Pediatric Enteral Nutrition

A Comprehensive Review

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Disclosure: Support for this educational activity was provided by Nestlé HealthCare Nutrition, Inc.

Objectives

- To understand
  - History
  - Indications
  - Delivery modes
  - Components
  - Monitoring
  - Safety

related to EN for pediatric patients

Program Outline

History

Indications

Delivery Modes/Tubes

Principles of Designing/Monitoring Pediatric EN Support

- *Age/Medical Condition*
- *Monitoring of Tolerance*
- *Safety*

Program Faculty

Chair:

Ann O Scheimann, MD, MBA

Associate Professor of Pediatrics,
Gastroenterology & Nutrition Division of Gastroenterology, Hepatology and Nutrition
Johns Hopkins School of Medicine
Baltimore, MD USA

Faculty:

Sabina M Ali, MD

Gastroenterology and Nutrition
Children's Hospital Oakland
Oakland, CA USA

Mark R Corkins, MD, CNSP, SPR, FAAP

Associate Professor of Clinical Pediatrics
Indiana University School of Medicine
Co-director, Nutritional Support Team
Riley Hospital for Children
Indianapolis, IN USA

Conrad R Cole MD, MPH, MSc

Associate Professor
Division of Gastroenterology, Hepatology and Nutrition
Associate Medical Director,
Intestinal Rehabilitation Program
Cincinnati Children's Hospital Medical Center
Cincinnati, OH USA

Ilana M Fortgang, MD

Assistant Professor of Clinical Pediatrics
Tulane University School of Medicine
Section Chief of Pediatric Gastroenterology,
Hepatology and Nutrition
New Orleans, LA USA

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Program Faculty *(continued)*

Faculty:

Praveen S Goday, MBBS, CNSC
Associate Professor of Pediatrics,
Medical College of Wisconsin
Milwaukee, WI USA

Beth Goldberg, NP
Nurse Practitioner
Children's Hospital of Philadelphia
Philadelphia, PA USA

Maria Mascarenhas, MBBS
Section Chief, Nutrition Division of Gastroenterology, Hepatology & Nutrition
Associate Professor of Pediatrics
University of Pennsylvania School of Medicine
Philadelphia, PA USA

Sarah Phillips, MS, RD, LD
Clinical Instructor, Manager Nutrition Support
Baylor College of Medicine
Texas Children's Hospital
Houston ,TX USA

David Suskind, MD
Attending Physician
Seattle Children's Hospital
Associate Professor of Pediatrics
University of Washington School of Medicine
Seattle, WA USA

Justine Turner, MBBS, PhD
Associate Professor
Department of Pediatric Gastroenterology & Nutrition
University of Alberta
Edmonton, Alberta CANADA

Program Content and CME Reviewers

Content Reviewer

Jeff Critch, MD
Assistant Professor of Pediatrics
Memorial University
St. John's, NL CANADA

Program Development and Facilitation

Paul Sinclair, MSc.
INSINC Consulting Inc.
Guelph, ON CANADA

Core Slide Content Co-ordinator

Praveen S Goday, MD, MBBS, CNSC
Associate Professor of Pediatrics
Pediatric Gastroenterology and Nutrition
Medical College of Wisconsin
Milwaukee, WI USA

CME Content Reviewers

Ed Hoffenberg, MD
Professor of Pediatrics
University of Colorado School of Medicine
Aurora, CO USA

Judith Kelsen, MD
Attending Physician
Assistant Professor of Pediatrics,
Perelman School of Medicine
University of Pennsylvania
Philadelphia, PA USA

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Faculty Disclosures

- Ann O Scheimann, MD, MBA, *has nothing to disclose*
- Sabina M Ali, MD, *has nothing to disclose*
- Mark R Corkins, MD, CNSP, SPR, FAAP *consultant for Nestlé*
- Conrad R Cole, MD, MPH, MSc., is a consultant for Abbott Nutrition and Nutricia
- Ilana M Fortgang, MD, *has nothing to disclose*
- Praveen S Goday, MBBS, CNSC, *has nothing to disclose*
- Beth Goldberg, NP, *has nothing to disclose*
- Maria Mascarenhas, MBBS, *has nothing to disclose*
- Sarah Phillips, MS, RD, LD, *has nothing to disclose*
- David Suskind, MD, *has nothing to disclose*
- Justine Turner, MBBS, PhD, *has a research Grant and is Principal Investigator for Fresenius Kabi*
- Jeff Critch, MD, *has nothing to disclose*
- Ed Hoffenberg, MD, h*as nothing to disclose*
- Judith Kelsen, MD, *has nothing to disclose*
- Paul Sinclair, MSc., *has nothing to disclose*

