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Types of diet in enteral nutrition in children – short review

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Abstract
Enteral nutrition is the most basic and important method of nutritional intervention. Indication for nutritional support in children is insufficient oral supply, including inability to cover 60-80% of individual caloric demand for more than 10 days. In newborns, the most common reason for the need for enteral nutrition is prematurity. In infants and older children the following are most often mentioned: short bowel syndrome, neurological disorders, cystic fibrosis, congenital heart disease, burns, severe injuries, renal failure requiring dialysis, inflammatory bowel disease, cancer.
According to a review of the literature, nutritional support should be started for children older than 1 year within 5 days, and for children under 1 year within 3 days of being diagnosed with eating disorders.

Key words: enteral nutrition, newborns, children, energy diet

Introduction

Chronic diseases in children are often complicated by serious nutritional deficiencies. In their treatment and secondary prevention, enteral nutrition is recommended as a more physiological and safer method of improving nutritional status compared to parenteral nutrition.
Enteral nutrition is recommended in situations where it is impossible to cover the protein-energy demand by regularly taking a balanced natural diet, while maintaining the function of the digestive tract to the extent that it allows digestion and absorption of the nutritional mixture provided by the enteral route. The aim of the study was discussion on the basis of literature analysis of diet types and their role in enteral nutrition in children.

Methodology

The literature review was performed using a systematic method. Search included articles that were published after 2000. As a result of the preliminary database search, after using the literature search strategy, a total of 475 potentially relevant publications were found: Pubmed– 300, Google Scholar –70, Polish Medical Bibliography –105. Based on the analysis of abstracts and publication titles, 102 of them were included in the review. Based on the analysis of the full-text articles, after eliminating non-compliant publications, 47 were selected for analysis. After data extraction and detailed publication analysis, 23 studies were finally included in the review. The selection of publications for analysis was based on the criteria of a systematic review. Database searches Polish Medical Library and Google Scholar were made according to the keywords: *enteral nutrition in children, industrial preparations in enteral nutrition in children, energy diets in enteral nutrition in children* in Pubmed and Medline bases by keywords : *enteral nutrition in children, industrial preparations in enteral nutrition in children, diet in enteral nutrition in children, energy diet in enteral nutrition in children.*

Enteral nutrition

An indication for nutritional support in children is insufficient oral supply including the inability to cover 60-80% of individual caloric demand.

An indication to start the enteral nutrition is:

- a situation in which there is an inadequate linear growth
- weight loss or lack of weight gaining in a child from 3 months to 2 years,
- changes in body mass index below 2 centiles
- thickness of skin folds above the triceps muscle below the 5th percentile for a given age,
- reduction of the linear growth rate above 2 cm/year compared to the previous year - in the first half of puberty [2,3,4].

In neonates, the most common reason for the necessity of enteral nutrition is prematurity (*impaired coordination of sucking with swallowing*). In infants and older children, clinical situations in which enteral nutrition should be used are: short bowel syndrome (in situations where complete parenteral nutrition is not necessary), neurological disorders: post-myoclonic encephalopathy, cerebral palsy, severe epilepsy, cystic fibrosis, congenital heart defects, burns, severe injuries, renal failure requiring dialysis, inflammatory bowel diseases, neoplastic diseases (Tab. 1.) [5,9,11].

Table 6. Disorders in the course of which the inclusion of enteral nutrition in children should be considered.

Insufficient oral intake	*Sucking and swallowing disorders: children born prematurely, neurological damage: cerebral palsy, dysphagia, congenital defects of the upper digestive tract: tracheostomy tube, cancer: e.g. the mouth of the head and neck, Injuries and extensive burns of the face, critical states, mechanical ventilation, severe gastro-oesophageal reflux, food aversions, anorexia, depression*
Disorders of digestion / absorption	*Cystic fibrosis. short bowel syndrome. inflammatory bowel diseases, malabsorption syndrome as a result of food allergy: for cow's milk protein, compound allergies, inflammation of the intestines as a result of chronic infections of Oiardia lamblia, Leśniowski-Crohn's disease, ulcerative colitis, chronic diarrhea of infancy, resistant to treatment of childhood diarrhea, congenital / acquired severe immunodeficiency, chronic liver disease, graft versus host disease, intestinal fistula*
Disorders of the digestive tract	*Chronic pseudo-construction, extensive Hirschsprung disease*
Growth inhibition or chronic malnutrition	*Anorexia, inorganic growth fluctuations*

Formulas used in enteral nutrition

In enteral nutrition in children, depending on the needs, complete and incomplete medical formulas in terms of nutrient content are used.

