - Compromised circulation
  - Lymphedema: presence of or at risk of developing (e.g. post-breast-cancer-related surgery)
  - Upper limb paralysis or orthopedic conditions
  - End Stage renal failure (preserve arm for fistula)
- Patient preference
- Standard of practice: insertion with ultrasound guidannce

Midlines

Advantages

- Reduces repeated PVAD insertions
- One stick for > 5 - ≤ 28 days
- Less pt trauma, lowered costs
- X-ray confirmation not needed (with exceptions)
- Option for elderly patients
- Lower rate of PLABSI than PICCs

Disadvantages

- Requires specialized training and ongoing competency
- High risk of extravasation
- Mechanical phlebitis
- Increase risk if thorough assessment not completed (i,.e. C:V ratio, history, lymphedema…)

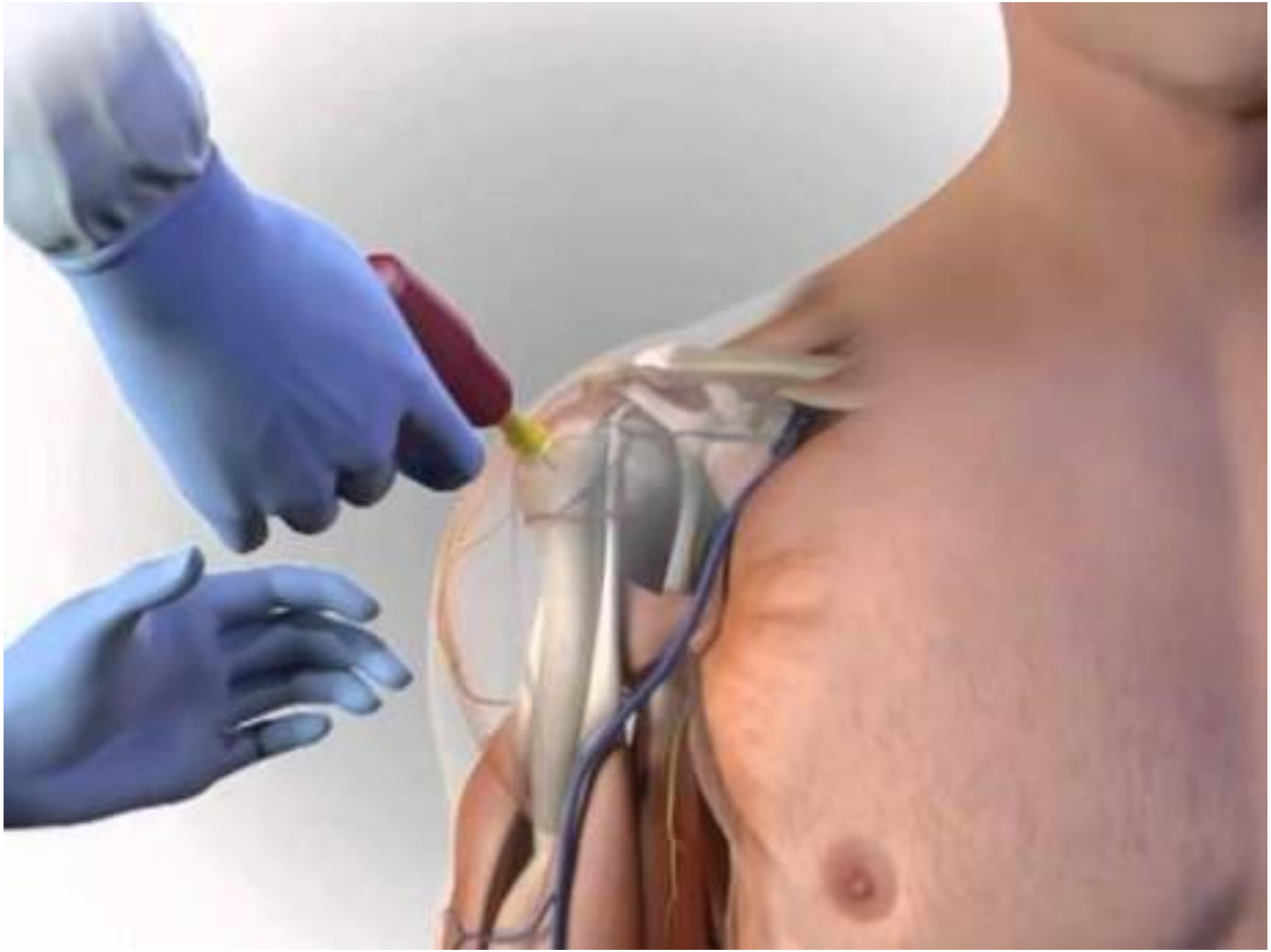
Intraosseous infusion (IO)

- The process of injecting directly into the marrow of a bone to provide a non-collapsible entry point into the systemic venous system. This technique is used to provide fluids and medication when intravenous **access** is not available or not feasible.
- According to the Emergency Cardiovascular Care Guidelines in 2000, IO recommended in all children after two failed attempts at IV access or during circulatory collapse.
- In 2005, the American Heart Association recommended intraosseous access if venous access cannot be quickly and reliably established
- All medications and blood products can be safely administered IO and the onset of action and peak drug levels are comparable to those of venous administration.
- Paediatrics used for anesthesia
- Dwell time is 24 - 48 hrs (
- Complications: extravasation from dislodgement, iatrogenic fracture, growth plate injury, infection, fat emboli, compartment syndrome, osteomyelitis

https://www.youtube.com/watch?v=TE_UxUUlndU

https://www.youtube.com/watch?v=2x28FW3oxNI

Intraosseous Infusion



Case Study Discussion

- What are Nora's risk factors
- Based on the information available what is her level of hydration?
- What would your recommendations be: short-immediate needs and then longer term?
- What information would you bring forward to support your recommendations?