Disclosures

- Educational Support for the NASPGHAN FOUNDATION & NASPGHAN *Pediatric Enteral Nutrition: A Comprehensive Review Slide Set* was provided by Nestlé HealthCare Nutrition, Inc.
- NASPGHAN FOUNDATION & NASPGHAN do not endorse any commercial product. Any products named in this slide set are presented as part of the scientific evidence being cited and are used only to illustrate teaching points. The opinions expressed in the educational activity are those of the faculty. Please refer to the official prescribing information for each product for discussion of approved indications, contraindications, and warnings. Audience members are required to critically evaluate any product that they will use in clinical care.
- Speaker Disclosure here

List of Abbreviations

AA - amino acid

ARA - arachidonic acid

Ca - calcium

CHO - carbohydrate

DHA - docosahexanoic acid

EN - enteral nutrition

EFA - essential fatty acid

Fe - iron

FOS - fructooligosaccharides

FTT - failure to thrive

GER(D) - gastroesophageal reflux (disease)

GI - Gastrointestinal

G-J - gastro-jejunal

GRV - gastric residual volume

GT - gastrostomy tube

IBD - Inflammatory Bowel Disease

K - potassium

MCT - medium chain triglycerides

Mg - magnesium

ND - nasoduodenal tube

NG - nasogastric tube

NJ - nasojejunal tube

Phos - phosphorus

RFS - re-feeding syndrome

Se - selenium

Zn - zinc

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

History

History of EN

18th Century

- John Hunter designed orogastric probe
- Whalebone encased in eel skin
- Jellies, eggs with milk, water with sugar beaten in

1930s:

Protein hydrolysate formulations fed to surgical patients

1940s:

First infant formula created: protein hydrolysate, corn oil, dextrimaltose, vitamins and minerals

1950s:

- Plastic tubing and pumps invented
- Formulations of blended infant foods

1960s:

Advanced understanding of nutrient needs and design of liquid formulas

Indications

Indications for Nutrition Intervention

- There is no Grade A level evidence that indicates that EN will shorten stay or improve outcomes
  - Logically nutrition is needed for healing and metabolic processes
  - Adult studies indicate that the malnourished benefit from nutritional intervention [1]
  - Can be used as exclusive or partial support

Gramlich et al. *Nutrition*. 2004;20(10):843-8.
Kleinman et al. *J Pediatr Gastroenterol Nutr*. 2004;39:15–27.

Pediatric Enteral Nutrition

- Enteral nutrition is the provision of nutrients via the gastrointestinal tract
- Enteral nutrition maintains the integrity of the GI tract and is associated with fewer infections than parenteral nutrition[1]
- Children who require EN support are those that
  - Eat less than 80% of needs by mouth
  - Require an extended period of time to eat

1. Gramlich et al. *Nutrition.* 2004;20(10):843-8.

Progressive Intervention

- Attempt oral feeding first. If the gut works, use it
  - There are no trials comparing enteral versus parenteral nutrition
  - EN is physiologic, has reduced, or less severe, incidence of infection as compared to parenteral EN, and is cost effective [1]

