Enteral Nutrition for the Pediatric Patient

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COURSE DIRECTOR

Debora Duro, MD, MS
Salah Foundation Children Hospital at
Broward Health, Fort Lauderdale, Florida
NOVA Southeastern University and
Florida International University

CO-CHAIR

Nicole Martin, RD, CSP, CD
Children's Wisconsin
Milwaukee, Wisconsin

FACULTY

Fatema Ali, MD
University of Tennessee Health Science Center
Memphis, TN

Stacey Beer, MPH, RD, LD CCTD
Texas Children's Hospital
Houston, TX

Paola Blanco, MD
University of Utah
Salt Lake City, UT

Katayoun Eslami, MD
University of Maryland Medical Centre
Baltimore, MD

Swetha Kotamraju, MD
Columbia University Irving Medical Center
New York, NY

Kara Ashby, MD, MPH
Stony Brook Children's Hospital
New York, NY

Michelle Binod, MD, MPH
UCLA Mattel Children's Hospital
Los Angeles, CA

Julie Buchholtz, MS, RDN, LD, CNSC
Mayo Clinic Children's Center
Rochester, MN

Christine Hoyer, MS, RD, CSP, CDN, CNSC
Morgan Stanley Children's Hospital
New York, NY

Catherine Larson-Nath, MD, CNSC
M Health Fairview Masonic Children's Hospital
Minneapolis, MN

FACULTY Cont'd

Veronica Lee, DO, MS
UPMC Children's Hospital of Pittsburgh
Pittsburgh, PA

Nicole Lidyard, RDN, LD
UH Rainbow Babies & Children's Hospital
Cleveland, OH

Tierra Mosher, MD
Lucille Packard Children's Hospital
Palo Alto, CA

Nneka Ricketts-Cameron, RDN, LD
Arnold Palmer Hospital for Children
Orlando, FL

Tamara Sims-Dorway, RDN, CSP, LD
Arnold Palmer Hospital for Children
Orlando, FL

Julia Leone, MS, RDN, LDN
Holtz Children's Hospital
Miami, FL

Lynn Mattis, RN, MSN
Johns Hopkins Hospital
Baltimore, MD

Sara Nandolia, DO
Johns Hopkins Children's Center
Baltimore, MD

Kate Samela, MS, RD, CSP
Connecticut Children's
Hartford, CT

Alexandria Speakman, DO
Cincinnati Children's Hospital Medical Center
Cincinnati, OH

Faculty Disclosure

Fatema Ali	None
Kara Ashby	None
Stacey Beer	Speaker's Bureau: Abbott Nutrition
Michelle Binod	None
Paolo Blanco	None
Julie Buchholtz	None
Debra Duro	Speaker's Bureau: Alcresta, Kate Farms, Abbott Nutrition, Fresenius Kabi
Katayoun Eslami	None
Christine Hoyer	None
Swetha Kotamraju	None
Catherine Larson-Nath	None

Faculty Disclosure – Cont'd

Veronica Lee	None
Julia Leone	None
Nicole Lidyard	None
Nicole Martin	None
Lynn Mattis	None
Tierra Mosher	None
Sara Nandolia	None
Nneka Ricketts-Cameron	None
Kate Samela	None
Tamara Sims-Dorway	None
Alexandria Speakman	None

Abbreviations

Aa: amino acid AgRP: Agouti-Related Peptide ARA: Arachidonic acid ASPEN: American Society for Parenteral and Enteral Nutrition ATP: Adenosine triphosphate	**B**M BPD: Bronchopulmonary dysplasia BTF: Blenderized tube feedings BW: Birth weight	**C**al: Calorie CART: Cocaine- and amphetamine-regulated transcript CBC: Complete blood count CD: Crohn's disease CDED: Crohn's disease exclusion diet CF: Cystic fibrosis CFTR: Cystic fibrosis transmembrane conductance regulator CHO: Carbohydrate CITREM: Citric acid ester of mono & diglycerides CKD: Chronic Kidney Disease CMP: Comprehensive metabolic panel CP: Cerebral palsy
DBM: Donor breast milk DHA: Docosahexaenoic acid DME: Durable medical equipment supplier DRI: Dietary reference intakes DS: Down syndrome	**E**BM: Expressed breast milk EEN: Exclusive enteral nutrition EN: Enteral Nutrition ETF: Enteral tube feeding EVOO: Extra virgin olive oil	**F**: Female FOS: Fructo-oligosaccharides Fr: French

Abbreviations – Cont'd

GA: Gestational age G: Gram GER: Gastroesophageal Reflux GI: Gastrointestinal GGT: Gamma-glutamyl transferase GJ: Gastrojejunal GOS: Galactooligosaccharides GRV: Gastric residual volume GT: Gastrostomy tube	**H**MF: Human milk fortifier HMO: Human milk oligosaccharides Hr: Hour	**I**BD: Inflammatory bowel disease ICV: Ileocecal valve IF: Intestinal failure IFALD: Intestinal failure associated liver disease IM: Intramuscular IV: Intravenous
J: Jejunostomy	**K**: Potassium	**L**CT: Long-chain triglycerides LFTs: Liver function tests
M: Male MD: Mediterranean diet MCT: Medium-chain triglycerides mEq: Milliequivalent MFGM: Milk fat globule membranes MOM: Mother's own milk MUAC: Mid upper arm circumference	**N**EC: Necrotizing enterocolitis syndrome ND: Nasoduodenal NG: Nasogastric NI: Neurological impairment NJ: Nasojejunal NKFA: No known food allergies NPY: Neuropeptide Y	**O**G: Orogastric

Abbreviations – Cont'd

PEG: Percutaneous endoscopic gastrostomy PEN: Partial enteral nutrition PERT: Pancreatic enzyme replacement therapy PKU: Phenylketonuria POMC: Pro-opimelanocorticon PN: Parenteral Nutrition PPI: Proton pump inhibitor PVC: Polyvinyl chloride PUFA: Polyunsaturated fatty acid	**S**SBS: Short bowel syndrome SCD: Specific carbohydrate diet	**U**CD: urea cycle disorders UC: Ulcerative colitis
WNL: Within normal limits		

Course Sections

1. Enteral Nutrition (EN) Overview
2. EN Delivery Modes and Tubes
3. EN Components
4. Principles of Designing and Monitoring EN Support
5. EN Support in Special Populations

1. EN Overview

Cases

- A 2-year-old patient with biliary atresia presents to the hospital with hematemesis. Is enteral nutrition indicated?

- A patient with short bowel syndrome has been weaned off parenteral nutrition for 5 years and currently is only on oral feeds but has stagnant growth. Is enteral nutrition indicated?

- A patient is admitted to the critical care unit and on 3 different vasoactive medications. Is enteral nutrition indicated?

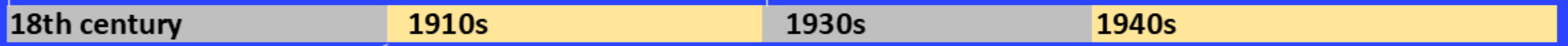
History of EN

Where and what to feed?

- Orogastric tube designed by John Hunter → transformed to nasogastric tube
- Rectal feeding → colonic absorption was widely debated
- Various foodstuffs → jellies, eggs with milk, sugar and water

Introduction of Modified Macronutrients

- Stengel and Ravdin designed mixture of skim milk, pepsin, electrolytes, with liver oil
- In 1939, evolved into 1st casein formula



Expansion of feeding routes

- Einhorn suggested small bowel feeding for those with orogastric feeding intolerance
- Anderson introduced jejunal feeding, inserted during surgery and continued up to 2400 kcal post-operatively
- Solution included dextrose, milk, whiskey, and coffee for stimulating effect

Research on EN and Patient Outcomes

- Co Tui treated 8 patients with high-energy jejunal casein hydrolysate feeds as part of research project
- Patients gained weight, had positive nitrogen balance, and spent half the time in recovery as controls
- 1949 → publication by Rose on essential amino acid requirements

Harkness L. *J Am Diet Assoc*. 2002 Mar;102(3):399-404.

History of EN - Cont'd

Increased Accessibility

- Increasing availability and manufacturing of commercial enteral products
- Hospital began looking into producing their own blenderized products

1950's | 1960s | 1970s

Development of Chemically Defined Formulas

- Large scale study on chemically defined diets by NIH in conjunction with Vivonex®
- Formulation of blended infant foods began to surface
- Supplies for tube feeding expanded

Further Advancement…

- Advanced understanding of nutrient needs and design of liquid formulas

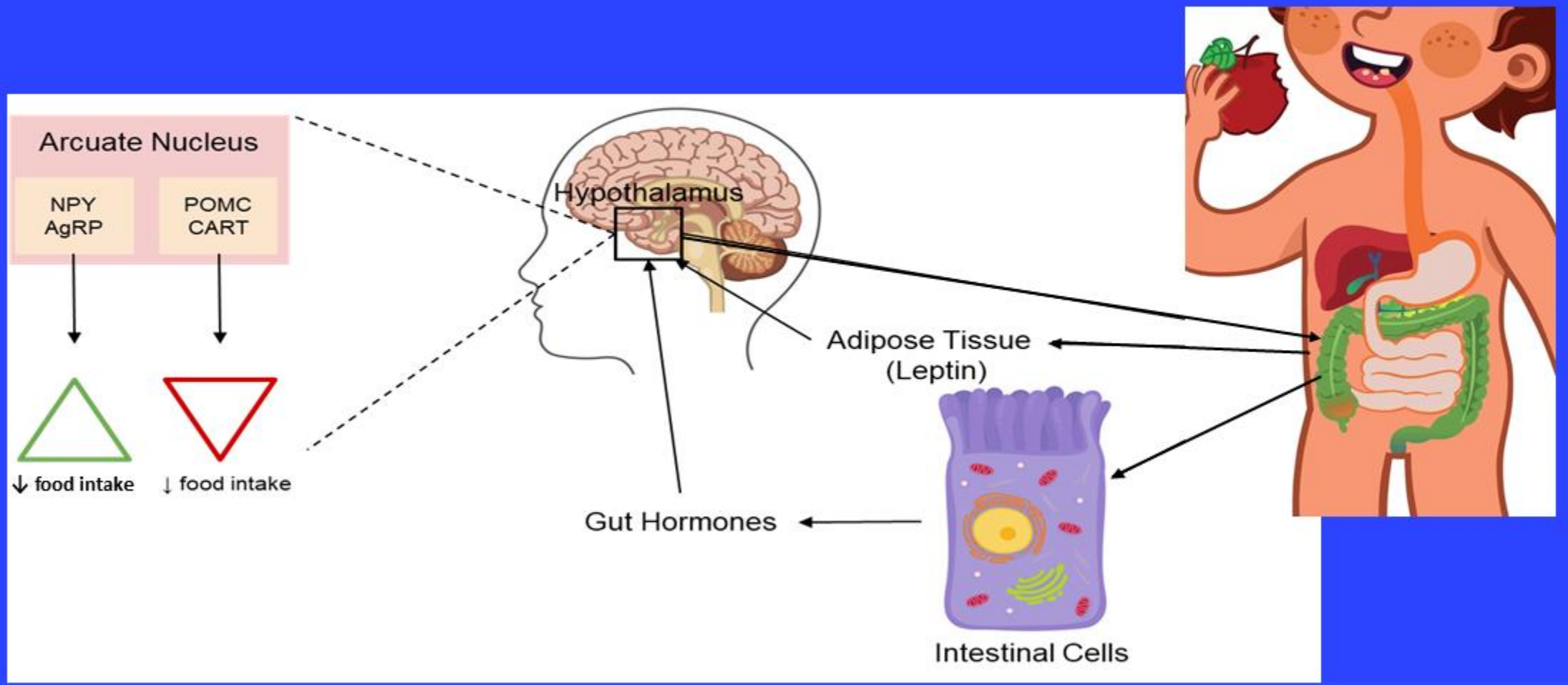
Harkness L. *J Am Diet Assoc*. 2002 Mar;102(3):399-404.

Appetite

- The ***desire*** to eat, which is then felt as hunger
- Regulated by a close interplay between the brain, digestive tract and adipose tissue
  - Hypothalamus acts as the control center for hunger and satiety
  - Peripheral peptides and proteins cross the blood-brain barrier into the arcuate/infundibular nucleus because this region is partially isolated from the barrier
- Two populations of neurons with respective neuropeptides
  - Stimulation of food intake
    - Neuropeptide Y (NPY)
    - Agouti-related peptide (AgRP)
  - Inhibition of feeding
    - Pro-opimelanocorticon (POMC)
    - Cocaine- and amphetamine-regulation transcript (CART)

Austin J, et al. *J Pediatr Endocrinal.* 2009;2009:141753.

Gut-Brain Axis – Regulation of Appetite



Adapted from Sam, Amir H. et al. *Neuropharmacology* 2012 Jul;63(1):46-56.

Causes of Decreased Appetite

- Chronic diseases causing anorexia or early satiety
  - Kidney disease (uremia and other metabolic derangements)
  - Gastrointestinal disorders
  - Cardiopulmonary disorders
- Discomfort or pain associated with eating
  - Peptic disease, dental caries, gingival disease, constipation, inflammatory bowel disease
- Medications
  - Anticonvulsant drugs, stimulants, chemotherapy
- Decreased palatability due to micronutrient deficiencies
  - Zinc deficiency, hyponatremia
- Stressful psychosocial conditions
  - Depression, anxiety, food insecurity
- Excessive intake of juice or other non-nutritious liquids

Kamat D. Quick Reference Guide to Pediatric Care, 3rd edition. 2024.

Pediatric EN

- EN refers to nutrition which bypasses the oral route and is fed directly into the gastrointestinal tract through a feeding tube
- Used in circumstances when a patient has a normal functioning gastrointestinal system but is unable to meet needs orally
  - If one has a functioning gastrointestinal system, EN is preferred over parenteral nutrition (PN)
- Requires regular monitoring due to the rapidly changing growth and development of the pediatric patient
  - Thorough nutritional assessment by a registered dietitian should be conducted to ensure all needs (macronutrients, micronutrients, and fluid) will be met

Pediatric Nutrition Care Manual®, accessed 12/20/2025 .
Boullata J, *et al*. *JPEN*. 2017;41:15-103.
Klepper CM, et al. *Nutr Clin Pract*. 2023;38:302-17.
Charney P, *et al.* Guide to Enteral Nutrition.2nd ed; 2013.
Delgado N, *et al.* Pediatric Nutrition Reference Guide. 13th ed;2022.
Cober MP, *et al. Am J Health-Syst Pharm*. 2019;76:1492-151.

EN versus Parenteral Nutrition

- EN is preferred over parenteral nutrition (PN) due to
  - Lower healthcare cost
  - Decreased hospitalizations (shorter length of stay, fewer readmissions)
  - Decreased risk for infectious complications (central line infection)
  - Preservation of gut barrier function
  - Maintaining activity of the gastrointestinal system (GI mucosal integrity, immunologic function)
- Note, in some circumstances both EN and PN will be used in combination to meet the patient's needs

Pediatric Nutrition Care Manual®, accessed 12/20/2025 .
Boullata J, *et al*. *JPEN*. 2017;41:15-103.
Klepper CM, et al. *Nutr Clin Pract*. 2023;38:302-17.
Charney P, *et al.* Guide to Enteral Nutrition.2nd ed; 2013.
Delgado N, *et al.* Pediatric Nutrition Reference Guide. 13th ed;2022.
Cober MP, *et al. Am J Health-Syst Pharm*. 2019;76:1492-151.

Indications for EN

- Patients with
  1) a functional gastrointestinal tract with appropriate length and absorptive capacity for nutrients AND,
  2) the inability to obtain adequate nutrition and hydration via the oral route without any contraindications to enteral nutrition
- Situations in which this occurs include
  - Oropharyngeal dysphagia (aspiration risks)
  - GI dysfunction or malabsorption
  - Early satiety
  - Increased caloric needs that surpass oral intake capability, i.e., critical care
  - Disease-related increased nutritional needs, including but not limited to: infant with low birth weight, altered intestinal anatomy, malignancy, immunodeficiency, infection, organ failure, chronic diarrhea, neurologic impairment

www.naspghan.org/files/documents/pdfs/training/curriculum-resources/nutrition/other%20guidelines.
www.aspenjournals.onlinelibrary.wiley.com/doi/epdf/10.1177/014860719301700401.

Absolute Contraindications for EN

- Obstruction of intestinal tract inhibiting appropriate transit, i.e., mechanical obstruction
  - Risk of perforation
- Ischemia of the intestines or severe ischemia of the mesentery
  - Risk of worsening bowel ischemia, necrosis, perforation
- Necrotizing Enterocolitis (NEC)
  - Risk of bowel necrosis, perforation, death
- Toxic megacolon
  - Risk of bowel perforation, death
- Perforated bowel
- Hemodynamic instability, i.e., shock, critical illness requiring high dose vasoactive medications

https://pmc.ncbi.nlm.nih.gov/articles/PMC5788946/?utm_source=chatgpt.com.
Goldstein JL, *et al. Gastrointest Endosc.* 2002;56:789-92.

Relative Contraindications for EN

- Colonic pseudo-obstruction
  - If no improvement in severe ileus over several days and patient at risk for toxic megacolon, may benefit from discontinuation
- Intractable vomiting or high-volume diarrheal output
  - Brief bowel rest may be indicated
- Intestinal failure secondary to ultrashort bowel syndrome
  - Insufficient absorptive capacity
- Active GI bleeding

https://pmc.ncbi.nlm.nih.gov/articles/PMC5788946/?utm_source=chatgpt.com.
Goldstein JL, *et al. Gastrointest Endosc.* 2002;56:789-92.

EN Considerations - Macronutrients

- Depending on calorie needs/formula volume required, protein intake from formula is generally higher than the Daily Recommended Intake
  - May be a concern for patients with CKD or other metabolic conditions
  - However, may better meet the needs of critically ill patients
- Modular additives can be added to EN regimens as needed to meet specific macronutrient needs
- Consider need for specialized formulas for specific diets (e.g., renal formula, metabolic formula)

Joffe A *et al*. Cochrane Database Syst Rev. 2016 May 27;2016(5):CD005144.
Davis, A *et al. J Parenter Enteral Nutr.* 1996;20:228-36.
Rolfe, M. *et al. Nutri Clin Pract.* 2003;18.469-75.

EN Considerations - Micronutrients

- Nutritionally complete formulas will meet the DRI for vitamins/minerals for certain age groups if minimum daily volume recommended for specific formula is provided
- When concentrating powdered formulas, micronutrients are also concentrated
  - Consider using products designed to provide increased calories (e.g., 1.5 kcal/mL or 2.0 kcal/mL formulas) as these products are formulated to meet increased macronutrient needs while still providing similar micronutrients as standard nutritionally complete formulas
- Diluting formulas will dilute both macronutrients and micronutrients
  - Consider using products designed to provide decreased calories (e.g., 0.6 kcal/mL formula) as these products are formulated to meet the needs of patients with decreased energy expenditure while still providing similar micronutrients as standard nutritionally complete formulas

Iacone R et *al. Nutr J.* 2016;15:30.

EN Considerations - Fluid

- Percent of free water in formulas may not meet maintenance fluid requirements
  - Additional water may need to supplemented via feeding tube (also known as water flushes)
- To calculate additional water required to meet fluid needs

Total maintenance fluid volume calculated minus
[(% free water of formula) X (daily volume of formula being provided)]

- Consider water flushes needed for medication administrations
- Fluid restrictions
  - Consider choosing an already concentrated formula (often labeled 1.5 kcal/mL or 2.0 kcal/mL) or concentrating powdered formulas

McNab S. *J Paediatr Child Health.* 2016;52:137-40.

Cases - Review

- A 2-year-old patient with biliary atresia presents to the hospital with hematemesis. Is enteral nutrition indicated?

