Hypovolemia, IV Fluids, and Access for POTS Patients

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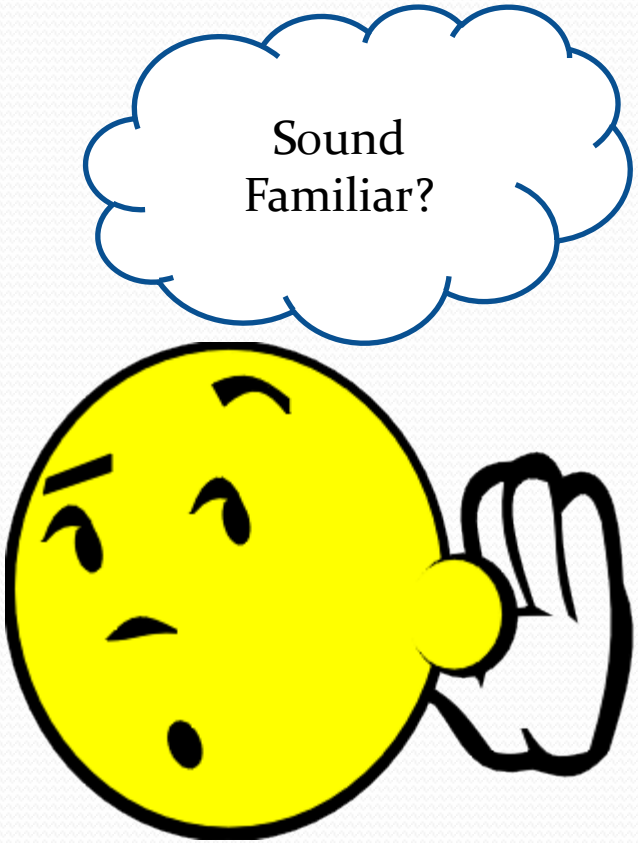
POTS and Low Volume

- Significantly low blood volume
  - Missing an average of 16.5% (≈460ml)[1,2,3,]
  - Hypovolemic shock occurs at 20%

Symptoms of Hypovolemic Shock

- Symptoms include:
  - anxiety
  - blue lips and fingernails
  - low or no urine output
  - profuse sweating
  - shallow breathing
  - dizziness
  - confusion
  - chest pain
  - loss of consciousness
  - low blood pressure
  - rapid heart rate
  - weak pulse



Why can't my doctor see it on my labs?

- Look at a normal red blood cell count for women:
  - 4.2 to 5.4 million **cells/mcL**

