Fluids and Electrolytes

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5 year old male admitted to pediatric service with 3 day history of vomiting, diarrhea and poor PO intake.

Surgery consult for abdominal pain and lethargy

Previously healthy, attends pre-school, full term. Many other children out this week from school with similar illness.
History Discussion Slide

- **History should focus on severity of dehydration:**
  - How long?
    - Symptoms began at 3 days ago
  - Frequency?
    - Initially both nausea and vomiting, now neither and has abdominal pain
  - Character of emesis?
    - Non-bilious at first, last 2 times with “yellowish tinge”
  - Frequency of urine output?
    - Last “pee” was yesterday
  - Activity level?
    - Seems less active and more sleepy
  - No Family History of similar condition

STEPS
STANDARDIZED TOOLBOX
OF EDUCATION FOR
PEDIATRIC SURGERY
Physical Exam

- **Vitals:** Temp 38.2°, HR 125, BP 90/70
- **Appearance:**
  - Lethargic, tired
- **Relevant exam findings**
  - Dry mucous membranes, decreased capillary refill
  - Abdomen: mild distention, diffuse tenderness, no rebound.
Physical Exam

• Vitals: Temp 38.2 HR 125 BP 90/70
• Appearance:
  – Lethargic due to dehydration
• Relevant exam findings
  – Dry mucous membranes, decreased capillary refill (represent dehydration)
  – Abdomen: mild distention, diffuse tenderness, no rebound. (also represents dehydration)
Studies: Labs, Imaging

- Serum Electrolytes
- Complete Blood Count
- Urinalysis
- Abdominal Ultrasound
Study Results

- **Serum Electrolytes**
  - Bicarbonate 21

- **Complete Blood Count**
  - HCT 48

- **Urinalysis**
  - Ketones 40
Case Discussion

• Diagnosis
  – Dehydration
    • Cause—Most likely gastroenteritis
  – Surgical causes of dehydration
    • Appendicitis
    • Intussusception
    • Bowel obstruction
  – Need to treat dehydration while continuing workup
Case Discussion

- **Resuscitation with IV fluids is key**
  - Dehydrated patients need initial resuscitation with IV bolus
  - Fluid bolus should be 20 mL/kg of crystalloid
    - NSS or LR
    - Repeat 20 ml/kg boluses x 2 or 3 if no response in heart rate
- **Ongoing workup**
  - Ultrasound for appendicitis and intussusception
Case Discussion

- Resuscitation with IV fluids is key (cont)

  - Calculate maintenance IV fluids
    - For 1-10 kg: 4 mL/kg/hr
    - For 11-20 kg: 2 mL/kg/hr
    - For > 21 kg: 1 mL/kg/hr

  - Example: Maintenance IVF (per hr) for 26 kg:
    - \(4 \text{ mL/kg} \times 10 \text{ kg} + 2 \text{ mL/kg} \times 10 \text{ kg} + 1 \text{ mL/kg} \times 6 \text{ kg}\)
    - \(= 40 \text{ mL} + 20 \text{ mL} + 6 \text{ mL} = 66 \text{ mL per hr}\)

  - After boluses, this patient still dehydrated
    - Continue MIVF x 1.5 maintenance to continue to replace losses if not tolerating PO
### Composition of fluid losses

#### Table 3: Composition of GI losses

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DAILY LOSS (ML)</th>
<th>[Na⁺]</th>
<th>[K⁺]</th>
<th>[Cl⁻]</th>
<th>[HCO₃⁻]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva</td>
<td>1,000</td>
<td>30-80</td>
<td>20</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Gastric</td>
<td>1,000-2,000</td>
<td>60-80</td>
<td>15</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Pancreas</td>
<td>1,000</td>
<td>140</td>
<td>5-10</td>
<td>60-90</td>
<td>40-100</td>
</tr>
<tr>
<td>Bile</td>
<td>1,000</td>
<td>140</td>
<td>5-10</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Small Bowel</td>
<td>2,000-5,000</td>
<td>140</td>
<td>20</td>
<td>100</td>
<td>25-50</td>
</tr>
<tr>
<td>Large Bowel</td>
<td>200-1,500</td>
<td>75</td>
<td>30</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Sweat</td>
<td>200-1,000</td>
<td>20-70</td>
<td>5-10</td>
<td>40-60</td>
<td>0</td>
</tr>
</tbody>
</table>

University of Michigan Health System Pediatric Critical Care Medicine. 
# Composition of IV Crystalloid Fluids

