Nutritional Support in Pediatric Patients

Topic 10

Module 10.3

Enteral Nutritional in Pediatric Patients

Sanja Kolaček
Darija Bender

Learning Objectives

- To discuss principles and specifics of EN in children;
- To define indications for and contraindications to EN in children;
- To describe nutrient composition of various enteral formulas;
- To present enteral formula selection adjusted for pediatric patients;
- To discuss principles of feed administration in respect of sites, routes and modes of EN delivery;
- To be able to initiate EN and to wean the patient from continuous tube feeding;
- To discuss the reasons for and mechanisms of possible complications; to give recommendations for prevention;
- To discuss issues of enteral versus parenteral nutrition;
- To present benefits and principles of home enteral feeding.

Contents

Key Messages (5-6)

- Enteral nutrition is a safe and effective method of nutritional therapy in pediatric patients;
- Enteral nutrition should be introduced in a child who has at least some GI function , but is unable to meet full dietary requirements by the oral route;
- Enteral formulas differ substantially in their nutrient content and physical properties; selection depends on the age and clinical condition, but for the majority of patients standard polymeric enteral formulas are the appropriate choice, and with the best cost-benefit ratio;
- Intragastric feeding is the preferred method of enteral feeding as it is associated with higher tolerance and fewer complications;
- Technical, metabolic, gastrointestinal, infective and psychological complications may occur during enteral nutrition, and therefore, close monitoring and strict adherence to the established protocols are of crucial importance;
- The main advantages of enteral over parenteral nutrition include preservation of gastrointestinal function, cost, manageability, and safety.

1. Basic Principles of Enteral Nutrition (EN) in Children

1.1 Specifics of Paediatric Age

Children present a nutritionally vulnerable population requiring a number of special considerations:

- nutritional requirements expressed per unit of body weight are much higher compared to adults due to:
  - growth and organ maturation;
  - increased losses (large surface area to body mass ratio);
  - limited body reserves;
- consequences of malnutrition are more pronounced and may be permanent if undernourishment persists during critical periods of rapid growth and maturation, causing stunted growth and impaired mental and psychological development;
- in infancy and childhood attitudes are changing towards different foods and methods of feeding with the realization that artificial feeding may adversely affect behavioral development;
- in the pediatric age group, dietetic/nutritional therapy is the treatment of choice for many different disorders such as primary metabolic illnesses and gastrointestinal diseases (i.e. chronic diarrhea of infancy, short gut syndrome, Crohn's Disease, etc.).

Therefore, the goal of nutritional support in pediatric patients is to provide appropriate amounts of energy and nutrients for optimal growth and development, while preserving body composition, minimizing gastrointestinal symptoms and promoting developmentally appropriate feeding habits and skills.

1.2 Type of Nutritional Intervention

There are various methods of nutritional intervention, and the choice of method depends on the child's age, clinical situation, possibilities of oral intake, as well as on dietary habits and cost:

- intensified nutritional counselling (type and quantity of food intake);
- oral nutritional supplements;
- different enteral feeding regimes;
- parenteral nutrition with or without oral or enteral intake (1).

1.3 Definition

Enteral nutrition is defined as oral supplements using special formulae or tube feeding directly into the stomach, duodenum or jejunum .

1.4 Indications and contraindications

In general, enteral nutrition should be introduced in a child who has at least some level of gastrointestinal function preserved, but is unable to meet their full energy and nutrient requirements by the oral route leading to failure of growth and development ie failure of weight gain or reduced height velocity. When one or more of the following factors are identified, enteral nutrition should be considered (2):

- inadequate growth or weight gain for > 1 month in a child under the age of 2 years;
- weight loss or no weight gain for a period > 3 months over the age of 2 years;
- a change in weight/age or weight/height (length) over 2 growth channels on the growth charts;
- triceps skinfolds consistently <5th percentile for age;
- inability to consume orally at least 80% of the calculated energy requirements;
- total feeding time in a neurologically impaired child >4 hours per day (2).

Clinical indications for EN are listed in Table 1.