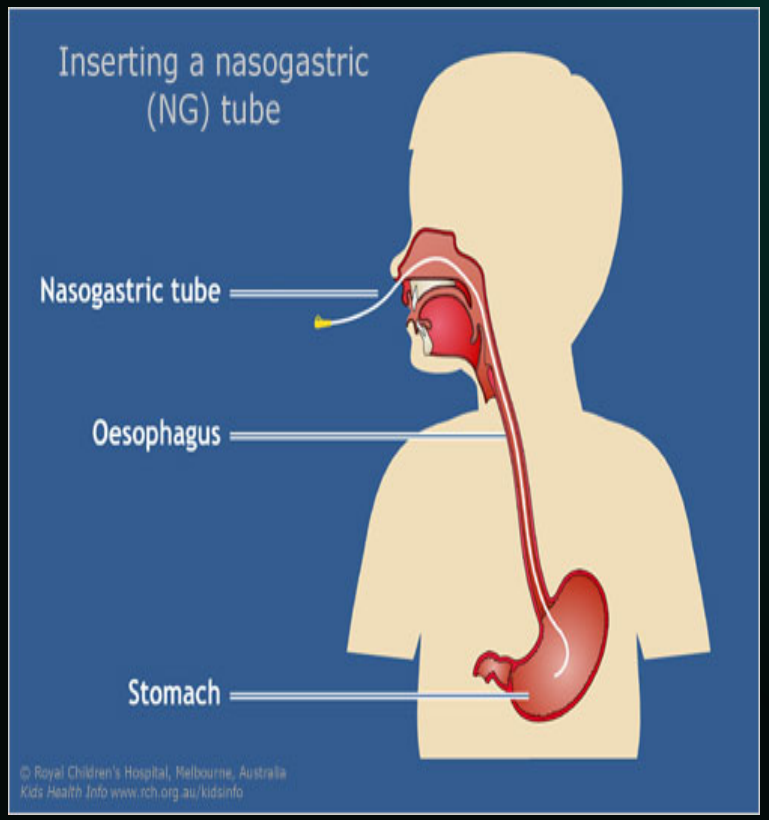
- If the patient cannot take enough nutrition orally or has intolerance, then begin NG feedings
  - Bolus usually first
  - Drip next

- If intolerant of NG feedings then transpyloric
  - Must be continuous feedings

1. Kawagoe et al. *Am J Infect Control.* 2001;29(2):109-14.

Delivery Modes/Tubes

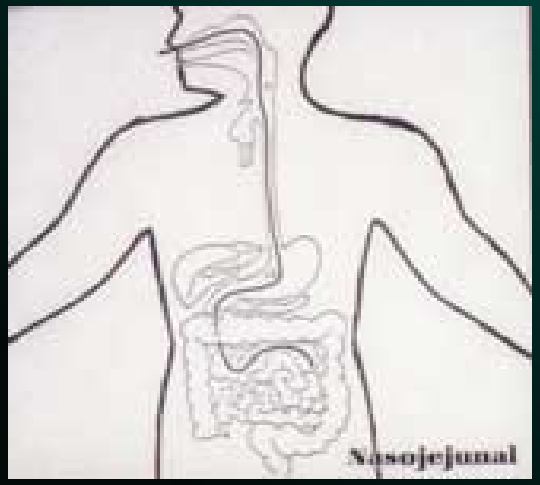
Nasogastric (NG), Nasoduodenal (ND) and Nasojejunal (NJ) Tubes



www.rch.org.au/kidsinfo/factsheets.cfm?doc_id=9766

NG tubes are temporary feeding tubes placed manually via the nose and esophagus into the stomach.

When feedings are not tolerated in the stomach, the tube may be placed into the duodenum (ND) or jejunum (NJ).



www.cincinnatichildrens.org/health/n/nasojejunal-kangaroo

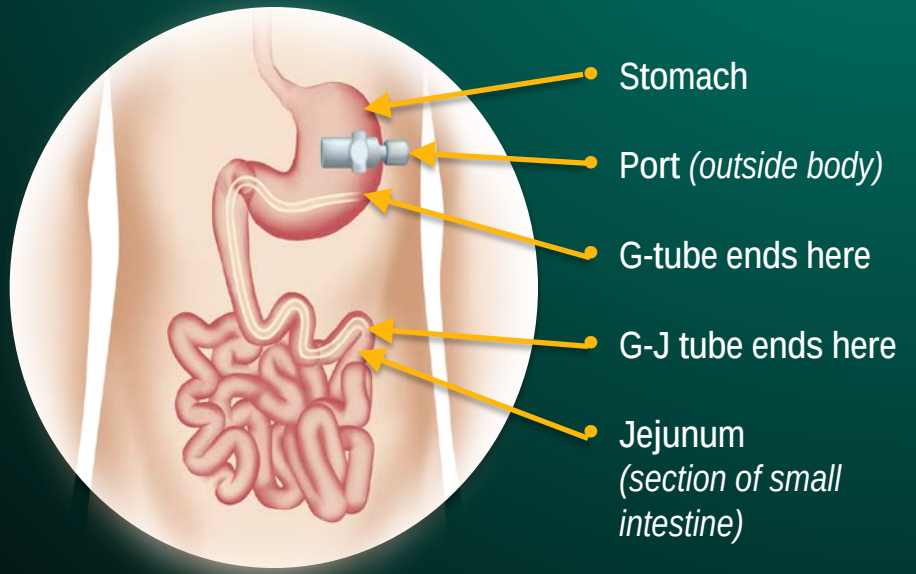
What is a G Tube?

