The Ins and Outs of Dehydration

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OHSU Doernbecher Pediatric Emergency Department
Background Information

- 1940 – oral solutions were developed
  - K+ replacement recognized for reducing mortality
- 1950’s – IV fluid became widespread treatment for epidemics of infectious diarrhea
- 1992 CDC prepared the first national guidelines for managing childhood diarrhea
  - Rehydration
  - Maintenance
  - Nutritional therapy
Burden of Disease

• United States
  ▪ >1.5 million outpatient visits
  ▪ 200,000 hospitalizations
  ▪ 300 deaths/year
  ▪ $1 billion/year in total costs for rotavirus alone

• Worldwide
  ▪ Diarrhea is leading cause of morbidity and mortality
  ▪ 1.5 billion episodes and 1.5-2.5 million deaths occur annually in children <5 years of age
Are We Making Any Progress?

• Worldwide mortality decreased
  ▪ 1982 5 million deaths/year
  ▪ 1992 3 million deaths/year

• Decreased mortality is attributable to worldwide campaigns to treat acute diarrhea with oral rehydration therapy
Causes of Dehydration

Diarrhea/Vomiting
  • Most common reason for loss of excess water

Sweat
  • Intense exercising, hot environment, fever

Diabetes
  • Sugar spills into urine – water follows

Chronic renal failure
  • polyuria

Burns
  • Water moves into damaged skin

Inability to drink fluids
Differentials

Decreased intake
- Voluntary/involuntary
- Anatomical (pharyngitis, facial dysmorphia)
- Neurological (brain tumor)
- Febrile illness

Increased Output
- Insensible loss (fever, respiratory)
- GI loss
- Renal
- Systemic (burns)
Daily Requirements

• Average daily requirements of water
  • First year: 130-150 ml/kg
  • 2-4 years: 100-130 ml/kg
  • 4-10 years: 70-100 ml/kg
  • 10-18 years: 50-70 ml/kg

• Average daily requirements of Sodium/Potassium
  • 1st 6 months: 120/500 mg/day
  • 7-12 months 200/700 mg/day
  • 1-3 years 225/1000 mg/day
  • 4-8 years: 300/1400 mg/day
Categorizing Dehydration

• **Mild**
  - 3-5% fluid deficit/loss of body weight
  - Encourage use of ORT
  - Nutrition should **not** be restricted

• **Moderate**
  - 6-9% fluid deficit/loss of body weight
  - ORT including NG rehydration

• **Severe**
  - >10% fluid deficit/loss of body weight (shock/near shock state)
  - IV rehydration, switch to oral route once LOC normal
Dehydration Categories

- Dehydration can also be categorized in relation to Serum Na levels:
  - **Hyponatremic**  <130 mEq/L
  - **Isonatremic**  130-150 mEq/L
  - **Hypernatremic**  >150 mEq/L

Lab test results **DO NOT** predict dehydration severity.
## Indications for Medical Evaluation

<table>
<thead>
<tr>
<th>Young age &lt;6 months or weight &lt;8 kg</th>
<th>History of premature birth</th>
<th>Chronic medical conditions or concurrent illness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever &gt;38°C &lt;3 months &gt;39°C 3-36 months</td>
<td>Visible blood in stool</td>
<td>High output (urine or diarrhea)</td>
</tr>
<tr>
<td>Persistent vomiting</td>
<td>Caregiver’s report of signs consistent with dehydration (decreased tears, decreased UO, dry mucous membranes)</td>
<td>Change in mental status (irritability, apathy, lethargy)</td>
</tr>
<tr>
<td>Suboptimal response to oral rehydration</td>
<td>Caregiver inability to administer oral rehydration</td>
<td></td>
</tr>
</tbody>
</table>
12 Clinical symptoms/manifestations of dehydration:

1. Mental status
2. Thirst
3. Heart rate
4. Quality of pulses
5. Breathing
6. Eyes
7. Tears
8. Mouth/tongue (mucous membranes)
9. Skin fold
10. Capillary refill
11. Extremities
12. Urine output
### Minimal or no dehydration (<3% loss of body weight)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Minimal or no dehydration (&lt;3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental status</td>
<td>Well, alert</td>
</tr>
<tr>
<td>Thirst</td>
<td>Drinks normally, might refuse liquids</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Normal</td>
</tr>
<tr>
<td>Quality of pulses</td>
<td>Normal</td>
</tr>
<tr>
<td>Breathing</td>
<td>Normal</td>
</tr>
<tr>
<td>Eyes</td>
<td>Normal</td>
</tr>
<tr>
<td>Tears</td>
<td>Present</td>
</tr>
<tr>
<td>Mouth and tongue</td>
<td>Moist</td>
</tr>
<tr>
<td>Skin fold</td>
<td>Instant recoil</td>
</tr>
<tr>
<td>Capillary refill</td>
<td>Normal</td>
</tr>
<tr>
<td>Extremities</td>
<td>Warm</td>
</tr>
<tr>
<td>Urine output</td>
<td>Normal to decreased</td>
</tr>
</tbody>
</table>
Mild to Moderate dehydration (3-9% loss of body weight)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Mild to Moderate dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental status</td>
<td>Normal, fatigues or restless, irritable</td>
</tr>
<tr>
<td>Thirst</td>
<td>Thirsty, eager to drink</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Normal to increased</td>
</tr>
<tr>
<td>Quality of pulses</td>
<td>Normal to decreased</td>
</tr>
<tr>
<td>Breathing</td>
<td>Normal; fast</td>
</tr>
<tr>
<td>Eyes</td>
<td>Slightly sunken</td>
</tr>
<tr>
<td>Tears</td>
<td>Decreased</td>
</tr>
<tr>
<td>Mouth and tongue</td>
<td>Dry</td>
</tr>
<tr>
<td>Skin fold</td>
<td>Recoil in &lt;2 seconds</td>
</tr>
<tr>
<td>Capillary refill</td>
<td>Prolonged</td>
</tr>
<tr>
<td>Extremities</td>
<td>Cool</td>
</tr>
<tr>
<td>Urine output</td>
<td>Decreased</td>
</tr>
</tbody>
</table>
Severe dehydration (>9% loss of body weight)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Severe Dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental status</td>
<td>Apathetic, lethargic, unconscious</td>
</tr>
<tr>
<td>Thirst</td>
<td>Drinks poorly; unable to drink</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Tachycardia, with bradycardia in most severe cases</td>
</tr>
<tr>
<td>Quality of pulses</td>
<td>Weak, thready, or impalpable</td>
</tr>
<tr>
<td>Breathing</td>
<td>Deep</td>
</tr>
<tr>
<td>Eyes</td>
<td>Deeply sunken</td>
</tr>
<tr>
<td>Tears</td>
<td>Absent</td>
</tr>
<tr>
<td>Mouth and tongue</td>
<td>Parched</td>
</tr>
<tr>
<td>Skin fold</td>
<td>Recoil &gt;2 seconds</td>
</tr>
<tr>
<td>Capillary refill</td>
<td>Prolonged; minimal</td>
</tr>
<tr>
<td>Extremities</td>
<td>Cold; mottled, cyanotic</td>
</tr>
<tr>
<td>Urine output</td>
<td>Minimal</td>
</tr>
</tbody>
</table>
ORT

**Reverse technology transfer**

Protocols originally implemented in developing countries which changed the standard of care in industrialized countries

Can any liquid be used as ORT?

**Ondansetron prior to ORT**

- 6 mo - 4 years 0.15 mg/kg
- 4-11 years of age 4 mg
- >11 years of age 8 mg
## 10 Minute Rule

- **Oral Rehydration Guidelines**

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>10-minute volume (mls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
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<tr>
<td>9</td>
<td>12</td>
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<td>10</td>
<td>14</td>
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<td>15</td>
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<td>30</td>
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<td>35</td>
<td>30</td>
</tr>
<tr>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>50</td>
<td>38</td>
</tr>
</tbody>
</table>
IF ORT Fails

- NG
- IV fluids
Barriers to Both

ORT

- Ingrained use of IV therapy
- Reduced appeal of a technologically simple solution
- 30% of practicing pediatricians withhold ORT for children with vomiting or moderate dehydration
- Practice of continued feeding during diarrhea episodes has been difficult to establish as soc.
- Time consuming in a “hot and now” world

IV Therapy

- Invasive
- Expensive
- Risk of infection/complications
- Time consuming
- Often requires transfer to ED or overnight admission
Two Phases of Treatment