Complete diets are: easy to prepare, balanced, determined in terms of composition - like the content of protein, vitamins, microelements, energy content or osmolar value (250-400 mOsm/L). They are sterile, mostly lactose-free and gluten-free, adapted to different clinical situations. They can be divided into:

- low-caloric, normocaloric (1 kcal /1ml) and hypercaloric (1,5 kcal / ml),
- normal protein and high-protein;
- low-resourced, rich-residual;
- polymeric (containing whole proteins), oligomeric (containing peptides) and elemental (containing amino acids).

These diets can be additionally enriched with medium-chain fatty acid triglycerides (MCT), omega-3 fatty acids, glutamine, arginine, nucleotides, and prebiotics. Enrichment in glutamine and arginine, is usually used in formulas intended for patients under severe metabolic stress or treated in intensive care. Both amino acids as well as nucleotides, enhance the immune system (it is so called immunonutrition). Glutamine is an energy substrate for immune cells associated with the digestive tract, arginine increases the mass of thymus and stimulates lymphocyte proliferation. Formulas containing MCT fats, which are absorbed directly into the portal vein and therefore do not require the presence of lipase and bile, are intended especially for patients suffering from cystic fibrosis, cholestasis and short bowel syndrome. In turn, formulas containing prebiotics (fructooligosaccharides) promote intestinal adaptation after resection of intestines through trophic effects [1,14,20,21].

Incomplete formulas contain one basic ingredient, such as protein, carbohydrates or fats. They can be used as an adjuvant therapy in clinically confirmed cases [8,12,16].

The enteral treatment in children, includes formulas for oral administration. A characteristic feature of this group of formulas is the taste, and the aroma acceptable to young patients. The biggest problem, however, is masking the smell of vitamin B1 and the smell and taste caused by hydrolysates of cow's milk.

Among the nutritional formulas, there are also standard preparations whose composition and proportions of nutrients correspond to the needs without special nutritional requirements as well as specialized preparations for patients with specific nutrient needs. These are formulas for children with phenylketonuria, with the intolerance of cow's milk protein, formulas for "non-eating kids”" but also for children with respiratory failure, with a tendency to diarrhea, formulas without dietary fiber and with dietary fiber, formulas for children with cancer and for patients in critical condition [15,20,21].

Among the medical formulas used in pediatric patients there are different diets for babies, diets for younger children (1-6 years old or body weight in the range of 8-20 kg) and diets for older children (7-12 years of age or body weight 21-45 kg).

Formulas used in nutritional treatment include dietary supplements and enteral diets with a balanced composition that completely cover the body's nutrient requirements and can be used as the only source of food (Tab. 2) [10,17].

Table 7. Characteristics of diets used in enteral nutrition.

Oligomeric and monomeric diets	*They are used in patients with digestive and absorption disorders, with pancreatic insufficiency, they can be administered to the small intestine. Examples:* *• nutritious diets;* *• chemically defined diets;* *• diets enzymatically hydrolyzed to varying degrees;* *• diets sometimes synthetically synthesized;* *• low-fat diets;* *• low-lactose and gluten-free diets.*
Special diets	*The composition of the basic substrates has been adapted to the needs of patients with a specific disease or with certain digestive, absorption or metabolic disorders:* *• diets used in diabetes, in cancer disease, respiratory failure, liver or kidney failure.*
Partial diets	*They are modified, containing only one nutrient, used as a supplement to nutrition in the case of shortages. Formulas can be divided to:* *- carbohydrates, which improve the taste and caloricity;* *- protein boosting nitrogen supply;* *- fat-enhancing fatty acids and calories.*

Fatty acids in enteral nutrition

Fatty acids, included in formulas of nutritional treatment, are divided into three groups depending on their chemical structure: saturated, monounsaturated, polyunsaturated. Fatty emulsions used for intravenous administration were based on the intestinal chylomicron model, whose nucleus is made of triglycerides and some fat-soluble vitamins, and the external layer consists of phospholipids and free cholesterol. The ethereal feeding solutions should contain saturated, monounsaturated and polyunsaturated fatty acids, an appropriate ratio of omega-3 and -6 fatty acids and antioxidants.