This is a RATIO of solids to liquid

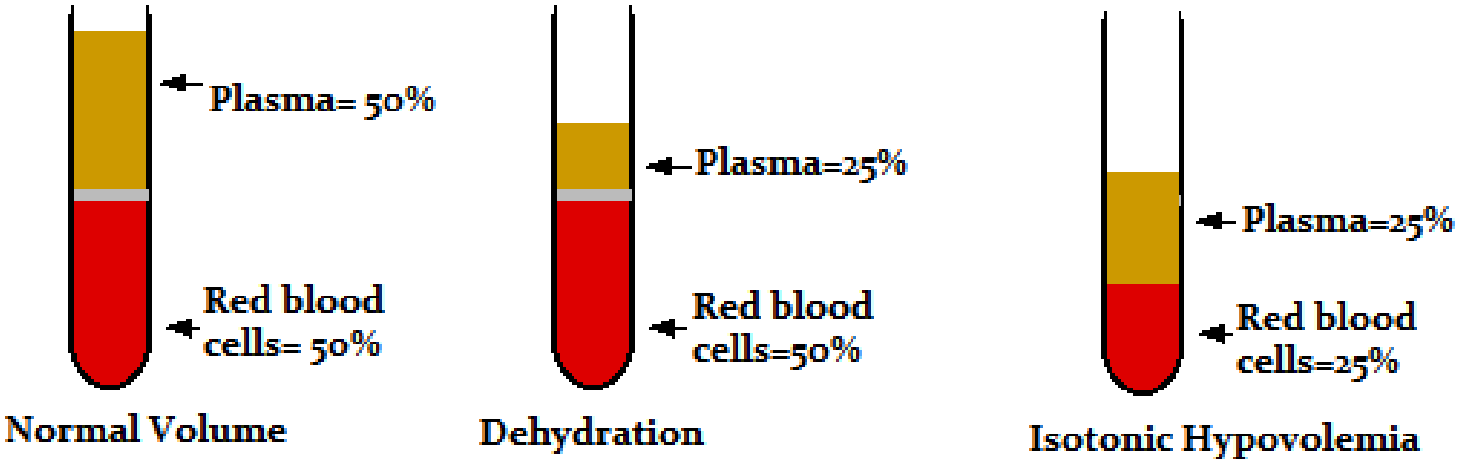
- Cells= solids and mcL=liquid

- In POTS, the solids and liquid are both low.

Why can't my doctor see it on my labs?

- Most lab values are in ratios of solids to liquid
- If the ratio is not changed, the labs will look normal
- When the solids and liquid are both low, this is called ***ISOTONIC HYPOVOLEMIA***

Isotonic Hypovolemia



How can you know then?

- Doctors can use a special dye and machine that measures the cells directly.
- This may take several hours and not every hospital can do it.
- They use a formula to calculate what your blood volume should be, then compare the results of the test to this number.

Volume expansion

- One goal of POTS treatment is volume expansion[4]
- This can be done by:
  - Increased salt consumption
  - Exercise
  - Oral Fluids
  - IV fluids
  - Medications

What about oral fluids?

- Nausea and vomiting may limit intake[6,7]
- Rapid motility decreases absorption[6,8]
- Delayed motility prevents high intake[6,9]
- Effect is temporary
- May not be able to absorb more fluids due to isotonic hypovolemia

Why IV fluids?

- Does not rely on absorption through GI system
- Immediate effect
- **1 liter normal saline over 1 hour shown to reduce heart rate and symptoms**[10]
- Reported as improving "brain fog"[11]
- May be necessary in patients with GI issues[9]

Venous Access

- Access is the main barrier in using IV fluid therapy in POTS.[4]
- Small difficult to access veins due to hypovolemia.
- Options for access include:
  - Central venous access devices
  - Peripheral venous access devices

Central and Peripheral Access Devices

Types, Pros and Cons, Complications, and Reducing Risk Factors

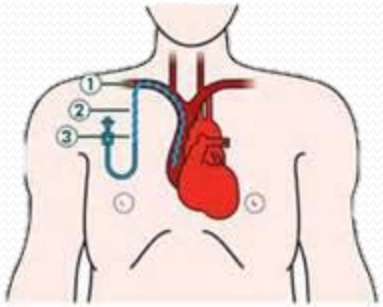
Central Access Devices

- All end in the central circulation just outside the heart
  - Superior Vena Cava
  - Superior Vena Cava/ Right Atrial Junction

- Types:
  - Tunneled Catheters
  - Implantable Ports
  - Peripherally Inserted Central Catheters (PICC)

Tunneled catheters

- Ex: Hickman, Broviac[12]



Enters the skin

Tunnelled under the skin for 3-4 inches

Enters the subclavian or jugular vein after tunnel

Tunneled Catheters Pros

- Patient can use the line at home for fluids[12]
- Large size of tubing allows for large volume[12]
- Once tunnel is healed, no dressing is needed[13]
- Good for frequent access[12]

Tunneled Catheters Cons

- Usually requires surgery and anesthesia to place
- Sterile dressing requires skilled care until cuff heals
- Hangs from chest, so risk for being caught or pulled
- Visible to others

Implantable Ports

- Implantable ports (Power Port, Mediport)[12,14]
  - A hub is placed into a small pocket under the skin
  - The tubing attaches to the hub and ends in the superior vena cava.
  - The hub is accessed with a special needle.

