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

Sound Familiar?
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 \textbf{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 \textit{isotonic hypovolemia}
Isotonic Hypovolemia

- Normal Volume: Plasma = 50%, Red blood cells = 50%
- Dehydration: Plasma = 25%, Red blood cells = 50%
- Isotonic Hypovolemia: Plasma = 25%, Red blood cells = 25%
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. This can be done by:

- Increased salt consumption
- Exercise
- Oral Fluids
- IV fluids
- Medications
What about oral fluids?

- Nausea and vomiting may limit intake\textsuperscript{6,7}
- Rapid motility decreases absorption\textsuperscript{6,8}
- Delayed motility prevents high intake\textsuperscript{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
- Reported as improving “brain fog”
- May be necessary in patients with GI issues
Venous Access

- Access is the main barrier in using IV fluid therapy in POTS.\textsuperscript{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

Enters the skin

Tunneled 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\textsuperscript{12}
- Large size of tubing allows for large volume\textsuperscript{12}
- Once tunnel is healed, no dressing is needed\textsuperscript{13}
- Good for frequent access\textsuperscript{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)\textsuperscript{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\textsuperscript{12}
- Requires dressing only when accessed
- Best for intermittent use\textsuperscript{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\textsuperscript{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

- 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

- 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

- 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

- 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 \textsuperscript{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\textsuperscript{12,19}
  - May require surgical repair or replacement
  - Includes breakage of catheter, hub failures, and mechanical defects

- Blood clot inside the catheter\textsuperscript{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
  - Birth control pills or estrogen
  - Corticosteroids
  - DDAVP
Reducing Risk

- Ensure correct tip placement and use\textsuperscript{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\textsuperscript{20}

- Remove line as soon as possible\textsuperscript{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
References


References