No, one shall wait until bleeding has become controlled

- A patient with short bowel syndrome has been weaned off parenteral nutrition for 5 years and currently is only on oral feeds but has stagnant growth. Is enteral nutrition indicated?

Yes, poor growth and development is an indication for enteral nutrition

- A patient is admitted to the critical care unit and on 3 different vasoactive medications. Is enteral nutrition indicated?

No, risks and benefits should be weighed at the appropriate time for enteral nutrition once patient is hemodynamically stable

2. EN Delivery Modes and Tubes

Case

- 12-month-old female (9 mos CGA) with past medical history significant for prematurity, esophageal atresia, tracheoesophageal fistula, BPD, and feeding difficulties. Parents report intermittent vomiting, but overall vomiting is improving.
- GJ tube placed 10 months ago
  - Remains on continuous GJ tube feeds over 16 hours from 7pm- 11am
  - Taking small amounts of fruit and vegetable purees 4 times per day while off tube feeds
- On elemental infant formula mixed to 26 kcal/oz; NKFA
- ***Nutrition Concern:*** Parents are interested in condensing overnight feeds and trying some bolus feeds during the day to increase time off feeding pump and encourage regularly scheduled meals; Weight gain has slowed down since last office visit; asking about need for increasing calories;
  - Weight: 7.44 kg (weight/age z-score: -0.98)
  - Length: 66.8 cm (length/age z-score of CGA: -1.71)
  - Weight for Length Z score: -0.05
- Medications: Pepcid, Infant multivitamin with iron
- Labs: CMP and CBC WNL from previous admission

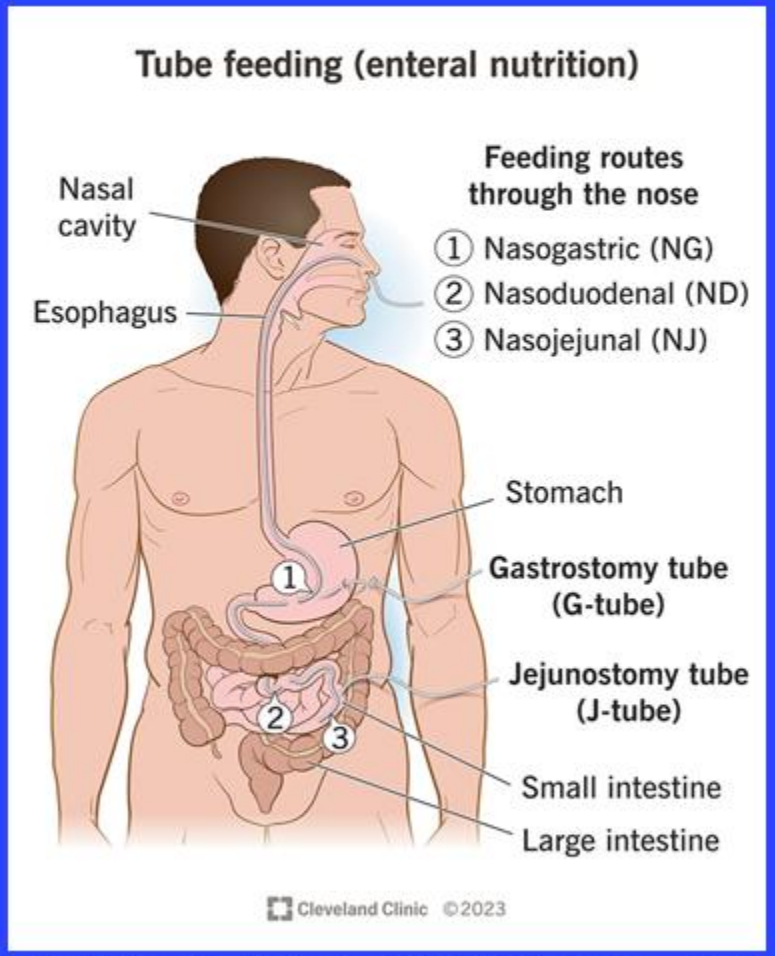
EN Access Considerations

- Utilize in patients with a functioning GI tract
- Determining the appropriate route of feeding and type of feeding tube requires consideration of
  - patient history
  - patient anatomy and unique GI function/dysfunction
  - potential feeding regimen and type of formula or feeding composition, etc.

Axelrod D, *et al. J Parenter Enteral Nutr.* 2006;30:S21-6.

EN Feeding Routes

- Intragastric (tubes at that allow feeding into the stomach)
  - Orogastric
  - Nasogastric
  - Gastrostomy
- Transpyloric/Small Bowel (tubes that allow feeding beyond the stomach)
  - Nasoduodenal
  - Nasojejunal
  - Gastrojejunal
  - Jejunostomy



https://my.clevelandclinic.org/health/treatments/21098-tube-feeding--enteral-nutrition.

https://my.clevelandclinic.org/health/treatments/21098-tube-feeding--enteral-nutrition.

Nasogastric (NG) and Orogastric (OG) Tubes

- Short-term nutrition support (usually 6 weeks or less)
- Indications
  - Inadequate oral intake or refusal to eat
  - Inability to suck or swallow
  - Nocturnal feeds

Edwards S, *et al. J Parenter Enteral Nutr.* 2016;40:616-22.

NG and OG Tubes – Cont'd

- Placed manually via the nose or mouth, through the esophagus and into the stomach, typically using a 5-8 French non-weighted tube
- Standard tubes are made of polyvinyl chloride (PVC); some tubes are made of polyurethane and silicone
- Tubes may be left in place short-term or replaced at home with proper training (such as for overnight feedings)
- Adding a bridle can be considered to hold the NG tube in place
- Potential complications include nasal trauma, sinusitis, aspiration, tube occlusion, otitis media

Edwards S, *et al. J Parenter Enteral Nutr.* 2016;40:616-22.

Nasoduodenal (ND) and Nasojejunal (NJ) Tubes

- Short-term nutrition support (usually 6 weeks or less)
- Indications
  - Congenital upper GI anomalies
  - Gas-bloat syndrome
  - Gastric dysmotility
  - Gastroesophageal reflux
  - Aspiration risk

Capriati T, *et al.* *Expert Rev Gastroenterol Hepatol.* 2015;9:929-41.
Zhao H, *et al.* *World J Pediatr.* 2021;17:536-43.

ND and NJ Tubes – Cont'd

- Typically placed radiologically or endoscopically but may be placed at bedside by trained healthcare provider
- 5-8 French weighted or non-weighted tube
- Made of polyurethane or silicone
- Indwell time indefinite if polyurethane or silicone tubes are placed as NJ tubes depending on maintenance of optimal tube position and function

Capriati T, *et al.* *Expert Rev Gastroenterol Hepatol.* 2015;9:929-41.
Zhao H, *et al.* *World J Pediatr.* 2021;17:536-43.

Gastrostomy Tube (GT)

- Mid- (several months) to long-term (more than 6 months) nutrition support
- Indications
  - Congenital anomalies such as tracheoesophageal fistula
  - Swallowing dysfunction or esophageal injury/obstruction
  - Motility disorders
  - Inadequate oral intake

Axelrod D, *et al. J Parenter Enteral Nutr*. 2006;30:S21-6.
Berman L, *et al. Pediatrics*. 2022;149.
Novak I, *et al. Pediatr Rev*. 2024;45:175-87.
Baker L, *et al. J Pediatr Surg*. 2015;50:718-25.
Bitar R, *et al. World J Gastrointest Surg*. 2023;15:1871-78.

GT Tube – Cont'd

- Initial placement may be endoscopic (percutaneous endoscopic gastrostomy) or surgical (Stamm gastrostomy)
  - A gastrostomy tube with an internal intragastric balloon is often inserted as the initial surgically placed gastrostomy tube for both approaches. The internal bolster may be a non-balloon bolster.
  - After initial replacement, tube can be replaced at home with proper training
    - Patients should have access to a replacement tube at home obtained from their home care company
- Placed into the stomach via an opening called a stoma

Axelrod D, *et al. J Parenter Enteral Nutr*. 2006;30:S21-6.
Berman L, *et al. Pediatrics*. 2022;149.
Novak I, *et al. Pediatr Rev*. 2024;45:175-87.
Baker L, *et al. J Pediatr Surg*. 2015;50:718-25.
Bitar R, *et al. World J Gastrointest Surg*. 2023;15:1871-78.

PEG Tube versus Surgically-Placed GT

Care	PEG Tube	Surgically-Placed GT
Initial Placement	By pediatric gastroenterologists; may also be performed by general pediatric surgeons or interventional radiologists	By general pediatric surgeons
Post-Placement Course	Often hospitalized for minimum of 1-2 days following placement, depending on institution guidelines, to establish enteral feeds	Often hospitalized for 24 hours following placement, depending on institution guidelines, to establish enteral feeds

Cyrany J, *et al. World J Gastroenterol.* 2016;22:618-27.
Fortunato JE, *et al. Curr Gastroenterol Rep.* 2011;13:293-9..

PEG Tube versus Surgically-placed GT – Cont'd

Care	PEG Tube	Surgically-placed GT
Post-Procedure Care	• Indwell time indefinite, depending on maintenance of optimal tube position and function • Generally, require cleaning and rotation daily, which aids in assessing position of the internal bolster • Should be secured to the abdomen with tube securement devices or tape to prevent tension on the tube and gastrostomy site • Most institutions have guidelines for elective replacement of original PEG tubes to take place at a minimum 8-12 weeks following the original gastrostomy procedure by a trained healthcare professional	• Most institutions have guidelines for elective replacement of original surgically/laparoscopically placed gastrostomy tubes to take place at a minimum 8-12 weeks following the original gastrostomy procedure by a trained healthcare professional. • Recommended site care varies by institution

Cyrany J, *et al. World J Gastroenterol.* 2016;22:618-27.
Fortunato JE, *et al. Curr Gastroenterol Rep.* 2011;13:293-9.

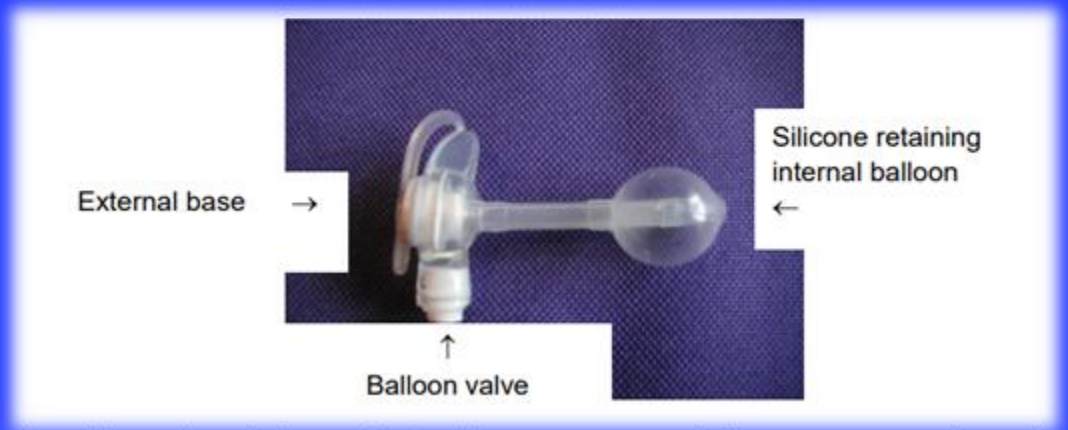
PEG Tube versus Surgically-placed GT – Cont'd

	PEG Tube	Surgical-placed GT
Contraindications	• Obesity • Severe scoliosis • Abnormal bowel/stomach anatomic position • Severe ascites • Gastric varices • VP shunt (relative contraindication)	• Massive ascites • Gastric varices • Infection or neoplasia along percutaneous tract • Hiatal hernia • Severe GER • Uncorrected coagulopathy

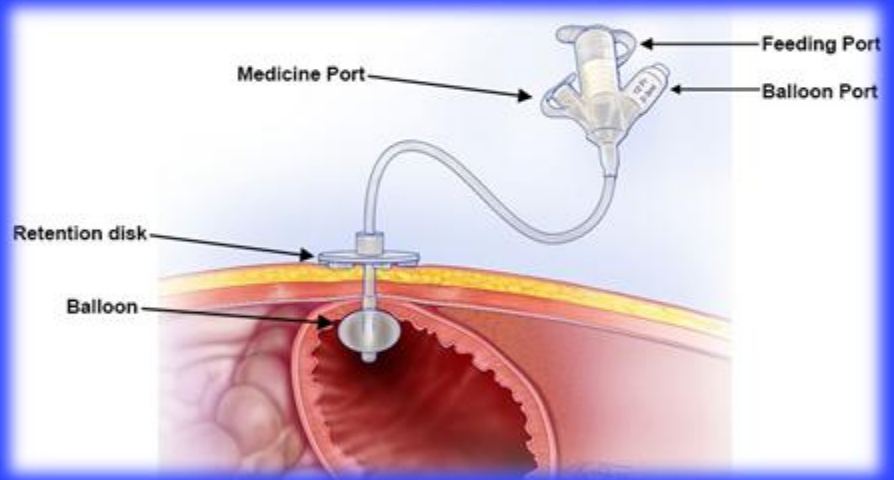
Cyrany J, *et al. World J Gastroenterol.* 2016;22:618-27.
Fortunato JE, *et al. Curr Gastroenterol Rep.* 2011;13:293-9.

Replacement Gastrostomy Tubes

- Standard balloon-replacement gastrostomy tube or low-profile gastrostomy tube
  - Inserted through the stoma
  - Balloon at the end goes into the stomach
  - Used after the initial tract has healed



https://www.chop.edu/patient-family-ed/patient-instructions-balloon-gastrostomy-tube-g-tube



https://www.cuh.nhs.uk/patient-information/low-profile-balloon-retained-gastrostomy-tubes

Novak I, *et al. Pediatr Rev.* 2024;45:175-87. Vermilyea S, *et al. Nutr Clin Pract.* 2016;31:59-67.
Wilson L. Gastroenterology Nursing 200023;121-24.

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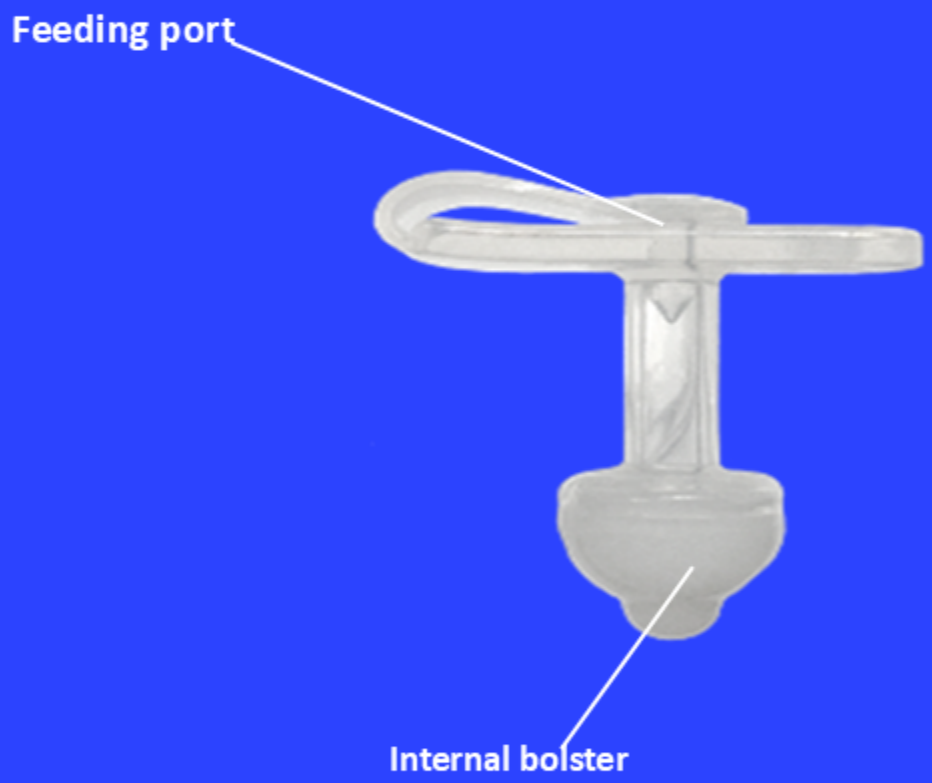
Replacement Gastrostomy Tubes - Cont'd

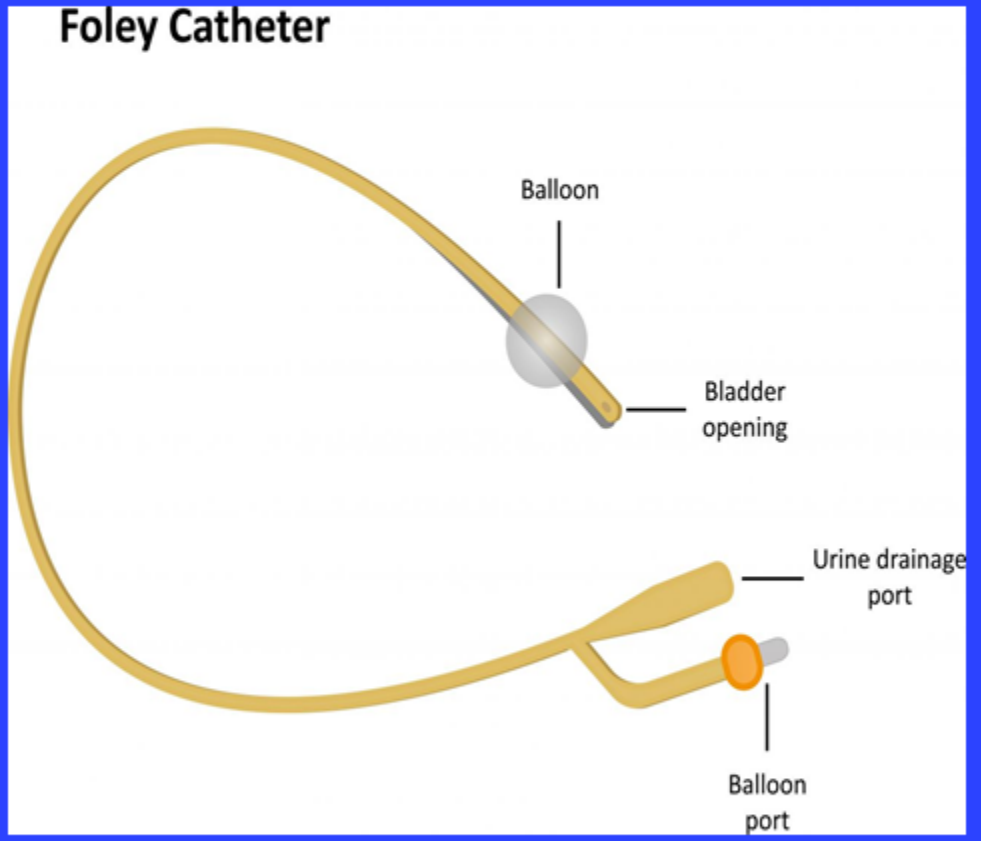
- Fixed dome low-profile gastrostomy tube
  - Small internal mushroom-shaped bolster
  - Requires stylet for insertion



Novak I, *et al. Pediatr Rev.* 2024;45:175-87.

