

Diet in Short Gut Syndrome

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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

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
 - Gastroschisis
- **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

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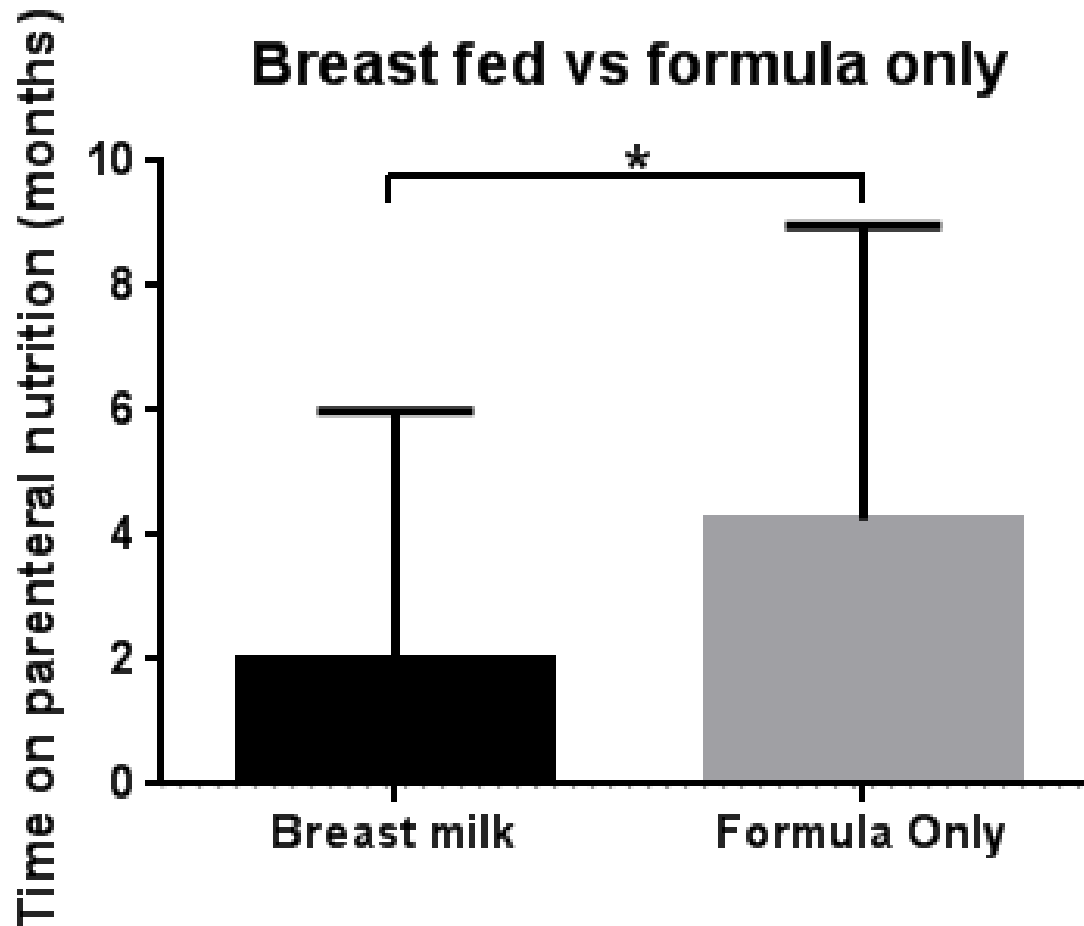
Breast Milk

