IV/IO Therapy & Fluid Administration
Gary Hoertz, EMT-P

Objectives
- Indications for IV Access
- Types of Intravenous Access
- IV fluids
- Flow Rates
- Fluid resuscitation

Cleansing of the soul

“To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science.”

Albert Einstein
Intravenous (IV) Access Indications

- Fluid and blood replacement – prevent / treat for hypovolemic or cardiogenic shock
- Drug administration – parenteral system bypasses the digestive tract
- Obtaining venous blood specimens for lab analysis
- Proactive from pre-hospital to in-hospital

Types of IV Access

- Peripheral venous access
- Central venous access
- Intraosseous

Intravenous Fluids
• Two major types of IV Fluids:
  – Colloids
  – Crystalloids

Colloids

• Colloids: large molecules that remain in the vascular space for a long period of time.
  • Plasma protein fraction (plasmanate)
  • Salt-poor albumin
  • Dextran
  • Hetastarch (Hespan)

Crystalloids

• Crystalloids:
  • soluble substance that can be dissolved through a semi-permeable membrane when dissolved in liquid
  • created by dissolving salts and sugars in water
  • 2/3 of infused crystalloid fluids leaves the vascular space within 1 hour (3ml of crystalloid solution = 1ml blood)
  • Isotonic Solutions: little or no significant shift of fluids across the cell membrane
  • Hypertonic solutions – shifts fluid shift from intracellular compartment to extracellular compartment - D50W, D10W, D5&1/2NS
  • Hypotonic solutions: causes fluid shift from extracellular compartment to intracellular compartment - D5W
Crystalloids

- Isotonic Solutions:
  - 0.9% Normal Saline – contains 9% of sodium chloride in water
  - Lactated Ringers – contains sodium chloride, calcium chloride, and sodium lactate in water.

Other Fluids

- Blood
- Oxygen-carrying solutions

Poiseuille’s Law - Flow is directly related to inside diameter of catheter and inversely related to length; large, short and fat catheters produces rapid infusion of fluids
  - 18ga = 4.8L / or 80ml / min
  - 16ga = 7.45L / 124ml / min
  - 14ga = 9.67L / 161ml /min

Other factors include:
  - Length of admin set
  - Size of vein
  - Viscosity & temperature of fluid
• IV Flow Rates
  – Keep Vein Open (KVO)
  – Wide Open (WO)
  – Volume control devices – rate controller, buretrol, IV pumps
  – Calculated Rates
    \[
    \text{Rate to be run} \times \text{drip set} \quad \frac{\text{gtts/min}}{\text{Time (in minutes)}}
    \]

• Historical Perspective
  – 19th century – physicians were dealing with cholera patients which was known to kill patients by causing rapid dehydration and volume depletion.
  – Dr. O'Shaughnessy noted the need for fluids by claiming the victim’s blood “lost a large portion of it’s water” and went on to state “IV fluids were able to aid in recovery in part because it gave blood the ability to return to its natural specific gravity by replacing deficient saline.”
FLUID RESUSCITATION (cont.)

- Historical Perspective
  - WWI:
    - was first war in which advances in blood preservation allowed for battlefield transfusion
    - first mention that the sooner a wounded soldier arrived at a hospital the better his chances were for survival
    - 1920-30's defined and described the types of shock and many of the effects uncontrolled hemorrhage had on the body
  - WWII:
    - use of blood, blood products (plasma) and crystalloid solutions use became widespread...because of limited use of IV solutions soldiers were under resuscitated for shock survived the initial injuries but later died due to irreversible shock
  - Korean War:
    - MASH units allowed for more rapid care and required immediate use of IV fluids...increased survival rates and reduced incidence of renal failure.
  - Vietnam War:
    - High volume crystalloid resuscitation of hypovolemic shock became widespread and considered the standard of care; renal failure was less common than previous wars however something called congestive atelectasis became common which became known as Adult Respiratory Distress Syndrome (ARDS).
    - 3-8 times liters of crystalloids were given for every unit of blood lost.
    - Crystalloids were seen as “maximizing or supernormalizing cardiac output”.

FLUID RESUSCITATION (cont.)

- Traditional approach with hypovolemic shock has been that the key to reversal of the organ dysfunction in hypoperfusion is to simply restore beneficial flow to the affected organs and reversing anaerobic metabolism.
- Many today are questioning this approach because simple return of blood flow to the injured cells may cause more harm than shock itself.

FLUID RESUSCITATION (cont.)

- Reperfusion Injury Concept - cells damaged by hypoperfusion and anaerobic metabolism are not equipped to manage its own permeability and cell production once adequate perfusion is restored.
- Oxygen Paradox - reintroduction of elemental O2 into previously anaerobic cell actually worsens the cell dysfunction...in addition certain crystalloids results in activation of destructive inflammatory WBC's within the organs which further worsens reperfusion injury.

Are we allowing the body to do its part?

- When our patients bleed they lose more than just their volume, they also lose their platelets, RBCs and WBCs. Then we come along and dilute it more with IV fluids which only hinders the body's ability to compensate.
- The liver meanwhile releases clotting factors during hypotensive states. When we administer IV fluids the liver won't release these factors.
- The kidneys play a part in regulating BP but only after it receives a message from the brain. When we give more IV fluids the kidneys will no longer get the message to secrete renin.
FLUID RESUSCITATION (cont.)

• Ongoing Research:
  – New England Journal -1994 – study showed higher mortality rate with those who received prehospital IV fluids...authors believed those given fluids disrupted blood clots by increased pressure, disruption of hemoglobin concentrations and poor oxygen delivery.
  – Houston Paramedics mid 1990’s showed high volume IV problems but recommended doing further studies.
  - Field Trial of Hypotensive Resuscitation vs Standard Resuscitation in Patients with Hemorrhagic Shock* completed, results pending.