Replacement Gastrostomy Tubes - Cont'd

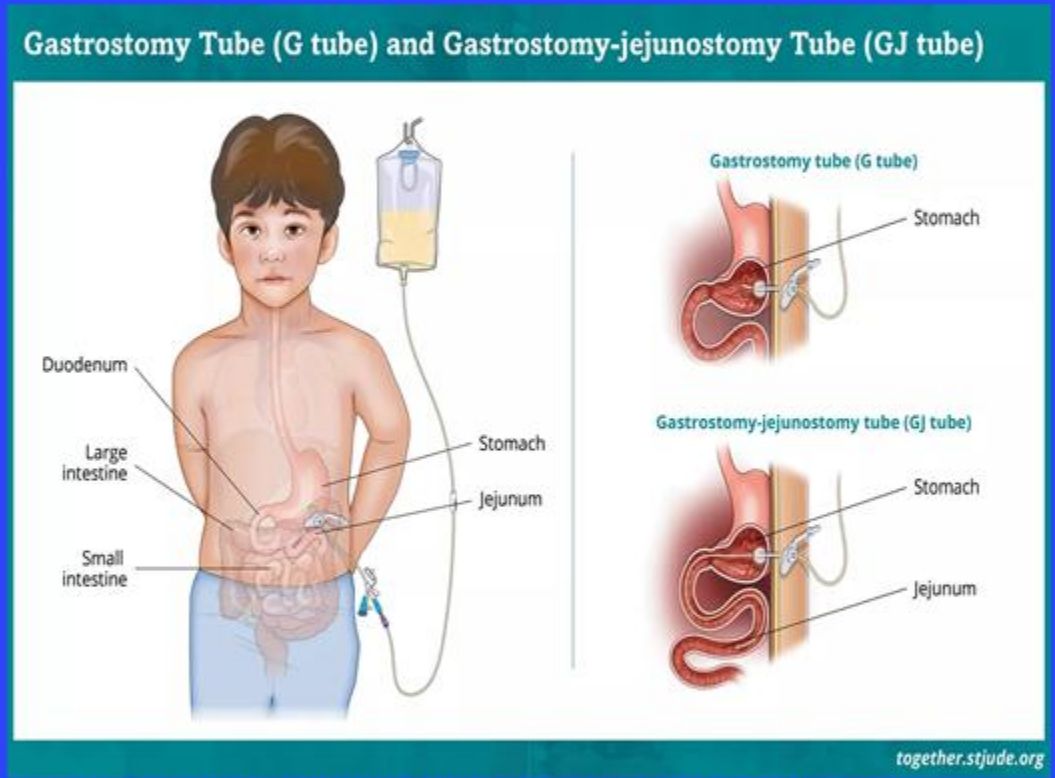
- Foley Catheter
  - Used only as very temporary gastrostomy tubes when a gastrostomy tract has narrowed or is being gradually dilated
  - Does not have an external bolster, so it must be secured to the abdomen to prevent internal migration



What's a Foley catheter? | Roswell Park Comprehensive Cancer Center - Buffalo, NY

Gastrojejunal (GJ) Tubes

- Indications
  - Require feeding beyond the stomach
  - Congenital upper GI anomalies
  - Gastric motility disorders
  - High aspiration risk
  - Severe Gastroesophageal Reflux
- Placed radiologically or endoscopically
- Potential complications include dislodgement, tube deterioration or occlusion, bleeding, wound infection
- Complex tube replacement – typically replaced in interventional radiology



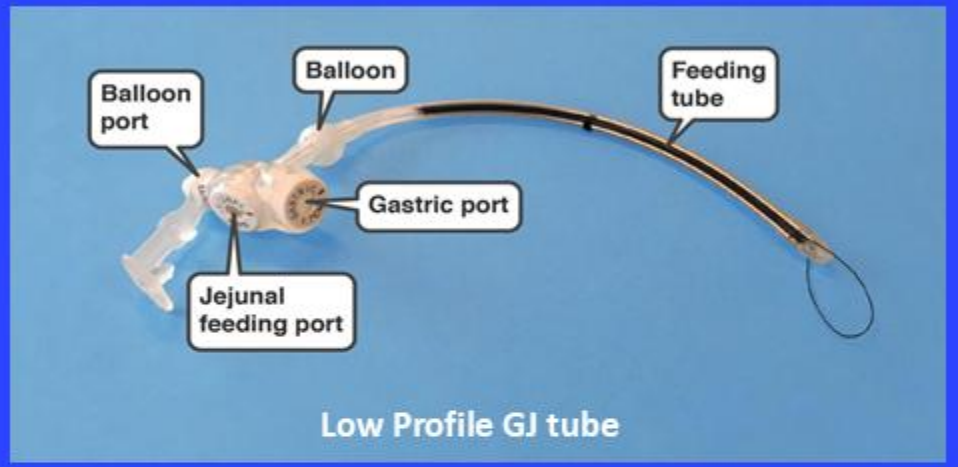
https://together.stjude.org/en-us/medical-care/clinical-nutrition/types-of-tubes-and-devices.html

Fortunato JE, *et al. Am J Gastroenterol.* 2005;100:186-9.

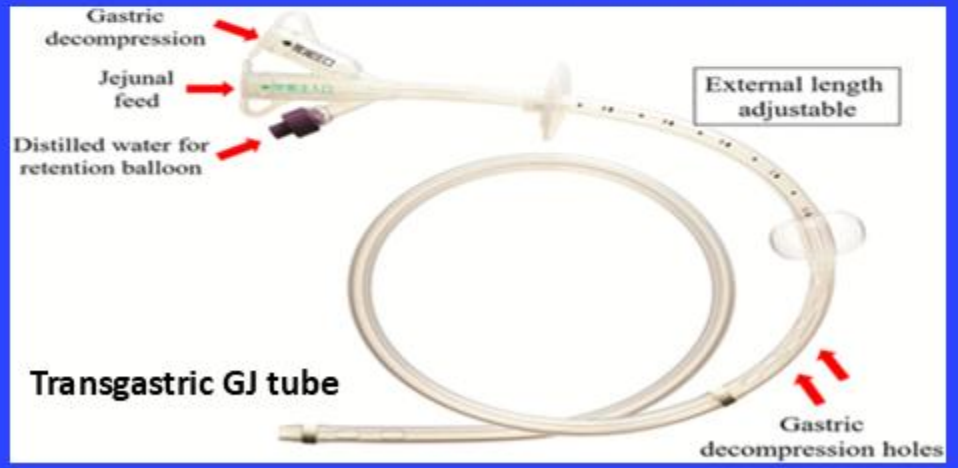
Gastrojejunal (GJ) Tubes – Cont'd

Low profile GJ tube or transgastric GJ tube

- Inserted via the opening into the stomach (stoma) and passed through the pylorus into the jejunum
- Includes G port and J port
  - G port can be used for gastric decompression, gastric medication delivery or bolus feedings
  - J port can be used for slow intermittent or continuous feedings; should not be used for bolus feedings
- Potential complications include dislodgement, tube deterioration or occlusion, bleeding, wound infection



Low Profile GJ tube



Transgastric GJ tube

Jejunostomy (J) Tube

- Indications
  - Require feeding beyond the stomach
  - Gastric motility disorders
  - Severe Gastroesophageal Reflux
  - Congenital upper GI anomalies
  - High aspiration risk
  - Intestinal dysmotility syndromes
- Inserted directly into the jejunum
  - After initial replacement, can be replaced at home with proper training
- Can only be used with slow intermittent or continuous feeding
  - Cannot use bolus feeding technique beyond the pylorus due to risk of dumping syndrome
- Potential complications include dislodgement, tube deterioration or occlusion, bleeding, wound infection

Capriati T, *et al. Expert Rev Gastroenterol Hepatol*. 2015;9:929-41.
Grant MJ, *et al. AACN Clin Issues*. 2000;11:507-16.

- Tube and Site Care -

Nasal Tubes: Care

Placement	Cleaning	Flushing
Routinely replaced every 1 months, alternating nares	Clean external tube surface with mild soap and water, remove debris as needed, and keep site dry	Flush with safe source of water every 4 hours while child is awake to prevent clogging
• Confirming correct placement ASPEN Gold standard for checking placement of NG tube: gastric aspirate/pH testing is used when radiograph (x-ray) is not available. • Recommended pH</= 5 for accurate placement.	• Wash face and nares daily with water and gentle skin soap as needed • Continue to brush teeth and gums routinely • Use thin layer of water-soluble lubricant to the nose as needed	Avoid excess water flushes with infants (3-5 mL flushes is typical)
	Use minimal adhesives to anchor tube to prevent skin breakdown	

NASPGHAN FOUNDATION

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:657- 660.
Boullata JI, *et al. J Parenter Enteral Nutr.* 2017;41:15–103. Irving SY, *et al. Nutrition in Clinical Practice*. 2018;33:921–27.

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Abdominal Tubes: Care

Cleaning	Dressings	Flushing
• Clean external tube surface with mild soap and water as needed • Wash stoma site daily with gentle soap and water, cleaning off any encrusted areas and dry skin well • Inspect site often looking for signs of infection, leakage, skin irritation/breakdown and granulation tissue growth • Do not use hydrogen peroxide, rubbing alcohol, or petroleum-based products to clean or treat • Use only approved cleaners, barrier creams	• Pre-split gauze use should be discouraged • If leakages occurs, then the source should be determined and treated • Avoid applying any occlusive dressings; the stoma should be open to air	• Flush tube using a safe source of tap water before and after each medication and tube feeding • Post-pyloric tubes can clog easily and often require more frequent flushing; recommend flushing every 4 hours while child is awake

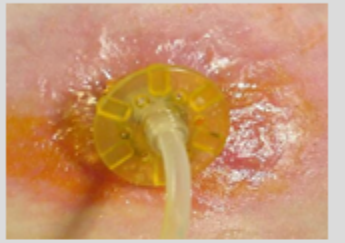
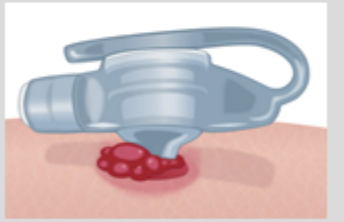
Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:659.

Abdominal Tubes: Care – Cont'd

Proper Placement	Rotations
Low Profile Tubes • Routinely measure for proper fit annually or when appears too loose/tight or with significant weight fluctuation • If there is increased leakage from stoma or indentations around the stoma from the tube's external bolster, the tube is likely not fitting correctly **Balloon Tubes** • Check to make sure the amount of fluid in the balloon is accurate; amount depends on the specific tube, but is typically 3-5 mL saline	**G-Tube** • Rotate low profile g-tube to assure proper fit and to minimize pressure points **Transgastric/GJ/J-Tube** • Never rotate as this may cause tube to twist in the small bowl or migrate up into the stomach

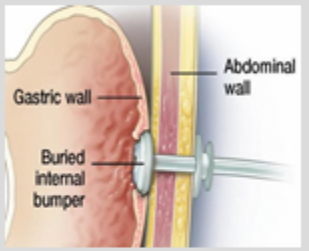
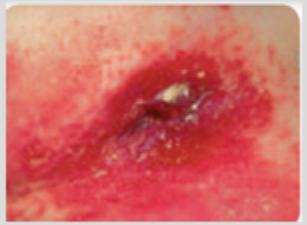
Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:659.

Abdominal Tubes: Common Site Concerns

Leakage utilize a nurse trained in stomal therapy	• A common and under recognized problem that can cause infection, skin excoriation, and abscess • Results from stretching of the stoma tract from excessive tension due to tube/extension site is not rotated when properly secured • An over-the-counter antibiotic can be applied if site becomes red and tender. If not improved in 3 days, then contact care provider. If improved, can continue to use 2-3 times per day up to 10 days.	 https://emedicine.medscape.com/article/149665-technique?form=fpf
Granulation Tissue utilize a nurse trained in stomal therapy	• Can occur due to movement of abdominal tube and moisture at tube site • Must be treated to prevent leakage, infection and bleeding • Can be treated with alum powder or steroid cream, chemical cauterization (silver nitrate), or other topical products that can shrink/remove the tissue. Occasionally, surgical excision is needed. • Gastric prolapse and granulation tissue can look similar, require assessment to determine correct treatment	 https://granulotion.com/pages/about-us

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:659.
Mueller CM. ed. American Society for Parenteral and Enteral Nutrition 2017:262.

Abdominal Tubes: Common Site Concerns – Cont'd

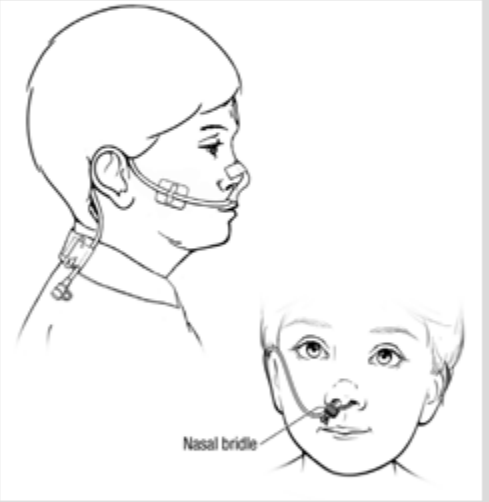
Buried Bumper	• Results from growth of gastric mucosa over the internal bumper or balloon • Caused by extension tension between internal and external retention, poor wound healing or significant weight gain	 https://www.researchgate.net/figure/Illustration-of-buried-bumper-syndrome-obtained-with-permission-from-Practical_fig2_352070218
Yeast Infection utilize a nurse trained in stomal therapy	• A rash with an area of redness with satellite lesions spreading away from the main area of redness • Caused by moisture, leakage around the tube • Treat with antifungal	 https://www.urmc.rochester.edu/childrens-hospital/gastroenterology/g-tube-home-care/troubleshooting

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:659.
Mueller CM. ed. American Society for Parenteral and Enteral Nutrition 2017:262.

Feeding Tube Securement

Nasal Tubes	• General practice: Use a hypoallergenic base layer material such as Duoderm ™ on the cheek near the nare. A transparent dressing or tape can be used to hold the feeding tube down onto the base layer to secure. • Avoid products that will tear the skin when removed • Nasal bridle: consider this method in active children
Abdominal Tubes	• Avoid using anchoring devices that attach to the skin when able, such as tapes, and other adhesives • If feeding extension sets are being accessed for longer periods of time, such as in continuous feeds or venting, silicone (AMT cinch ™) or tape like (Grip Lock ™) securement products can be used to hold the extension in place and prevent disconnection but must be rotated on the abdomen to prevent tissue breakdown • Abdominal binders (Benik™ belts and Gus gear™) are also options

Typical Nasal Securement



Mayo Clinic:
Feeding Your Child with a Nasal Tube.
MC1456-19. (2020)

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:658.

Medication Administration

- Liquid medications are preferred
  - Avoid viscous and sorbitol containing medications
- Tablets and capsules must be crushed or opened and mixed with water following manufacturers guidelines. Contact pharmacist for assistance.
- Always flush with water before medications, in between each medication, and after medications are given.
- When in doubt, involve a pharmacist to determine appropriate port to deliver medications, vitamins and minerals, especially with a GJ tube

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025:661.

Feeding Tube Replacement or Removal

- Child's school should have a letter from medical provider on what to do and who to call if feeding tube falls out at school
- Parents should **ALWAYS** have a spare nasal tube, balloon low profile gastrostomy or temporary replacement tube on hand. Emergency departments and smaller medical offices may not carry feeding tubes
- Stomas may start to close in just a few hours, need to be replaced same day. If the initial planned tube change has not occurred and the tube is accidentally removed, placement should be confirmed by a medical professional as there is risk that the track has not epithelialized.
- Home care companies can provide spare feeding tubes. Typically, insurance providers will cover the cost of a new feeding tube every 1 month for nasal tubes and every 3 months for low-profile balloon gastrostomies.

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025.

Feeding Tube Replacement or Removal – Cont'd

Accidental	Planned

• NG: replaced by trained medical professionals or trained parents
• NJ: will need radiology to position post-pylorically
• G-tube (balloon type): replaced by trained medical professionals or trained parents
• GJ-tube (balloon type): replaced by trained medical professionals
• G-tube/J-tube (non-balloon type): replaced by trained professionals
	• Nasal tubes - suggested monthly, rotating nares. Insurance will typically cover this cost. Obtain from home care company.
	• G-tube - industry suggests every 3-5 months
	• GJ- tube - industry suggests every 6 months. Typically replaced in interventional radiology.
	• When no longer needed
	  • Nasal tubes can often be removed easily at the bedside with a medical professional, or parents can remove at home
	  • Abdominal tubes, especially low-profile balloon G-tubes, can be removed at home if parents are able, otherwise can be removed by a medical professional. If stoma does not fully close, patient may require surgical closure.

Corkins MR. American Society for Parenteral and Enteral Nutrition. 2025.

Considerations Before Removal of Feeding Tube

- Does child have any procedures, surgeries, or treatments in the next 6-12 months that may prevent them from getting enough nutrition and fluids by mouth?
- Is there any concern that they continue to have dysphagia?
- Has child been able to take all food, fluids and medications by mouth over the past 6 months?
- Is child gaining and growing appropriately with oral nutrition alone for the past 6 months?
- Stoma site should be at least 6 weeks old so that tissue will heal well and infection can be prevented before removed
- If the child tends to become ill during cold and flu season, suggest tube be removed after typical seasons of higher incidence of illness

https://www.aboutkidshealth.ca/deciding-to-permanently-remove-a-feeding-tube.

- Bolus versus Continuous -

Bolus versus Continuous Feedings

Continuous feedings

- Provides steady supply of nutrients
- Less likely to cause gastrointestinal intolerance or large gastric residual volumes
- Potential to minimize feeding interruptions (i.e., can be given overnight to avoid disruption of daytime schedule and oral intake)
- Slow infusion may improve tolerance and absorption
- Encourages intestinal adaptation by constant mucosal stimulation
- Requires an enteral pump

Useful for patients who are

- Critically ill/hemodynamically unstable
- Short Bowel Syndrome/Intestinal Failure or other malabsorptive conditions
- High risk for aspiration
- Premature infants

Mehta NM, *et al.* *J Parenter Enteral Nutr.* 2017;41:706-42.
Brown AM, *et al.* *J Parenter Enteral Nutr.* 2022;46:1011-21.

Bolus versus Continuous Feedings

Bolus feedings

- Can mimic or supplement meals = more physiologic. Can promote better gastrointestinal hormone secretion and motility.
- Freedom of movement between feedings
- May not require a pump (can feed by gravity or slow push)
- Can be via syringe (push or gravity), regulated enteral feeding bag, or enteral feeding pump
- Can only be given via gastrostomy tube to be fed into the stomach
- Can promote osmotic diarrhea

Useful for patients who are

- Stable
- Mechanically ventilated but otherwise stable

Mehta NM, *et al. J Parenter Enteral Nutr.* 2017;41:706-42.
Brown AM, *et al. J Parenter Enteral Nutr.* 2022;46:1011-21.

