Diet in Short Gut Syndrome

Valeria Cohran M.D.
Medical Director of Intestinal Rehabilitation/Transplant
October 23, 2014
Definition of Intestinal Failure

- Intestinal failure
  - obstruction
  - dysmotility
  - surgical resection
  - congenital defect
  - disease-associated loss of absorption

- Characterized by the inability to maintain
  - protein-energy
  - fluid
  - electrolytes
  - micronutrient balances

Clin Gastro Hepatol 2006:4:6-10
Disclosures

• I serve on Nutricia’s speaker bureau

• I am the Lurie Children’s Hospital of Chicago site PI for the NPS-sponsored safety trial of Gattex®
Common Pediatric Diagnoses

• **Short bowel syndrome**
  – Necrotizing Enterocolitis
  – Gastroschisis, primary indication for intestinal transplant
  – Intestinal Atresias
  – Long-segment Hirschsprung’s Disease
  – Midgut or Intrauterine Volvulus

• **Motility Disturbances**
  – Chronic intestinal pseudo obstruction
  – Gastroscisis

• **Mucosal lesions**
  – Microvillous Inclusion Disease
  – Tufting enteropathy
Outline

• Understand the advantages and limitations of carbohydrates, protein, and fat

• Develop regimen to introduce solid foods

• Recognize the optimal timing to refer to a multidisciplinary feeding clinic
Outline

• Understand the advantages and limitations of carbohydrates, protein, and fat

• Develop regimen to introduce solid foods

• Recognize the optimal timing to refer to a multidisciplinary feeding clinic
Breast Milk

• Breast milk always been encouraged
  – 19% of Pediatric Intestinal Failure Consortium (PIFCON) cohort, n=272
  – 20 different infant formulas

• Growth Factors
  • Glucagon like peptide-2
  • Epidermal growth factor
  – Secretory immunoglobulins
  – Lysozyme
  – Interferon

• Improved outcomes with enteral autonomy
  – Mean duration of TPN 290 vs 720 days in non-breast milk infants

Breast fed vs formula only

Time on parenteral nutrition (months)

* Choquette et al abstract PIFRS 2014
Breast milk pathologies breakdown

Choquette et al abstract PIFRS 2014
Formula/Protein

- No significant difference in absorption between hydrolyzed and non-hydrolyzed formulas.
- Isosmotic
- Anecdotal data
  - Hydrolyzed and Amino Acid based formulas
    - Evidence of improved absorption in sitting of inflammation
    - Non-IgE mediated milk protein allergy in patients with short bowel syndrome
    - Shorter duration of TPN dependence
- Drawbacks for Amino Acid based formulas
  - Will require calcium/phosphorus supplementation especially in premature infants
  - Expensive

Carbohydrates

- Standard infant formulas 19-20 kcal/oz
- May dilute to 10 or 15 kcal/oz
  - Decreasing the osmotic load to reduce diarrhea
- Avoid fruit juices/fruits
  - Worsen D-lactic acidosis
  - Diarrhea
- If volume sensitive
  - More concentrated formulas 24 kcal/oz or greater
  - Increase caloric intake without increasing volume/fluid load especially in sensitive children
- More concentrated the increased chance of osmotic diarrhea
Fat

• Long chain Triglycerides (LCT)
  – Require bile acids to absorb LCT
  – Ileal resection, loss of enterohepatic circulation

• Medium Chain Triglycerides (MCT) can be directly absorbed
  – Slightly less calories
  – Less helpful adaptation
  – Improved absorption in preserved colon

• Elemental and casein hydrolysate formulas
  – High in MCT
  – More calories from fat even in setting of malabsorption, intestinal resection

Randomized Controlled Trial of Early Enteral Fat Supplement and Fish Oil to Promote Intestinal Adaptation in Premature Infants with an Enterostomy