- A G tube is a tube placed into the stomach through an opening called a stoma

http://www.adamimages.com

Gastrojejunostomy Tube (G-J Tube)

A G-J tube is a tube that is placed via the opening into the stomach (stoma) and passes through the pylorus into the mid section of the small intestine (the jejunum). It has a G port which can be used for gastric decompression with jejunal feeds, gastric med delivery or bolus feeds. The J port can be used for continuous feeds.



Why Use a G or J Tube?

- A G tube allows need for EN to be met by feeding into the stomach

- A J tube can be used when needs for EN may not be met by feeding into the stomach, allowing EN feeding to occur past the stomach, i.e. in the jejunum
  - Cannot use bolus feeding technique beyond the pylorus due to dumping syndrome

Bolus vs. Continuous Feedings

Bolus

- Can mimic or supplement meals
- More physiologic
- May not require a pump
- Freedom of movement between feedings
- Only GT feeding
- Can promote osmotic diarrhea

Continuous

- Slow infusion may improve tolerance and absorption
- Can be given overnight to avoid disruption of daytime schedule and oral intake
- Encourages intestinal adaption by constant mucosal stimulation
- Reduces need for parenteral calories

Parker et al. *J Pediatr.*1981;99:360-61.

Review of EN Components

Protein

Infant Formulas: Protein Content

- Divided into 4 classes of formulas:
  - Cow's milk–based formulas
    - Preterm and follow-up preterm formulas as well
    - Partially hydrolyzed whey; not considered hypoallergenic but less allergic diseases
  - Soy formulas
  - Casein hydrolysate formulas
  - Amino acid–based formulas

http://depts.washington.edu/growing/Nourish/Formula.htm.

Review of EN Components

Carbohydrates

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Infant Formulas – CHO

- Main types of carbohydrate in formulas[1]
  - Lactose
  - Sucrose
  - Glucose polymers
- Galactosemia: soy formulas, because they do not contain lactose[2]
  - Isomil®
- Which formulas contain sucrose?[1]
  - Alimentum® and soy formulas, except Prosobee®

PerIstein D. *Infant Formulas.* MedicineNet.com
Bhatia et al. *Pediatrics*. 2008;121:1062-68.

Review of EN Components

Fat

Infant Formulas – Fat Content

- Main types of fats in formulas
  - Long-chain triglycerides
  - MCTs
- When are MCTs beneficial?
  - Impaired fat absorption or lymphatic abnormalities
  - Cystic fibrosis, short gut syndrome, cholestasis, and protracted diarrhea
- Which formulas contain MCTs?
  - Alimentum® (33%), Pregestimil® (55%)
  - Enfacare® (20%)
  - Enfaport® (84%)
  - Elecare Infant® (33%), Neocate Infant® (33%)
  - Premie formulas (50%)
  - *3232A* (85%)

Green et al. In Corkins M, Ed. The ASPEN Pediatric Nutrition Core Curriculum. ASPEN; 2010.

DHA and ARA

- Docosahexaenoic acid (DHA) and arachidonic acid (ARA), both long-chain polyunsaturated fatty acids
- Present in breast milk; were not in formulas [1]
- Animal models showed increased visual acuity and neurologic development; some infant studies agree [2]
- No harmful effects found
- Now in most infant formulas
- A recent meta-analysis found no effect of DHA/ARA on cognitive development [3]

1. Groh-Wargo et al. *Pediatr Res*. 2005;57:712-18.
2. Uauy et al. *J Pediatr*. 2003;143(4 Suppl):S17-25.
3. Qawasmi et al. *Pediatrics*. 2012;129(6):1141-9.

