Hypovolemia, Shock, and Fluid Resuscitation for Children in Limited Resource Areas

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Hypovolemia in Children

- 3 leading causes of death of infants and children
  - Diarrhea, malaria, bacterial sepsis
  - Fluid resuscitation decreases mortality 10-fold

Shock

- When oxygen delivery to the tissues is inadequate... supply does not meet demand
  - \( CO = SV \times HR \)
  - SV= preload, afterload, contractility
- Clinical manifestations
  - AMS/agitation, tachycardia, tachypnea, vasodilated or vasoconstricted, low UOP
  - Hypovolemic, cardiogenic, distributive
Surviving Sepsis Campaign

In The Bush

- Diagnosing dehydration and shock
- Estimating weight
- Type of IVF
- Establishing IV access
- Bolus or not to bolus
- IVF rate → "drip" rate

...In The Bush

- Must differentiate malnourished child from acutely ill, non-malnourished child
- Malnourished patient should not be given IV fluids for rehydration unless circulatory collapse is present
  - IVF should contain dextrose
  - ½ strength Darrow's solution with 5% glucose
  - Ringer's lactate with 5% glucose
  - ½ NS with 5% glucose
Diagnosing Dehydration and Shock

- **Dehydration**
  - History of diarrhea, thirst, sunken eyes

- **Septic Shock**
  - Hypothermia, weak/absent radial pulse, cold hands/feet, decreased UOP
  - *unreliable in setting of malnutrition*
...In The Bush

Estimating Weights… The Broselow Tape

<table>
<thead>
<tr>
<th>Color</th>
<th>Estimated Weight (in kilograms)</th>
<th>Estimated Weight (in pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey</td>
<td>3-5 kg</td>
<td>6-11 lbs</td>
</tr>
<tr>
<td>Pink</td>
<td>4-7 kg</td>
<td>9-15 lbs</td>
</tr>
<tr>
<td>Red</td>
<td>6-9 kg</td>
<td>13-20 lbs</td>
</tr>
<tr>
<td>Purple</td>
<td>10-11 kg</td>
<td>22-24 lbs</td>
</tr>
<tr>
<td>Yellow</td>
<td>12-14 kg</td>
<td>26-30 lbs</td>
</tr>
<tr>
<td>White</td>
<td>15-18 kg</td>
<td>33-40 lbs</td>
</tr>
<tr>
<td>Blue</td>
<td>19-23 kg</td>
<td>42-50 lbs</td>
</tr>
<tr>
<td>Orange</td>
<td>24-29 kg</td>
<td>53-64 lbs</td>
</tr>
<tr>
<td>Green</td>
<td>30-35 kg</td>
<td>66-78 lbs</td>
</tr>
</tbody>
</table>

Bolus or Not to Bolus

- Oral rehydration (+/- NG tube) whenever possible
- IVF Bolus
  - Evidence of shock in non-malnourished child → rapid bolus
  - Evidence of circulatory collapse in malnourished child → bolus over 1hr
The FEAST Trial

Multicenter, RCT in sub-Saharan Africa
Inclusion: 60 days – 12 years old, severe febrile illness with altered LOC, respiratory distress, or both and impaired perfusion
Exclusion: severe malnutrition, gastroenteritis, non-infectious causes of shock, volume expansion contraindicated

2 strata:
A- children with dehydration without severe hypotension (n=3141)
B- children with dehydration and severe hypotension (n=289)
Randomized to albumin bolus, NS bolus, or no bolus (stratum A only)
All received maintenance IVF, antibiotics, antimalarials, antipyretics, anticonvulsants, and whole blood transfusions for Hgb <5
The FEAST Trial

- **Conclusions:**
  - Bolus fluid resuscitation increased risk of death by 3.3% at 48hrs, and increased risk of death, neurologic sequelae, or both by 4% at 4 weeks.
  - Results do not support routine use of bolus resuscitation in severely ill febrile children in African hospitals.
  - Cannot extrapolate to children with gastroenteritis, severe malnutrition, or other causes of shock.
  - Study terminated early due to safety concerns in bolus groups.

### Maintenance IVF Rates

**Holliday-Segar Method**

<table>
<thead>
<tr>
<th>Body Weight</th>
<th>mL/kg/day</th>
<th>mL/kg/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 10kg</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>Second 10kg</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Each additional kg</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**WHO Method**

<table>
<thead>
<tr>
<th>Age</th>
<th>mL/kg/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 months</td>
<td>5</td>
</tr>
<tr>
<td>12 months - 5 yrs</td>
<td>4</td>
</tr>
</tbody>
</table>
IVF Rates

- mL/hour (on a pump)
- Slow, medium, fast, very fast, wide open (not recommended!)
- Drips per minute (gtts/min)
  - The drip factor: a burette with needle or plastic dropper gives # of drops per mL—determined by length and diameter of the needle
  - Common drip factors
    - gtts/mL (blood set), 15gtts/mL (regular set), 60gtts/mL (microdrop)
  - Flow rate (gtt/min)=volume (mL)/A drop factor (gtts/mL)/time (min)

IVF Rate

- due to gastroenteritis and is unable to tolerate oral rehydration solution.
  - How do you give a 20ml/kg fluid bolus over 15 minutes?
    20ml x 10kg= 200ml bolus
    200ml x 15gtts/ml = 2000gtts min 15 min
  - How do you calculate and order maintenance IVF
    10kg x 4ml/kg/hr= 40ml/hr x 24 hr= 960ml/day
    960ml x 15gtts/ml = 15333.33gtts
    1440min = 10.41666667gtt/min

References

Tricks of the Trade
NPO Status!

Intraosseous Lines