Table III. Nutritional outcomes after bowel reanastomosis

<table>
<thead>
<tr>
<th>Infants</th>
<th>All</th>
<th></th>
<th>High ostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (n = 17)</td>
<td>Treatment† (n = 18)</td>
<td>Control (n = 6)</td>
</tr>
<tr>
<td>Hyperalimentation, d</td>
<td>13 ± 17</td>
<td>10 ± 13</td>
<td>27 ± 23</td>
</tr>
<tr>
<td>Intravenous lipid, d</td>
<td>11 ± 13</td>
<td>6 ± 5†</td>
<td>21 ± 18</td>
</tr>
<tr>
<td>Total calorie, cal/kg/d</td>
<td>115 ± 10</td>
<td>114 ± 12</td>
<td>112 ± 14</td>
</tr>
<tr>
<td>Weight gain, g/d</td>
<td>20 ± 9</td>
<td>27 ± 11†</td>
<td>14 ± 4</td>
</tr>
<tr>
<td>Length gain, cm/wk</td>
<td>0.9 ± 1.3</td>
<td>2.1 ± 1.5†</td>
<td>0.6 ± 0.8</td>
</tr>
<tr>
<td>Head circumference gain, cm/wk</td>
<td>.1 ± 0.7</td>
<td>1.4 ± 1.0</td>
<td>0.8 ± 0.9</td>
</tr>
</tbody>
</table>

*Mean ± SD in the interval between resumption of enteral feedings and attainment of 150 mL/kg/day of enteral feedings.
†Treatment group received early enteral fat supplement and fish oil.
‡P < .05 treatment vs control.

Yang et al J Peds 2014;165:274-9
Supplements

• Duocal Powdered carbohydrate ®
  – Hydrolyzed cornstarch 73% Fat supplement 22% (35% MCT)
  – Added to formulas to increase the caloric density
  – 42 kcal/Tablespoon

• Microlipid® (100% LCT)
  – Safflower oil
  – 67.5 kcal/tbsp

• Liquigen®
  – Emulsified MCT
  – 67.5 kcal/tbsp
Fiber

- Soluble fiber is fermented by colonic bacteria
  - Short chain fatty acids; acetate, butyrate, propionate
    - Colonocyte fuel/health
    - Enterocyte proliferation
    - Water and sodium resorption
- Delays gastric emptying
- Decreases gut transit
- Increase fluid absorption decreasing fluid losses

Fiber

- **Green beans/Pectin**
  - Case series using green beans in 3 children with sbs with increase form in their stool
  - Retrospective cohort SBS/IF n=18 with reduction in stool number and increase in consistency with addition of green beans
  - Stage 2 green beans 1 jar/240 ml of formula

- **Benefiber®**
  - Guar gum (Benefiber®)
    - RCT in persistent diarrhea decreased duration in children receiving hydrolysed guar gum in chicken diet

Outline

• Understand the advantages and limitations of carbohydrates, fats, and proteins

• Develop regimens to introduce solid foods

• Recognize the optimal timing to refer to a multidisciplinary feeding clinic
"It wasn't an easy decision for me to make. Lots of coin tossing went into it."
Oral Nutrition

• Underlying intestinal physiology
  – Remnant length
  – Motility disturbances
  – Ileum vs jejunum
  – $B_{12}$ deficiency, bile acid diarrhea
    • MCT
  – Colonic resection
    • Pectin/Benefiber®/Green beans
  – Milk protein allergies
### Table 1. Diet and Fluid Suggestions in Older Children and Adults with Short Bowel Syndrome (24, 32)

<table>
<thead>
<tr>
<th></th>
<th>Colon Present</th>
<th>Colon Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>50–60% of caloric intake</td>
<td>40–50% of caloric intake</td>
</tr>
<tr>
<td></td>
<td>Complex carbohydrates</td>
<td>Complex carbohydrates</td>
</tr>
<tr>
<td>Fat</td>
<td>20–30% of caloric intake</td>
<td>30–40% of caloric intake</td>
</tr>
<tr>
<td></td>
<td>Ensure adequate essential fats</td>
<td>Ensure adequate essential fats</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>LCT</td>
</tr>
<tr>
<td>Protein</td>
<td>20–50% of caloric intake</td>
<td>20–30% of caloric intake</td>
</tr>
<tr>
<td></td>
<td>High biologic value</td>
<td>High biologic value</td>
</tr>
<tr>
<td>Fiber</td>
<td>Net secretors</td>
<td>Net secretors</td>
</tr>
<tr>
<td></td>
<td>Soluble</td>
<td>Soluble</td>
</tr>
<tr>
<td>Oxalate</td>
<td>Restrict</td>
<td>–</td>
</tr>
<tr>
<td>Fluids</td>
<td>ORS and/or hypotonic</td>
<td>ORS</td>
</tr>
</tbody>
</table>

MCT; medium-chain triglycerides, LCT; long-chain triglycerides, ORS; oral rehydration solution.

