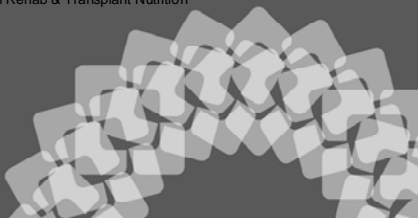


# The Clinical Approach to SBS Management

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January 31, 2009



I have no commercial relationships to disclose.



## Presentation Overview

- Intestinal Rehab & Transplant Program
- Definition & Pathophysiology of SBS
- Dietary & Medical Intervention
- Transitional Feedings
- Patient Monitoring & Micronutrient Repletion



## Intestinal Rehab & Transplant Program (IRTP)

To enhance absorptive capacity, improve nutritional status, and reduce need for PN through the use of:

- Diet
- Medications
- Additional fiber
- Growth factors
- Oral rehydration solutions
- Reconstructive surgery
- Enteral Nutrition
- Small bowel or multivisceral transplant



## SBS Management within an IRTP Improves Survival

### Center for Advanced Intestinal Rehabilitation (CAIR) of Children's Hospital Boston

- Dedicated staff in surgery, gastroenterology, nutrition, pharmacy, nursing and social work

### Inpatient and Outpatient Medical Record Review

- Control group: 30 severe SBS patients treated between 1998 and 1999
- Study group: 64 severe SBS patients treated between 1999 and 2008 and managed by CAIR

Modi et al. J Ped Surg. 2008; 43:20-24



## SBS Management within an IRTP Improves Survival

o Survival in pts not able to wean off PN

- Control group: 90% died
- CAIR cohort: 33% died
- (P < .01)

Table 4 Comparison of the CAIR cohort to a historical cohort reported previously [3]

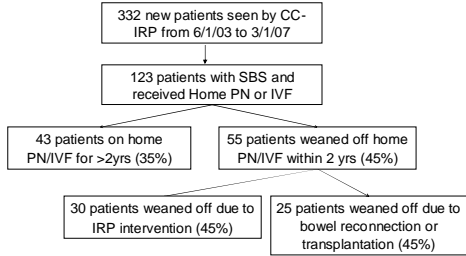
Variable	Historical Group (n = 30)	CAIR cohort (n = 54)	P
Diagnosis of NEC, n (%)	13 (43)	16 (30)	NS
Residual bowel length (cm)	83 ± 67	70 ± 36	NS
Peak direct bilirubin (mg/dL)	9.0 ± 7.4	8.1 ± 7.9	NS
Enteral autonomy at follow-up, n (%)	20 (67)	36 (67)	NS
Duration of PN (d)	606 ± 719	475 ± 1026	NS
Ileocecal valve preserved, n (%)	17 (54)	23 (49)	NS
Mortality, n (%)	9 (30)	6 (11)	<.05

Values are expressed as n (%) or mean (SD).

Modi et al. J Ped Surg. 2008; 43:20-24



### Early Referral to an IRTP Improves Outcomes in SBS Patients on Home PN or IVF

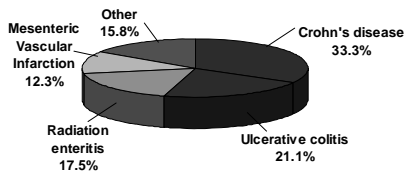


Parekh NR. Xth International SB Transplant Symposium, Santa Monica, CA, Sept 2007.

### Early Referral to an IRTP Improves Outcomes in SBS Patients on Home PN or IVF

Characteristic	Weaned Off (N=55)	On PN/IVF >2yrs (N=43)	P
Age (yrs)	53.0	57.0	0.17
Gender (Female/Male)	32/23	33/10	0.054
Diagnosis (Crohn's/Non-Crohn's)	33/22	20/23	0.18
<b>SB length (&lt; 90cm)</b>	<b>7</b>	<b>20</b>	<b>&lt;0.001</b>
Ileocecal Valve	5	3	0.99
Colon (< 50%)	33	34	0.027
<b>Rectum/Anus</b>	<b>43</b>	<b>19</b>	<b>&lt;0.001</b>
<b>Months on PN/IVF</b>	<b>4.6</b>	<b>81.6</b>	<b>&lt;0.001</b>
<b>Months from start PN/IVF to 1st IRP visit</b>	<b>0.3</b>	<b>53.1</b>	<b>&lt;0.001</b>

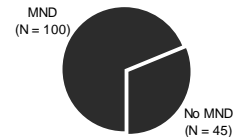
### Diagnoses Leading to SBS in an Adult IRTP



Parekh NR. *Gastroenterology*, 2006; 130(4, S2): A-605.