Case

- 12-month-old female (9 mos CGA) with past medical history significant for prematurity, esophageal atresia, tracheoesophageal fistula, BPD, and feeding difficulties. Parents report intermittent vomiting, but overall vomiting is improving.
- GJ tube placed 10 months ago
  - Remains on continuous GJ tube feeds over 16 hours from 7pm- 11am
  - Taking small amounts of fruit and vegetable purees 4 times per day while off tube feeds
- On elemental infant formula mixed to 26 kcal/oz; NKFA
- ***Nutrition Concern:*** Parents are interested in condensing overnight feeds and trying some bolus feeds during the day to increase time off feeding pump and encourage regularly scheduled meals; Weight gain has slowed down since last office visit; asking about need for increasing calories;
  - Weight: 7.44 kg (weight/age z-score: -0.98)
  - Length: 66.8 cm (length/age z-score of CGA: -1.71)
  - Weight for Length Z score: -0.05
- Medications: Pepcid®, Infant multivitamin with iron
- Labs: CMP and CBC WNL from previous admission

Case

- A 24-month-old male with a history of Trisomy 21 presents to their pediatrician for a well-child check. At this appointment, physical exam is significant for a weight of 8.4kg (2%ile, z-score -2.14) on the CDC Growth Chart for Children with Down Syndrome. It was noted during his previous 18-month-old appointment that he weighted 8kg (3%ile, z-score -1.86). Before then, he consistently tracked along the 5%ile curve. He is otherwise, well-hydrated and well-appearing on exam.
- Upon further questioning, parents noted that he has been more picky with his eating and will often throw his solid food. They deny any choking, dysphagia or recent fevers and illnesses. You want to determine the daily caloric goal for him. If his goal weight is 9kg to return to the 5%ile (z-score -1.65), what would be his daily caloric goal?

    a) 810-1080 kcal/day

    b) 540-675 kcal/day

    c) 675-810 kcal/day

    d) 1200-1500 kcal/day

Case Review – Cont'd

- Establish a plan to begin 1-2 small bolus feeds during the day via G port of the GJ tube. Run remainder of feeds overnight continuously via J port as family advances small volume feeds via G port.
- Keep concentration of formula the same for now to avoid intolerance of hyperosmolar feedings
- To determine volume of bolus and continuous feedings
  - Daily volume to be delivered: 750 mL/day
  - Estimate amount of bolus to given based on weight in kg (7.44 kg x 5-10 mL/kg) = ~75 mL 1-2 times/day. Establish whether this should be given via pump or gravity method
  - Establish times the (2) boluses via G port can be trialed based on family schedule and when patient is off pump
  - 750 mL (total daily volume) - 150 mL (to be delivered via bolus) = 600 mL (to be run overnight via J port)

Case Review – Cont'd

- Intervention/Plan
  - Run overnight feeds of 600 mL via J port at 43 mL/hour over 14 hours from 7pm – 9 AM
  - Give 75mL of formula via G port at 12pm and run on pump to start to establish tolerance; suggest family run at 75 mL/hour over 1 hour until 1pm
  - Give 75 mL of formula via G port at 4pm and run on pump at 75 mL/hour over 1 hour until 3pm
- If patient tolerates continue to condense overnight feeds and duration of bolus feeds
  1. Give 600 mL overnight over 10 – 12 hours, add a third daytime bolus feeding pending timing
  2. Give 525 mL overnight over 8 – 10 hours, 75 mL at 3 daytime bolus feedings run over 30 minutes or via gravity
- Next Step
  - Continue to increase volume of boluses with concurrent reduction in overnight tube feeding, always considering oral intake/adequate calories/growth

Case Review – Cont'd

- Monitor / Evaluation
  - Watch for increased vomiting and or abdominal distension as volume of gastric feeds increases
  - Assess ability for patient to take a portion of the bolus feedings by mouth and then give remainder via G port as needed
  - Assess table food intake and potential for decreasing the volume of tube feedings being administered if patient demonstrating age-appropriate weight gain
  - Assess hydration status
  - Have continuous conversations with family about tube feeding and schedules at home
  - Make a plan to have GJ tube replaced with GT

3. EN Components

Case

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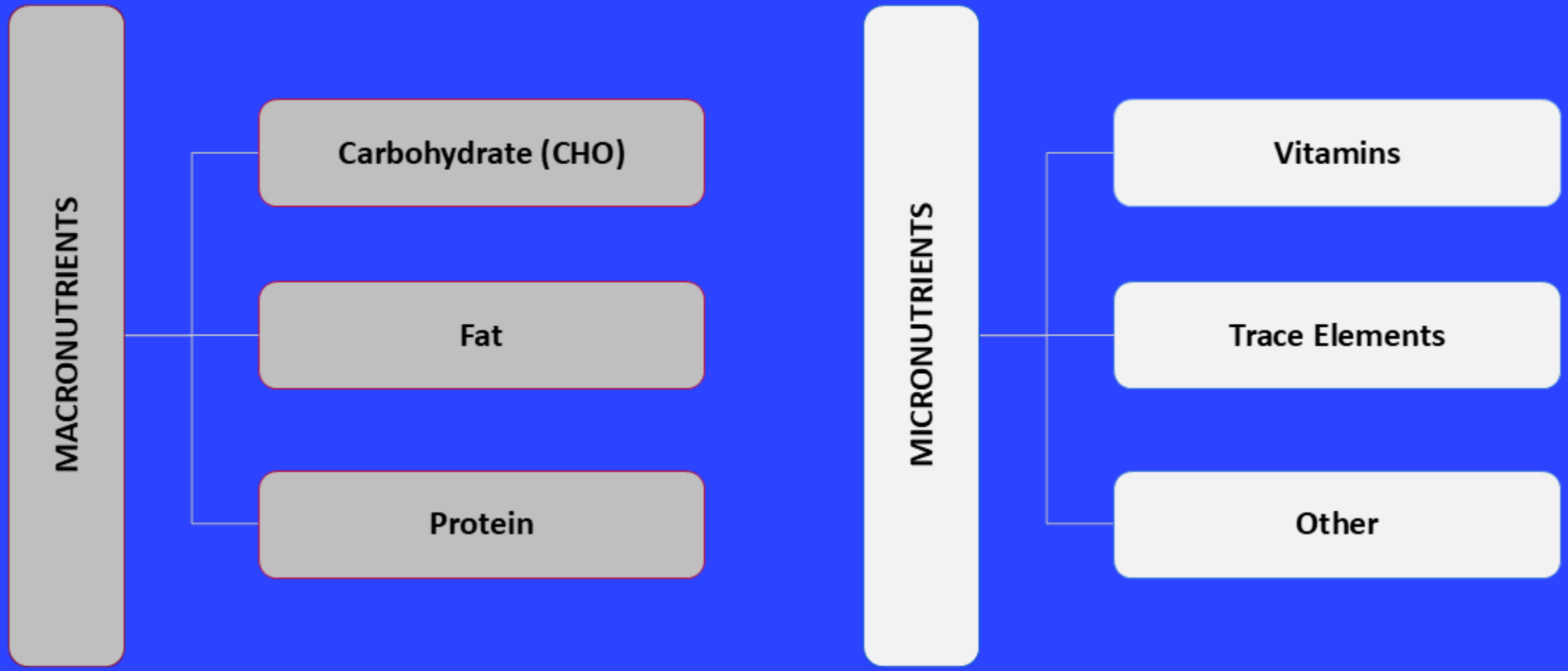
EN Components



Berger MM, *et al. Clinical Nutrition* 2022;41:1357-1424.

Estimated Caloric Needs per Day by Age

Age (years)	Kcal / kg / day
0-12 months	~90-120
1-7	~75-90
7-12	~60-75
12-18	~30-60
>18	~25-30

Jacobs Danny O, *et al. J Parenteral Enter Nutr.* 2002;26:22SA-24SA.

Composition of Formula by Age

Macronutrient	Age Range		
	0-12 Months	**1 – 13 Years**	**14 – 19 Years**
Carbohydrate	40-45% of kcal	44-53% of kcal	26-57% of kcal
Fat	~50% of kcal	25-60% of kcal	30-44% of kcal
Protein	8-12 % of kcal	10-20% of kcal	14-25% of kcal

Klepper CM *et al. Nutrition in Clinical Practice 2023;38*:302-17.

Carbohydrate (CHO)

- 4 kcal/g
- Provided via monosaccharides (glucose, fructose), disaccharides (lactose, sucrose, maltose), complex carbohydrates (starches)
- Main carbohydrates in formulas are glucose, sucrose and lactose
- Lactose is the primary carbohydrate in breast milk and standard infant formulas
- Many formulas contain corn syrup (glucose syrup, solids, high-fructose), which have different proportions of glucose and fructose

Considerations regarding CHO

- Galactosemia: eliminate lactose in diet, restrict breast milk to avoid lactose, use soy-based formula because it does not contain lactose
- True primary lactose intolerance (lactase enzyme deficiency): use low lactose or soy-based formula
- Inborn errors of metabolism: PKU and maple syrup urine disease require specialized formula and amount of recommended breast milk varies

Savino P. *Nutrition in clinical Practice.* 2018;33:90-8.
Jacobs Danny O, *et al. J Parenteral Enter Nutr.* 2002;26:22SA-24SA.

Fat

- 9 kcal/g
- Main types of fats in formulas:
- Long-chain triglycerides (LCTs): safflower oil, canola oil, soybean oil
- Medium-chain triglycerides (MCTs)

Considerations regarding fat

- MCTs are directly absorbed into the portal circulation
  - Useful in patients with fat malabsorption (i.e., cholestasis, exocrine pancreatic insufficiency, cystic fibrosis, short bowel syndrome, lymphatic malformations, chylothorax)
- Hydrolyzed and elemental formulas have higher MCT content

Jacobs Danny O, *et al. J Parenteral Enter Nutr.* 2002;26:22SA-24SA.

Protein

- 4 kcal/g
- Infant formulas divided into 4 categories based on protein content:
  - Cow's milk-based (casein, whey)
  - Soy
  - Hydrolysate (peptides, amino acids)
  - Elemental (amino acids)
- For cow's milk protein intolerance/allergy, do not use soy formula due to cross-reactivity (10-14% of infants have a reaction), use hydrolysate formula as first-line treatment
- Soy formulas should only be used after 6 months of age (except for infants with galactosemia)

Estimated Protein Requirements by Age (g/kg/day)	
Low birth weight infant	~3-4
Full term infant	~2-3
1-10 years old	~1.0-1.2
Adolescents	~0.8-0.9
Critically-ill child / adolescent	~1.5

Jacobs Danny O, *et al. J Parenteral Enter Nutr.* 2002;26:22SA-24SA.
Kipfer S *et al.* *Family Physician.* 2021;67:180-82.

Trace Elements

Vitamins	Trace Elements	Other
Thiamine (vitamin B1)	Chromium	L-carnitine
Riboflavin (vitamin B2)	Cobalt	Choline
Niacin (vitamin B3)	Copper	Coenzyme Q10
Pantothenic acid (vitamin B5)	Fluoride	
Pyridoxine (vitamin B6)	Iodine	
Biotin (vitamin B7)	Iron	
Folate and folic acid (vitamin B9)	Manganese	
Cobalamin (vitamin B12)	Molybdenum	
Vitamin A	Selenium	
Vitamin C	Zinc	
Vitamin D		
Vitamin E (alpha-tocopherol)		
Vitamin K (phylloquinone)		

Berger MM *et al. Clinical Nutrition.* 2022;41:1357-1424.

DHA and ARA

- Docosahexaenoic acid (DHA) and Arachidonic acid (ARA)
  - Long-chain polyunsaturated fatty acids
- Naturally found in breast milk
- Included in most infant formulas
- Important in early infant development (cognitive functions, visual acuity, immune responses)
- Patients on a low long-chain triglyceride formula are at risk for developing essential fatty acid deficiency
  - Clinical signs of essential fatty acid deficiency include dry skin, poor growth, hair loss
  - Elevated triene:tetraene ratio blood test (usually >0.2) indicates a deficiency

Lien EL *et al. Prostaglandins Leukot Essent Fatty Acids*. 2018;128:26-40.
Mogensen KM. *Pract Gastroenterol*. 2017;41:37-44.

European Infant Formulas

- Often organic and free from pesticides, growth hormones, GMO's, synthetic chemicals and preservatives
- Lactose is the main source of carbohydrate and whey is the main source of protein (from cow's or goat's milk)
- Not all are regulated by the FDA in the United States
  - FDA regulation ensures that formulas meet strict safety, quality and nutritional standards
- Concerns with non-FDA regulated formulas
  - Nutritional inadequacy - may not provide essential nutrients (e.g., iron, DHA, choline) in appropriate amounts - risking deficiency
  - Safety risks - may have unverified ingredients, poorly manufacturing practices or contamination
  - Label inaccuracies - claims on the packaging may be misleading or unsupported by evidence

(https://pmc.ncbi.nlm.nih.gov/articles/PMC7416159/).
https://naspghan.org/wp-content/uploads/2019/10/October-2019-Article-B.pdf
https://www.fda.gov/food/buy-store-serve-safe-food/handling-infant-formula-safely-what-you-need-know

Infant & Pediatric Formulas – Polymeric

- CHO: corn maltodextrin, rice syrup solids, sugar, cornstarch
- Fat: LCT, MCT
- Protein: milk, soy and/or pea
- Calories: 0.6-1.5 kcal/mL (non-infant), 20 kcal/oz but can mix to higher kcal (infant)
- Meets 100% of dietary reference intakes for essential vitamins and minerals

Klepper CM *et al. Nutrition in Clinical Practice 2023;38*:302-17.

Infant & Pediatric Formulas – Elemental

- CHO: corn syrup solids, tapioca starch
- Fat: LCT, MCT
- Protein: amino acids
- Calories: 0.8-1.5 kcal/mL (non-infant), 20 kcal/oz but can mix to higher kcal (infant)
- Hypoallergenic
- Higher MCT content, can be used in patients with fat malabsorption

Klepper CM *et al. Nutrition in Clinical Practice 2023;38*:302-17.

Infant & Pediatric Formulas – Hydrolyzed Protein

- CHO: maltodextrin, sugar, cornstarch
- Fat: LCT, MCT
- Protein: whey, casein, pea
- Calories: 1.0-1.5 kcal/mL (non-infant), 20 kcal/oz but can mix to higher kcal (infant)
- Hypoallergenic (*partially hydrolyzed formulas are NOT hypoallergenic)
- Higher fat content compared to polymeric (↑MCT content, can be used in patients with fat malabsorption)

*Hydrolyzed, elemental formulas and select polymeric formulas are either lactose-free and/or suitable for lactose intolerance. Latter not suitable for galactosemia. Products labeled suitable for lactose intolerance can still contain <4g/L or <0.5g/serving

Klepper CM *et al. Nutrition in Clinical Practice 2023;38*:302-17.

Infant & Pediatric Formulas – Blenderized

- CHO: varies widely
- Fat: LCT, MCT
- Protein: beef, poultry, fish, legumes, rice, dairy
- Calories: 1.0-1.3 kcal/mL (non-infant)
- Some are deficient in micronutrients and require supplementation if used as sole source of nutrition

Klepper CM *et al. Nutrition in Clinical Practice 2023;38*:302-17.

Overview of Human Milk

- Carbohydrate
  - Lactose
  - Oligosaccharides (HMO)
  - Contributes 42% of calories
- Fat
  - Palmitic (saturated), oleic, linoleic, linolenic, long chain PUFA, DHA and ARA
  - Contributes 50% of calories

Kim SY *et al. Clin Exp Pediatr*. 2020;63:301–9.

Overview of Human Milk – Cont'd

- Protein
  - 60% whey; 40% casein
    - Predominant whey protein is lactalbumin
  - Lower protein content than cow's milk
  - Immunological properties: lactoferrin, lysozyme, secretory IgA
  - Contributes 7% of calories
- Milk fat globule membranes (MFGM)
  - Naturally occurring 3-layer membrane surrounding a lipid core
  - Found in every droplet of human milk
  - Outer layer has gangliosides, sphingolipids, phospholipids, and proteins
- Probiotics

Kim SY *et al.* *Clin Exp Pediatr.* 2020;63:301–9.

Additional Formula Considerations

- Adult formula
  - Typically, can transition when reach adolescence (13 years of age)
  - Higher protein content
  - May contain higher fiber content
    - Ensure adequate fluid intake
  - Assess vitamin/mineral content and adequacy

https://doi.org/10.1542/9781610024181.

Case Review

- A 24-month-old male with a history of Trisomy 21 presents to their pediatrician for a well-child check. At this appointment, physical exam is significant for a weight of 8.4kg (2%ile, z-score -2.14) on the CDC Growth Chart for Children with Down Syndrome. It was noted during his previous 18-month-old appointment that he weighted 8kg (3%ile, z-score -1.86). Before then, he consistently tracked along the 5%ile curve. He is otherwise, well-hydrated and well-appearing on exam.
- Upon further questioning, parents noted that he has been more picky with his eating and will often throw his solid food. They deny any choking, dysphagia or recent fevers and illnesses. You want to determine the daily caloric goal for him. If his goal weight is 9kg to return to the 5%ile (z-score -1.65), what would be his daily caloric goal?

a) 810-1080 kcal/day

b) 540-675 kcal/day

C) 675-810 kcal/day (75-90 kcal/kg/day)

d) 1200-1500 kcal/day

4. Principles of Designing and Monitoring EN Support

Case

- 13-year-old male with a history of severe avoidant/restrictive food intake disorder presents with a 3-month history of abdominal pain, diarrhea, and poor appetite and is diagnosed with Crohn's disease
- He has had a 10% weight loss over the past 3 months
- His BMI is 19 kg/m^2
- Initial electrolytes: mild hypophosphatemia (2.5 mg/dL), normal potassium (4.0 mEq/L), and mild hypomagnesemia (1.5 mg/dL).
- Phosphorus and magnesium supplementation is administered after labs result
- He is hemodynamically stable but had mild orthostatic hypotension

Approach to Administration

Route and duration of EN should be in accordance with

- Patient's nutritional needs
- Medical stability and reversibility of condition
- Structural and functional status of GI tract
- Duration of EN
  - If required <6 weeks, consider nasal or oral tube
  - If required >6 weeks, consider gastrostomy or jejunostomy
- Risk of aspiration

Yi DY. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:12-19.

Approach to Administration

Feeding Route	Advantages	Disadvantages
Gastric Feeds	Physiologic, optimal absorption of certain nutrients	Risk of GI reflux, aspiration
Post-pyloric Feeds	Indicated for aspiration, gastroparesis, gastric outlet dysfunction, or previous gastric surgery	Requires slow intermittent or continuous feeds

- Consider providing volume-based regimen (goal volume over 24 hours) rather than goal rate or number of daily feeds
  - May be more likely to receive goal daily calories

Yi DY. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:12-19. Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103. da Silva JSV *et al. Nutr Clin Pract*. 2020;35:584-85. Mehta NM. *Pediatric Critical Care*. Elsevier; 2011:1073-88.

Suggested Bolus Gastric Feeding Regimens

- Bolus gastric feeds are preferred over continuous feeds
- Encourage physiologic GI hormonal secretion, stimulate hunger, and allow greater mobility

Age	Initiation	Advance	Suggested Tolerance Volumes
0 – 12 months	10 - 15 mL/kg every 2 to 3 hours	10 – 30 mL per feed	20 – 30 mL/kg every 4 to 5 hours
1 – 6 years	5 – 10 mL/kg every 2 to 3 hours	30 – 45 mL per feed	15 – 20 mL/kg every 4 to 5 hours
> 7 years	90 - 120 mL every 3 to 4 hours	60 – 90 mL per feed	330 - 480 mL every 4 to 5 hours

Broekaert IJ *et al. J Pediatr Gastroenterol Nutr*. 2019;69:239-58.
Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.

Suggested Continuous Feeding Regimens

- Continuous feeds are indicated if not tolerating bolus gastric feeds or at risk of aspiration
- Optimal for overnight feeds
- Can improve nutrient absorption
- All post-pyloric feeds should be continuous

Suggested continuous feeding regimen

Age	Initiation	Advance	Suggested Tolerance Volumes
0 – 12 months	1 - 2 mL/kg/hour	1 – 2 mL/kg every 2 to 8 hours	6 mL/kg/hour
1 – 6 years	1 mL/kg/hour	1 mL/kg every 2 to 8 hours	1 – 5 mL/kg/hour
> 7 years	25 mL/hour	25 mL every 2 to 8 hours	100 - 150 mL/hour

Broekaert IJ *et al. J Pediatr Gastroenterol Nutr*. 2019;69:239-58.
Wang Y *et al. Eur J Clin Nutr.* 2020;74:775-83.

Monitoring

- Required regularly to assess if nutritional goals are being met and to detect complications
- Frequency of monitoring is based on the patient's status and healthcare setting
- Need to regularly monitor metrics including fluid balance, anthropomorphics, electrolytes, glucose, vitamins, stool/ostomy output, GRV, abdominal distention/pain, and emesis
- Position of the exit site of the feeding tube should always be checked prior to each feed

Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.