DiBaise et al. *Am J of Gastro* 2004;99;1823-1832
Introduction of foods

• Starches
  – Complex carbohydrates but maybe bland
  – Milk free cereal (Beechnut or Earth’s Best)

• Meat
  – Protein absorption in stomach and proximal small intestine

• Vegetables
  – Green beans-pectin
  – Beneficial in the setting of a colon

• Foods to avoid
  – Milk protein in allergic patients
  – Juices
  – Fruits
Taste

- Short bowel syndrome
  - Spicy
  - Sharp
  - Salty
- Tend to avoid bland foods
  - cereals
Outline

• Understand the advantages and limitations of carbohydrates, protein, and fat

• Develop regimens to introduce solid foods

• Recognize the optimal timing to refer to a multidisciplinary feeding clinic
Normal progression of feeding skill acquisition:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast / Bottle only</td>
<td>0-4 mos</td>
</tr>
<tr>
<td>Smooth puree by spoon</td>
<td>4-6 mos</td>
</tr>
<tr>
<td>Soft chewables and cup</td>
<td>6-8 mos</td>
</tr>
<tr>
<td>Mashed table food</td>
<td>8-12 mos</td>
</tr>
<tr>
<td>Chopped table food</td>
<td>12-18 mos</td>
</tr>
</tbody>
</table>

*Development of Swallowing and Feeding: Prenatal through First Year of Life*  
*Delaney & Arvedson, Dev Dis Res Rev, 2008*
Taste/Easting

• Oral feedings
  – Physiologic
    • Pleasurable, part of culture
    – Secretion of GI trophic factors
    – Minimizes feeding disorders
    – Introduced as soon as medically stable
      • Dipping pacifier into formula

• Non-nutritive sucking appears to facilitate development of sucking behavior and may improve the transition from tube to bottle feedings

Oral Feedings

Oral Aversion

- May be a direct result from prolonged intubation, nasogastric tube feedings, hospitalizations
- Eating is not pleasurable and maybe associated with very negative feelings
- Solids are typically introduced 4-6 months (corrected for gestational age)
  - Significant delay in SGS patients
- Small amounts of formula on pacifier to try to minimize
Speech Therapist

• Evaluate child’s oral motor skills
• Must be able to master suck/swallow/breathe sequence or unable to advance
  – Breast or bottle feed** foundation of all eating
  – Forward and backward tongue movements

• Spoon feed
  – Close their lips and draw food into the mouth and subsequently to the back of their mouth

• Table foods
  – Move tongue to side of the mouth and place food onto their molars
Oral Aversion

• Occupational Therapist
  – Evaluate your child’s ability to process sensory information
  – Create a treatment program to help improve tolerance of sensory input
  – Helps parents to understand and be able to help the child enjoy feedings
Timing of referral

• Depends on your resource availability
• Expertise in eating/feeding disorders ASAP
  – Speech Therapist
  – Occupational Therapist
• GI MD
  – Vomiting
    • Milk protein allergy
    • Delayed gastric emptying/motility disorder
  – Choking and gagging
  – GER
Specialized Feeding teams

• MDs
  – GI, ENT, general pediatrician
  – Ensure no other medical problem is contributing to the feeding disorder

• Speech Therapist
  – Feeding disorders that pertain to oral motor skills and swallowing

• Occupational Therapist
  – Sensory processing disorder or feeding disorder

• Registered Dietician
  – Nutritional needs

• Behavioral Psychologist
  – Guide caretakers with their interaction during meals
Nutritional and Psychosocial Outcomes of Gastrostomy Tube–Dependent Children Completing an Intensive Inpatient Behavioral Treatment Program


51% weaned by 2 weeks off g-tube feedings
Additional 12% by 1 year

**FIGURE 2.** Longitudinal nutritional status of study participants.

Silverman et al. JPGN 2013:57:668-72
Conclusion

• Underlying pathophysiology of the patient
  – Remnant length
  – Colonic resection

• Foods
  – Vegetables, meats
  – Avoid high sugar containing foods
  – Spicy, salty

• Oral Aversion
  – Common in these patients
  – Speech Therapy/Occupational Therapy
  – Multidisciplinary Feeding Teams beneficial if available