Short Gut Syndrome

Carlos U. Corvera M.D.
Associate Professor
Department of Surgery
Chief, Liver, Biliary and Pancreatic Surgery
University of California, San Francisco School of Medicine

Overview

- Etiology and Pathophysiology
- Intestinal adaptation
- Medical Management – rehabilitation
- Surgical Management
- Intestinal transplantation
- The UCSF program

Definition = Intestinal Failure

- Short Bowel Syndrome = Intestinal failure from inadequate length of bowel
- A condition in which inadequate digestion and/or absorption of nutrients leads to malnutrition and/or dehydration
- Inability of the native gastrointestinal tract to provide nutritional autonomy

Incidence and Prevalence

- 3-4/million in western countries eventually develop intestinal failure
- It occurs in ~ 15% of pts undergoing intestinal resxns
  - ¾ occur from massive resxns
  - ¼ from multiple sequential resxns
- ~70% pts with SBS are d/c from the hospital & ~ 70% of these remain alive one year later.
- Improved Survival is due to ability to deliver long-term nutritional support.

Nightingale J, ed. Intestinal Failure. 2001
Fishbein TM et al. Gastroenterology 2003;124:615
Messing B. et al Gastroenterology 1999; 117:1043-50
**Etiology**

- Conditions requiring intestinal resection -> SBS from series of N = 210 cases.
  - Postoperative bowel obstruction (25%)
  - Irradiation/cancer (24%)
  - Mesenteric Vascular disease (22%)
  - Chron’s Dz (16%)
  - Other benign causes (13%)
- Manifestations of SBS are caused by:
  1. Loss of absorptive surface area
  2. Loss of site-specific transport processes
  3. Loss of site-specific endocrine cells and gastrointestinal (GI) hormones
  4. Loss of the ileocecal valve


**Pathophysiology**

- **INTESTINAL REMNANT LENGTH** is the primary determinant of outcome.
- Resection of up to ½ of the SB is generally well tolerated.
- SBS is most likely to develop in patients losing > 2/3 length of SB.
- “Critical” number is < 120 cm of intestine w/o colon, and 60 cm with colon continuity.
- Preserve the ileocecal jxn—improves function of remnant.


**Pathophysiology**

- Besides Malabsorption of Macro and Micro nutrients, this leads to water and electrolyte malabsorption.
- Large fluid/electrolyte losses (weeks)
- Fewer fluid and electrolyte problems; need for nutritional support (1 year)
  - TPN weaning?


**Normal Intestinal Function**

- Macronutrients
  - Macroglycans
  - Monosaccharides
  - Amino acids
  - Water soluble vitamins
- Micronutrients
  - Vitamins
  - Minerals
  - Trace elements

*Feldman’s GastroAtlas online*
### Macronutrients

<table>
<thead>
<tr>
<th></th>
<th>Colon present</th>
<th>Colon absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>Complex carbohydrate 30-35 kcal/kg per day</td>
<td>Variable 30-35 kcal/kg per day</td>
</tr>
<tr>
<td></td>
<td>Soluble fiber</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>MCT/LCT 20%-30% of caloric intake ± low fat/high fat</td>
<td>LCT 20%-30% of caloric intake ± low fat/high fat</td>
</tr>
<tr>
<td>Protein</td>
<td>Intact protein 1.0-1.5 g/kg per day ± peptide-based formula</td>
<td>Intact protein 1.0-1.5 g/kg per day ± peptide-based formula</td>
</tr>
</tbody>
</table>

* Buchman AL et al. Gastroenterology 2003;124:1111

### Micronutrients

<table>
<thead>
<tr>
<th>Vitamin A</th>
<th>10000-50000 units daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B₁₂</td>
<td>300 µg subcutaneously monthly</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>200-500 mg</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>1600 units DHT daily (25-OH- or 1,23 (OH₂)-D₃)</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>30 IU daily</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>10 mg weekly</td>
</tr>
<tr>
<td>Calcium</td>
<td>As needed</td>
</tr>
<tr>
<td>Magnesium</td>
<td>As needed</td>
</tr>
<tr>
<td>Iron</td>
<td>60-100 µg daily</td>
</tr>
<tr>
<td>Selenium</td>
<td>220-440 mg daily (sulfate form)</td>
</tr>
<tr>
<td>Zinc</td>
<td>As needed</td>
</tr>
<tr>
<td>Bicarb</td>
<td>As needed</td>
</tr>
</tbody>
</table>