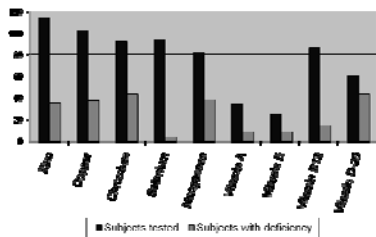
### Presenting Symptoms

- Severe malabsorption
- Malnutrition
- Recurrent dehydration
- Electrolyte abnormalities
- Vitamin/mineral deficiencies
  - 69% of patients with IF have at least 1 micronutrient deficiency (MND)



Chhatrivalia EG. "Factors Associated with Micronutrient Deficiency in Intestinal Failure." ASPEN Scientific Poster, Chicago, IL, Feb 2008.

### Micronutrient status in SBS



Chhatrivalia EG. "Factors Associated with Micronutrient Deficiency in Intestinal Failure." ASPEN Scientific Poster, Chicago, IL, Feb 2008.

### Nutrient Intake from Habitual Oral Diet

- 19 SBS patients living in southeast US
- On TPN for ~31 months
- Mean residual SB 118cm with varying amounts of residual colon
- Very little previous dietary instruction
- 7-day food recall with detailed RD-conducted interviews
- 7-day admission to GCRC for balance studies to assess intestinal nutrient absorption

Estivariz CF. *Nutrition*, 2008; 24: 330-339.

## Nutrient Intake of SBS Patients - Results

- Average oral intake:
  - 2650 kcal (~39 kcal/kg/day)
  - 92 g fat (35% of total daily oral energy intake)
  - 120 g protein (~1.4 g/kg/d)
  - 346 g CHO (42% simple sugar)
  - 2700 ml fluid (49% of total daily oral + IV fluid intake)
- Intake did not meet RDA for:
  - Fat soluble vitamins, B6, B12, C, folate, iron, calcium, magnesium, and zinc
  - Only 37% of patients were taking an oral multivitamin/mineral supplement

Estivariz CF. Nutrition. 2008; 24: 330-339.

## Severity of intestinal failure by intestinal nutrient absorption in patients with short bowel syndrome\*

	Oral intake	GI output	% GI absorption
Energy (kcal)	2656 ± 242	1143 ± 149	59 ± 3
Fat (g)	92 ± 11	58 ± 9	41 ± 5
Nitrogen (g)	17 ± 2	9 ± 1	42 ± 5
Carbohydrate (g)	346 ± 31	90 ± 15	76 ± 3
⇒ Fluid (mL)	2712 ± 240	2192 ± 282	18 ± 10 ⇐
⇒ Sodium (mEq)	207 ± 17	202 ± 32	6 ± 12 ⇐
Potassium (mEq)	100 ± 11	58 ± 8	38 ± 7
⇒ Calcium (mg)	1190 ± 158	1165 ± 118	-7 ± 8 ⇐
Phosphorus (mg)	1441 ± 132	948 ± 390	30 ± 6
⇒ Magnesium (mEq)	26 ± 3	25 ± 4	2 ± 8 ⇐

GI, gastrointestinal

\* Data are presented as mean ± SEM (n = 19). The %GI absorption was calculated with the formula: (oral intake – intestinal output)/oral intake) × 100.

Estivariz CF. Nutrition. 2008; 24: 330-339.

## Conclusions

- Subjects under-reported oral intake of total kcals, fluid, and macronutrients
- Authors concluded that the types of foods and fluids usually consumed by SBS patients are likely to worsen malabsorption and thus increase PN requirements
- Study underscores importance of thorough review of oral intake as well as referral to IRTP for complete diet instruction, optimal medical intervention and potential PN weaning

Estivariz CF. Nutrition. 2008; 24: 330-339.