- 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

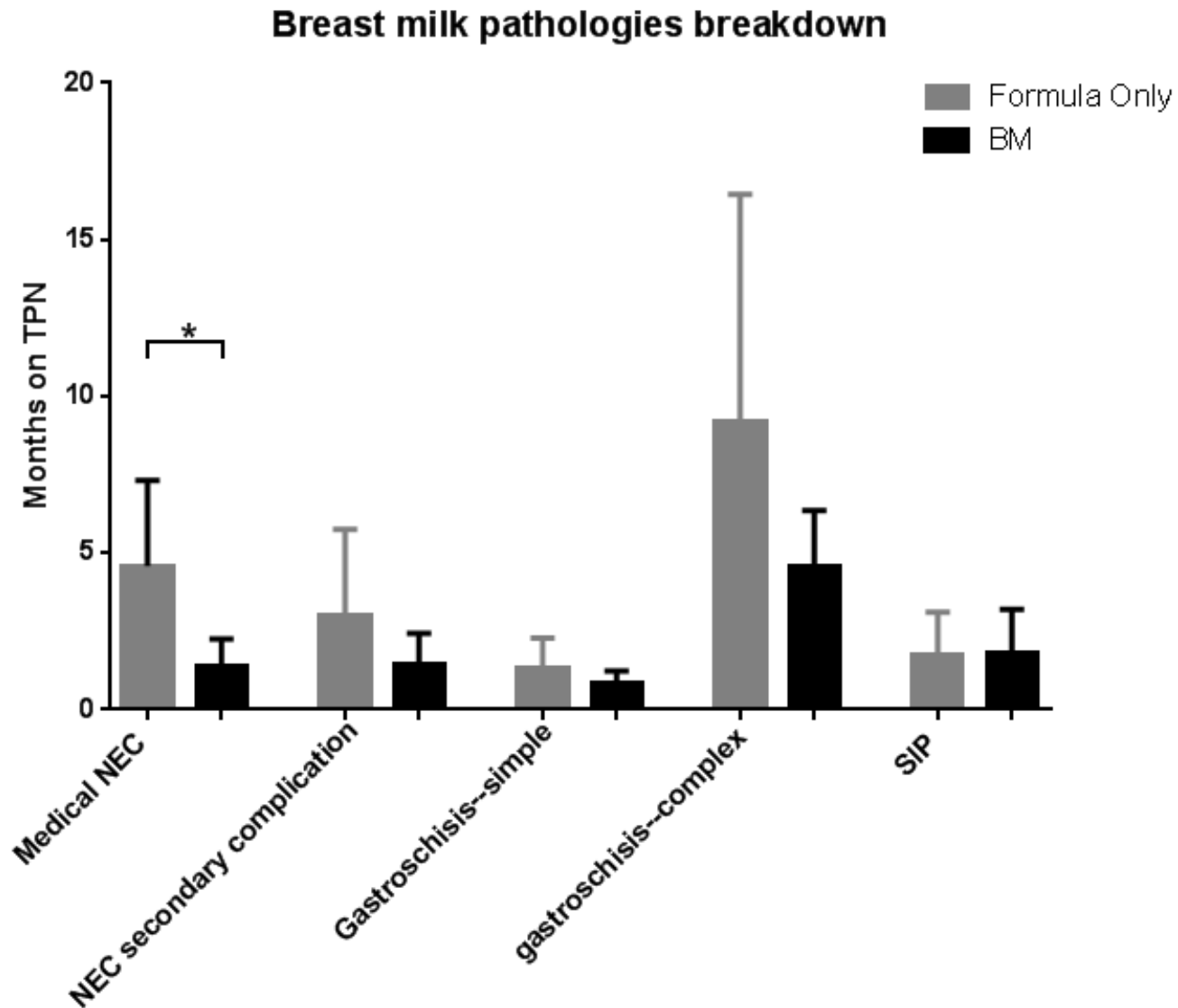


Squires et al *J Pediatr* 2012;161:723-8, Andorsky et al. *J Pediatr* 2001: 139:27-33,

PIFCON



Choquette et al abstract PIFRS 2014



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 setting 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

Andorsky et al. *J Pediatr* 2001; 139:27-33, Bines et al. *JPGN* 1998; 27(5):614-616, Degreeef et al *Journal of Nutrition and Metabolism* 2010, Kaufman et al *J Pediatr* 1997;131:356-61