* Buchman AL et al. Gastroenterology 2003;124:1111

### Intestinal Adaptation

- The SB is able to compensate for loss of absorptive SA
- The process takes 1-2 yrs.
- Dependent on enteral nutrients
- Changes in structure, motility and function.
  - **Structural**: involves all layers of the intestine
  - **Motility**: motor adaption is more prominent in jejunum than ileum, disruption of motility occurs for a few months following resx
  - **Functional**: adaption results in improved absorption by individual enterocytes. This process is facilitated by structural and motor adaptation increased intestinal transit time.
- **Exact mechanism remains unknown, but related to SITE and EXTENT of resx
- **IA is greatest with extensive resx and ileum has the greatest capacity.**
- **IA is influenced by GI regulatory peptides, growth factors, hormones, cytokines, etc.**
- **Blunted adaptation**: Active Crohn’s, radiation enteritis, carcinoma, pseudoobstruction

* DiBaise JK et al., Am J Gastroenterol 2004;99:1386
* Buchman AL et al. Gastroenterology 2003;124:1111
**Medical Management**

- **Early management:** Critically ill in post-op setting
  - Control of sepsis, maintenance of fluid and electrolyte balance
  - TPN is required early.
  - Initiation of enteral nutritional support is important.
- For pts that survive the early phase, goals are to maintain adequate nutritional status and prevent complications.

**MAINTENANCE OF NUTRITIONAL STATUS BECOMES THE PRIMARY GOAL.**

- Fluid and electrolytes losses are high in post-op period.
  - Oral rehydration solution = Glucose polymer-base rehydration salts (active transport)
  - Antisecretory agents (PPI)
  - Antimotility agents
  - Cholestyramine and octreotide have all been used to control diarrhea

*Niv Y. Am J Gastroenterology*

---

**Treatment of Steatorrhea**

- Fat maldigestion is due to BA malabsorption when >100 cm of TI is resxned.
- Treatment: Bile Acid (cholesarcosine), or BA sequestering agent-cholestyramine- binds BAs
  - Cholestyramine can bind other medications.
- Treat with low-fat, high CHO diet
  - Low fat diet helps with steatorrhea, but decreases energy consumption.
  - MCT are absorbed in the colon, and may help with increasing energy consumption.

*Woolf GM et al Gastroenterology 1983; 84;823-8*

---

**Pharmacologic Options**

- Antisecretory, antimotility agents
- Antibiotics for overgrowth
- Growth hormone-improves intestinal absorption.
- Glucagon-like peptide II (GLP-II)?
- (Glutamine supplementation? Glutamine and glucose: preferred fuel of enterocytes)


*Jepsen PB et al. Gastroenterology 2006; 130(2 suppl 1):S127-31*
Home Parental Nutrition

- TPN should be compressed volume and time of infusion. (preferably over night)
- Tapered over 30-60 min to avoid hypoglycemia.
- Complications;
  - Avoid line sepsis (0.3/ year)
  - Line thrombosis

Wooff GM et al Gastroenterology 1983; 84:823-8

Complications & Treatment

- In Pts on long-term TPN, control of sepsis and liver disease will dictates long-term outcome.
- ESLD occurs in ~ 15 of patients on TPN
  - Reversible early, but not late stages-> Severe Steatosis & Cirrhosis.
  - Avoided by maximizing calories given by enteral route.
  - Ursodeoxycholic acid might help.
- Other Metabolic complications:
  - Cholelithiasis (30-40%) from bile stasis. (CCK, or Chole)
  - Renal calculi from Calcium Oxalate stones. (Cholestyramine)
  - Gastric Hypersecretion from parietal cell hyperplasia. (PPI)
  - Bacterial overgrowth from dysmotility (Intestinal Abxs)

Non-Transplant Surgical Management

- Increase absorptive Capacity-
- Preserving existing intestine-
  - Avoid reresxn, if necessary end-to-end anastomosis
- Improving function by improving motility & slowing intestinal transit.
- Improving motility which ↓ w/ ↑ bowel dilation.
  - The intraluminal pressure is ↓ resulting in poor peristalsis.
Improving Intestinal Motility

Tapering Enteroplasty

- Preferred Methods:
  - Imbrication of the redundant bowel.
  - Longitudinal transection and removal of part of the circumference of the intestine along the antimesenteric border.