## IRTP Consultation

2-3 hrs for initial assessment, 1 hr for follow up

- Remaining anatomy
  - Recent GI testing
  - Surgical & pathology reports
- Diet history
  - Oral intake
  - TPN, EN, IVF
- Bowel function
  - Quantitative
  - Qualitative
- Medications
  - Current vs. past
- Weight history
- Labs/Physical Exam
  - Vitamins/Minerals/Electrolytes
  - Hydration Status
- Assessment
  - Nutrition/medical status
- Care Planning
  - Extensive diet counseling
  - Enteral/parenteral nutrition
  - Vitamin/mineral/electrolyte repletion
  - Medications to enhance absorption
  - Further GI testing
  - Restorative surgery
  - Referral for transplantation

## Bowel Length and PN Dependency in SBS

High risk for long-term home PN if...

< 30 cm SB to entire colon

< 65 cm jejunum to partial colon

< 100 cm SB without colon



Carbonnel et al. JPEN. 1996; 20:275-280.

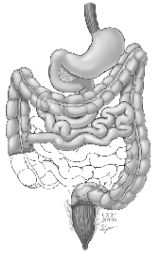
## Anatomical Considerations Jejunal Resection



- Adequate absorption unless >75% resected
- Preserved absorption of B<sub>12</sub> and bile salts
- Good ileal adaptation
- Normal transit
- In most cases will not need PN

Jeejeebhoy KN. CMAJ. 2002; 166:1297-1302.

## Anatomical Considerations: Ileal Resection



- Adequate calorie and fluid absorption if  $\geq 60$  cm jejunum to colon
- Malabsorption of bile salts, vitamin B<sub>12</sub>
- Poor jejunal adaptation
- Rapid intestinal transit
- Small bowel bacterial overgrowth

Messing B. Gastroenterol. 1999; 117:1043-1050.

## Anatomical Considerations: Extensive Bowel Resection

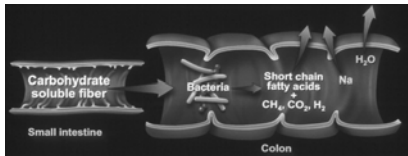


- Large fluid losses
- Nutrient malabsorption
- Poor jejunal adaptation
- Acid hypersecretion
- Rapid gastric emptying
- Rapid intestinal transit
- $\geq 100$  cm SB to avoid PN

Wilmore D. Best Pract Res Clin Gastroenterol. 2003; 17:895-906.

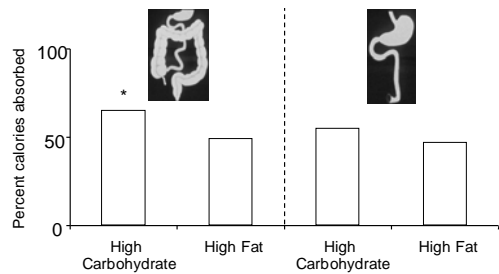
## Carbohydrate Salvage

- Undigested carbohydrates and soluble fiber are fermented by colonic bacteria into short chain fatty acids (SCFAs)
  - Used as an additional source of energy
  - Enhance sodium and water absorption
  - Stimulate mucosal adaptation in SB and colon

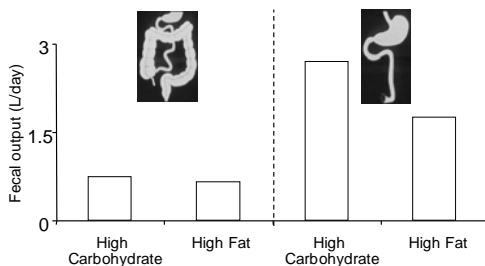


Jeppesen et al. JPEN. 1999; 23:S101-S105.

## Diet Based on Presence of Colon



## Diet Based on Presence of Colon



## Dietary Management: Treating the Symptoms



- Rapid transit
  - Small frequent meals
  - Reserve fluids for sipped between meals
- Impaired absorption and increased losses
  - Encourage hyperphagia
- Osmotic diarrhea
  - Minimize simple sugars (high osmotic load)
  - Maximize complex carbohydrates
  - Add salt

## Dietary Modification

### WITH COLON

- CHO 50-60% (limit sweets)
- PRO 20%
- FAT 20-30%
- Meals 5-6 daily
- Avoid oxalates
- Isotonic fluids
- Fiber as tolerated
- Lactose as tolerated

### NO COLON

- CHO 40-50% (limit sweets)
- PRO 20%
- FAT 30-40%
- Meals 4-6 daily
- Oxalates: no restriction
- Isotonic, high Na fluids
- Fiber as tolerated
- Lactose as tolerated