Monitoring – Cont'd

- Review metrics and feeding regimen daily in patients who are initiating PN, have a new tube, critically ill, neonates, recovering from surgery, have unstable fluid or electrolyte status, or at risk for refeeding
- Re-evaluate metrics and feeding regimen in stable, hospitalized patients every 2-7 days
- If patient is outpatient and tolerating regimen, feeds and metrics can be reviewed every 1-4 weeks
- If patient is gaining weight and stable on regimen, can consider spacing out reevaluation of feeds, metrics, and labs even further

Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.

Potential Complications

Potential Complications	Possible Causes	Interventions

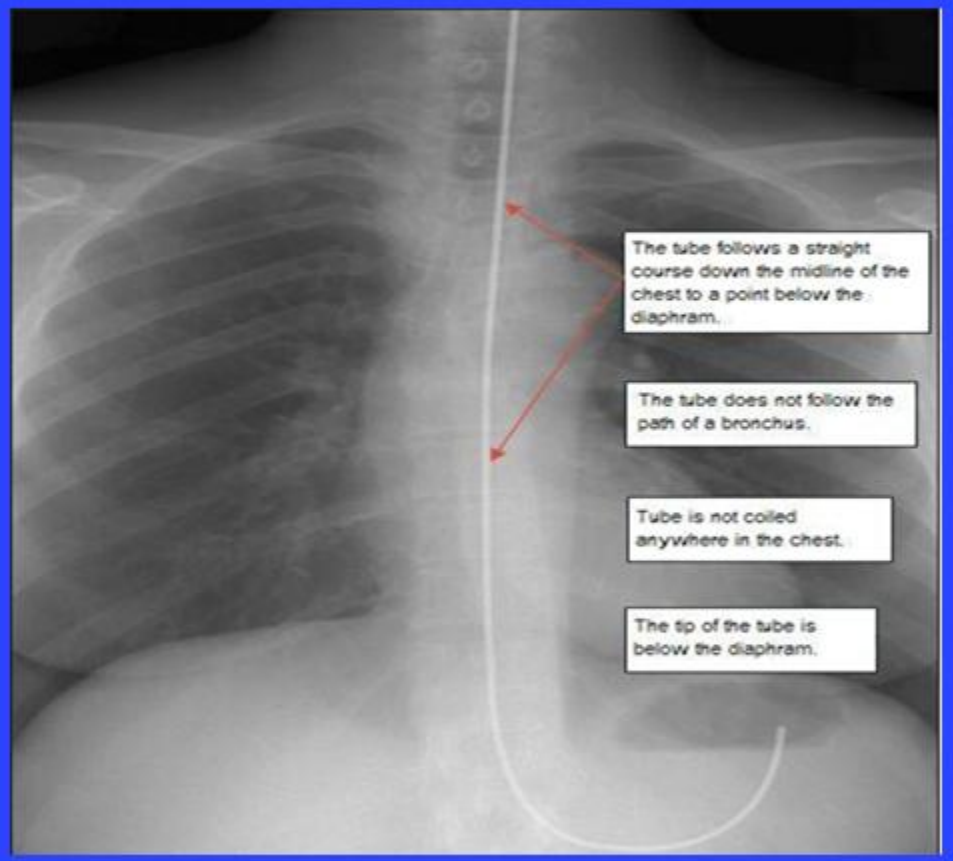
• Misplacement (initial position is incorrect)
• Displacement (tip is inadvertently moved to incorrect position)
• Site leakage
• Gastric outlet obstruction
• Buried bumper syndrome
	Improper tube positioning	• Check position and tube site prior to accessing
		• Gold standard to confirm position of a blindly-placed tube is radiographically
		• 2nd line or in outpatient setting: Gastric pH testing and visual observation of gastric aspirate can assess tube position
		  • pH ≤ 5 confirms gastric position
		  • pH testing may be inaccurate if tube is in the esophagus or patient is on antacids

NASPGHAN FOUNDATION

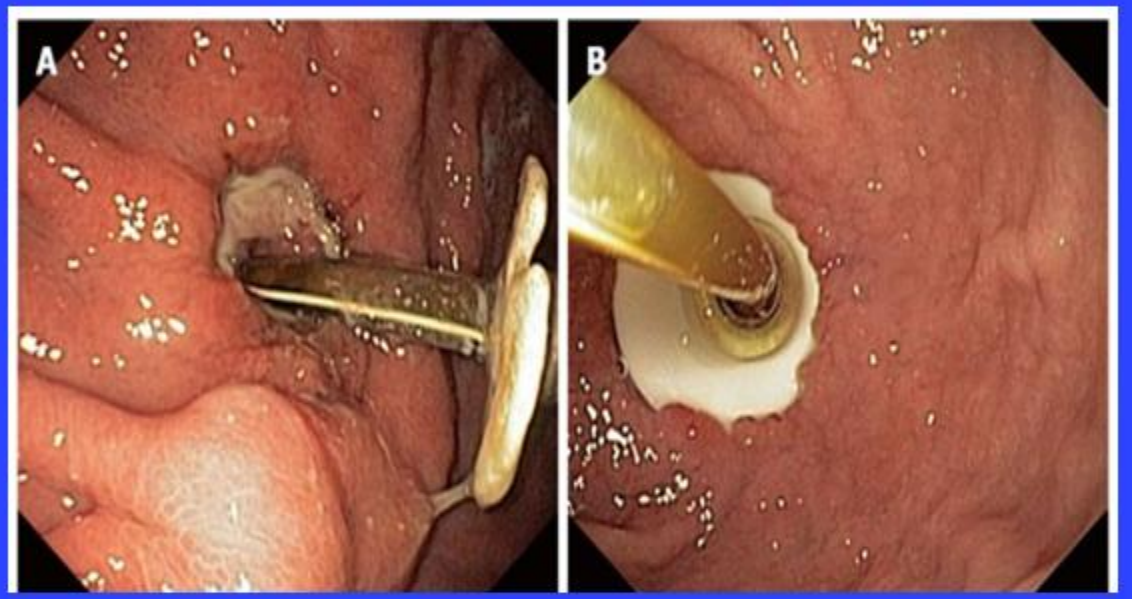
Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.
Rowat AM *et al. BMJ Open Gastroenterol.* 2018;5:e000218.

NASPGHAN

Complications



Chest radiograph demonstrating proper nasogastric feeding tube position with the tip in the stomach



Endoscopic view of buried bumper syndrome: A: Pressure ulcer under the internal bolster repositioned to the gastric lumen; B: Hyperplastic tissue growing over the edge of the internal bolster

NASPGHAN FOUNDATION

Education OM. Checking nasogastric (Ng) tube position. Oxford Medical Education.
Cyrany J *et al.* *World J Gastroenterol.* 2016;22):618-27.

NASPGHAN

Potential Complications

Potential Complications	Possible Causes	Interventions
• Aspiration • Diarrhea • Abdominal Pain/Cramping • Distention • Vomiting	• Positioning: dislodged tube, head not elevated • Formula and rate: excessive infusion rate, high osmolarity, fiber content, degree of protein hydrolysis • Clinical status: insufficient GI function, slow gastric emptying, constipation, metabolic complications • Psychological factors	• Reposition tube • Elevate head of bed • Adjust infusion rate • Change formula • Consider post-pyloric or continuous feeding • Start medication to improve gastric emptying • Start bowel regimen
• Constipation	• Inadequate fluid intake	• Ensure optimal fluid intake • Increase free water intake • Change to formula containing fiber

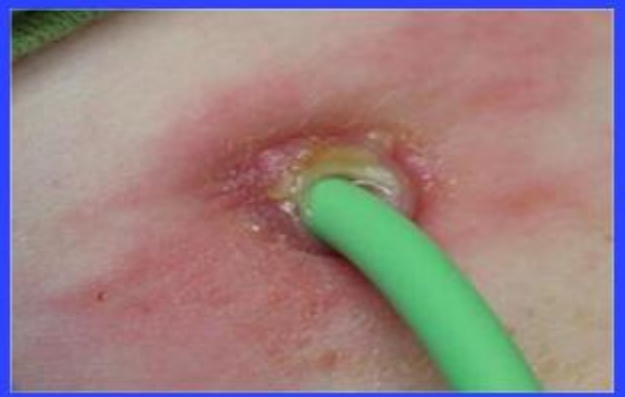
NASPGHAN FOUNDATION

Yi DY. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:12-19.

NASPGHAN

Potential Complications

Potential Complications	Possible Causes	Interventions
• Infection	• Wound infection such as cellulitis, peristomal abscess, or septicemia associated with tube • Contamination of formulas and delivery sets	• Use antimicrobials and sterile dressings • Prepare formula in sanitary conditions, using closed feeding systems, and reducing formula hang time



Peristomal cellulitis

Yi DY. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:12-19.
Boeykens K *et al. BMJ Open Gastroenterology* 2022;9:e000975.

Potential Complications

Potential Complications	Possible Causes	Interventions

• Tube clogging	• Lack of adequate water flushes
	• Tube size
		• Prevent with scheduled water flushes:
		  • Before and after feeds
		  • Before, after, and in between different medications
		• For NG and OG tubes, consider at least 2-5 mL in children or 1 mL or less in neonates
		• NJ tubes require 10-20 mL water flushes before and after feeds or every 4-8 hours
		• Check tube size for appropriateness

Broekaert IJ *et al. J Pediatr Gastroenterol Nutr*. 2019;69:239-58.
Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.

Potential Complications

Potential Complications	Possible Causes	Interventions
• Drug-nutrient interactions	• Unexpected interactions may occur if drugs are administered via feeding tube	• Check for drug-nutrient interactions prior to administering any drug • Feeds should be held if administering medications that are known to interact with formula or clog tube • Avoid administration of coated or slow degrading drugs

Broekaert IJ *et al. J Pediatr Gastroenterol Nutr*. 2019;69:239-58.
Boullata JI *et al. J Parenter Enteral Nutr.* 2017;41:15-103.

Selecting the Right Formula

Select formula based on gut function, volume tolerance and caloric needs

- Gut function
  - Normal gut function
    - Able to tolerate intact protein and long chain fats
  - Abnormal gut function
    - Unable to tolerate intact protein related to allergy or malabsorption
    - Unable to tolerate long-chain fats related to liver function, pancreatic function or malabsorption

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Selecting the Right Formula – Cont'd

- Volume tolerance
  - Volume sensitive/fluid restricted - consider 1.5 kcal/mL or greater
- Caloric needs
  - Hypercaloric - consider 1.5 kcal/mL or greater
  - Hypocaloric - consider < 1 kcal/mL

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Outline of Products

- Infant Formulas
  - 0 to 1 year of age
  - Standard, premature, specialty
- Pediatric Formulas
  - 1 to 13 years of age
  - Standard, specialty
- Clear Liquid Supplements
- Modular Additives

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Infant Formulas

Standard

- 20 kcal/oz (one formula that is 30 kcal/oz)
- Composed of intact protein, CHO and fat
- Indications for use
  - Functional gastrointestinal tract
  - Appropriate for less than 1 year of age

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Standard Infant Formulas

Component	Cow's Milk-Based (20 kcal/oz)	Soy-Based (20 kcal/oz)	Goat's Milk-Based (20 kcal/oz)	Cow's Milk-Based (30 kcal/oz)
Protein	Intact milk protein (casein and/or whey)	Soy protein isolate, partially hydrolyzed soy	Intact milk protein (casein/whey)	Intact milk protein (whey)
CHO	Varies: lactose, corn syrup solids, rice starch, corn maltodextrin, sugar	Varies: Corn syrup solids, corn maltodextrin, sucrose	Varies: Lactose, GOS, FOS, glucose syrup solids	Maltodextrin, lactose, GOS, FOS
Fat	Varies: HO safflower or sunflower, soybean, coconut oils, palm oil	Varies: HO safflower oil, soy oil, coconut oil, palm olein	Vegetable oils	Canola, coconut, HO sunflower, corn, palm kernel oils
mOsm	180 - 310	180 - 200	N/A	N/A

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Infant Formulas

Premature

- 20 kcal/oz or greater
- Composed of intact protein, CHO, and fat
- Indications for use
  - Functional gastrointestinal tract
- Appropriate for up to 1-year corrected age
- Higher amounts of calcium, phosphorus, and protein for the premature infant

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Premature Formulas

Component	20 kcal/oz	22 kcal/oz	24 kcal/oz	30 kcal/oz
Protein	Non-fat milk (whey)	Non-fat milk (whey)	Non-fat milk (whey)	Non-fat milk (whey)
CHO	Corn syrup solids, lactose	Corn syrup solids, lactose RTF: maltodextrin, lactose	Corn syrup solids, lactose	Varies: corn syrup solids, maltodextrin, lactose
Fat	Varies: MCT 40-50%, soy oil, HO sunflower oils, coconut oil, DHA, ARA	Varies: MCT 20-25%, soy oil, HO safflower/sunflower oils, coconut oil, MFGM, DHA, ARA	Varies: MCT 40-50%, soy oil, HO sunflower oil, coconut oil, DHA, ARA	Varies: MCT 40-50%, soy oil, HO sunflower oil, coconut oil, DHA, ARA
mOsm	235-260	230-250	280-320	320-325

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Specialty Infant Formulas

Indications for use

- Intact protein allergy/intolerance
  - Cow's milk allergy, multiple food allergies
- Malabsorption
  - Short bowel syndrome/intestinal failure
  - Liver disease
  - Cystic fibrosis
  - Pancreatic insufficiency
  - Chylous Effusion

Konek S *et al. Pediatric Nutrition in Clinical Care*. 5th ed. Jones & Bartlett Learning; 2020.

Specialty Infant Formulas

Component	Hydrolyzed (20 kcal/oz)	Elemental (22 kcal/oz)	High MCT (30 kcal/oz)
Protein	Varies: whey protein/casein hydrolysate	Free amino acids	Nonfat milk, whey protein conc
CHO	Varies: maltodextrin, potato starch, corn syrup solids, modified corn starch, sugar	Varies: Corn syrup solids, potato starch, maltodextrin, modified corn starch, modified tapioca starch	Corn syrup solids
Fat	Varies: MCT, soy oil, HO sunflower oil/safflower oil, CITREM, vegetable oil, DHA, ARA	MCT (33%-43%), vegetable oils, DHA, ARA, HO safflower oil, soy oil, HO sunflower oil	MCT, DHA, ARA
mOsm	220-370	330-350	360
Nutritional Considerations	MPA, SBS/IF, liver disease, CF, PI	MPA, SBS/IF, liver disease, CF, PI	Chylous effusion

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Standard Pediatric Formulas

- Children ages 1 - 13
  - 1 kcal/mL
  - Options: milk-based, plant-based, blenderized
  - With or without fiber
  - Gluten-free, lactose-free
  - Oral, tube

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Pediatric Formulas

Component	Milk-Based (30 kcal/oz)	Milk-Based (22 kcal/oz)
Protein	Varies: Milk protein conc, whey protein conc, dehydrated chicken powder, pea protein isolate, soy protein isolate, nonfat milk	Varies: Milk protein conc, soy protein isolate
CHO	Varies: brown rice syrup, sugar, fruit/vegetable blend, maltodextrin, scFOS	Varies: brown rice syrup, sugar, corn maltodextrin
Fat	Varies: canola oil, MCT, soybean oil, HO safflower oil, corn oil, tuna oil	Varies: canola oil, MCT, soybean oil, HO safflower oil, tuna oil
mOsm	260-525	400-620
Nutritional Considerations	• May be flavored • May contain fiber	• May be flavored • May contain fiber

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Pediatric Formulas – Cont'd

Component	Hypocaloric (18 – 19 kcal/oz)	High MCT
Protein	Varies: Dehydrated chicken powder, milk protein conc, pea protein isolate, soy protein isolate	Sodium caseinate
CHO	Varies: Brown rice syrup, fruit/vegetable blend, sugar, scFOS	Corn syrup solids, sugar
Fat	Canola oil, MCT, soy oil	MCT, corn oil
mOsm	310-420	350
Nutritional Considerations	• May be flavored • May contain fiber • Appropriate for patients needing less calories	• 87% MCT • Fat malabsorption • Defective lymphatic transport of fat • Not nutritionally complete

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Plant-Based Pediatric Formulas

Component	Plant-Based (30 kcal/oz)	Plant-Based (36 kcal/oz)	Plant-Based (42 kcal/oz)
Protein	Pea protein isolate, L-Cystine	Pea protein	Pea protein isolate, L-Cystine
CHO	Brown rice syrup	Brown rice syrup, agave syrup	Brown rice syrup
Fat	HO sunflower oil, canola oil, MCT	MCT, high linoleic sunflower oil, flaxseed oil	HO sunflower oil, canola oil, MCT
mOsm	410	300	650
Nutritional Considerations	• May be flavored • Contains fiber	• May be flavored • Contains fiber	• May be flavored • Contains fiber

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Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

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Blenderized Pediatric Formulas

Component	Blenderized (30 kcal/oz)	Blenderized (34 kcal/oz)
Protein	Pea protein	Pea protein, whole grain brown rice, garbanzo beans, green peas, sprouted quinoa
CHO	Fruit/vegetables, oat flour	Vegetables, garbanzo beans, brown rice, sprouted quinoa
Fat	MCT, high linoleic sunflower oil, flaxseed oil	EVOO, flax oil
mOsm	305	553
Nutritional Considerations	• Flavored • Contains fiber	• Contains fiber

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Blenderized Pediatric Formulas – Cont'd

Component	Blenderized (36 kcal/oz)	Blenderized-Enzymatically Hydrolyzed (43 kcal/oz)
Protein	Varies: Chicken, brown rice flour, hydrolyzed pea protein, rice protein conc, sweet potato puree	Varies: Hydrolyzed pea protein, garbanzo beans, green peas, brown rice, sprouted quinoa,pumpkin seed protein
CHO	Fruits/vegetables, brown rice flour	Varies: garbanzo beans, acacia fiber, brown rice, vegetables, fruit, sprouted quinoa
Fat	EVOO, canola oil	EVOO,coconut MCT oil, flax oil
mOsm	710-720	460
Nutritional Considerations	• Requires 12Fr or larger feeding tube • Gravity feeding not recommended • Contains fiber	Nectar-like viscosity at room temperature

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Specialty Pediatric Formulas

Enzymatically hydrolyzed protein

- Indications for use
  - GI tract impairment/malabsorption
  - Allergy
    - Most children will outgrow protein allergies
- Costly
  - Unavailable in stores, available online
  - 3x the cost of standard pediatric formulas

Pushpa S *et al.* *Paediatrics & Child Health*. 2024;29:382-88.