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

DiBaise et al. *Am J of Gastro* 2004;99;1823-1832, Jeppesen and Mortensen. *Gut* 1998;478-483

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*

Infants	All		High ostomy	
	Control (n = 17)	Treatment [†] (n = 18)	Control (n = 6)	Treatment (n = 8)
Hyperalimentation, d	13 ± 17	10 ± 13	27 ± 23	16 ± 18
Intravenous lipid, d	11 ± 13	6 ± 5 [‡]	21 ± 18	7 ± 7 [‡]
Total calorie, cal/kg/d	115 ± 10	114 ± 12	112 ± 14	117 ± 13
Weight gain, g/d	20 ± 9	27 ± 11 [‡]	14 ± 4	23 ± 5 [‡]
Length gain, cm/wk	0.9 ± 1.3	2.1 ± 1.5 [‡]	0.6 ± 0.8	2.2 ± 1.6 [‡]
Head circumference gain, cm/wk	.1 ± 0.7	1.4 ± 1.0	0.8 ± 0.9	1.2 ± 0.8

*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.

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

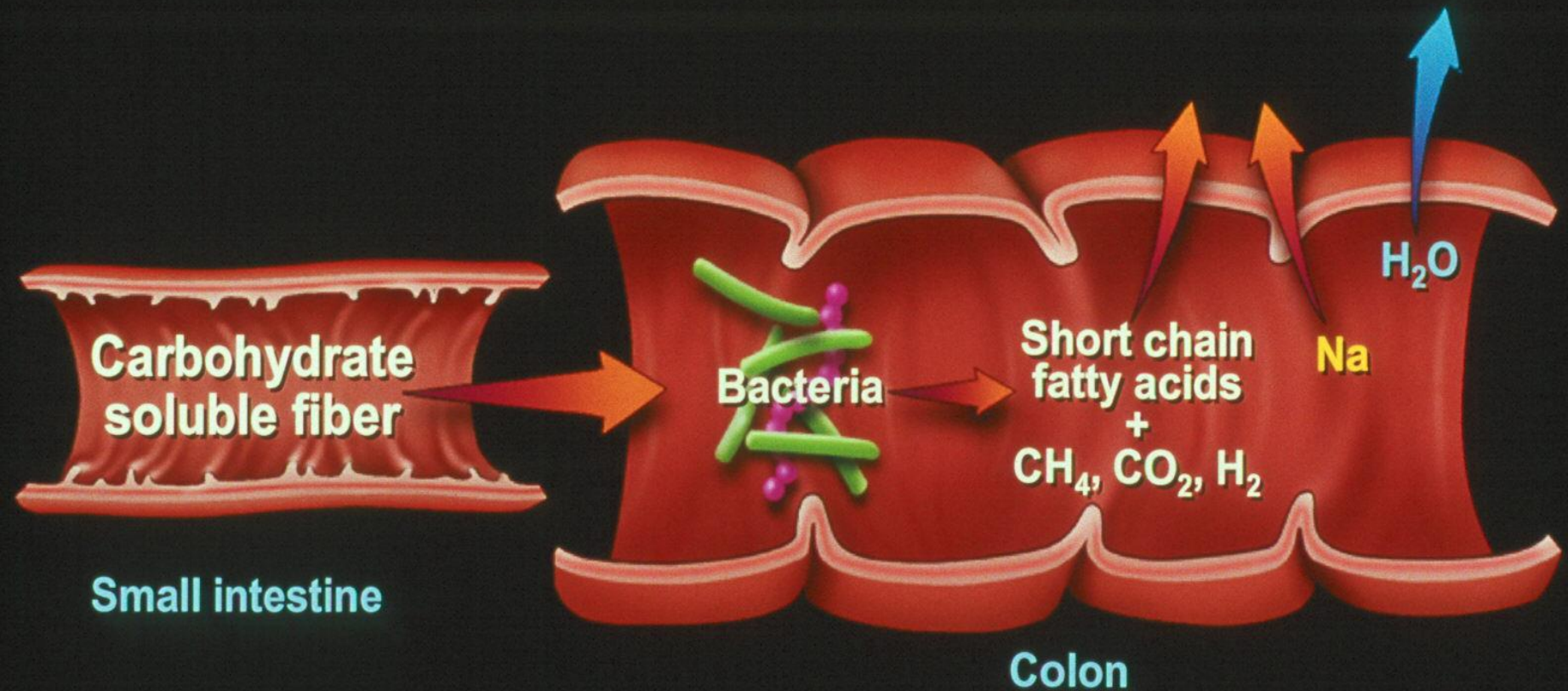


Fiber

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



Carbohydrate Salvage



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

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**"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
 - B₁₂ 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)

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