Byrne et al. NCP 15:306-311, 2000

## Simple vs. Complex CHO

### AVOID

- Sugar
- Candy
- Cakes, cookies, pies
- Regular soda pop
- Jelly, jam, syrup
- Ice cream, sherbet
- Sorbet
- Sugar-containing supplements



### INCLUDE

- Pasta
- Potato
- Breads
- Cereals
- Rice
- Whole grains as tolerated
- Fruits and vegetables as tolerated



## Fiber in SBS: Soluble vs. Insoluble

	Soluble	Insoluble
Example	Pectins, gums	Soy polysaccharides
Fermentation	Yes	No
SB Transit	Slows (viscous gel formation)	Slows (adds bulk to trigger ileal brake) <sup>1</sup>
Absorption	↑ fluid/electrolyte uptake, may ↓ macronutrient/mineral uptake	No effect on macronutrient absorption <sup>1</sup> , may ↑ fluid/electrolyte losses <sup>2</sup>
Adaptation	Enhances <sup>3</sup>	Enhances <sup>4</sup>
Quantity	~ 20 g/d	~ 30 g/d

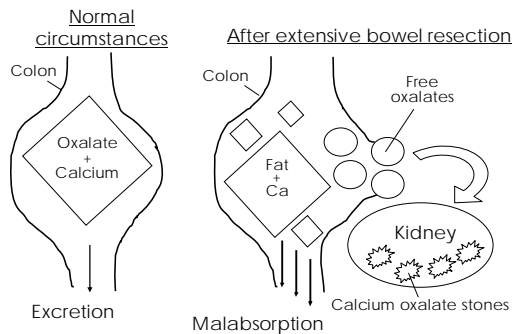
1. Lien et al. *Am J Clin Nutr.* 1996;63:584-595.

2. Rodrigues et al. *Aliment Pharmacol Therap.* 1989;3:159-169.

3. Koruda et al. *JPEN.* 1986;10:343-350.

4. Michail et al. *J Pediatr Gastroenterol Nutr.* 1997;24:140-145.

## Oxalate Nephrolithiasis

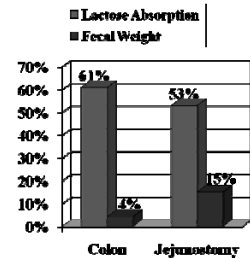


## Low Oxalate Diet

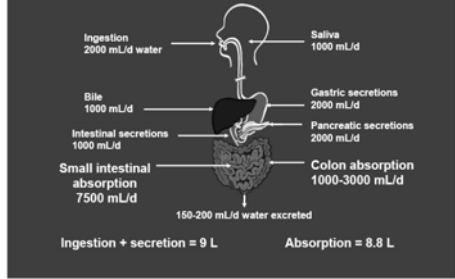
Food Group	Food to Avoid
Starches	Bran, whole wheat
Fruits	Berries, grapes, citrus, plums, prunes
Vegetables	Beans, greens, spinach, squash, tomato
Beverages	Black tea, instant coffee, draft beer
Other	Chocolate, cocoa, tofu, soy, nuts

## Do SBS Pts Need a Lactose-Free Diet?

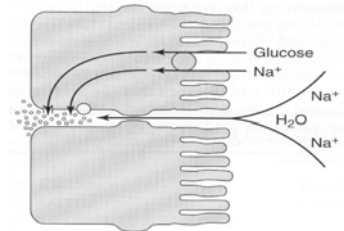
- 14 SBS pts
  - 8 with colon
  - 6 with jejunostomy
- 20 g/d lactose diet vs. lactose-free diet
- Lactose malabsorption in both groups
- Only slight ↑ in fecal weight and no sx of intolerance
- BUT, lactose-rich diet limited milk to 3oz/day



## Fluid Secretion and Absorption



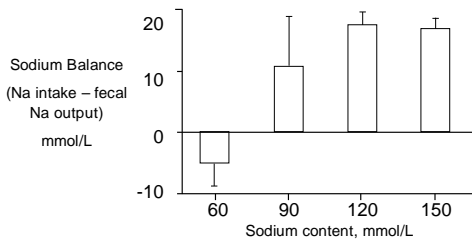
## Oral Rehydration Solutions



Sodium-glucose Co-transport

## Oral Rehydration Solutions

Sodium balance with Short Bowel Syndrome



Rodriguez CA, et al. Clin Sci. 1988;74(suppl18):69.