Table 1 Clinical indications for Pediatric Enteral Nutrition (3)

1. Inadequate oral intake
Disorders of sucking and swallowing – Prematurity – Neurologic impairment (eg. cerebral palsy, disphagia)
Congenital abnormalities of the upper gastrointestinal tract – Tracheoesophageal fistula
Tumors – Oral cancer – Head and neck cancer
Trauma and Extensive facial burns
Critical illness – Mechanical ventilation
Severe gastroesophageal reflux
Food aversion
Anorexia and depression
2. Disorders of digestion and absorption
Cystic fibrosis
Short bowel syndrome
Inflammatory bowel disease
Malabsorption syndrome due to food allergy – Cow's milk protein – Multiple food
Enteritris due to chronic infection – Giardia lamblia
Protracted diarrhea of infancy
Intractable diarrhoea of infancy
Severe primary or acquired immunodeficiency
Chronic liver disease
Graft – versus – host disease
Intestinal fistulae
3. Disorders of gastrointestinal motility
Chronic pseudo – obstruction
Extensive ileocolonic Hirschsprung's disease
4. Increased nutritional requirements & losses
Cystic fibrosis
Chronic solid organ diseases: renal, heart, liver
Inflammatory bowel disease (Mb Crohn, Ulcerative Colitis)
Multiple trauma, extensive burns

5. Growth failure or chronic malnutrition (in addition to above)
Anorexia nervosa
Non-organic failure, Food deprivation
6. Crohn's Disease: primary disease treatment
7. Metabolic diseases

The **absolute contraindications** to EN are: necrotizing enterocolitis and intestinal perforation, GI tract obstruction, inabilitiy to access GUT (severe burns, multiple trauma.), paralytic ileus, intestinal atresia, severe inflammatory bowel disease,major intra-abdominal sepsis.
The **relative contraindications** are intestinal dysmotility, GI bleeding, high-output enteric fistula, unexplained severe vomitting and diarrhoea, severe pancreatitis, and shortly after major abdominal surgery.

2. Nutrient Composition of Enteral Formulas

2.1 Carbohydrates

Carbohydrates in enteral formulas are sourced from different starches, including corn and tapioca. Maltodextrin and hydrolyzed cornstarch, glucose-derived saccharides, and corn syrup are the most commonly used (3). Concerning lactose, the majority of paediatric enteral formulae do not contain lactose or it is present in trace/limited amounts.The optimal amount of carbohydrate in enteral formulas is unknown, but most available standard pediatric enteral formulae contain 40 – 55 % of carbohydrates.

2.2 Proteins

Most enteral formulas are casein, soy, or whey protein based. Protein content is mostly around 10%, but may vary between 10%-20%.The nitrogen to non-nitrogen calorie ratio is approximately 1 to 150 (3).

2.3 Lipids

In enteral nutrition, lipids are administered predominantly as triglycerides – either as long-chain fatty acids triglycerides (LCT) or medium-chain fatty acids triglycerides (MCT). MCT, derived mostly from coconut oil, is rapidly hydrolysed and effectively absorbed into the portal circulation, even at low concentrations of pancreatic enzymes and in the absence of bile acids. However,theenergy content per unit of MCT is some 14% lower than that of LCT, a high intake may promote osmotic diarrhoea, and it contains no essential fatty acids (EFA). Therefore, most of the MCT-based enteral formulae include up to 50% of EFA rich LCT. LCT promotes intestinal motility and stimulates biliary and pancreatic secretions. However, an excess of LCT in the intestinal lumen, especially if it is hydroxylated by bacteria, reverses water and electrolyte absorption and causes net secretion, thereby worsening malabsorption.

Total lipid intake should be 3–4 $g \cdot kg^{-1} \cdot day^{-1}$,depending on age, absorption capacity and digestive tolerance (1).

2.4 Fibres

Enteral formulae were originally designed to have a low fibre or residue content. However, fibre has been found beneficial in constipated patients, and serves as a substrate for bacterial production of short-chain fatty acids. Short-chain fatty acids, particularly butyrate, are considered to be trophic for large bowel mucosa as they are preferentially used as an energy source for colonocytes. It is, therefore, currently recommended that enteral formulas enriched with fibres should be used in constipated patients, and in patients who require EN for a prolonged period of time (3, 4).