Are we using the right measurement?

• In the last decade we’ve used blood pressure as the measurement of how much IV fluids to give. More specifically it’s been based on systolic BP.
  • We’ve heard and taught more about “permissive hypotension” with the idea of running fluids until the patient has a systolic BP of 80-90.

Are we using the right measurement?

• More recently there is a discussion on using the Mean Arterial Pressure (MAP) as a means of a more appropriate measurement for someone in shock
  MAP= Diastolic Pressure + 1/3 pulse pressure (systolic pressure – diastolic pressure)
  • In a 2011 study (Morrison CA, et.al) found that trauma patients requiring surgery who were kept at a MAP of 50 (BP=70/40) versus a more typical MAP of 65 (BP=90/50) needed less blood transfusions, less fluid resuscitation needed and a better mortality rate at 30 days post-op.
Are we using the right measurement?

- There is yet one more measurement that is being discussed and even used in some pre-hospital agencies and that is the measurement of lactate.
- Lactate measures the amount of lactate acid in the bloodstream. Higher levels give a more accurate indication of the patient’s condition and need for fluid resuscitation.

FLUID RESUSCITATION (cont.)

- So what’s the perfect IV solution for fluid replacement in the field??

**BLOOD:** Blood is considered by many to be the perfect solution for acute hemorrhaging…downside is availability, cost, blood typing, transfusion reactions, consent and storage issues.

** COLLOIDS:** Colloid solutions were first used in military settings, small amount will improve the vascular space…downside allergic reactions, cost, storage problems…synthetic colloids available less expensive, easier to store and shows some promise.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>1st Choice</th>
<th>2nd Choice</th>
<th>3rd Choice</th>
<th>4th Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhagic shock</td>
<td>Whole Blood</td>
<td>Packed RBC’s</td>
<td>Plasma or plasma substitute</td>
<td>LR or NaCl</td>
</tr>
<tr>
<td>Shock due to plasma loss (burns)</td>
<td>Plasma</td>
<td>Plasma Substitute</td>
<td>LR or NaCl</td>
<td></td>
</tr>
<tr>
<td>Dehydration</td>
<td>LR or NaCl</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FLUID RESUSCITATION (cont.)

• Hypertonic Saline (7.5% Sodium Bicarb) … 3% & 5% hypertonic solution in a 500ml bag…increases cardiac output has shown to result in less reperfusion injuries than isotonic solutions

• Finally…combination of hypertonic solution and synthetic colloids (dextran) are showing possible promising results in raising BP’s as well as increased survival rates of hypotensive trauma patients…hypertonic solution causes shift of body water from intracellular to extracellular space and the colloid causes redistribution into vascular compartment-->more sustained hemodynamic recovery …average size adult would need about 280ml bolus for hypovolemic shock resuscitation (4ml/kg).

POST-TEST

1. A colloid is:
   a) a type of IV solution with large molecules that remain in the vascular system for a longer period of time.
   b) an isotonic IV solution that quickly dissolves into the vascular system.
   c) a blood product used for IV administration
   d) an IV solution that causes a fluid shift from extracellular compartment into the intracellular compartment.

2. Poiseuillie’s law refers to:
   a) total amount of IV fluids to be infused
   b) directly related to volume of IV fluids that may be administered
   c) overload of IV fluids to a patient
   d) correct rate of IV fluids over an hour’s period of time

3. The reperfusion injury concept refers to:
   a) the idea that too much IV fluids will create an acute fluid overload process to occur
   b) the idea that cells damaged by hypoperfusion are not equipped to manage its own permeability and cell production once adequate perfusion is restored
   c) the idea of using permissive hypotension only
   d) certain crystalloids results in active destruction of certain white blood cells
4. How does the liver respond during hypotensive states?
   a) It produces a greater blood flow to the body
   b) It produces a greater amount of white blood cells to be produced
   c) It produces a greater amount of clotting factors for the body
   d) It produces renin to help regulate the blood pressure

5. In the normally hydrated patient, isosonic IV solutions refer to:
   a) A shift of fluids from the intracellular compartment to the extracellular compartment
   b) A shift of fluid from the extracellular compartment to the intracellular compartment
   c) Little shift across the cell membrane
   d) Moving solutes from an area of higher concentration to an area of less across the cell membrane

SECRET QUESTION

What part may the Mean Arterial Pressure play in determining the severity of a hypoprefusion state?

Special thanks to
Sheila Crow
Stitchin’ Dreams Embroidery
wcsocrow@yahoo.com

For providing our Secret Question prize
Questions?

Contact: Samantha Roberts
509-242-4264
1-866-630-4033
robertss@inhs.org
Fax: 509-232-8344

Updates Please

EMS Live@Nite presentation, all certificates will be printed by participants or their agency. The certificate template will be available through the health training website at the same location as all presentation downloads. It will be posted the day after each monthly presentation.

Alert Us for Possible Activation
A smartphone application for our EMS partners
Alert Us for Possible Activation
MedStar, Inc., a free SMS application for you, your family, and caregivers, enables immediate notification of Medical and Veterinary response time should an emergency be needed.

- Download MedStar and register.
- Alert us by sending your GPS coordinates to MedStar's Communication Center with the free MedStar app.
- Receive immediate ETS and availability of MedStar's closest location.
- Alert MedStar for possible activation of the first aid kit.
- Communicate with MedStar through the app.

Available for both iPhone and Android™ smartphones.

Visit our website for a free download and more information.