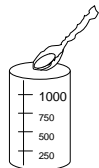
## Oral Rehydration Solutions

	Na (mMol/L)	Carbohydrate* (g/L)	Osmolality (mOsm/kg)
WHO-ORS	90	20	310
Rice-based	70	20	260
Pediatric solution	50	20	270
Sports Drink	20	60	380
Ginger ale	3	90	540
Apple juice	3	124	730
Chicken broth	250	0	450

\*All contain glucose except rice-based solution

## Home Recipe for ORS

- 1 liter water
- ¾ teaspoon table salt
- 4 tablespoons sugar (sucrose)
- 1 teaspoon baking powder (or ½ teaspoon baking soda)
- ½ teaspoon 20% potassium chloride (by prescription)
- Sugar-free artificial flavoring/sweetener to taste



Alternative: 1 liter Gatorade G2 + ½ tsp salt

## Medications for SBS and Intestinal Failure

- Antidiarrheals
- H<sub>2</sub> blockers
- Proton pump inhibitors
- Pancreatic enzymes
- Antimicrobials
- Bile acid therapy
- Somatostatin analogue
- Probiotics
- α<sub>2</sub>-adrenergic receptor antagonist
- Growth hormone
- Glucagon-like peptide 2

## Antidiarrheal Therapy

To increase intestinal transit time

Medication	One dose	Starting dose	Max dose
<b>Loperamide</b> (Imodium)	2 mg (5 mL)	1 to 2 tablets (5 to 10 mL) PO QID	8 tablets (40 mL)/d
<b>Diphenoxylate</b> (Lomotil)	2.5 mg (5 mL)	1 to 2 tablets (5 to 10 mL) PO QID	8 tablets (40 mL)/d
<b>Codeine elixir</b> <b>Tylenol # 3</b> <b>w/codeine</b>	15 mL 15, 30, 60 mg	15 to 30 mL PO QID 15 mg PO QID	180 mL/d 360 mg/d
<b>Opium</b> <b>Tincture</b>	0.3 mL (6 drops)	6 to 20 drops (0.3 to 1 mL) PO QID	120 drops (6 mL)/d

\* All antidiarrheal meds should be given ½ hr to 1 hr before meals

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## Anti-secretory Agents

To reduce gastric acid secretion

- **Hypersecretion**
  - Occurs immediately after intestinal resection
  - Possibly r/t ↓ in intestinal inhibitory hormones (CCK and somatostatin)
  - Impairs fat digestion and absorption
  - Continues for up to 6 months post-rxn
- **H<sub>2</sub> blockers**
  - Famotidine (Pepcid)
  - Ranitidine
  - Cimetidine
- **Proton pump inhibitors**
  - Omeprazole (Prilosec)
  - Lansoprazole (Prevacid)
  - Esomeprazole (Nexium)

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## Treatment of Secretory Diarrhea

> 800 mL/d output while NPO

- **Somatostatin analogue: Octreotide**
  - Via PN: 300mcg/day (up to 900mcg/day)
  - Injection: 100mcg sq TID or Octreotide LAR 20mg IM monthly or bimonthly
- **α<sub>2</sub>-adrenergic receptor antagonist: Clonidine**
  - Inhibits GI motility, increases Na and H<sub>2</sub>O absorption, and reduces GI secretions
  - 0.2mg PO BID resulted in decreased rectal outputs from ~ 4L/d to ~1.5L/d in 2 SBS pts with high intestinal outputs

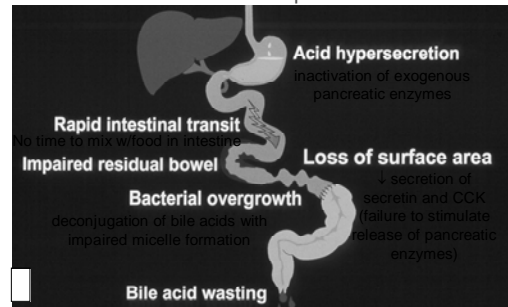
McDoniel et al. JPEN 2004; 28:265-268

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## Why Pancreatic Enzymes?