2.5 Micronutrients

Due to growth and organ maturation children have increased requirements for vitamins and trace elements, and the Recommended Dietary Allowances, therefore, depend on the age of the patients (3).

Although the amount of micronutrients varies among different dietetic products, most enteral formulae contain sufficient micronutrients to meet increased needs associated with stress and wound healing provided that the recommended daily dose of feed is delivered. L-carnitine, taurine and inositol are also added in most pediatric enteral formulas. Supplementation of specific vitamins and/or minerals may be needed in patients with specific disorders or with documented vitamin or mineral deficiency. In addition, extra micronutrients may be required in patients who cannot tolerate sufficient feeding to meet overall requirements (5).

2.6 Nutrient Density and Osmolarity

The nutrient density of enteral feeding is a function of its fluid content. At standard dilution, the caloric content of infant formula is usually 0.67 kcal/mL, and of standard pediatric enteral formula equals 1 kcal/mL(3). More concentrated enteral formulas are also available (1.3-2.0 kcal/mL) for patients with increased energy requirements or with limited fluid intake.

Osmolality refers to the concentration of osmotically-active particles per liter of a liquid formula, expressed as mOsm/L. The osmolality is affected by the concentration of all constituents such as amino acids, carbohydrates, lipids, and electrolytes. Formulae with higher osmolality than normal body fluids produce an osmotic effect on the intestinal wall, drawing water into the lumen. An influx of water may result, therefore, in diarrhea, nausea, cramping, and abdominal distention (6). This is particularly important in children with severe small intestinal disease, or when EN is delivered directly into the jejunum. In those patients, isotonic formulae of approximately 300 mOsm/L, are preferred.

3. Enteral Formula Selection

Enteral formulae should supply an adequate intake of nutrients in a form and volume that the child can tolerate. In selecting an appropriate formula, the following factors should be considered:

- nutrients and energy requirements adjusted for the age and clinical condition of the child;
- history of food intolerance or allergy;
- intestinal function;
- site and route of delivery;
- formula characteristics such as osmolality, viscosity, nutrient content;
- taste preference;
- cost.

Criteria for the selection of enteral formulas are listed in Figure 1. For the great majority of paediatric patients, the standard paediatric polymeric enteral formula is sufficient and well tolerated, with the best cost-benefit ratio. However, there are many other, specialized and disease-specific pediatric enteral formulas. They are tailored to meet the specific requirements of patients with decreased intestinal length and altered intestinal absorptive or digestive capacity, insufficient pancreatic, hepatic or renal function, and with pulmonary failure. Also, age appropriate enteral formulas for children with either milk or multiple food allergy, and with inborn errors of metabolism are available. For their detailed description more extensive literature sources should be consulted (7-10).

Commercial polymeric diets for pre-school and school children are also available that are adapted to the age specific nutrient needs (e.g., a lower protein-energy ratio than in infancy and in adulthood, age adapted micronutrient concentrations) (1).