Review of EN Components

Additives

Immune Input

- Probiotics
  - Evidence of decreased infectious illnesses, especially diarrheal illnesses
  - Now present in some infant formulas
- Prebiotics
  - Growth factors that foster the growth of “good bacteria” in the gut e.g., inulin, fructooligosaccharides (FOS)

Weizman et al. *Pediatrics*. 2005;115:5-9.

Standard Cow Milk–Based

- Widely available
- Cheap
- Unflavored, which lowers osmolarity
- Lactose-free
  - Potential for lactose intolerance
- Fat mixture
  - Mixture of long and medium-chain fats

Di- and Tripeptide Formulas

- Not designed for allergy or malabsorption conditions
- Better gastric emptying [2,3]
- Better tolerated
  - Fats contain a percentage of MCT

1. Corkins M, ed. *Dietary Sources in Pediatric Nutrition Support Handbook.* ASPEN; 2011.
2. Tolia et al. *J Pediatr Gastroenterol Nutr.* 1992 Oct;15(3):297-301.
3. Billeaud et al. *Eur J Clin Nutr*. 1990 Aug;44(8):577-83.

Elemental Pediatric Formulas

- AA–based
- Contain MCT
- Use for allergic?
- Short bowel
  - Better emptying
  - Absorption immediately

Corkins M, ed. *Dietary Sources in Pediatric Nutrition Support Handbook.* ASPEN; 2011.

Enteral Feeding Questions

- Fiber? Helps with stooling issues
  - Soluble versus insoluble
- Transpyloric feeds - Elemental?
  - Tolerance okay
  - Animal studies; absorption better
- When are adult EN formulas suitable?
  - Adolescent? Ca and Phos needs to be higher
  - Do contain higher protein content

Blenderized Formula

- One commercially available
  - *Compleat® Pediatric*
- Parents perceive as better
  - Potential to be nutritionally incomplete without guidance
  - Resources available with carefully worked out recipes
  - Labor intensive for the family

Principles of Designing/Monitoring Pediatric EN Support

Age / Medical Condition

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Administration

- The route of and duration (bolus vs. continuous) of enteral administration depends on:
  - Indication for EN, the duration of need
  - Anatomical integrity of the GI tract
  - Functional integrity of the GI tract
  - Risk of aspiration

Enteral Feeding Methods
Gastric Vs. Post-pyloric - I

Site	Delivery Route	Indications	Potential Complications
Stomach	Orogastric (infants) Nasogastric	• Short-term nutrition support (6-8 wks) • Inadequate oral intake due to increased needs or anorexia of chronic disease • Refusal to eat • Nocturnal feeds • Inability to suck or swallow	• Aspiration • Nasal mucosal ulceration • Tube occlusion • Pneumothorax • Bleeding • Epistaxis • Sinusitis • Otitis Media
	Gastrostomy	• Long term tube feeding • Congenital anomalies, such as tracheo-esophageal fistula, esophageal atresia • Esophageal injury/obstruction • Failure to thrive	• Dislodgement • Aspiration • Tube deterioration • Bleeding • Tube occlusion • Pneumoperitoneum • Wound infection • Stoma leakage

Texas Children's Hospital. *Texas Children's Hospital Pediatric Nutrition Reference Guide*, 9th Edition, 2009.

Enteral Feeding Methods
Gastric Vs. Post-pyloric - II

Site	Delivery Route	Indications	Potential Complications
Transpyloric Postpyloric	• Nasoduodenal • Nasojejunal • Gastrojejunal • Jejunostomy	• Congenital upper GI anomalies • Inadequate gastric motility • High aspiration risk • Severe GER • Functioning intestinal tract with obstruction above it	• Pneumatosis intestinalis • Bleeding • Dislodgement • Tube deterioration • Tube occlusion • Bowel obstruction • Stomal leakage • Wound infection

Bolus vs. Continuous Feeds

- Enteral feeds may be given as bolus (intermittent), continuous, or a combination
- Bolus Feedings

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

- Continuous Feedings

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

Monitoring /Evaluation

		Initial	Hospital	Outpatient
Anthropometrics	Weight Height	Daily Baseline	Daily Monthly	Weekly- monthly Monthly or at clinic
Intake	Calories, protein, fluid	Daily	Weekly	Monthly
GI Tolerance	Abdominal girth, residuals , emesis	As ordered, reported	As ordered, reported	As reported
Stool/ Ostomy	Volume , frequency, consistency	Daily	Daily	Report changes in stool pattern
Tube Placement	Prior to each feeding	Prior to each feeding	Prior to each feeding	Prior to each feeding
Tube Site	Daily	Daily	Daily	Daily

Green et al. In Corkins M, Ed. *The ASPEN Pediatric Nutrition Core Curriculum.* ASPEN; 2010.