Mechanisms of Fat Malabsorption



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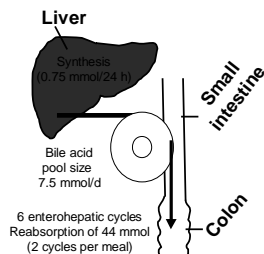
## Enterohepatic Circulation of Bile Acids

### • Bile acid sequestrants

- Small ileal rxn + colon
- Cholestyramine 4g/d

### • Bile acid supplements

- Large ileal rxn + colon
- Cholylsarcosine 6g/d



Hofmann AF. Clin Gastroenterol. 1977;6:3-24.

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## Small Bowel Bacterial Overgrowth

### • Cause: Impaired peristalsis due to

- Post-surgical SB inflammation and dilatation
- Loss of ICV, loss of terminal ileum
- Changes of adaptation

### • Symptoms: Excessive gas, odor, bloating, diarrhea

### • Diagnosis: Hydrogen breath testing, SB biopsy

### • Treatment:

- Antimicrobials (Flagyl, Cipro, Bactrim, Keflex, etc.)
- Rotate over the first 7-10 days of each month to avoid resistance

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## Probiotics

- Active (live) human-derived organisms:  
Lactobacillus, Bifidobacteria, etc.
- Promote beneficial bacterial flora
- Examples: Culturelle, Align, VSL #3, Primal Defense 1-3 caps/d
- Benefits controversial: relatively small #'s of probiotic orgs are actually able to grow in the GI tract following their administration

## PRBCT's on Probiotics in SBBO

Trial	Subjects	Probiotic	Result
Stotzer et al. 1996	14 pts w/ SBBO <sup>1</sup>	L. fermentum KLD	No Δ in breath H <sub>2</sub> , stool freq, or sx
Gaon et al. 2002	22 pts w/ SBBO <sup>2</sup>	L. casei and L. acidophilus	Sig ↓ in breath H <sub>2</sub> and stools, no Δ in sx
Galpin et al. 2005	119 kids w/ enteritis	Lactobacillus GG	No Δ in intestinal integrity (sugar absorption tests)

<sup>1</sup> SBBO due to gastric surgery, pSBO, radiation enteritis, etc.  
<sup>2</sup> SBBO due to surgical blind loops, strictures or pSBO

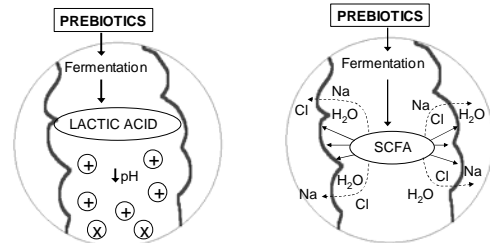
Stotzer et al. Scand J Inf Dis. 1996; 28:615-619.  
 Gaon et al. Medicina. 2002; 62:159-163.  
 Galpin et al. Am J Clin Nutr. 2005; 82:1040-1045.

## Prebiotics Fructooligosaccharides (FOS)



- Chain polymers of the sugar fructose
- Water-soluble and non-digestible
- Naturally occurring in Jerusalem artichokes, onions, garlic, oats, barley, rye, bananas
- **Oligofructose**: FOS used in Europe and Japan as a sugar-substitute
- **Inulin**: a longer chained FOS compound derived from chicory

## Colonic Fermentation of Prebiotics

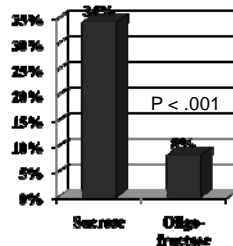


Lactic acid decreases colonic pH to support growth of beneficial bacteria ( + ) and discourage growth of potentially harmful bacteria ( X ) in the intestinal tract.

Short-chain fatty acids (SCFA) provide fuel for the colonic mucosa and enhance the absorption of water and electrolytes in the colon.

## Prebiotics Reduce Diarrhea Relapse Rate in C diff Colitis

- Randomized, controlled study
- 142 pts w/c diff colitis
- 12g oligofructose vs. 12g sucrose per day for 30 d
- Abx: flagyl, vanco
- Tracked relapse of diarrhea for 60 d from dx



Lewis S et al. Clin Gastroenterol Hepatol. 2005; 3:442.