Implantable Port Pros

Greater freedom in patient activity (showering, swimming)

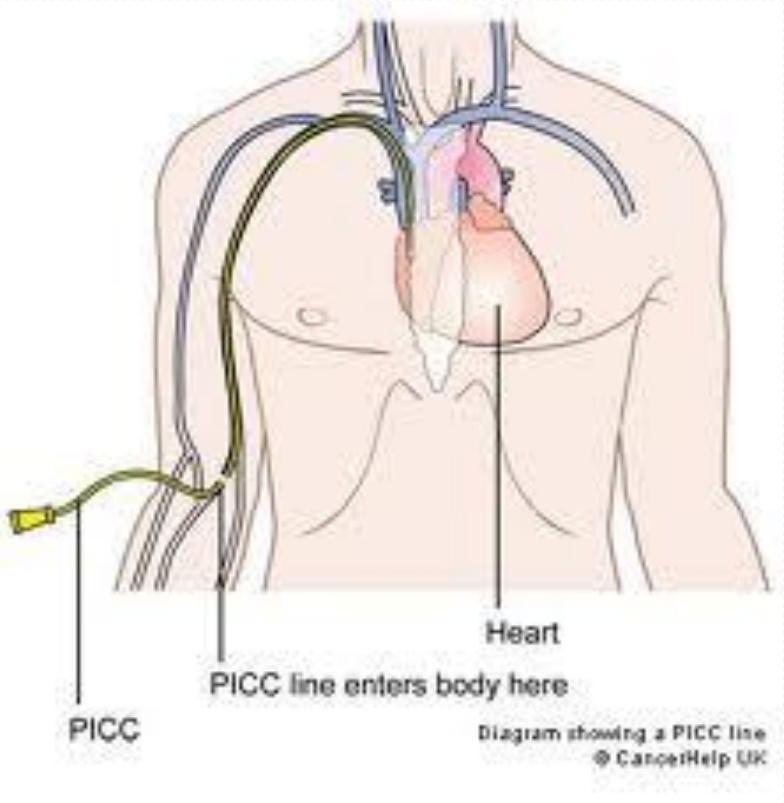
- Patient can use the line at home for fluids[12]
- Requires dressing only when accessed
- Best for intermittent use[12]

Implantable Port Cons

- Placement requires surgery and anesthesia
- Must have sterile dressing while accessed
- Requires skilled nursing care to access with needle
- Can only be accessed between 2000-2500 times, so daily access will require frequent replacement of device

Peripherally Inserted Central catheters (PICC)

- Goes into a large vein in the arm
- Threaded through to the veins in the chest
- Ends in the superior vena cava



PICC Pros

- Easy to insert at bedside by specially trained nurses or doctors
- Patient can use for fluids at home
- Can be hidden by clothes
- Excellent for frequent access[12]

PICC Cons

- Higher risk for DVT[15]
- Requires sterile dressings
- Hangs out of body risks pulling
- Visible to others

Peripheral Venous Access

- Stay in the veins in the arms
- Never approach the heart or the veins of the chest
- Types:
  - Peripheral intravenous access angiocatheters
  - Midline Catheters

Peripheral IV's

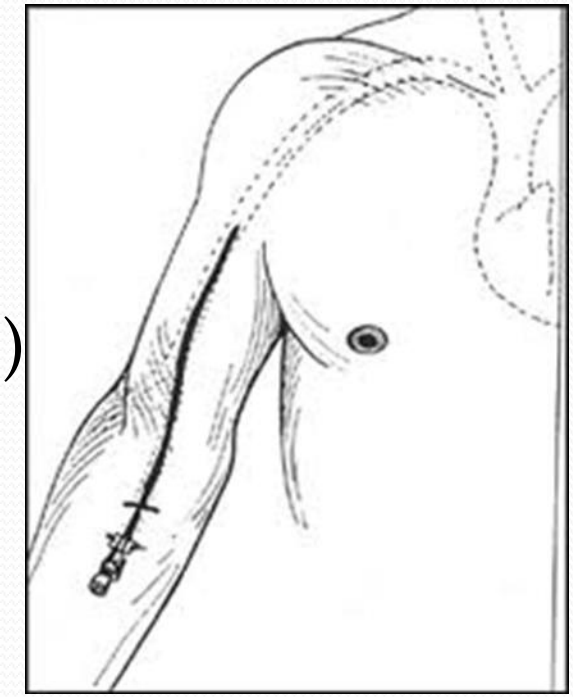
- What we think of when we hear IV
- Placed in the arm, hand, neck, even scalp or feet
- Usually less than 2 inches long
- Placed by most nursing staff