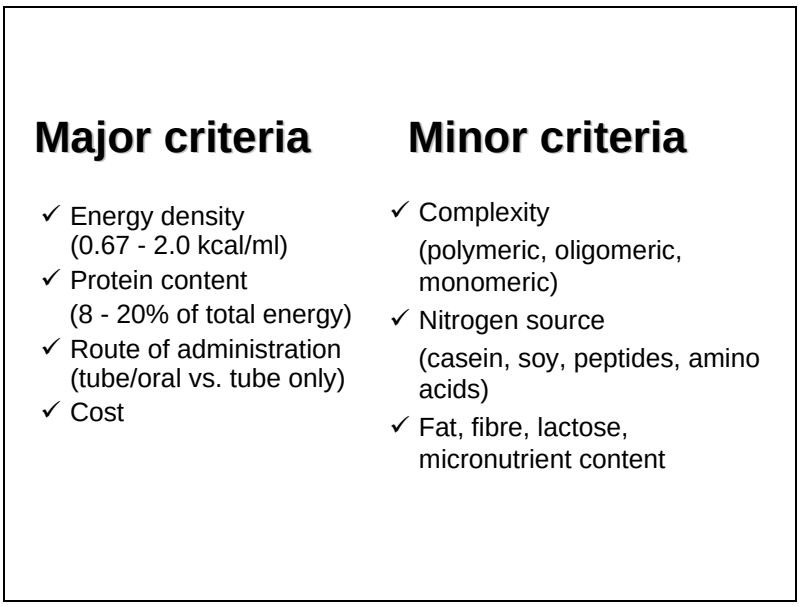

Figure 1 Criteria for selecting enteral formulas

3.1 Polymeric Formula Selection

Polymeric formulas contain macronutrients in the form of intact protein, triglycerides and carbohydrate polymers. These formulas are in general terms nutritionally complete, iso-osmolar and cheap, and are therefore the most frequent choice, both in hospital and in home settings. Most of them are also lactose–free and gluten–free. Since these preparations are palatable, they may be used for oral / bolus feeding, as well as for tube feedings. Their caloric density ranges between 1–2 kcal/ml (11).

3.2 Oligomeric Formula Selection

Chemically defined oligomeric enteral formulas contain macronutrients that are pre-digested, thus requiring minimal digestion and being almost completely absorbed in the upper jejunum. Most importantly, proteins are hydrolysed to a degree when most of the epitopes are destroyed, and are therefore called hypoallergenic. By definition, hypoallergenic formulas are tolerated by at least 80% of children, mostly infants, with already established cow's milk protein allergy (12). 10% to 20% of patients have multiple food allergies and require an elemental formula (13).
Commercially available semi-elemental formulas containing protein hydrolysate and MCT can be safely used in children with GI disease, but their use is more costly and should be limited to specific indications. As they are hyperosmolar, the total daily volume as well as the concentration of the delivered solution should be increased slowly and gradually.

3.3. Monomeric Formula Selection

Monomeric/elemental formulas are nutritionally complete solutions containing a nitrogen source in the form of amino acids, carbohydrates as oligosaccharides, and fats as a mixture of LCT and MCT. They are often used in patients with severe multiple food allergy non-responsive to oligomeric formulas (13), and in patients with severely impaired digestion and absorption. Their osmolarity is high (500–900 mOsmol/l) and they may, therefore, cause osmotic diarrhea, particularly if delivered directly into the jejunum, in the form of a bolus or by too rapid infusion. The un-palatability and high osmotic load limit the use of elemental formulae to tube feeding of patients with specific clinical indications (e.g. severe malabsorption, extremely short GUT syndrome, infants with severe multiple food allergy) (11).

A comparison of polymeric, oligomeric and monomeric formulas (concerning energy, macronutrient content, and osmolarity) is presented in Figure 2.

	Polymeric formulas	Oligomeric formulas	Monomeric formulas
Protein content	30-80 g/L	20-50 g/L	19,5 – 25 g/L
Caloric density	1-2 kcal/mL	1-1.7 kcal/mL	0.67 - 1 kcal/mL
Carbohydrate content	90 –200 g/L	100-200 g/L	81 - 146 g/L
Fat content	20-90 g/L	5-20 g/L	35 g/L
Osmolarity	300 mOsmol/L	300-600 mOsmol/L	300 - 600 mOsm/L

Figure 2 Energy, macronutrient content and osmolarity of polymeric, oligomeric and monomeric formulas

3.3 Modular Feeds

Most of the above mentioned formulae are nutritionally complete and commercially prepared. However, EN can be prepared in a hospital kitchen by a dietician mixing separate, commercially available nutritional solutions which contain only one or two of the major nutrients. In this way, nutrients are added separately, and are tailored to meet the specific requirements of an individual patient. Modular feeding allows variation in the ratio of nutrients without affecting the quantity of other substances. Special indications include: specific organ dysfunctions (renal, liver, cardiac), metabolic errors, fluid restriction, diabetes mellitus, respiratory and cardiac failure and major electrolyte disorders (11).