Enzymatically Hydrolyzed Specialty Pediatric Formulas

Component	30 kcal/oz	36 kcal/oz	45 kcal/oz
Protein	Varies: whey protein hydrolysate, hydrolyzed sodium caseinate, hydrolyzed pea protein	Enzymatically hydrolyzed whey protein	Varies: whey protein hydrolysate, hydrolyzed sodium caseinate, organic hydrolyzed pea protein
CHO	Varies: corn maltodextrin, corn starch, sugar, scFOS, brown rice syrup solids, agave syrup, pea starch, monk fruit juice conc	Maltodextrin, cornstarch, sugar	Varies: corn maltodextrin, corn starch, sugar, scFOS, brown rice syrup solids, agave syrup, pea starch, monk fruit juice conc
Fat	Varies: MCT, high linoleic sunflower oil, organic flaxseed oil, soybean oil, structured lipid, canola oil, tuna oil	MCT, soybean oil, canola oil	Varies: MCT, high linoleic sunflower oil, organic flaxseed oil, soybean oil, structured lipid, canola oil, tuna oil, refined fish oil (anchovy, sardine)
mOsm	260-450	450	340-567
Nutritional Considerations	May be flavored May contain fiber	Vanilla, 0.4 g fiber/100 mL	Unflavored/vanilla

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Specialty Pediatric Formulas

Elemental (free amino acids)

- 30 kcal/oz
- Indications for use
  - Severe multiple food protein allergy/intolerance
  - Gastrointestinal tract impairment/malabsorption
  - Eosinophilic esophagitis
  - Pancreatic Insufficiency
- Decreased palatability
- Costly
  - May be available in stores
  - 15x the cost of standard pediatric formulas

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Elemental Specialty Pediatric Formulas

Component	Powdered Amino-Acid Based Formulas	Ready to Use	0.8 kcal/mL powder
Protein	Free amino acids	Free amino acids	Free amino acids
CHO	Varies: Corn syrup solids, potato starch, Tapioca food starch, tapioca syrup solids, food starch modified, maltodextrin, FOS,modified tapioca starch	Maltodextrin, sugar	Maltodextrin, modified cornstarch
Fat	Varies: MCT, soybean oil, HO safflower oil, HO canola oil, canola oil, refined vegetable oil, HO sunflower oil, sunflower oil	Refined vegetable oils	MCT, soybean oil
mOsm	590-800	670-790	360
Flavors	Varies: Unflavored, Multi Flavors, prebiotic option, probiotic option	Unflavored, orange-pineapple, tropical fruit, grape	Unflavored

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Clear Liquid Supplements

Indications for Use

- Clear Liquid Diet
- Milk-based protein source
- Fat malabsorption or fat-restricted diet
- Not a sole source of nutrition

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Clear Liquid Supplements

Component	Clear Liquid Supplements
kcal/oz	30-31.5 kcal/oz (1-1.05 kcal/mL)
Protein	Whey protein isolate (3.4-3.8 gm/100 mL)
CHO	Varies: sugar, glucose syrup, corn syrup solids
Fat	None
mOsm	820-920
Flavors	Varies: orange, wildberry, apple mixed berry

https://www.nestlemedicalhub.com/products/boost-breeze.
https://www.abbottnutrition.com/our-products/ensure-clear-therapeutic.

Modular Additives

- Used to increase calories and/or protein
- Can be solely protein, carbohydrate, fat or a mixture of any of the three
- Not nutritionally complete or meant to be sole sources of nutrition
- Most can be mixed into beverages and food
- Can be given orally or via GT
- Typically unflavored

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Modular Additives – Protein

- Beneprotein®
  - Whey Protein Isolate
  - For patients with increased protein requirements
  - Mix in warm or cold foods and beverages or give via feeding tube as a flush
  - 6 g protein and 25 calories per scoop (7g)
- Proteinex®
  - Hydrolyzed collagen protein
  - For patients with increased protein requirements
  - 15 or 18 g protein/30 mL, 2-2.4 kcal/mL
  - Multi-flavored, unflavored

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Modular Additives: Combination of Macronutrients

- Duocal®
  - Dissolves in liquids and soft foods, unflavored
    - Does not mix well into carbonated beverages, not recommended to mix into fruit juices
    - Does not alter taste or texture
  - 25 kcal/scoop
  - Corn syrup solids, refined vegetable oils (MCT)
  - No protein, vitamins or minerals
  - Dairy free, protein free, lactose free, gluten free

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Modular Additives – Carbohydrate

- Cornstarch
  - Slow release of carbohydrate
    - Useful for hypoglycemia, dumping
  - Not to be premixed or for 24-hour batch/continuous feedings (thickens over time)
    - Add at time of feeding
  - 30 kcal/Tbsp

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Modular Additives – Carbohydrate Cont'd

- PureCarb®
  - Soluble carbohydrate powder
  - Proprietary blend of simple and complex carbohydrates
  - Allergen tested at no detectable limit for eggs, dairy, fish, crustacean, soy, corn, gluten, tree nuts and peanut
  - 17.5 kcal/scoop
- Corn syrup, dextrose, fructose, sucrose
  - Not used often

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Modular Additives – Fat

- Liquigen®
  - Mixes into beverages and food, unflavored
  - 4.5 kcal/mL
  - 50% MCT (refined vegetable oils) / 50% water
- MCT oil
  - Mixes into beverages and food, unflavored
  - 7.7 kcal/mL
  - Coconut and/or palm kernel oil

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Modular Additives – Fat Cont'd

- Microlipid®
  - Mixes into beverages and food, unflavored
  - 4.5 kcal/mL, safflower oil
- Oils
  - Plant based: avocado, canola, coconut, corn, flaxseed, grapeseed, olive, safflower, soybean, walnut
  - Over the counter, less expensive
  - 8 - 8.8 kcal/mL depending on oil
  - Contain MUFA, PUFA, SFA, essential fatty acids

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Modular Additives: Combination of Macronutrients

- Duocal®
  - Dissolves in liquids and soft foods, unflavored
    - Does not mix well into carbonated beverages, not recommended to mix into fruit juices
    - Does not alter taste or texture
  - 25 kcal/scoop
  - Corn syrup solids, refined vegetable oils (MCT)
  - No protein, vitamins or minerals
  - Dairy free, protein free, lactose free, gluten free

Texas Children's Hospital. Texas Children's Hospital Pediatric Nutrition Reference Guide. 13th edition; 2022.

Modular Additives: Combination of Macronutrients

- Benecalorie®
  - Mixes into foods and beverages, unflavored
  - 44 mL cup serving- 330 cal, 33 g fat, 7 g protein
  - HO sunflower oil, calcium caseinate (milk)
  - Gluten free, lactose free

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Modular Additives: Combination of Macronutrients

- MCT ProCal®
  - Appropriate for oral and tube feeding in children > 3 years, unflavored
  - Not recommended to mix into fruit juices
  - Appropriate for fat malabsorption, disorders of long chain fatty acid oxidation, conditions requiring a high MCT/low LCT diet
  - Packet provides 112 cal, 10 g MCT, 2 g protein
  - Glucose syrup, MCT, sodium caseinate (milk)

https://www.vitaflousa.com/sites/g/files/lpfasj266/files/2024-04/MCTprocal_Datasheet_final.pdf.

Monitoring Tube Position

- Check tube position and site prior to feeding
- NG Tube and NJ Tube Surveillance
  - Mark insertion point
  - Proper position of tube can be confirmed by injecting air while listening over the abdomen.
  - Initial radiograph to confirm initial position
  - Recheck with change in tube length or feeding tolerance

Gastric Residual Volumes

- The use of gastric residual volumes (GRVs) as a clinical monitor for patients receiving enteral tube feeding is poorly standardized
- Little data exist to support a correlation of GRV with gastric emptying, volume of gastric contents, or changes in the infusion of ETF
- GRVs do not correlate to regurgitation or aspiration, and their use cannot be relied on to protect patients against aspiration pneumonia
- The practice of GRV may in fact impede delivery of ETF by promoting inappropriate cessation and reducing potential infusion time

McClave SA *et al. J Parenteral Enter Nutr.* 2002;26:S43-50.

ICU and Aspiration Risk

- Risks for aspiration
  - Decreased level of consciousness
  - Sustained supine position
  - Positive pressure ventilation
- Less agreement regarding the effect of a NG tube (or its size) on aspiration and on the effect of various formula delivery methods (NG vs. ND vs. NJ/GJ tubes)
- Recommendation: initiate NG tube feeding unless there is a heightened risk for intolerance or other reason that nasogastric feeding is not indicated

Metheny NA. J Parenteral Enteral Nutr. 2002;6:S26-S33.
Marik PE *et al. Crit Care.* 2003;7:R46-51.
Ho KM *et al. Intensive Care Med.* 2006;32:639-49.

Intolerance Interventions

- Consider
  - Evaluate for and address tube complication
  - Change feeding rate or formula
    - Transition to continuous feedings
  - Trial of promotility agents either to advance tube or enhance emptying/feeding tolerance
    - Note that several promotility agents have side effects
- Post-pyloric feedings
  - Consider with high aspiration risk or intolerance to gastric feedings

Ho KM *et al. Intensive Care Med*. 2006;32:639-49.

Refeeding Syndrome (RFS)

- RFS refers to the triad of congestive heart failure, elevated liver enzymes and peripheral edema that results from the depletion of total body phosphorus
- RFS can develop before patients become symptomatic. It is important to monitor for RFS in appropriate patient even w/o symptoms
- Patients may have weakness, delirium, seizures, rhabdomyolysis, respiratory failure and death

Pediatric Gastrointestinal and Liver disease 6th edition.
da Silva JSV *et al Nutr Clin Pract*. 2020;35:178-95.

Refeeding Syndrome (RFS) – Cont'd

- Risk factors for refeeding syndrome include
  - Chronic malnutrition (including children of neglect)
  - Rapid weight loss (5-10 weight loss in 1 to 20-month period)
  - Anorexia Nervosa
  - Malabsorptive states (including IBD, cystic fibrosis, chronic pancreatitis, short bowel syndrome)
  - Cerebral palsy

Pediatric Gastrointestinal and Liver disease 6th edition.
da Silva JSV *et al Nutr Clin Pract*. 2020;35:178-95.

Refeeding Syndrome (RFS) – Cont'd

- Serum abnormalities and fluid dysregulation
  - Serum abnormalities often seen
  - Hypophosphatemia (hallmark of RFS)
    - Hypomagnesemia
    - Hypokalemia
    - Glucose abnormalities
    - Thiamine deficiency
  - Fluid dysregulation
    - Derangements of sodium, nitrogen and fluid balance

Management Guidelines for RFS

- Electrolyte deficiencies should be corrected before starting enteral or parenteral support
- Thiamine should be initiated
  - Thiamine serves as a coenzyme in many of the metabolic pathways that are upregulated once feeding is initiated
- In patients at risk of refeeding syndrome, initiate EN at 25-50% estimated goal and advance by 10-33% daily over 3-5 days
  - Advancement of nutrition is based on biochemical stability
- Protein intake does not require restriction
- Sodium and fluids should be restricted during the initial period of refeeding to prevent fluid overload, especially in a patient at risk for RFS, whose cardiac function may be compromised

Fuentebella J *et al. Pediatric Clinics.* 2009;56:1201-10.
da Silva JSV *et al Nutr Clin Pract.* 2020;35:178-95.
Pediatric Gastrointestinal and Liver disease 6th edition.

Electrolyte/Micronutrient Replacements for RFS

Potassium	0.3-0.5 mEq/kg/dose Max dose: 30 mEq/dose
Phosphorus	0.08-0.24 mmol/kg Max single dose: 15 mmol Max daily dose: 1.5 mmol/kg
Magnesium	25-50 mg/kg/dose (0.2-0.4 mEq/kg/dose) Max single dose 2000 mg (16 mEq)
Thiamine	10-25 mg/day administered IV or IM if extremely ill or 10 -50 mg per dose administered PO every day for 2 weeks and then 5-10 mg/day for 1 month

Fuentebella J *et al. Pediatric Clinics.* 2009;56:1201-21.

Case

- 13-year-old male with a history of severe avoidant/restrictive food intake disorder presents with a 3-month history of abdominal pain, diarrhea, and poor appetite and is diagnosed with Crohn's disease
- He has had a 10% weight loss over the past 3 months
- His BMI is 19 kg/m^2
- Initial electrolytes: mild hypophosphatemia (2.5 mg/dL), normal potassium (4.0 mEq/L), and mild hypomagnesemia (1.5 mg/dL).
- Phosphorus and magnesium supplementation is administered after labs result
- He is hemodynamically stable but had mild orthostatic hypotension

Case Review

Initiation of Enteral Nutrition

- Due to moderate malnutrition and patient's restricted diet, he is started on enteral nutrition via NG tube
- As the patient is high risk for refeeding syndrome, feeds are initiated in accordance with refeeding syndrome management guidelines
- Feeds were initiated at 30% of goal caloric needs with a standard pediatric polymeric formula
- Fluids were restricted to 85% of maintenance requirements
- Empiric thiamine repletion is initiated
- Patient was assessed daily for abdominal distention/pain, stooling pattern, fluid overload, respiratory difficulty, and mental status
- Electrolytes are monitored every 12 hours
- Caloric intake via enteral nutrition is increased by 15% daily

Case Review

Manifestation and management of refeeding syndrome

- By day 3 of feed advancement, the patient develops electrolyte derangements:
  - Hypophosphatemia (1.2 mg/dL)
  - Hypokalemia (2.8 mEq/L)
  - Hypomagnesemia (1.2 mg/dL)
- He also develops generalized edema and mild tachycardia (HR 105 bpm)
- Feeds are held for 12 hours while electrolyte abnormalities are corrected
- Feeds are then restarted at a lower rate (25% of goal calories) with slower daily caloric advancement of 10% per day
- Fluids are restricted to 70% maintenance
- Patient continues to be closely monitored for further electrolytes derangements and signs of worsening fluid overload
- Electrolytes normalize by day 7 and he reaches goal feeds by day 10

5. EN Support in Special Populations

EN Support in Special Populations

– Intestinal Failure/Short Bowel Syndrome –

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Case

E.G. is a 1-month-old, ex 36 weeker with gastroschisis s/p resection, found to have 50 cm remaining bowel, no ICV, in continuity + full colon. Fully PN dependent at this time; however, patient has NG tube in place and cleared by surgery to start feeds.

1) What are the challenges EG will likely face with this anatomy?

2) What basic nutrition interventions would you implement for EG?

Etiologies of Intestinal Failure (IF)/ Short Bowel Syndrome (SBS)

Mucosal Conditions (Intestinal Failure)	• Microvillus inclusion disease • Crohn's disease (without resection) • STAT1 gene mutation • Tufting's enteropathy	• DGAT-1 deficiency/intestinal lymphangiectasia • Cancer/radiation resulting in malabsorption • Fistula
Dysmotility Conditions (Intestinal Failure)	• Pseudo-obstruction • Omphalocele • Hirschsprung's disease	• TTC7A deficiency (gene mutation) • Scleroderma
Short Bowel Syndrome (with surgical resection)	• Necrotizing enterocolitis • Gastroschisis • Volvulus • Intestinal atresia	• Trauma (accident, gunshot wound) • Crohn's disease with resection • Mesenteric vascular disease

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Modi BP *et al. J Parenter Enteral Nutr.* 2022; 46:42-59.
Duro D et *al. J Ped Gastroenterology and Nutrition.*2008;47:533-36.
Pironi L *et al. Clinical Nutrition.* 2015;34:171-80.

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Definition of IF

- Intestinal failure is the reduction of functional intestinal mass below that which can sustain life, resulting in dependence on supplemental parenteral support (PN) for a minimum of 60 days within a 74 consecutive day interval

- Intestinal Failure Classifications
  - Type I: acute, short-term, often self-limited
  - Type II: subacute in development, prolonged course, requires several weeks/months of parenteral support
  - Type III: chronic, parenteral support needed for months/years and may or may not be reversible
  - Note: short bowel syndrome is one type of intestinal failure and often falls under Type III intestinal failure classification

Modi BP *et al. J Parenter Enteral Nutr.* 2022; 46:42-59.
Pironi L *et al. Clinical Nutrition.* 2015;34:171-80.

Predictors of Outcomes/ Potential for Enteral Autonomy

- Length of residual small intestine AND function of remaining intestine
  - Length < 35 cm if jejunoileal anastomosis and colon in continuity
  - Length < 60 cm if jejunocolonic anastomosis with no ileum remaining but colon in continuity
  - Length < 115 cm if end jejunostomy with no ileum and only portion of jejunum remaining
  - Some conditions (such as gastroschisis may have significant remaining SB; however, the function of the remaining SB may be compromised due to mucosal damage/exposure to amniotic fluid)
- Presence of the colon and ileocecal valve (ICV)
  - Patients with ICV are 2x more likely to achieve enteral autonomy

Khan FA *et al. Journal of Pediatrics*. 2015;167:29-34. Sz-Ying C *et al. J Pediatric Gastroenterol Nutr.* 2019;69:E79-89.
Raghu VK *et al. J Parenter Enteral Nutr.* 2023;47:1047-55. Pierret A. *Amer J Clin Nutr.* 2019;110:430-36.

Predictors of Outcomes/ Potential for Enteral Autonomy – Cont'd

- Underlying disease/severity
  - Long-segment Hirschprung's disease (RET gene)
  - Rare gene mutations (STAT1, TTC7A)

- PN dependence < 2 years
  - Patients who are PN-dependent > 2 years are at increased risk for Incidence of sepsis, IFALD (intestinal failure associated liver disease), and CLABSI (central-line associated bloodstream infections)
  - Importance of Multidisciplinary Intestinal Failure Program to wean off PN (patients cared for at IF programs significantly more likely to wean off PN)

Khan FA *et al. Journal of Pediatrics*. 2015;167:29-34. Sz-Ying C *et al. J Pediatric Gastroenterol Nutr.* 2019;69:E79-89.
Raghu VK *et al. J Parenter Enteral Nutr.* 2023;47:1047-55. Pierret A. *Amer J Clin Nutr.* 2019;110:430-36.

Clinical Complications Associated with SBS/IF

- Central line catheter-related: infection, occlusion of line, thrombosis
- PN-related complications
  - Hepatic: steatosis, cholestasis, fibrosis, cirrhosis
  - Biliary: gallstones
  - Bone: metabolic bone disease (contaminants of PN/challenge of meeting calcium/vitamin D needs in PN dependent patients)
- Bowel anatomy-related: malabsorptive diarrhea, electrolyte abnormalities, micronutrient deficiencies, essential fatty acid deficiency, SIBO, D-lactic acidosis, oxalate nephropathy, renal dysfunction, anastomotic strictures/ulcers

Parrish CR. *Gastroenterol Heptatol*. 2017;13:600-8.

Principles of Nutrition Management

- Meet high calorie/protein demand
  - Use oral, EN, PN or combination of routes
- Adequate hydration and electrolyte repletion
  - Close management of PN/EN regimens and/or use of oral rehydration solution
- Maximize bowel adaptation
  - Use of additives to thicken output
  - Avoid dumping syndrome (no simple sugars/separate food and fluids)
- Promote enteral autonomy/Minimize oral aversion
  - Encourage oral intake, refer to speech therapy
  - Adjust formula regimens based on output/tolerance
- Prevent/treat micronutrient deficiencies

Rees-Parish C *et al.* *Practical Gastroenterology*. 2021;26:10-23.

Sites of Absorption

Site	Normal Length	Nutrients Absorbed	Comments
Duodenum	• Full-term infant: 25 cm • Adolescent: 25 cm • Adult: 25 – 30 cm	Calcium, amino acids, iron, zinc, copper	
Jejunum	• Full term infant small bowel: 250 – 270 cm • 1 year-old: 380 cm • 5 year-old: 450 cm • Adult: 550-600 cm	Lipids, Peptides, vitamin C, iron, B-vitamins, calcium, folate, Fat soluble vitamins, (ADEK), water, zinc	Remaining jejunum does not adapt after resection
Ileum	(see length in jejunum section above)	Vitamin B12, intrinsic factor, bile salts/acids, water, sodium	Remaining ileum has ability to adapt by increasing villi length and deeper crypts
Colon	• Full-term infant: 52 cm • Adolescent: 73 – 95 cm • Adult: 150 cm	Electrolytes, water, short-chain fatty acids	

Strujis MC *et al. J Pediatric Surg*. 2009.;44:933-38. Merritt RJ *et al. J Pediatric Gastroenterol Nutr.* 2017;65:588-96.
Hounnou G *et al. Surgical and Radiologic Anatomy*. 2002;24:290-4.

Estimated Needs

Age	Primarily PN Dependent	Enterally Dependent
Infant 0 - 6 months	85 - 105 kcal/kg	120-200 kcal/kg
Infant 6 - 12 months	80 - 100 kcal/kg	100+ kcal/kg
Toddlers/Children (1 – 13 yrs)	50 - 90 kcal/kg	80+ kcal/kg
Adolescent (> 13 yrs)	30 - 50 kcal/kg	DRI x 2

Duggan CP *et al. N Engl J Med*. 2017;377:666-75.
Rees-Parish C *et al. Practical Gastroenterology*. 2021;26:10-23.