Emulsions based on long chain triglycerides (LCT) have many disadvantages: they contain excessive content of unsaturated fatty acids, too little tocopherol and too many metabolites of oxygen metabolism. These emulsions also cause the disruption of cell membrane structure, increase the synthesis of proinflammatory leukotrienes and prostaglandins and also impair immune responses [4,13,17].

As a result of many years of work currently available formulas contain a medium triglyceride (MCT) and long chain triglicerides (LCT) mixture in the ratio 50:50, emulsions based on olive oil, fish oil or triglycerides. MCTs contain fatty acids that have 6-12 carbon atoms in the molecule, while LCT contains long chain fatty acids (>16 carbon atoms per

molecule) [6,18,21]. These differences in chemical structure determine the different metabolic properties of the MCT/ LCT emulsion. Medium molecular chain triglycerides are smaller molecules that are better soluble in water than LCT, what facilitates the action of lipases (MCTs are easier and faster hydrolysed to glycerol and fatty acids than LCT) and are transported mostly via the portal circulation directly to the liver. MCTs during the transport in the blood, do not require the participation of albumin (as opposed to LCT, which can displace bilirubin or drugs with connections to albumins). Emulsions with 50% of MCT, enable the production of ketone bodies, which are the physiological fuel of the body in case of glucose deficiency, promote the maintenance of intestinal integrity and prevent bacterial translocation. In addition, the presence of 50% MCT has made it possible to limit the supply of excessive amounts of polyunsaturated fatty acids such as omega-6 present in soybean oil [4,10].

The use of MCTs reduces the incidence of atherosclerotic changes and heart disease, or decreases cholesterol in plasma. The beneficial effect of using MCTs is its immune function by increasing the T and B lymphocyte population, stimulating interleukin 2 synthesis, increasing the activity of natural killer (NK) cells or improving the function of Kupffer – Borowicz cells in the liver (their activity is inhibited e.g. by LTC emulsions) [17,19,20].

Kupffer – Borowicz cells prevent blood clotting, through phagocytosis of the fibrin, participate in the body's immune mechanisms, through bacterial phagocytosis, antibody-antigen complexes, phagocytosis of tumor cells, erythrocytes or fragments thereof (this process is done mainly in the spleen, but after its surgical removal this function is taken by the liver). After the use of MCT, the total number of T cells is not reduced, which is observed when using LCT or fatty acid-free dietary supplements.

The way of food mixture suppling

Nutritional mixtures are administered continuous by supply through the enteral pump, so called gravity method or intermittently in the form of bolus feeding. Intermittent feeding is considered more physiological because it stimulates the cyclic secretion of enterohormones that regulate the secretory and motor activity of the gastrointestinal tract and exert a trophic effect on the mucous membrane. Some studies, however, indicate that continuous supply is better tolerated and can be used to provide more energy and to achieve better weight gain. With intragastric delivery, bolus feeding is recommended as a standard procedure (5-6 times a day, by 200-300 ml portions) or microboles (administration of 50-100 ml of portions, under the control of stomach retention - control by aspiration of stomach contents using a syringe). The final choice of the suppling method, depends on the patient's individual tolerance [18,20,14,15]. In children fed enterally, the most commonly used method is continuous nutrition with a constant controlled volume. The continuous infusion is carried out by gravity or using a nutritional pump (the infusion rate is usually 30-50 ml / hour) [6,7,11].

Conclusions

For nutritional treatment, through the use of industrial diets, provided by special access to the gastrointestinal tract (tube or nutritional fistula), children with eating disorders or at risk of eating disorders are qualified due to their inability to eat a properly composed regular diet. Nutritional support should be started in children from 1 year in 5 days, and in children under 1 year in 3 days. Among the medical formulas used in pediatric patients there are different diets for babies, diets for younger children and diets for older children. Types of diet used in nutritional treatment include dietary supplements and enteral diets with a balanced composition that completely covering the body's nutrient requirements.

Enteral nutrition can help in the proper growth and recovery of pediatric patients with nutritional imbalances or nutritional needs.

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