4. Administration of EN

4.1 Sites of Delivery

EN can be administrated either into the stomach or into the proximal small intestine, depending on: a) morphological and functional status of the gut; b) expected duration of EN; c) anticipated risk of aspiration.

Intragastric feeding is the preferred method as it:

- stimulates physiologic digestive and hormonal responses;
- retains antimicrobial function of gastric juice though not of saliva;
- hyperosmolar solutions are better tolerated;
- tubes are more easily placed and maintained;
- the stomach serves as a reservoir gradually releasing nutrients into the small bowel.

Therefore, intragastric feeding is associated with more flexible feeding schedules, larger volume and higher osmotic tolerance, lower frequency of diarrhoea and of dumping syndrome.

However, if there is an acute pancreatitis or a high risk for aspiration such as in patients with gastroparesis, severe gastroesophageal reflux or gastric outlet obstruction, **intrajejunal feeding** is the preferred route. Although often preferred in small preterm babies, a recent meta-analysis has not confirmed that transpyloric feeding in preterm babies is associated with either a lower rate of complications or with better growth rate compared to intragastric nutrient delivery (14).

4.2 Routes of Delivery

If the expected duration of EN is short (< 6-8 weeks), EN is preferentially delivered by nasogastric or nasoenteric feeding tube but, if the expected duration is > 6 – 8 weeks, a feeding gastrostomy or jejunostomy is recommended.

Gastrostomies and jejunostomies can be placed:

- surgically;
- endoscopically;
- radiologically.

Endoscopy is the quickest and the cheapest procedure with a low rate of complications. However, in neurologically severely impaired children operatively placed gastrostomy combined with Nissen fundoplication is a procedure of choice. Radiologic procedures expose children to ionizing radiation and are more expensive compared to endoscopy (2) - detailed guidelines are provided elsewhere (5, 15, 16).

The most common route for delivering EN in children, irrespective of their age, is via a nasogastric (NG) feeding tube made from polyvinyl chloride - PVC, polyurethane or silicon. The first option is the least desirable because PVC tubes can release potentially toxic phthalate esters into lipid containing feeds, and if left in place for > 4 days become rigid and may cause lesions of the upper GI tract.

Feeding tube diameter is selected according to the weight and age of the child, with the smallest external diameter being preferred as it causes less patient discomfort. The required length of the tube equals the distance between nose and the umbilicus, and the placement into the stomach is confirmed by epigastric auscultation during injection of air + measuring pH of the aspirate (should be bellow 4).

Radiologic confirmation must be obtained when:

- pH is >5;
- an aspirate cannot be obtained;
- the patient's condition changes during NG tube insertion with prolonged coughing, restlessness and severe discomfort or hoarseness (17).

PVC tubes should be changed every 3-4 days when placed into the stomach, and every 8 days if used transpylorically. Silicon and polyurethane tubes can be safely kept in place for several weeks.

4.3 Modes of Delivery

Modes used to deliver enteral feeding are:

- intermitent
- continuous
- combined

If well tolerated, bolus administration into the stomach is generally preferred as it is more physiological, cheaper and less restrictive. However, in patients with severely impaired GI function, continuous feeding is beneficial due to:

- lower thermogenic effect thus contributing to enhanced weight gain;
- improved substrate utilization.

A constant infusion of nutrients at a rate bellow 3 kcal/min^{-1} is required to avoid exceeding the gastric emptying rate and causing vomiting. The risk of vomiting may also increase if the gastric emptying rate is slowed by increasing the nutrient concentration and or osmotic load (1). An appropriate and constant flow can be ensured by the use of a peristaltic pump. When the child can eat, both methods of feed delivery can be combined with tube feeding overnight for 10-12 hours and oral intake during the day. This combination is particularly beneficial for the preservation of sensory and motor oral functions.

4.4 Initiation of EN

Continuous enteral nutrition should be introduced gradually and its rate and concentration increased in a stepwise manner depending on:

- age;
- clinical condition of the patient, particularly the functional and morphological state of the gut;
- formula choice, i.e. polymeric *versus* elemental;
- route of delivery, i.e. stomach *versus* small intestine.