Monitoring/ Evaluation - I

Problem	Prevention/Intervention
Diarrhea/ Abdominal Cramping	• Decrease delivery rate • Recognize or avoid drugs that result in diarrhea • Consider fiber containing products • Consider osmolarity and addition of modular additives • Semi-elemental or elemental formula if indicated
Vomiting/ Nausea	• Ensure formula is always at room temperature prior to tube feedings • Elevate head of bed • Consider postpyloric or continuous feeding
Hyperglycemia	• Reduce flow rate • Use formulas with minimal simple sugars • Consider insulin if clinically indicated

Monitoring/ Evaluation - II

Problem	Prevention/Intervention
Constipation	• Ensure optimal fluid intake • Increase free water intake • Change to a product containing fiber
Gastric Retention of Formula	• Monitor for correct tube placement • If residuals are high (>2 hour volume of feeds), hold feeds; recheck residuals in 1 hour • Consider continuous or postpyloric feeding • Position patient on right side
Clogged Feeding Tube	• Ensure tube is flushed after checking residuals, boluses and every 4 – 8 hours with continuous feeds • Check tubing size for appropriateness for some formulas • Infuse formula past pylorus • Consider continuous infusion

Selecting the Right Formula

- Select formula based on gut function and volume tolerance
  - Normal function
    - Able to tolerate intact protein and long chain fats
  - Abnormal 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
  - Volume tolerance
    - Fluid restricted

Outline of Products

- Infant Formulas
  - 0 to 1 year of age
- Pediatric Formulas
  - 1 to 13 years of age
- Specialized formulas/supplements
- Modular Additives

Infant Formulas

Standard and Premie

- Goal
  - simulate human milk (20 kcal/oz), Premie (22 kcal/oz or greater)
- Composed of intact protein, CHO, and fat
- Indications
  - functional gastrointestinal tract
- Intended for less than 1 year old

Specialty Infant Formulas

- Protein allergy/malabsorption
  - Cow milk allergy, multiple food allergies
  - Short bowel syndrome
- Fat malabsorption
  - Liver disease
  - Cystic fibrosis
  - Steatorrhea
  - Short bowel syndrome
  - Persistent diarrhea

Standard Pediatric Formulas

Children 1-10 years, vitamins/minerals

- 30 kcal/oz (1kcal/ml)
- Milk based (whey, casein)
- With or without fiber
- Usually gluten-free, lactose free

Specialty Pediatric Formulas

Semi Elemental

- Partially hydrolyzed protein (casein or whey)
- Indications:
  - Malabsorption/GI impairment
    - Short bowel syndrome, IBD
  - Protein allergy
    - Most children will outgrow their protein allergies
- Costly: $

Specialty Pediatric Formulas

Elemental

- Broken down even more = Free AA
- Decreased palatability
- Indications:
  - Severe multiple food protein allergy/intolerance
  - Eosinophilic esophagitis
  - Gastrointestinal tract impairment/malabsorption
  - Severe GERD
- Costly: $$$

Modular Additives - Protein

- Modular additives are used to increase kcals and/or protein
- Protein
  - Beneprotein®
    - Whey and soy protein isolates
    - NOT for milk protein allergy!!
  - Amino acid module

Modular Additives - CHO

- Carbohydrate
  - Polycose® powder
    - Low osmolality, minimal sweetness
  - Cornstarch
    - Slow release CHO – helpful to treat hypoglycemia/dumping
    - NOT for 24 hour batch/continuous feeds. Thickens over time
    - Add at time of feeding
  - Corn syrup, dextrose, fructose, sucrose
    - Not used often

Modular Additives - Fat

- Corn oil (8.4 kcal/mL)
  - Over the counter, inexpensive
  - Oleic/linoleic unsaturated. Fatty acids
  - Boluses acceptable
- MCT Oil® (7.7 kcal/mL)
  - Absorbed directly into portal system (bile salts & lipase not needed)
  - Does not contain EFA
  - Expensive
  - Good for patients with cholestatic liver disease
- Microlipid® (4.5 kcal/mL)
  - Safflower oil
  - 50% fat emulsion – mixes well with formulas/foods
- MCT Procal
  - 97% MCT per 16g sachet – powder form
  - Contains milk protein and lactose