Parenteral Nutrition

- Essential for survival in most Intestinal Failure cases before enteral autonomy is reached
  - Compensates for fluid and electrolyte losses
  - Provides calories/protein/micronutrients in children beyond what they can absorb enterally
- Has prolonged life expectancy with improvements in PN administration
  - Mixed-lipid/fish-oil based IV lipids FDA approved and widely used
- Cause of many risk factors for morbidity/mortality
  - Line infections, sepsis, liver disease
- Does not promote intestinal adaptation

Bielawska B. *Nutrients* 2017;9:466.
Rees-Parish C *et al.* *Practical Gastroenterology*. 2021;26:10-23.
Tanyaporn K. *Nutri. Clinical Practice* 2024;39:991-1002.

Enteral Therapy / Oral Feeding

- Route: oral, NG, ND, GT, GJT, JT
  - Imperative to involve Speech Language Pathologist as early as possible
  - High incidence of oral aversion in SBS / IF

- Administration: bolus, intermittent, continuous
  - Depends on function of remaining bowel/can use a combination of regimens to support oral intake

Elfadil OM *et al. J Parenteral Enter Nutr*. 2021;46:626-34. Tanyaporn K. *Nutri. Clinical Practice* 2024;39:991-1002.
Rees-Parish C *et al. Practical Gastroenterology*. 2021;26:10-23.

Enteral Therapy / Oral Feeding – Cont'd

Formula type

- Human milk is first choice even in more severe short bowel cases, should always be attempted first when available
- Protein hydrolysate/Peptide: patients that do not tolerate standard formula but have some EN autonomy, available in very low fiber content or with mixed fiber (inulin, guar gum, or FOS)
- Elemental formula (amino acid-based, hypoallergenic): patients that do not tolerate more intact formulas, often required in patients with ostomies, most do not contain any fiber
- Blended feeds (> 1 year of age): commonly used in combination with standard, hydrolysate or elemental formula to thicken stools, often not able to tolerate as sole-source due to high fiber content

Elfadil OM *et al. J Parenteral Enter Nutr.* 2021;46:626-34. Tanyaporn K. *Nutri. Clinical Practice* 2024;39:991-1002.
Rees-Parish C *et al. Practical Gastroenterology.* 2021;26:10-23.

Tools for Absorption: Fiber and Pharmacotherapy

- Additives: fiber/thickening agents
  - Fiber: guar gum, wheat dextrin, Pectin/green beans, baby oatmeal
  - Thickeners: rice cereal, banana flakes, potato starch

- Glucagon-like-Peptide-2 analog injection
  - Daily injection approved for children >1 year of age and adults on PN support
  - Promotes repair and growth of the intestinal mucosa by increasing villi height and crypt depth

Pironi L *et al.* *Nutrition in Clinical Practice*. 2023;39:141-53. Harvie ML. *Nutrition in Clinical Practice* 2018;33:539-44.
Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23. Parrish CR. *Gastroenterol Heptatol*. 2017;13:600-8.

Tools for Absorption: Fiber and Pharmacotherapy – Cont'd

- Loperamide (tablets): slows intestinal motility to decrease stool output
- Ursodiol (ursodeoxycholic acid): dissolves gallstones
- PPI/H_2 blocker: help to control gastric acid production, prevents/treats reflux
- Cholestyramine: bile acid sequestrant to limit reabsorption of bile acids in GI tract
- Motility agents: increase gastric accommodation, improve dysmotility
- Pancreatic enzymes (newer therapy): aid in fat breakdown/increase fat absorption with meals/enteral feeds

Pironi L *et al.* *Nutrition in Clinical Practice*. 2023;39:141-53. Harvie ML. *Nutrition in Clinical Practice* 2018;33:539-44.
Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23. Parrish CR. *Gastroenterol Heptatol*. 2017;13:600-8.

Anthropometric Monitoring / Assessment

Measurement	Age	Initial Period	Long-Term Follow-up
Weight (kg) [infant scale up to 2 years of age]	Preterm / term infants	Daily	Every 2 – 4 weeks
	> 1 year of age	2 times per week	Monthly
Length / Ht (cm)	Infants	Weekly	Every 1 – 3 months
	> 1 year of age	Every 2 – 4 weeks depending on age	
Head Circumference	0 – 24 months (some resources recommend up to 36 months)	Weekly	Every 1 – 3 months until age 24 months

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Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23.
Freeman H et al. The Practitioner's Guide to Nutrition-Focused Clinical Exam of Infants, Children, and Adolescents. 2019.

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Anthropometric Monitoring / Assessment – Cont'd

Measurement	Age	Initial Period	Long-Term Follow-up
MUAC (mid-upper arm circumference)	2 months (CGA) – 60 months (WHO chart)	Every 1 – 2 weeks	Every 1 – 3 months
	Age 5 – 18 yo (CDC chart)	Every 2 weeks	Every 1 – 3 months
Nutrition-Focused Physical Exam	Infants	Daily to weekly (often in inpatient setting)	With every exam/visit (every 1 – 3 months)
	>1 year of age	Weekly	With every exam/visit (every 1 – 3 months)

Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23.
Freeman H et al. The Practitioner's Guide to Nutrition-Focused Clinical Exam of Infants, Children, and Adolescents. 2019.

Laboratory Monitoring Protocol

- Check C-reactive protein with all nutrition labs
- Consider checking labs sooner in cases of deficiency

Lab	Initial	Long-Term PN Dependent	Enterally Dependent	Comments
Electrolytes	Daily	Every 1 – 4 weeks	3 – 6 months	*depending on stability of pt
LFTs, GGT, bilirubin	Weekly	Monthly	3 – 6 months	More often in cholestatic patients
CBC, reticulocyte count	Weekly	Monthly	3 – 6 months	Always check when checking iron panel
PT/INR, iron studies	After 2 – 4 weeks on PN/baseline	Every 3 months	3 – 6 months	More often in deficiency
Free/total carnitine	After 1 month on PN	Every 6 months	Every 6 – 12 months	Infants have about 1-2 weeks of maternal stores

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Berger M. *Clin Nutrition*. 2022;41:1357-1424.
Tanyaporn K. *Nutri. Clinical Practice*. 2024;39:991-1002. Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23.

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Laboratory Monitoring Protocol – Cont'd

Lab	Initial	Long-Term PN Dependent	Enterally Dependent	Comments
Vitamin A/D/E (fat soluble)	After 1 month on PN (baseline)	Every 3 months	Every 6 months (sooner if cholestatic)	
Vitamin B12, Folate		Every 6 – 12 months	Every 6 months (or sooner in deficiency)	Check homocysteine and Methylmalonic acid
Zinc, Copper, selenium	After 2 – 4 weeks on PN	Every 3 months	Every 6 months	Check ceruloplasmin with copper level
Manganese, Chromium, Aluminum	Yearly	Yearly	N/A	*chromium level not great indicator of body stores
Iodine level and thyroid panel	Yearly	Yearly	N/A	Consider urine iodine level
Urine sodium	Every 2 – 4 weeks	Monthly	Every 1 – 3 months	Ostomy patients only

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Berger M. *Clin Nutrition*. 2022;41:1357-1424.
Tanyaporn K. *Nutri. Clinical Practice*. 2024;39:991-1002. Rees-Parish C et al. Practical Gastroenterology. 2021;26:10-23.

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Case

E.G. is a 1-month-old, ex 36 weeker with gastroschisis s/p resection, found to have 50 cm remaining bowel, no ICV, in continuity + full colon. Fully PN dependent at this time; however, patient has NG tube in place and cleared by surgery to start feeds.

1) What are the challenges EG will likely face with this anatomy?

2) What basic nutrition interventions would you implement for EG?

Case Review

1) No ICV, gastroschisis may result in dysmotility regardless of remaining bowel length

2) Short term: discuss starting human milk feeds via NG tube (vs formula alternative if human milk not available), request SLP evaluation to assess oral feeding, adjust estimated needs to include PN vs EN, start following lab monitoring protocol

EN Support in Special Populations
– Inflammatory Bowel Disease –

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Dietary Interventions for IBD

Includes

- Exclusive enteral nutrition (EEN)
- Partial enteral nutrition (PEN)
- Crohn's disease exclusion diet (CDED)
- Specific carbohydrate diet (SCD)
- Low FODMAP diet
- Mediterranean diet (MD)

Dietary Interventions for IBD

Diet	Include	Avoid
Exclusive Enteral Nutrition	Nutritional complete formula with variable nutrient composition	All other nutritive sources
Partial Enteral Nutrition with Crohn's Disease Exclusion Diet	• Induction: First six weeks 50% of calories from formula, followed by 25% in weeks 7 – 12. Rest of calories CDED allowed foods including fruits, vegetables, meat, grains, oats, rice • Maintenance: once in remission, continue allowed foods	Seafood other than fish, dairy, processed foods, artificial sweeteners, emulsifiers, cocoa, coffee, and alcohol
Specific Carbohydrate Diet	Whole food diet with emphasis on fruits, most vegetables, fresh legumes, meat, seafood, hard cheeses, yogurt fermented greater than 24 hour	Grains, starchy vegetables, most dairy, processed foods, artificial sweeteners, emulsifiers, cocoa, sugars outside of honey

Reznikov EA *et al. Nutrients* 2023;5:668.

Dietary Interventions for IBD – Cont'd

Diet	Include	Avoid
Low FODMAP Diet	Certain fruits and vegetables, low lactose dairy, gluten-free grains	Certain fruits and vegetables high in fructose, fructans, and polyols, grains, most legumes high in galacto-oligosaccharides, dairy
Mediterranean Diet	Whole food diet with emphasis on fruits, vegetables, whole grains, legumes, seafood, nuts, olive oil	High red meat intake, sweets, sugar, processed meat, dairy

Reznikov EA *et al. Nutrients* 2023;5:668.

EN Guidelines & Recommendations for IBD

- Standard EN formula (polymeric, moderate fat content, no particular supplements) can be initiated for primary and supportive nutritional therapy in active IBD
- Advantages of early EN within 24 hours of surgery vs later commencement have been shown in two meta-analyses
- Comparing one form of EN to another has not shown any difference in effectiveness for treating active Crohn's disease (CD), but a non-significant trend favoring low fat formulations has emerged
- For tube feeding in IBD, nasal tubes or percutaneous access can be used
- Tube feeding in CD should be administered via an enteral feeding pump

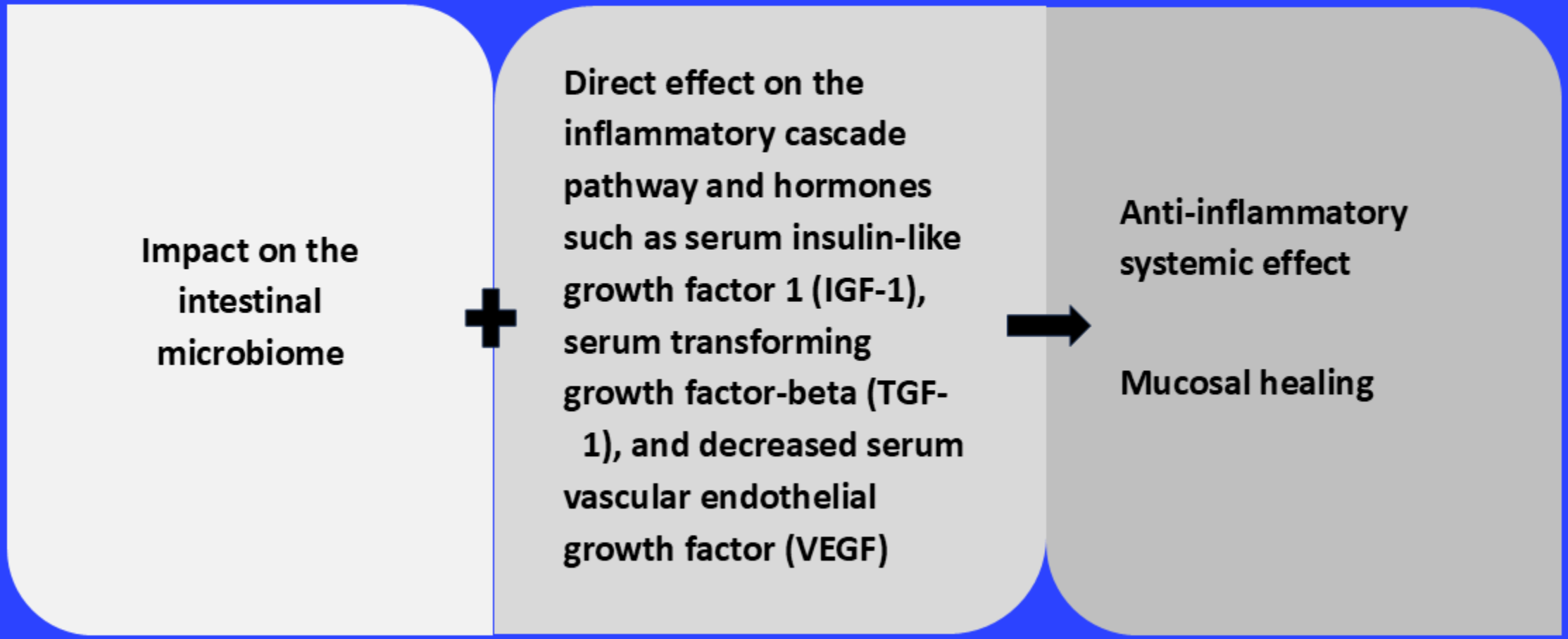
Forbes A.*et al.* *Clinical nutrition.* 2017;36:321–47.

Exclusive Enteral Nutrition (EEN) for IBD

- First-line treatment for the induction of remission for mild-to-moderate pediatric CD
- Use of a complete nutritional formula as sole dietary intake for 6 – 10 weeks
- Achieve clinical and biochemical remission in approximately 80% of pediatric CD patients with significantly improved endoscopic mucosal healing as compared to corticosteroids
  - Adult CD studies on EEN induction of remission have shown overall less efficacy
- Long-term therapy with EEN has limited utility given the concerns of "formula fatigue"
- There is no current data to support the routine use of EEN for the induction of remission in ulcerative colitis (UC), although EEN may provide benefits to UC patients by improving symptoms and nutritional status

Reznikov EA *et al. Nutrients* 2023;5:668.

Proposed Mechanism of Action



Reznikov EA *et al. Nutrients* 2023;5:668.

Partial Enteral Nutrition (PEN) for IBD

- Dietary intake of 50-90% of calories from formula and the rest by whole foods
- Johnson *et al*
  - Fifty children with active CD were randomized to receive PEN (50% of calories) or EEN
  - While both groups had improved symptoms and nutritional benefit, those on PEN had a significantly lower remission rates (15 versus 42%)
  - The EEN group as compared to the PEN group showed significant improvement in laboratory measures including increased albumin and decreased erythrocyte sedimentation rate (ESR)

Johnson T *et al. Gut*. 2006;55:356-61.
Reznikov EA *et al. Nutrients* 2023;5:668.

Crohn's Disease Exclusion Diet (CDED)

- Whole food diet intended to limit exposure to foods that are believed to negatively impact the intestinal microbiome, alter intestinal barrier function, or induce colonic inflammation
- CDED is combined with varying amounts of PEN over time including an induction and maintenance phase
- Clinical trials have shown remission rates in children and adults similar to that of EEN

Note: Whether diet is being used as a primary intervention, such as EEN, PEN with CDED or SCD, or a secondary intervention, such as MD, development of a patient specific plan is essential

Reznikov EA *et al. Nutrients* 2023;5:668.

EN Support in Special Populations

– Cystic Fibrosis –

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Nutrition in Cystic Fibrosis (CF)

- A strong correlation exists between pulmonary function test (FEV1) and nutritional status
- Malnutrition in CF results from
  - Increased calorie needs (increased metabolic rate, infections, work of breathing, cough)
  - Increased losses (malabsorption due to pancreatic, liver, and intestinal disease; intestinal section; vomiting; and CFRD)
  - Decreased nutrient intake (anorexia, reflux, eating disorders, abdominal pain, constipation, malaise, medications)

Nutrition in CF

- Goals: normal growth and optimal nutritional status
  - Ages 0 – 2 year: weight for length >50th percentile
  - Ages 2 – 20 year: BMI percentile >50th percentile
  - Adults: BMI of 22 for women and 23 for men

What is New in CF?

- Typical unrestricted high-calorie, high-fat CF diet that was encouraged for years might not be always needed with newly added CFTR modulator treatments
- Excessive weight gain has been noted in patients on CFTR modulators
- Weight stigma and body changes are associated with eating disturbances, depression, anxiety and body image issues

Nutrition Assessment in CF

- Growth (growth curve, head circumference, BMI percentile)
- Biochemical indicators such as vitamins and mineral levels
- Nutrient intake
- Micronutrient supplementation (fat soluble vitamins – A, D, E, K), Ca, Fe, Zn, Na (salt), EFA
- Eating behavior and family eating pattern
- PERT (Pancreatic enzyme replacement therapy)

Nutrition Assessment in CF – Cont'd

- Physical activity
- Severity of lung disease
- Presence of any comorbidity such as CFRD, chronic infections, cirrhosis, or bacterial overgrowth
- Factors that may impact the patient's ability to meet nutrition goals including psychosocial factors
- CFTR modulator eligibility and adherence

Guidelines for Infant Growth

- Calculate average daily weight gain since last visit and compare to expected

Age Range	Male (gm/day)	Female (gm/day)
Birth – 1 month	30	26
1 – 2 months	35	29
2 – 3 months	26	23
3 – 4 months	20	19

Age Range	Male (gm/day)	Female (gm/day)
4 – 5 months	17	16
5 – 6 months	15	14
6 – 9 months	10 – 13	10
9 – 24 months	7 – 10	7 – 10

Based on expected rate of weight gain at the 50th percentile for age

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Borowitz D *et al. J Pediatr.* 2009;155:S73-93.

Guo *et al. J Pediatr.* 1991;119:355-62.

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Guidelines for Infant Nutrition

- Expected weight gain not achieved: refer to registered dietitian for evaluation and nutritional assessment
- Values for weight gain and intake are based on term, well-nourished infants; increased intakes and rates of weight gain are needed for catch-up growth

Age Range	Required Intake (kcal/kg/day)
Birth to 3 months	≥ 115 – 130
3 – 6 months	≥ 100 – 110
6 – 24 months	≥ 100

Beal VA. Human Growth and Development, McCammon ed., Springfield, IL 1970;63-100.
Guo *et al. J Pediatr.* 1991;119:355-62.

Guidelines for Infant Nutrition – Cont'd

- Human milk is recommended
  - If the infant is formula fed, standard infant formulas (as opposed to hydrolyzed protein formulas) should be used
- Calorically dense feeds with weight loss / inadequate weight gain
- Encourage positive feeding behaviors / use available educational resources
- When growth deficits are present, intensive treatment with behavioral intervention and nutrition counseling is required
  - Follow up at 2 – 6 week intervals (shorter intervals for younger infants)
  - Discuss gastrostomy tube placement with family early in the process; proceed with gastrostomy tube sooner in younger patients or those with more severe weight deficits

Borowitz D *et al.* *J Pediatr.* 2009;155:S73-93.

Guidelines for Infant Nutrition – Cont'd

Steps to Address Insufficient Weight Gain

- Increase caloric density of feedings
- Increase PERT dose to the higher end of the dosing range
- Consider the following

Expenditure or Metabolic Issues?	Poor Absorption?	Socioeconomic/Educational /Behavioral Issues?	Poor Appetite?
• Pulmonary exacerbation (acute, subacute, or recurrent) • GERD • Salt depletion • Zinc deficiency • Increased activity	• Problems with PERT administration or adherence in PI patients • Need for acid-blocker • Other GI conditions • Suck-swallow problem	• Inadequate feeding knowledge • Maladaptive feeding behaviors • Financial difficulties • Maladaptive family functioning	• Iron deficiency • Constipation • GERD • Zinc deficiency • Suck-swallow problem

Borowitz D *et al.* *J Pediatr.* 2009;155:S73-93.

