Challenges in Pediatric Nutritional Support

Donald E. George, MD
What is so special about Kids

- They Grow
- They Change
- They Explore
- They Frequently get better
What is so special about Kids

• They require more sugar:
  - 6mg/kg/min for infants
  - 2 mg/kg/min in adults
• The major difference is the relative size of the brain
• They have markedly decreased energy reserves
Challenges in Pediatrics

• Support growth
• Encourage development
  - Gross motor
  - Fine Motor
  - Psycho social
• Improve health
• Improve Quality of life
Challenges for patients and parents

• Ensuring the adequacy of the nutritional prescription which is often complex and always cumbersome
• Allow for normal behaviors and exploration without allowing risk
• Access
• Infection
• Complications
Challenges for the Team

- Gut Adaptation
- Cholestasis
- Food refusal
- Development
- Maintaining access
When Did Specialized Nutrition Support Begin

- Helfric and Abelson: Intravenous feeding of a complete diet in a child
  - J Pediatr 25:400 1944
- Wilmore and Dudrick Growth and development of an infant receiving all nutritents by vein
  - JAMA 203:860-864 1968
When Did Specialized Nutrition Support Begin

- First English language reports of PEGs was in children in 1980. 12 children, later 19 adults received PEGs

- So Children contributed to 2 important breakthroughs in nutritional support
Short Bowel Syndrome

A complex disorder characterized by multiple disruptions of normal anatomy and physiology complicated by a variety of nutritional, infectious and metabolic alterations that challenge both the art and science of medicine.

J.A. Vanderhoof
Intestinal Adaptation

• Process of upregulation of nutrient absorption following small bowel resection

• Stimulation of adaptation should be a goal of any successful medical management strategy

• Highly dependent on enteral nutrition
Gut Adaptation

Many factors influence the ability of the gut to improve:

• Underlying disease
• Age
• Quantity and type of enteral nutrition
# How long is long

<table>
<thead>
<tr>
<th>Gest Age (wks)</th>
<th>Total (cm)</th>
<th>Duodenum</th>
<th>Jejunoileum</th>
<th>Colon</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 - 27</td>
<td>142 +/- 22</td>
<td>3.8 +/- 1</td>
<td>115 +/- 25</td>
<td>23 +/- 4</td>
</tr>
<tr>
<td>27 - 35</td>
<td>217 +/- 24</td>
<td>5.3 +/- 2</td>
<td>172 +/- 29</td>
<td>41 +/- 8</td>
</tr>
<tr>
<td>35+</td>
<td>304 +/- 44</td>
<td>6.5 +/- 2</td>
<td>248 +/- 40</td>
<td>49 +/- 6</td>
</tr>
</tbody>
</table>

*Touloukian and Walker Smith*

*J Pediatr Surg 18:720 1983*
How short is short

- After birth, intestine growth continues in proportion to crown heel length until a length of 100 cm (50th percentile for 3 1/2 year boy)

Siebert JR  Am J Dis Child
134:543  1980

Therefore we assume there will be continued adaptation of the gut that is dependent on the age of injury, type of injury and age of the child
Intestinal Adaptation

Duration of the adaptation process

- Unclear in humans
- Rats:  
  function: 1-3 days
  morphologic: 2-3 weeks
- Humans: intestinal length may increase up to 5 yrs of age
Intestinal Adaptation

Management strategies to induce adaptation:
• Feed the Gut!!
• Complex diets are better than elemental diets
• Hydrolyzed casein is better than whole protein
• LCT’s are better than MCT’s
Enteral Feeding Strategy Issues

- Early introduction
- Preservation of suck/swallow mechanism
- Delivery route
- Delivery mode
- Optimal formula choice
PN Induced Cholestasis

• Leading cause of morbidity
  • (Teitelbaum Curr Opin Ped 1997)

• Incidence is inversely proportional to age

• Children at risk:
  • Premature
  • Low birth weight
  • Intestinal resection
  • Bowel disease
  • Overnutrition
  • Sepsis
Cholestasis

• Why do infants and young children fed by parenteral nutrition frequently develop liver disease
• Why after 30 years of experience is this still an unanswered question
Cholestasis: Treatment