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

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



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Normal progression of feeding skill acquisition:

Breast / Bottle only	0-4 mos
Smooth puree by spoon	4-6 mos
Soft chewables and cup	6-8 mos
Mashed table food	8-12 mos
Chopped table food	12-18 mos



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

Taste/Eating

- 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

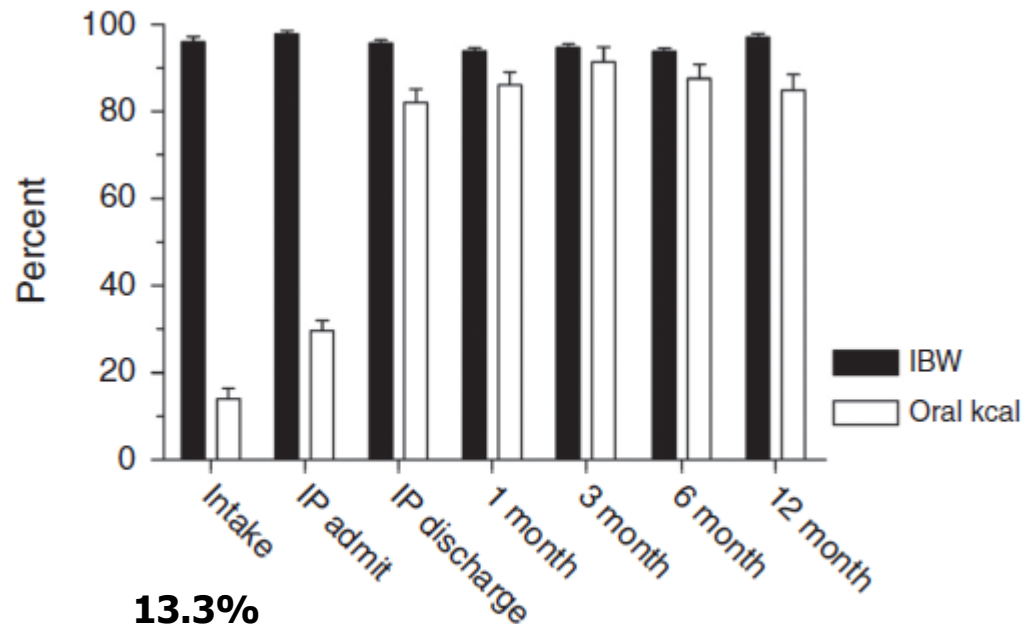
- Depends on your resource availability
- Expertise in eating/feeding disorders ASAP
 - Speech Therapist
 - Occupational Therapist
- GI MD
 - Vomiting
 - Milk protein allergy
 - Delayed gastric emptying/motility disorder
 - Choking and gagging
 - GER

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

**Alan H. Silverman, *Midge Kirby, *Lisa M. Clifford, †Elizabeth Fischer,
‡Kristoffer S. Berlin, *Colin D. Rudolph, and *Richard J. Noel*



51% weaned by 2 weeks off g-tube feedings

Additional 12% by 1 year

FIGURE 2. Longitudinal nutritional status of study participants.

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