Modular Additives - Combination

DuoCal®

- Used mostly in outpatient clinic
- Dissolves in water, liquids and moist foods
- No altered taste
- High kcal (cornstarch + refined vegetable oils + MCT)
- Protein free, lactose free, gluten free

Principles of Designing/Monitoring Pediatric EN Support

Monitoring of Tolerance

NASPGHAN
NORTH AMERICAN SOCIETY FOR PEDIATRIC GASTROENTEROLOGY, HEPATOLOGY AND NUTRITION

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Monitoring Tube Position

- NG tube surveillance
  - Mark insertion point[1]
  - Recheck X-ray if change in tube length
- NJ tube surveillance
  - As above
  - Recheck X-ray if change in tube length or change in feeding tolerance

Metheny et al. *J Neurosc Nurs*. 2005;37:320-25.

Gastric Residual Volumes (GRV)

- No standard practices on how, when and what is a high value gastric residual volume (GRV)
- Difficult to withdraw well with small tube
- No studies that prove correlation of GRV with intolerance
- GRVs result in holding feedings despite no other signs of intolerance[1]

1. Marshall et al. *Int Crit Care Nurs*. 2006;22:95-105.

Intolerance Interventions

- Drip feedings-continuous
- Consider trial of promotility agents either to advance tube or enhance emptying/feeding tolerance
  - Several promotility agents have side effects
- Trans-pyloric feedings
  - Previous adult studies show it ends up delaying feeding initiation
  - Consider if aspiration risk or intolerance to gastric

Ho et al. *Intens Care Med.* 2006;32:639-49.
Marik et al. *Crit Care*. 2003;7(3):R46-51.

Principles of Designing/Monitoring Pediatric EN Support

Safety

Refeeding Syndrome (RFS)

- RFS is a term used to describe the metabolic and clinical changes that can occur during nutritional support of a malnourished patient
  - Normally occurs within 3-4 days after initiating feeds
  - Signs/symptoms include weakness, muscle pain, ataxia, paresthesia, confusion, arrhythmia, seizures
  - Phos depletion is the hallmark and cause of the majority of symptoms

Solomon et al. *J Parenter Enteral Nutr*. 1990;14:90-97.
Schnitker et al. *Ann Intern Med*. 1951;35:69-96.

Serum Abnormalities During Refeeding

Serum abnormalities are often seen in patients during refeeding and may include:

- Hypophosphatemia
- Hypokalemia
- Hypomagnesemia
- Glucose abnormalities
- Thiamine deficiency
- Derangements of sodium, nitrogen, and fluid balance

Crook et al. *Nutrition.* 2001;17:632-37.
Brooks et al. *Pharmacotherapy.* 1995;15:713-26.

Management Guidelines for RFS

- Identify patients at risk of RFS
  - Check electrolytes (including K, Ca, Phos, Mg, blood urea nitrogen, and creatinine) prior to start of feeding
  - Start refeeding at 50-75% of goal calories and increase to goal over 3-5 days
- Protein does not need to be restricted
- Rehydrate carefully, being careful not to fluid overload
- Monitor K, Ca, Phos, and Mg levels frequently during first four days and replace appropriately

Afzal et al. *Clin Nutr*. 2002;21:515-20.

Electrolyte/Micronutrient Replacements

K	2-4 mmol/kg daily
Phos	0.3-0.6 mmol/kg daily
Mg	0.2 mmol/kg daily IV or 0.4 mmol/kg daily orally

Multivitamin and mineral supplementation

- Thiamine, Zn, and Se
- Fe usually not given during initial phase, as increased risk of infection and oxidative stress

Afzal et al. *Clin Nutr*. 2002;21:515-20.

Summary

- Consider EN in patients who cannot take enough nutrition orally or have intolerance to oral feeding
- A variety of enteral tubes, feeding modalities and formulas are available
  - Each should be tailored to the individual patient
- Patients should be monitored to ensure tolerance of EN
- RFS should be anticipated in malnourished patients who are begun on EN and should be prevented / managed