Rehydration phase

- Water and electrolytes are administered as ORT/IV to replace existing losses

Maintenance phase

- Includes both replacement of ongoing fluid and electrolyte losses and adequate dietary intake
Types of IV fluid

Initial Resusitation: isotonic crystalloid (NS/LR)

<table>
<thead>
<tr>
<th>IV Fluid (meq/L)</th>
<th>Na</th>
<th>Cl</th>
<th>K</th>
<th>Glu</th>
<th>Bicarb</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50g/L</td>
<td>0</td>
</tr>
<tr>
<td>D5W ¼ NS</td>
<td>34</td>
<td>34</td>
<td>0</td>
<td>50g/L</td>
<td>0</td>
</tr>
<tr>
<td>D5W ½ NS</td>
<td>77</td>
<td>77</td>
<td>0</td>
<td>50g/L</td>
<td>0</td>
</tr>
<tr>
<td>LR</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>D5LR</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>50g/L</td>
<td>28</td>
</tr>
<tr>
<td>D5 0.9% NS</td>
<td>154</td>
<td>154</td>
<td>0</td>
<td>50g/L</td>
<td>0</td>
</tr>
</tbody>
</table>
**Hypo and Hypernatremia Dehydration**

**↓ Na ↓ Volume**

Signs and symptoms depend on Na levels and rate of falling

- CNS changes
- Nausea, vomiting, HA, MS changes
- Weakness/cramps

**Treatment**

20 ml/kg bolus, repeat if needed

Maintenance for ongoing loss

**↑ Na ↓ Volume**

Signs and symptoms result from cellular dehydration

- MS changes, weakness, ataxia, tremors

**Treatment**

20 ml/kg bolus, repeat if needed

Maintenance D5 ½ and ¼ come into play

Dialysis
Risk Factors for suboptimal outcomes

Risk Factors:
• Prematurity
• Young maternal age
• African American race
• Rural residence

When is hospitalization indicated?
• Severe dehydration
• Social or logistical concerns that might prevent return evaluation
• Factors such as age, unusual irritability or drowsiness, uncertainty of diagnosis, progression of symptoms
1. Oral rehydration solutions (ORT) should be used for rehydration

2. Oral rehydration should be performed “rapidly” – within 3-4 hours

3. Age-appropriate, unrestricted diet is recommended as soon as dehydration is corrected

4. Nursing should continue for breastfed infants

5. If formula-fed, diluted formula or special formula is not recommended

6. Additional ORT should be administered for ongoing losses through diarrhea

7. No unnecessary laboratory tests or medications should be administered
BRAT diet is out
unnecessarily restrictive and provides suboptimal nutrition
Severe malnutrition can occur if prolonged gut rest or clear fluids are prescribed

Zinc
trials are supporting zinc supplements as an effective agent in treating and preventing diarrheal disease

Probiotics
live microorganisms in fermented foods help establish improved balance in intestinal microflora

Prebiotics
complex carbohydrates used to preferentially stimulate growth of health-promoting intestinal flora (whole grains, barley, flax)
Case Studies

General appearance?
- looks good/looks bad

Quick visual assessment?
- 12 clinical signs

Severity of dehydration?
- mild/moderate/severe

Plan?
- ORT/NG/IV

Fluid type/amount?
Case Study

General appearance?  
looks good/looks bad

Quick visual assessment?  
12 clinical signs

Severity of dehydration?  
mild/moderate/severe

Plan?  
ORT/NG/IV

Fluid type/amount?
Sent from clinic by private vehicle
HR 178, RR 28, BP 86/56  T 38.1
Vomited bottle of pedialyte at clinic, 4 episodes of diarrhea in clinic
2 older siblings also home sick with similar symptoms earlier this week

General appearance?
- looks good/looks bad

Quick visual assessment?
- 12 clinical signs

Severity of dehydration?
- mild/moderate/severe

Plan?
- ORT/NG/IV

Fluid type/amount?
Case Studies

General appearance?
- looks good/looks bad

Quick visual assessment?
- 12 clinical signs

Severity of dehydration?
- mild/moderate/severe

Plan?
- ORT/NG/IV

Fluid type/amount?
Case Study
Questions?