## The Effect of Synbiotics in SBS

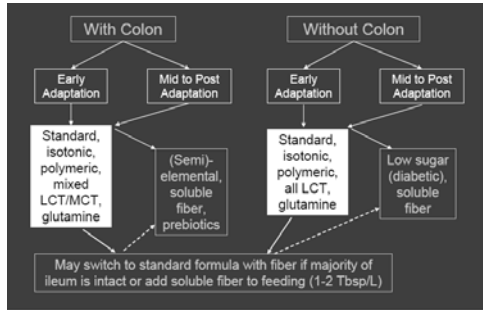
- **Synbiotics**: Probiotics + Prebiotics
- **Subjects**: 7 malnourished children with SBS and refractory enterocolitis tested for 1 year
- **Therapy**: Bifidobacterium breve, L. casei, galactooligosaccharides
- **Results**:
  - Improved intestinal flora
  - Increased SCFA's in feces
  - Accelerated wt gain in 6 pts
  - Increased serum proteins in 5 pts



Kanamori et al. J Ped Surg. 2004; 39:1686-92.



## Enteral Formula Selection in SBS



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## Enteral Nutrition in SBS: Formula Delivery

- **Route**
  - **Gastric:** maximizes absorptive surface area, controls delivery of nutrients to SB
  - **Jejunal:** if necessary, feed as proximal as possible
- **Rate**
  - **Continuous:** ↓ GI distress, enhances absorption, promotes adaptation through slow delivery and constant saturation of mucosal transport proteins
    - start at 10-20 mL/hr and advance by 20 mL/hr every 24 hrs
  - **Intermittent:** if necessary, use very small and frequent amounts
    - 100 – 200 mL q 2-4 hrs

Goulet et al. *J Ped Gastroenterol Nutr*. 2004; 38:250-269.  
Vanderhoof et al. *Best Pract Res Clin Gastroenterol*. 2003;17:997-1015

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## Nocturnal Enteral Rehydration

- 3 cases of IF or SBS dependent on PN or IVF
- Diet and meds optimized → all remained PN/IVF dependent
- One to four liters of rehydration (i.e. WHO, ORS) given via overnight continuous drip through enteral feeding tube → all were weaned off of PN/IVF

WHO: World Health Organization rehydration salts, Jianas Bros, Kansas City, MO, 816-421-2880  
ORS: Oral Rehydration Solution (3 T sugar + 1 tsp salt + 1 liter water)

Nauth et al. *Nutr Rev*. 2004; 62 (5):221-231

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## Transitioning from PN to EN

- Wean PN when pt tolerating 50% or more of goal EN (reduce to 1/2, then D/C at goal EN)
- If PN cycled over 8-12 hrs, wean by reducing number of days per week on PN (non-concurrently)
- May try to cycle EN overnight when goal rate achieved
- Antidiarrheals: orally, bolus through feeding tube, or mix directly with enteral formula prior to administration in open systems

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## Intake and Output Record Keeping

Patient Name \_\_\_\_\_  
RTP Physician \_\_\_\_\_  
RTP Dietitian \_\_\_\_\_

The Cleveland Clinic Foundation  
**INTESTINAL REHAB & TRANSPLANT PROGRAM**  
Daily Intake/Output Record  
FAX to: 216-636-1529  
Intestinal Rehab & Transplant Program  
or SEND to: 8900 Euclid Avenue A490  
Cleveland, OH 44195

Date					
Wt (lbs.)					
Goal Wt (lbs.)					
Temperature					
<b>INTAKE (ml)</b>					
Oral Fluid					
PN					
TPN					
IV Fluid					
<b>TOTAL INTAKE</b>					
<b>OUTPUT (ml)</b>					
Urine					
Stoma					
<b>OTHER OUTPUT (ml)</b>					
GT	JT	PEG			
Drain	Fistula				
Empic	Diarrhea				
<b>TOTAL OUTPUT</b>					
Urine Glucose (mmole)					
Accu Check					

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## Transitioning off Parenteral Nutrition

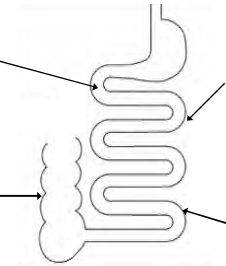
- ✓ Weight stability or edema-free wt gain
- ✓ Adequate urine output (at least 1000 mL/d)
- ✓ Adequate fluid intake (daily oral/enteral fluid intake at least 500 to 1000 mL > daily stool output)
- ✓ Adequate oral/enteral caloric intake (at least 80% of estimated daily requirements)
- ✓ Stable BUN and creatinine or normal urine osmolarity and urine Na concentration
- ✓ Stable electrolyte status
- ✓ Intact serum proteins, vitamins, minerals