Peripheral Pros and Cons

- Only an option for those with good veins and infrequent access
- Must be placed by nursing staff
- Has to be monitored during infusions (due to risk of infiltration)
- Easily placed and removed
- Inexpensive

Midlines

- Longer than a regular IV, shorter than a PICC
- Placed in large veins of the arm (usually upper arm)
- Threaded up several inches
- Does not go past the axilla (underarm)



Midline Pros

- Can stay in place for up to 28 days
- Inexpensive to place
- Placed by trained nursing staff without surgery
- Can be used at home by patient

Midline Cons

- May use for isotonic solutions only (such as normal saline and lactated ringers)
- Requires placement by specially trained staff that may not be found in all hospitals

Serious Complications

- Blood clots
- Bloodstream Infection
- Perforation
- Pneumothorax
- Heart Rhythm Disturbance
- Migration

Blood Clots[17,18,19]

- Can occur in the veins of the arm and chest
- May break off and enter the lungs (pulmonary embolism)
- Can be fatal
- May require anti-coagulant treatment, clot busting medications, or surgery to correct
- Correct tip placement single greatest factor in prevention

Bloodstream Infection[19]

- Most common serious complication of CVAD
- Usually requires removal of the line and IV antibiotics
- May lead to sepsis (a systemic infection)
- Up to 25% of patients with CVAD associated sepsis will not survive

Perforation[19,20,21]

- Usually happens during insertion, but is rare
- Tip of the catheter or guidewire can perforate blood vessel or heart chamber walls.
- High mortality if this occurs.
- Risk reduced by skilled provider and radiology guided insertion

Pneumothorax[19]

- Usually occurs during insertion, but is rare
- Happens when guide wires perforate the lung allowing air into the pleural space (area around the lung)
- May require a chest tube or needle decompression to correct
- Risk decreased with radiology guided placement

Heart Rhythm Disruption

- The tip of a central venous access device can come into contact with heart chamber walls causing:
  - Supraventricular tachycardia (SVT)
  - Premature ventricular contractions (PVCs)
  - Premature atrial contractions (PACs)
  - Ventricular tachycardia (Vtach)
  - This usually occurs with insertion, but can happen later with catheter migration or breakage

Migration

- Can occur during placement (misplacement) or later
- Catheter tip can migrate to other connected vessels
  - Can migrate to internal jugular, mammary veins, etc.
- Usually due to tip placement too high in SVC and/or vigorous activity
- Can cause occlusion of veins

Minor complications

- Insertion site infection
- Local reactions
- Mechanical malfunction
- Line occlusion

Local Infection[16,19]

- Insertion site infections are more common within 2 weeks of placement
- Should be cultured to determine causative agent
- Easily treated with oral antibiotics
- Does not require removal of line

Local Reactions

- Reduce by allowing antiseptics to dry completely
- Can occur from dressing, antiseptic, or adhesive
- Consider reactions if negative cultures but redness or exudate present
- Choose sensitive skin or pediatric options if available

Mechanical Malfunction

- Failure of device[12,19]
  - May require surgical repair or replacement
  - Includes breakage of catheter, hub failures, and mechanical defects
- Blood clot inside the catheter[12,19]
  - Prevent with effective flushing
  - Consider brands with back flow valve

Reducing Risk

- Assess Immune Function
- Screen for thrombophilic tendencies
  - Factor V (Most common)
  - Antiphospholipid Syndrome
- Assess medications that increase risk[20]
  - Birth control pills or estrogen
  - Corticosteroids
  - DDAVP

Reducing Risk

- Ensure correct tip placement and use[20,22,23]
  - Use two or more methods
  - Use ultrasound during procedure in the OR is best
  - EKG can show incorrect placement in the atrium or ventricle
  - Right sided lines less risk of clots and perforation
- Start with least invasive option[20]
- Remove line as soon as possible[22]

Education

- Patient and family education is vital
- Educate warning signs and symptoms of complications
- Sterile Technique
- Proper care of dressing and accessing hub
- Always wash your hands!

Considerations

- Expense
  - Will insurance cover home healthcare, fluids, supplies
- Patient lifestyle
  - Will lifting restrictions be a problem
  - Can they maintain dressing
  - Risks of small children pulling on external line components
- No data on long term use in POTS patients

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