Slow introduction is particularly important for patients with chronic intestinal failure, where partial parenteral nutrition may be necessary for many months – sometimes for life or until intestinal transplantation is performed.
Slow increase in feeding volumes is particularly important in preterm - low birth weight infants to minimize the chance of developing necrotizing enterocolitis (NEC). This practice has been challenged by the Cochrane meta-analysis of rapid versus slow advancement that failed to demonstrate any difference in NEC (18). However, a very recently performed randomized prospective trial in preterm infants has clearly shown that infants fed greater volumes developed NEC significantly more frequently (10% vs. 1.4%), while the maturation of intestinal motor patterns, the incidence of late sepsis and feeding intolerances were similar in both feeding groups (19).

4.5 Weaning from EN

Once the child is in a stable condition, and after achieving satisfactory nutritional status, transition from EN, particularly the continuous one, to normal oral bolus feeds should be considered. In that process the following should be anticipated:

- weaning process consists of increasing oral intake pari passu with decreasing enteral feeding;
- it may take from a few to many months;
- close supervision is required to ensure adequate total nutrient intake, and to avoid cessation of weight and/or height gain;
- EN can be stopped when oral intake satisfies recommended caloric requirements and growth continues to be appropriate to age.

5. Monitoring and Complications

Children receiving enteral nutrition should be monitored regularly for growth, fluid, energy and nutrient intake, therapeutic efficacy, clinical, blood and biochemical changes, intolerances and other possible adverse effects.
Several groups of complications may occur during enteral nutrition such as:

- Technical complications during tube and/or stoma placement and maintenance may occur, such as malposition, displacement, migration, blockage. If kept in place for more than 4 – 5 days, PVC NG tubes become rigid and may, therefore, cause GIT bleeding, inflammation or perforation. Strict adherence to protocol and careful supervision of the procedure and of the patient are essential.
- Metabolic complications most commonly comprise fluid, glucose and electrolyte imbalances. Re-feeding syndrome and trace element deficiencies. Regular monitoring, dietetic supervision, selection of a formula appropriate to age and clinical condition, avoidance of drip feeding and of blenderized feeds are the best preventive measures.
- Gastrointestinal symptoms are the most common including aspiration, diarrhoea, constipation, nausea, vomiting, bloating, and abdominal distention. These may be minimized by selection of the appropriate enteral formula and mode of delivery, gradual introduction of the feed with monitoring of residual gastric volumes and anticipation of the patient's clinical condition. Infective complications are a consequence of bacterial contamination of the feeding solutions, and may present as gastroenteritis or even with septicemia. Manipulation at the bedside seems to be critical for bacterial safety (20). Therefore, handling procedures, hanging time for decanted feeds (should be < 5 hours), and bacteriological monitoring must follow the established standards and undergo regular quality controls (20). Local infections of nose, ear and pharynx are described during use of NG tubes. Therefore, if long-term EN is anticipated, gastrostomy or jejunostomy are the preferred routes for nutrient delivery.
- Psychological consequences such oral aversion and altered body self-image may result from deprivation of normal oral feeding experience. Training of sucking and swallowing, introduction of non-nutritive sucking (dummy), tasting as many different foods as allowed, speech therapy and initiation of oral bolus feeds as soon as possible are most important measures in the prevention of psychological complications.

The groups of complications of enteral feeding are shown in Figure 3.