Guidelines for Infant Nutrition – Cont'd

- Start appropriate multivitamins shortly after diagnosis. Check fat soluble vitamin levels 2 months later and annually thereafter; increase frequency if values are abnormal
- Salt
  - Diagnosis – 6 months of age: ⅛ tsp
  - 6 – 12 months of age: ¼ tsp
- Zinc: a trial of zinc supplementation (1 mg elemental zinc/kg/day in divided doses for 6 months) may be given to patients who are not adequately growing despite adequate calorie intake and pancreatic enzyme replacement therapy

Borowitz D *et al.* *J Pediatr.* 2009;155:S73-93.

Nutrition Requirements

- Daily calorie requirements: 110 – 200% of recommended intakes for normal individuals
  - Utilize an individualized approach to determine calorie needs based on weight gain pattern and fat stores
- Indirect calorimetry is the gold standard in estimating energy needs
- Macronutrients: protein, fat, carbohydrates
- Micronutrients: fat soluble vitamins, water soluble vitamins, minerals (NaCl, Zn, Fe, Ca, Mg, Fl), essential fatty acids
- If poor growth is identified, evaluate PERT usage, active pulmonary disease, diet adequacy/need for nutrition supplement or EN support

ASPEN pediatric nutrition support core curriculum 3rd edition.

Enteral Nutrition Indications in CF

- Initiate EN as a means to improve age-dependent anthropometrics in individuals with CF who are unable to consume adequate calories and protein to meet growth/weight maintenance goals
  - NG, NJ, G, GJ or J tubes
    - NG tube feeding avoids the risk of surgery, is easily reversible, short-term, trial of feeding tolerance prior to gastrostomy tube placement
- Individuals with CF may be at increased risk of GER, bile reflux, and delayed gastric emptying
  - If active GER pre-operatively, can be considered for fundoplication at the time of gastrostomy tube placement

Schwarzenberg SJ *et al.* *J Cyst Fibros.* 2015;15:724-35.

Initiating Enteral Feedings

- Patients should be at their optimal respiratory status prior to undergoing gastrostomy tube placement procedure
  - Careful consideration of the capacity for post-operative recovery should be made in patients with severe pulmonary dysfunction
- Risk for refeeding syndrome should be evaluated prior to initiation of EN
- Patients utilizing enteral tube feeding should meet with a CF-trained registered dietitian regularly to ensure goals are achieved

Schwarzenberg SJ *et al.* *J Cyst Fibros.* 2015;15:724-35.

Initiating Enteral Feedings – Cont'd

- Standard formula (complete protein, long-chain fat) typically well tolerated
- Calorically dense formulas (1.5 – 2.0 kcal/mL) may be required to provide adequate calories
  - Nocturnal infusions encouraged to promote normal eating pattern during the day
  - Initially 30 – 50% of estimated energy requirements may be provided overnight
- Pancreatic enzymes should be given with enteral feeding

EN Support in Special Populations

– Growth Failure / Faltering –

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Case

A 5-year-old male with no notable past medical history presents to clinic with concerns for poor weight gain. Current weight at 8%ile for age (z-score -1.3) and height at 25%ile for age; weight previously trending along the 20%ile but weight gain has become stagnant. Parents report he is generally healthy and active, but appetite is variable. After obtaining a feeding history, you estimate his daily caloric intake is 1050 kcal/day and determine daily calorie goal of 1200 kcal/day. You discuss options that could be supplemented in order to meet his daily calorie goal. Which of the following can be considered to help increase his daily calorie intake?

a) Supplement with an 8 oz standard pediatric nutrition supplement (1.0 kcal/mL) daily

b) Supplement with 6 scoops of Duocal® throughout the day

c) Provide education on calorie-rich foods and encourage parents to utilize calorie boosters at home

d) All of the above are options

Causes of Growth Failure / Faltering

Multifactorial causes may include

- Inadequate calorie intake e.g., disordered eating, eating disorders, neurological, aerodigestive conditions, psychosocial, environmental factors
- High metabolic demands e.g., cardiac, cancer, pulmonary, renal and liver disease, chronic infection, critical care, burns
- Gastrointestinal pathology e.g., aerodigestive conditions, inflammatory bowel disease, short bowel syndrome or intestinal failure, celiac, food allergy, EoE, vomiting, maldigestion, malabsorption
- Endocrine and Genetic Factors e.g., inborn errors of metabolism, chromosomal abnormalities, diabetes, inability to utilize nutrients consumed

https://www.nationaleatingdisorders.org/

ASPEN Ped and Neonatal Nutr Support Handbook, 3rd edition.

ASPEN Ped Nutr Support Core Curr, 2nd edition.

Assessment

Initial evaluations include

- Thorough medical assessment
- Growth chart/Z-score assessment - utilize correct growth chart (WHO, CDC, CP, DS)
- document both wasting, evidence of stunting, and degree of malnutrition
- Nutrition focused physical exam
- Diet recall/ food record

Initial referrals to consider

- Referral to appropriate ancillary specialist as appropriate: registered dietitian, speech therapist, occupational therapist, lactation consultant, disordered eating program, social worker

https://www.nationaleatingdisorders.org/

ASPEN Ped and Neonatal Nutr Support Handbook, 3rd edition.

ASPEN Ped Nutr Support Core Curr, 2nd edition.

Interventions in Infants

- Confirm correct mixing of formula
- See lactation consultant if warranted
- Review feeding schedule
- Provide intake goals

ASPEN Ped Nutr Support Core Curr, 2nd edition.
ASPEN Ped and Neonatal Nutr Support Handbook, 3rd edition.

Additional Interventions in Infants

- Frequent feedings
- Fortification of formula or breastmilk
  - Some ready to feed formulas are available in higher concentrations (24 kcal/oz, 30 kcal/oz)
- Provide supplemental bottles of formula to breastfeeding infants, consider supplemental nursing system (SNS) for breastfed infants
- Calorie boosters added to solids (when age-appropriate)
- Vomiting / reflux management

Interventions in Children

- Determine any concerns for disordered eating (intervention may vary if disordered eating present)
- Review meal and snack structure/schedule
  - Feed every 2.5 – 3 hours
  - Limit grazing
  - No more than 20 – 30 minutes to eat/drink
- Encourage meals be eaten at table in an age-appropriate seat
- Present solids before liquids, provide milk with meals and only water between meals and snacks
- Avoid juice and other sugary beverages

https://www.nationaleatingdisorders.org/

ASPEN Ped and Neonatal Nutr Support Handbook, 3rd edition.

ASPEN Ped Nutr Support Core Curr, 2nd edition.

Interventions in Children – Cont'd

- Increase calories in all solids and liquids
- Utilize at home calorie boosters (oil, butter, dips, dried milk powder) and/or modular additives (e.g., Duocal®)
- Provide list of calorie-rich foods/snacks
- Discuss high calorie liquids availability, including oral nutrition supplements (1 kcal/mL, 1.5 kcal/mL, 2 kcal/mL)
- Vomiting / reflux management
- Determine appropriateness of appetite stimulant medication
- Consider multivitamin that contains iron and zinc

ASPEN Ped Nutr Support Core Curr, 2nd edition.
ASPEN Ped and Neonatal Nutr Support Handbook, 3rd edition.

Follow-up

- Schedule follow up visits: 2 - 6 weeks after initiation of intervention(s). Shorter follow-up time frame is warranted for infants and severity of growth faltering.
- Send appropriate referrals to specialist providers/departments (if not already referred)
- If not meeting weight gain goals, initiate NG tube feedings to supplement oral intake (take into account the degree of malnutrition and any at risk factors)
  - Monitor for refeeding syndrome, as indicated
- If long-term nutrition support is warranted, proceed with G tube placement; benefits include
  - Optimize nutrition (calories, fluid, micronutrients)
  - Optimize medical care (access for medications and nutrition after operative procedures)
  - Optimize skill acquisition and behavioral therapy

Abdelhadi RA et al. Nutr Clin Pract. 2021;36:654-64.

Case

A 5-year-old male with no notable past medical history presents to clinic with concerns for poor weight gain. Current weight at 8%ile for age (z-score -1.3) and height at 25%ile for age; weight previously trending along the 20%ile but weight gain has become stagnant. Parents report he is generally healthy and active, but appetite is variable. After obtaining a feeding history, you estimate his daily caloric intake is 1050 kcal/day and determine daily calorie goal of 1200 kcal/day. You discuss options that could be supplemented in order to meet his daily calorie goal. Which of the following can be considered to help increase his daily calorie intake?

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c) Provide education on calorie-rich foods and encourage parents to utilize calorie boosters at home

d) All of the above are options

Case Review

A 5-year-old male with no notable past medical history presents to clinic with concerns for poor weight gain. Current weight at 8%ile for age (z-score -1.3) and height at 25%ile for age; weight previously trending along the 20%ile but weight gain has become stagnant. Parents report he is generally healthy and active, but appetite is variable. After obtaining a feeding history, you estimate his daily caloric intake is 1050 kcal/day and determine daily calorie goal of 1200 kcal/day. You discuss options that could be supplemented in order to meet his daily calorie goal. Which of the following can be considered to help increase his daily calorie intake?

d) All of the options

Supplementing with an 8 oz standard pediatric nutrition supplement will provide an additional 240 kcal/day. Supplementing with 6 scoops Duocal® will provide an additional 150 kcal/day. Providing education to parents on calorie-rich foods and calorie boosters available at home will increase calorie intake and decrease financial burden. If weight gain does not improve despite supplementing orally and otherwise negative workup, tube feeding placement may be considered.

EN Support in Special Populations

– Premature Infant –

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Nutrition Assessment

- Typical anthropometrics: weight, length, and head circumference
  - Weights are often measured daily
  - Head circumference and length measured weekly
- Birth weight often regained by 7 – 14 days of life
- Typical weight gain goals
  - 15 – 16 g/kg/day for infants under 2kg
  - 25 – 35 g/day for infants ≥ 2kg

Goldberg DL *et al. J Acad Nutr Diet.* 2018;18:1571-82.

Enteral Nutrition

- Optimal nutrition for preterm infants is critical
- Preterm infants have higher calorie and protein needs than term infants

Enteral Requirements for Preterm Infants by Birth Weight		
Weight (g)	**< 1,000 g**	**1,000-1,500 g**
Fluids (mL/kg)	160 – 220	135 – 190
Energy (Kcal/kg)	130 – 150	110 – 130
Protein (g/kg)	3.8 – 4.4	3.4 – 4.2
Fat (g/kg)	6.2 – 8.4	5.3 – 7.2
Carbohydrate (g/kg)	9 – 20	7 - 17

Kleinman RE, Greer FR, eds. Nutritional Needs of the Preterm Infant. In: *Pediatric Nutrition*. Amer Acad Pediatr.
Goldberg DL *et al. J Acad Nutr Diet*. 2018;18:1571-82.

Enteral Feeding

- Human milk is preferred
  - Improves feeding tolerance
  - Contains important antibodies, epithelial growth factor, erythropoietin, insulin-like growth factor, and anti-inflammatory cytokine IL-10
  - Decreased risk of NEC

Mother's own milk (MOM)

- Gold standard

Donor Breast Milk (DBM)

- Pasteurized
- Not equivalent to MOM
- Use when MOM unavailable

Infant Formula

- If MOM or DBM are unavailable
- Many varieties
- Gestational age specific

Sullivan S *et al. J Pediatr.* 2010;156:562–67.
Herrmann K *et al. Breastfeed Med.* 2014;9:184–90.

Infant Formulas

- Use if MOM or DBM are unavailable
- Preterm infant formulas
  - Highest in protein, calcium, and phosphorus
  - Ready to feed liquid available in 20, 24, and 30 kcal/oz
- Nutrient-enriched formulas
  - Designed for preterm infants to transition to for discharge
  - 22 kcal/oz standard concentration
  - Less calcium and phosphorus than preterm formulas but more than term formulas
  - Available in liquid and powder

Cristofalo EA *et al. J Pediatr*. 2013;163:1592–95.
Corkins M, ed. Dietary Sources in Pediatric Nutrition Support Handbook: ASPEN; 2011.
Kleinman RE, Greer FR, eds. Nutritional Needs of the Preterm Infant. In: *Pediatric Nutrition*. Amer Acad Pediatr.

Enteral Nutrition

Trophic Feeds

- Benefits
  - Shortens time to regain birth weight
  - Improves feeding tolerance
  - Improves mineral absorption
  - Lowers incidence of cholestasis
  - Improves GI motility
- Early trophic feeds
  - No increased risk of NEC

Initiation

- Feeds: 10 – 24 mL/kg/day
- Caloric density: 20 kcal/oz
- Trophic feeds typically for first 1 – 3 days

Morgan J *et al*. Cochrane Neonatal Group. Published Online: 16MAR2011. CD001241.
Oddie SJ et al. Cochrane Database Syst Rev, 2021(8): p. CD001241.
Embleton ND et al. J Pediatr Ggastroenterol Nutr. 2023;76:248-68.
Salas AA *et al. Am J Clin Nutr.* 2018:107:365-70.

Enteral Nutrition – Cont'd

Feeding Advancement

- Advancement rates of 15 – 30 mL/kg/day as tolerated depending on infant weight, feeding tolerance, and comorbid disease
  - Slow advancement has not been shown to reduce NEC
- Target volume: 160 mL/kg/day
- Fortify feeds to 22 – 24 kcal/oz when enteral intake reaches 40 – 100 mL/kg/day
  - A 2020 Cochrane review showed that infants receiving early fortification (≤ 100 mL/kg/day or ≤7 days postnatal age) compared to later fortification had no adverse outcomes
- Contraindications to starting EN: hemodynamic instability or impaired GI perfusion, high dose pressor support, NEC, bowel obstruction

Morgan J *et al*. Cochrane Neonatal Group. Published Online: 16MAR2011. CD001241.
Oddie SJ et al. Cochrane Database Syst Rev, 2021(8): p. CD001241.
Embleton ND et al. J Pediatr Ggastroenterol Nutr. 2023;76:248-68.
Salas AA *et al. Am J Clin Nutr.* 2018:107:365-70.

Human Milk Fortifier (HMF)

- Human milk alone does not meet the micronutrient needs of preterm infants
- HMF provides additional protein, calcium, phosphorus, vitamin D, and sodium
- Has not been associated with NEC or intestinal injury
- Use in infants < 32 weeks GA or BW < 1,500 grams to prevent poor growth and osteopenia
- Start when enteral intakes reaches 40 – 100 mL/kg/day
- Typically continued throughout hospitalization; titration/discontinuation is based on growth and nutritional status

Moya F *et al. Pediatrics*. 2012;130:e928–e35.
Thoene M *et al. Nutrients* 2016. 8:451.
Thanigainathan S *et al.* Cochrane Database of Systematic Reviews 2020, Issue 7. Art. No.: CD013392.
Kleinman RE, Greer FR, eds. Nutritional Needs of the Preterm Infant. In: *Pediatric Nutrition*. Amer Acad Pediatr.

EN Support in Special Populations

– Cerebral Palsy –

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Nutrition and Cerebral Palsy (CP)

- Nutrition and growth disorders can be the result of a number of factors
- Non-nutritional factors
  - Severity of neurologic injury
  - Motor impairment & ambulatory status
  - Medications
  - Endocrine disorders
  - Inherent genetic factors
  - Social/environmental factors
- Nutritional factors
  - Oropharyngeal dysphagia
  - Digestive losses
  - Inappropriate dietary intake
  - Altered energy needs

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Marchand V *et al. J Pediatr Gastroenterol Nutr*. 2006;43:123-35.
Mayer R. and Zeiter, D. in Pediatric Gastrointestinal and Liver Disease. 6th ed. Philadelphia, PA:1032–38.

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Nutrition and CP – Cont'd

- Undernutrition, growth failure, and overweight may be present
- Micronutrient deficiencies
  - Vitamins C, D and E
  - Trace elements: zinc and selenium
  - Minerals: iron, calcium and phosphorus
  - Essential fatty acid
- Osteopenia
  - Contributed by limited ambulation, increased duration of anticonvulsant therapy, and reduced sun exposure

Nutrition Assessment

- Multidisciplinary team ideally including physician, registered dietitian, nurse, speech therapist, physical therapist, occupational therapist, psychologist
- Obtain feeding history, anthropometrics and laboratory measurements
- Feeding history: food intake record, feeding capabilities, feeding time

Romano C *et al. J Pediatri Gastroenterol Nutri.* 2017;65:242-64.

Nutrition Assessment – Cont'd

- Anthropometrics: Weight, length, head circumference, triceps skinfold, MUAC
  - Alternative measurements for linear growth: knee height, tibial length, ulnar length, upper-arm length
  - Appropriate measure equipment needed: wheelchair scale, sitting scale, hoist scale
  - Use the same method for obtaining anthropometrics to aid in monitoring
  - DXA scans to measure bone mineral density
  - Growth Charts: use standard growth charts to assess growth in children with CP; monitor the trend rather than absolute percentile
  - CP growth charts are available and stratified by gender and gross motor function classification system; use in conjunction with standard growth charts
- Labs: CBC, CMP, iron studies, vitamins, minerals, trace elements

Romano C *et al. J Pediatri Gastroenterol Nutri.* 2017;65:242-64.

Monitoring Undernutrition

- Obtain anthropometrics at least every 6 months
- Monitor for physical signs of undernutrition (ulcers, skin problems, poor circulation)
- Check micronutrients (iron, calcium, zinc, selenium, vitamins C, D, and E) annually

Nutrition Plan

- In children with NI, use macronutrient and micronutrient standards for typically developing children to estimate:
  - Calorie needs: note that calorie needs may be overestimated; monitor weight trend and adjust intake calorie intake as needed
  - Protein needs: increased protein is needed if evidence of skin breakdown
  - Vitamin and mineral needs: supplementation may be required
- At risk for dehydration for a variety of reasons, such as inability to communicate thirst, drooling, unsafe swallow, low calorie needs (i.e., low formula volume); carefully monitor hydration status

Marchand V *et al. J Pediatr Gastroenterol Nutr*. 2006;43:123-35.
Romano C *et al. J Pediatri Gastroenterol Nutri*. 2017;65:242-64.

Nutrition Plan – Cont'd

- Individualized plan based on nutritional status, feeding abilities, and medical condition is key
- Positioning of patient, behavior modification, and feeding therapy are important for oral feeding and help with food acceptance
  - Patients with dysphagia may require thickened fluids
- Consider initiating tube feeding if
  - Unable to meet nutrition needs orally
  - Unable to eat safely
  - Feeding time exceeds 3 hours per day

Marchand V *et al. J Pediatr Gastroenterol Nutr*. 2006;43:123-35.
Romano C *et al. J Pediatri Gastroenterol Nutri*. 2017;65:242-64.

Enteral Nutrition

- EN preferred over PN
- Determine route of administration and method of feeding
  - Short-term versus long-term need
  - Bolus versus continuous feeding
- Selecting a formula
  - Use a standard (1.0 kcal/mL) polymeric age-appropriate formula
    - Calorie needs may be low, and a reduced calorie formula may be warranted; monitor sufficient intake of protein and micronutrients
  - Consider using a 1.5 kcal/mL formula in cases of poor volume tolerance
    - Warrants monitoring of fluid, protein, and micronutrient intake
  - Whey-based formula can be considered in cases of GERD, gagging, and retching

Feeding Intolerance

- Symptoms: nausea, vomiting, reflux, bloating, constipation, diarrhea
- Treatment
  - Exclude progression of neurological disease, infection, intestinal obstruction
- Consider
  - Change from bolus to continuous feeds
  - Decrease feeding rate
  - Decrease volume by concentrating formula
  - Trial alternative formula
  - Treat reflux, gastroparesis, constipation

Marchand V *et al. J Pediatr Gastroenterol Nutr*. 2006;43:123-35.

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