- **FEED!!!**
- Alter PN solution
  - Reduce or eliminate fat
  - Reduce or eliminate trace elements
- Metronidazole
  - (bacterial overgrowth)
- UCDA
Food Refusal

This is what you want

But, this is what you get
Food Refusal: Causes

• Unpleasant history with oral stimulation
  - Intubation and suctioning
  - Nasogastric and/or orogastric feeding tubes
• Discomfort associated with feeding
  - Gastroesophageal reflux
  - Gaging/Vomiting
• Oral-motor immaturity
  - Suck/swallow/breath pattern
  - Weak flexion and muscle strength
  - Poor endurance for full oral feeds
• Disruption of hunger-satiety cycle
Food Refusal: Intervention

• Nonnutritive sucking
• Facial and oral stimulation
• Small volume oral feeds once tongue thrust resolves
  - Minimize environmental stimulation
  - Feeding should be fun for baby so watch for signs of readiness
  - Monitor for signs of fatigue
  - Alter textures and tastes gradually
Transition Goals

- TPN → enteral
- enteral → PO
- elemental → table foods
- hospital → home
- nurse → parent
- patient → child
- child → adult
Kid Friendly PN

• **Cycled PN (aka: “Windowed“)**
  - Time off of the pump to allow for mobility and development of hunger
  - Usually 12 hour cycle

• **Portable pumps**
  - Allow mobility for toddlers and older children
  - Pump is placed in a backpack
Equipment Needed

• Pump
  - Lock-out option
  - Small increment adjustment capability
  - Alarm feature at a low psi
Equipment Needed

- Tubing/bag
  - Locking connections
  - Clamp

- Pole and/or backpack
Catheter Related Complications

- Dislodgment
- Thrombosis
- Infection
Maintaining Access
“Easier Said Than Done”

Things kids will do with a tube

Play jump rope

Chew on it
Maintaining Access: Tips

- Circle the tubing and secure
- Dress kids in one piece outfits
- At night dress baby in a sleeper and cut a hole in the footy for the line to run safely
Keep it away from the diaper area

1. Central line is inserted into your chest here
2. The line is tunneled under your skin
3. The line comes out here
Infection!

- Major factor for morbidity and mortality
- Mantra: Less is more
  - The less you mess with the line the smaller the risk of infection will be
- Practice good line care
- Keep the dressing intact
  - Excessive drooling, stool or urine output can dirty the dressing
- Secure the catheter cap out of the diaper area and don’t let baby teeth on the cap
Scrupulous washing
Assess and organize operations
Friction to the Hub
Establish Sterile Fluid Path
Oley Foundation
The “Team Players” for Managing TPN

• Physician
• Pharmacist
• Nurse
• Dietitian
• Speech therapist
• Home health care company
Thank you Very Much
## Short Bowel Syndrome: Prognosis

**Criterion:** Off TPN by 36 months

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<tr>
<th></th>
<th>P.N.I.</th>
<th>PND</th>
<th>p</th>
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<tbody>
<tr>
<td><strong>Bowel Remaining</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>91±12</td>
<td>34±6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>%</td>
<td>46±6</td>
<td>16±4</td>
<td>&lt;0.0</td>
</tr>
<tr>
<td><strong>% enteral calories at 3 mths.</strong></td>
<td>43±6</td>
<td>10±4</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td><strong>Ileo Cecal Valve</strong></td>
<td>54%</td>
<td>43%</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Cholestasis</strong></td>
<td>67%</td>
<td>57%</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Infections/month TPN</strong></td>
<td>0.21</td>
<td>0.11</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*Sondheimer et al J Pediatr 132:80 1998*
SBS: Intestinal Adaptation

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• Stimulation of adaptation should be a goal of any successful medical management strategy

• Highly dependent on enteral nutrition
Management strategies to induce adaptation:

- Feed the Gut!!
- Complex diets are better than elemental diets
- Hydrolyzed casein is better than whole protein
- LCT’s are better than MCT’s
Elemental, low fat formulas are better tolerated for children with short bowel syndrome.
What Parents Need to Ask

• How do you assess the adequacy of treatment?
• How do you deal with complications?
• How do you plan for transitions?