<table>
<thead>
<tr>
<th>Solution</th>
<th>pH</th>
<th>[Na+]</th>
<th>[Cl-]</th>
<th>[K+]</th>
<th>[Ca2+]</th>
<th>Other Components</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactated Ringer's (LR)</td>
<td></td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td>Lactate 28 meq/L</td>
<td>Fluid choice for initial resuscitation</td>
</tr>
<tr>
<td>Normal saline (NS)</td>
<td></td>
<td>154</td>
<td>154</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Alternative to LR; watch for hyperchloremic acidosis</td>
</tr>
<tr>
<td>D5LR</td>
<td>5</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td>Dextrose 50 g, Lactate 28 meq/L</td>
<td>Initial postoperative maintenance; caution bolusing with dextrose</td>
</tr>
<tr>
<td>D5NS</td>
<td>4</td>
<td>154</td>
<td>154</td>
<td>0</td>
<td>0</td>
<td>Dextrose 50 g</td>
<td>Alternative to D5LR</td>
</tr>
<tr>
<td><strong>D5.45NS</strong></td>
<td>4</td>
<td>77</td>
<td>77</td>
<td>0</td>
<td>0</td>
<td>Dextrose 50 g</td>
<td>Hypotonic maintenance</td>
</tr>
<tr>
<td>D5.25NS</td>
<td>4</td>
<td>34</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>Dextrose 50 g</td>
<td>Hypotonic maintenance</td>
</tr>
<tr>
<td>7.5% NS</td>
<td>4</td>
<td>1,283</td>
<td>1,283</td>
<td>0</td>
<td>0</td>
<td>Dextrose 50 g</td>
<td>Hypertonic; further study</td>
</tr>
<tr>
<td>D5W</td>
<td>4.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Dextrose 50 g</td>
<td>Free water; no role in resuscitation</td>
</tr>
</tbody>
</table>

For more information, visit: [http://www.learnpicu.com/fluids-electrolytes](http://www.learnpicu.com/fluids-electrolytes)
Case Discussion

- **Resuscitation with IV fluids is key**
  - Thus, to replace fluid losses, the optimal initial fluid bolus is LR or NSS depending on source of fluid losses (majority of time it is LR)
  - Usual MIVF after boluses is D5 1/2NS + 20KCl
    - Patient will require additional IVF above maintenance rate
    - Would run at 1.5 X maintenance rate
  - Use caution about adding KCL to MIVF before patient voids. Low risk but possible renal failure
Questions

• What is the most common acid-base derangement in severe viral gastroenteritis?
  A. Metabolic Acidosis
  B. Metabolic Alkalosis
  C. Respiratory Acidosis
  D. Respiratory Alkalosis
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  A. Metabolic Acidosis
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  C. Respiratory Acidosis
  D. Respiratory Alkalosis
Questions

Which of the following is the most appropriate initial resuscitative strategy for a patient with severe dehydration?

A. 0.9% NS bolus 10ml/ kg
B. 0.45% NS bolus 20ml/ kg
C. LR bolus 20ml/ kg
D. 3% NS bolus 10ml/ kg
Questions

• Which of the following is the most appropriate initial resuscitative strategy for a patient with severe dehydration?

A. 0.9% NS bolus 10ml/kg
B. 0.45% NS bolus 20ml/kg
C. LR bolus 20ml/kg
D. 3% NS bolus 10ml/kg
Questions

- All of the following are usual clinical signs of severe dehydration in a pediatric patient except:
  A. Lethargy
  B. Tachycardia
  C. Shortness of breath
  D. Abdominal pain
Questions

• All of the following are usual clinical signs of severe dehydration in a pediatric patient except
  A. Lethargy
  B. Tachycardia
  C. Shortness of breath
  D. Abdominal pain
Final Discussion/Review

Top 5 take home points for disease:

1. Dehydration is common result from multiple medical and surgical conditions. Delay in treatment can lead to severe electrolyte derangements, and eventually metabolic collapse.

2. Correction of hydration and electrolyte status is first priority and can be initiated even before final diagnosis is made.
Final Discussion/Review

Top 5 take home points for disease:

3. Calculate maintenance IVF rate

4. Determine whether patient needs more or less than maintenance rate

5. Determine the type of IVF based on need of patient
The preceding educational materials were made available through the American Pediatric Surgical Association.

In order to improve our educational materials we welcome your comments/suggestions:

www.eapsa.org