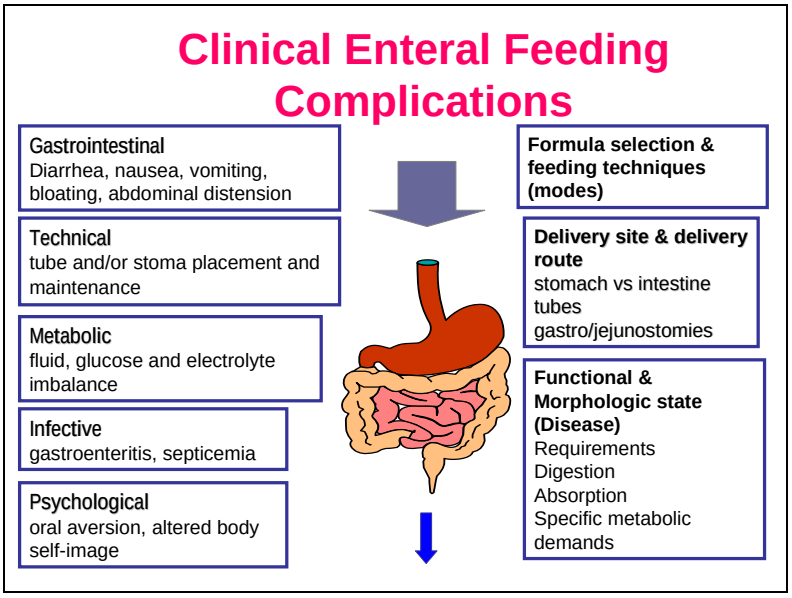

Figure 3 Clinical enteral feeding complications

Despite the broad range of possible complications, EN is a relatively safe and effective way of improving nutritional status, clinical condition and growth of pediatric patients, particularly if procedural protocols are followed, and regular quality control is applied (21).

6. Enteral versus Parenteral Nutrition

Enteral nutrition has a number of potential advantages over parenteral nutrition in the management of patients requiring nutritional support. The main advantages of enteral nutrition include preservation of gastrointestinal function, cost, manageability, and safety.

- Preservation of gastrointestinal function

Apart from the oral phase of digestion, enteral nutrition activates the same gastrointestinal responses as the ingestion of normal meals. The presence of intra-luminal nutrients stimulates (1) gastrointestinal neuroendocrine function, affects motility and digestion through the secretion of digestive juices and gastrointestinal hormones, and (2) maintains gut mucosal mass, including gut-associated lymphoid tissue (GALT).

- Cost

Enteral nutrition is estimated to be two- to fourfold less expensive than parenteral nutrition on an inpatient or outpatient basis (22).

- Manageability and safety

As a result of the advances in tube technology, delivery methods, technical skill of health professionals, and better education of parents and caregivers, the administration of enteral nutrition has been associated with improved clinical outcome and safety profiles (23). Compared to parenteral nutrition, enteral feeding is much easier and safer, and there is also a much wider margin for errors resulting in metabolic complications.
Therefore, it is generally recommended to use the enteral route whenever the gut is functional, and to use it in a maximally tolerated amount, so as to minimize the need for parenteral intake as much as possible, either in hospital or at home (3).

7. Home Enteral Nutrition

It is well established that home EN is safe and effective, and though this is difficult to asses, children seem to be more active and happier at home. Home EN must be considered whenever the clinical condition of the patient is stable and well controlled. In the latest pediatric series, the indications for home EN were digestive disorders in 35% of patients, neurological and muscular diseases also in 35%, malignancy in 11%, and failure to thrive in 8% of children (24). The range of indications will probably continue to grow, following the advances in clinical care, and particularly the development of cheaper, safer and more portable enteral pumps and other facilities.
Children on home EN should be followed by a dedicated multidisciplinary team, the importance of which can not be overemphasized (25). A good collaboration with the Primary Heatlh Service on the field is also required. One of the most important roles of the team is teaching parents and/or children the techniques required for EN, before being discharged home including:

- NG tube placement, NG tube or gastrostomy tube management and maintenance care;
- sterile preparation and appropriate feed storage;
- feeding administration and enteral pump handling and operating;
- monitoring of the child, and the prevention, recognition and management of the most common complications (1).

Summary

In this module we discuss various aspects of enteral nutrition in paediatric patients. Indications, contraindications, administration of EN, monitoring and complications are described. Nutrient composition of various enteral formulas is presented and criteria for enteral formula selection are described.