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## Sites of Absorption in GI Tract

**Duodenum**  
amino acids,  
mono- and  
disaccharides,  
iron, selenium  
folate, copper



**Jejunum**  
monosaccharides,  
a.a.'s, lipids, A-D-  
E-K, Ca, PO<sub>4</sub>, Mg,  
zinc, chromium,  
H<sub>2</sub>O and lytes

**Colon**  
H<sub>2</sub>O, Na, Cl,  
K, bile salts

**Ileum**  
Vitamin B<sub>12</sub>,  
intrinsic factor,  
bile salts, H<sub>2</sub>O  
and lytes

## Supplement Form

- Pill or capsule
- Chewable tablets
- Liquid
- 2-3 x's normal dose
- Intramuscular (IM)
  - Magnesium sulfate (2 to 4 g IM once or twice/wk)
  - Vitamin B<sub>12</sub> (1,000 µg IM monthly)



## Common Orally-Supplemented Micronutrients in SBS

Nutrient	Strength	Dose
Vitamin A-D-E	25,000 IU of A 1,000 IU of D 400 IU of E	1 tab PO daily
Calcium	500mg tab	2 to 6 tabs PO TID
Magnesium lactate	84mg tab	3 to 6 tabs PO TID
Potassium chloride	20mg tab	1 to 2 tabs PO daily
Sodium bicarbonate	1mL = 1mEq NaHCO <sub>3</sub>	10 mL PO TID
Chromium	100 µg tab	1 to 3 tabs PO TID
Copper	3 mg tab	1 to 2 tabs PO daily
Zinc sulfate	220 mg tab	1 to 3 tabs PO daily

## Dosing of Commonly Depleted Vitamins

Vitamin	Range	Dose
<b>Vitamin D 25 Hydroxy (31-80)</b>	>20-30 or up	Ca (500-600) with Vit D 400 IU TID
	15-20	50,000 IU 1x/week
	10.0-15.0	50,000 IU 2x/week
	<10	50,000 IU 3x/week
<b>Vitamin B12 (221-700)</b>	221-300	1000mcg IM once monthly
	175-221	1000mcg IM twice monthly
	<175	1000mcg IM four times monthly
<b>Vitamin A (20 - 120)</b>	50-120	5000 IU/day
	20-50	10,000 IU/day
	10.0-20.0	20,000 IU/day
	<10	30,000 IU/day

## Dosing of Commonly Depleted Electrolytes

Electrolyte	Range	Dose
<b>Magnesium (1.7-2.6)</b>	1.5	Start with 3 tabs nightly
	1.2-1.5	1 tab 1 hr after meals & 3 tabs nightly
	<1.2 (not symptomatic)	2 tabs 1 hr after meals & 3 tabs nightly
*MagTab (84mg elemental magnesium) = 7 mEq magnesium		
<b>Calcium (8.5-10.5)</b>	8.5-10.0	1000mg/day
	8.0-8.5	2000mg/day
	7.0-8.0	3000mg/day
<b>Potassium (3.5-5.0)</b>	3.4-3.6	20 mEq 1x/day
	3.1-3.3	20 mEq 2x/day
	<3.0	20 mEq 3x/day
	Critical Value	Symptomatic? Admit for repletion

## Initial Laboratory Monitoring

- CMP
- Phosphorus
- Magnesium
- CBC
- Zinc
- Copper
- Chromium
- Selenium
- Manganese
- Vitamin A
- Vitamin E
- Vitamin D25
- Vitamin B12
- Folate
- Prealbumin
- CRP
- Citrulline
- Iron, TIBC, Ferritin

## Patient Monitoring

Upon return to clinic

	Baseline	Daily	Weekly	Monthly	3 – 6 mos
Weight	X			X	
24-hr urine & stool output	X				X
Dietary intake	X			X	X
Medications				X	X
Electrolytes			X	X	X
Serum proteins, vitamins & trace elements					X
Anthropometrics & functional status				X	X



## Optimal Management of Intestinal Failure