Techniques in Prolonging Intestinal Transit

- Reversed intestinal segments: ~ 80% success
  - Goal = slowing transit time.
  - Optimal length ≤ 10 cm
  - Place in distal bowel
- Intestinal Valves:
  - External constriction, segmental denervation or intussusception of intestinal segment.
  - Intussuscepted valves ~ 2 cm in length.
- Colonic Transposition: helps absorb water & electrolytes and decreases transit.


Increasing Absorptive Surface Area

Bianchi Procedure

- Pt selection - Dilated intestinal segment, bacterial overgrowth.
- Stapler is from Alternating directions.
- Less complicated than Bianchi Procedure.
- Improves absorptive capacity in ~ 90% pts.
- Complications:
  - Leak and obstruction ~20%


Increasing Absorptive Surface Area

Serial Transverse Enteroplasty (STEP)

- Pt selection - Dilated intestinal segment, bacterial overgrowth.
- Stapler is from Alternating directions.
- Less complicated than Bianchi Procedure.
- Improves absorptive capacity in ~ 90% pts.
- Complications:
  - Leak and obstruction ~20%
Intestinal Transplantation
• Therapy for patient with life-threatening complications of intestinal failure.
• Types:
  – Isolated intestinal transplantation
  – Combined liver and intestinal transplantation

Intestinal Transplantation
• Indications:
  – TPN related complications: i.e. liver disease.
  – Irreversible permanent TPN requirement along with episodes of sepsis
  – Irreversible permanent TPN requirement with loss of venous access

Intestinal Transplant Registry
Outcomes

Database
- Number of centres: 61
- Number of transplants: 989
- Number of patients: 923
- Current survivors: 484
Intestinal Transplant Registry Outcomes

Intestinal Transplants by Year

Discharged Patients
Length of Stay (Days)

<table>
<thead>
<tr>
<th>Tx Type</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intestine (336)</td>
<td>59.8 ± 62</td>
<td>43</td>
<td>8 – 477</td>
</tr>
<tr>
<td>Intestine + Liver (248)</td>
<td>77.1 ± 72</td>
<td>59</td>
<td>15 – 827</td>
</tr>
<tr>
<td>Multivisceral (110)</td>
<td>79.7 ± 71</td>
<td>55</td>
<td>8 – 532</td>
</tr>
</tbody>
</table>
**UCSF Program**

- Multidisciplinary team
- Outpatient and inpatient
- Intestinal rehabilitation
- TPN management
- Intestinal transplantation
- Gastric neurostimulator for refractory gastroparesis

**UCSF Program**

<table>
<thead>
<tr>
<th>Nursing</th>
<th>Gastroenterology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betsy Haas-Beckert</td>
<td>Sue Rhee</td>
</tr>
<tr>
<td>Christine Mudge</td>
<td>Uri Ladabaum</td>
</tr>
<tr>
<td>Claudia Praglin</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrition</th>
<th>Surgery</th>
<th>Administrative Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheryl Davis</td>
<td>Sang-Mo Kang</td>
<td>Cindy Huynh</td>
</tr>
<tr>
<td>Viveca Ross</td>
<td>Shen Hirose</td>
<td></td>
</tr>
</tbody>
</table>

**Pharmacy**

<table>
<thead>
<tr>
<th>Pharmacy</th>
<th>Social Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Quan</td>
<td>Wendy Kahn</td>
</tr>
</tbody>
</table>

**UCSF Program**

877-sm-bowel  
(877-762-6935)  
Fax referrals: 415-353-8917