References

1. Goulet O, Koletzko B. Nutritional support in children and adolescents. In: Sobotka L (ed). Basics in clinical nutrition, 3rd ed. Prague: Galen; 2004, p.439-454.
2. Axelrod D, Kazmerski K, Iyer K. Pediatric enteral nutrition. JPEN 2006;30:S21-S26.
3. Forchielli, M.L., Bines J: Enteral nutrition. In: Walker WA, Watkins JB, editors. Nutrition in Pediatrics: Basic Science and Clinical Applications. Hamilton, Ontario: BC Decker, Inc; 1996, p. 945-956
4. Silk DB, Walters ER, Duncan HD, Green CJ. The effect of a polymeric enteral formula supplemented with a mixture of six fibres on normal human bowel function and colonic motility. Clin Nutr. 2001;20(1):49-58.
5. Atten MJ, Skipper A, Kumar S et al. Nutriton in the paediatric population, older adults and obese patients. Part IV. Enteral nutrition support. Disease-a-Month 2002;48:749-782.
6. Alpers DH, Stenson WF, Bier DM. Manual of Nutritional Therapeutics. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2002.
7. Shaw V, Lawson M, editors. Clinical Paediatric Dietetics. 2nd ed. London: Blackwell; 2001.
8. Sobotka L. Basics in Clinical Nutrition, 3rd ed. Prague:Galen;2004.
9. Lochs H, Dejong C, Hammarqvist F et al. ESPEN Guidelines on Enteral Nutrition: Gastroenterology. Clin Nutr. 2006;25:260–274
10. A.S.P.E.N. Board of Directors and The Clinical Guidelines Task Force. Guidelines for the Use of Parenteral and Enteral Nutrition in Adult and Pediatric Patients JPEN 2002;26(1):S97-S137
11. Zadak Z, Kent-Smith L. Commercially prepared formulas. In: Sobotka L (ed). Basics in clinical nutrition, 3rd ed. Prague:Galen;2004, p. 221-227
12. Lake A. Beyond hydrolysates: use of L-amino acid formulas in resistant dietary protein-induced intestinal disease in infants. J Pediatr 1997;131:658-60.
13. American Academy of Pediatrics Committee on Nutrition Consensus Statement. Hypoallergenic infant formulas. Pediatrics 2000;106:346-9.
14. McGuire W. Arch Dis Child Fet Neonatal 2004

15. Loser C, Aschl G, Hebuterne X, et al. ESPEN guidelines on artificial enteral nutrition – Percutaneous endoscopic gastrostomy (PEG). Clin Nutr 2005;24:848-61.
16. Raval MV, Phillips JD. Optimal enteral feeding in children with gastric dysfunction: surgical jejunostomy vs image-guided gastrojejunal tube placement. J Pediatr Surg 2006;41:1679-82.
17. Richardson DS, Branowicki PA, Zeidmanj-Rogers L et al. An evidence-based approach to nasogastric tube management: Special considerations. J Pediatr Nurs 2006;21:388-93.
18. Kennedy KA, Tyson JE, Chamnanvanakij S. Rapid versus slow rate of advancement of feeding for promoting growth and preventing necrotizing enterocolitis in parenterally fed low-birth-weight infants (Review). Cochrane database Syst Rev 2000;2:CD001241.
19. Berseth CL, Bisquera JA, Paje VU. Prolonging small feeding volumes early in life decreases the incidence of necrotizing enterocolitis in very low birth weight infants. Pediatrics 2003;111:529-34.
20. Roy S, Rigal M, Doit C et al. Bacterial contamination of enteral nutrition in a pediatric hospital. J Hosp Infect 2005;59:311-16.
21. Jeejeebhoy KJ. Enteral feeding. Curr Opin Gastroenterol 2005;21:187-91.
22. Deswarte-Wallace J, Firouzbakhsh S, Finklestein JZ. Using research to change practice: enteral feedings for pediatric oncology patients. J Pediatr Oncol Nurs 2001;18:217–23.
23. Anonymous. Making health care safer: a critical analysis of patient safety practices. Evid Rep Technol Assess 2001;43:1–668.
24. Develuy W, Guimber D, Mention K et al. Home enteral nutrition in children: an 11-year experience with 416 patients. Clin Nutr 2005;24:48-54.
25. Agostoni C, Axelson I, Colomb V, et al. The need for Nutrition Support Teams in pediatric units: A Commentary by the ESPGHAN Committee on Nutrition. J Pediatr Gastroenterol Nutr 2005;41:8-11.