

Paediatric parenteral nutrition

(Żywnienie pozajelitowe u dzieci)

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Abstract – Introduction. A number of diseases are associated with increased metabolism and thus a greater need for energy and nutrients. Patients may develop or worsen malnutrition. This has an adverse effect on the overall condition of the patient and on the course and effectiveness of the therapy provided. It may also increase the risk of complications. In such situations parenteral nutrition is often the only chance of survival.

Aim of the study. The aim of the study was to discuss selected issues in the field of parenteral nutrition in children.

Selection of materials. The search was conducted in the Scopus database for the period 2009-2020, using the terms *parenteral nutrition in children*. From the literature found in the Google Scholar database, studies were selected which, in the opinion of the authors, would be most useful in the preparation of this study.

Conclusions. Parenteral nutrition is currently a common form of treatment for sick children who cannot be fed through the digestive tract. Nutrition at home is a continuation of hospital treatment. For families of chronically ill children, nutrition at home is a major challenge, both in organisational and medical terms. Nutrition must be administered daily for several to several hours (cyclic supply) and in case of some children even for 18-22 hours (continuous supply).

Key words - parenteral nutrition in children.

Streszczenie – Wprowadzenie. Szereg chorób wiąże się ze zwiększoną przemianą materii, a tym samym z większym zapotrzebowaniem na energię i składniki odżywcze. U chorych może dochodzić do rozwoju lub pogłębienia niedożywienia. Wpływa to niekorzystnie na ogólny stan chorego oraz przebieg i skuteczność prowadzonej terapii. Może również zwiększać ryzyko powikłań. W takich sytuacjach żywnienie pozajelitowe bywa często jedyną szansą na przeżycie.

Cel pracy. Celem pracy było omówienie wybranych zagadnień z zakresu żywienia pozajelitowego u dzieci.

Dobór materiału. Poszukiwania przeprowadzono w bazie Scopus za okres 2009-2020, używając pojęć *żywnienie pozajelitowe u dzieci*. Ze znalezionego w bazie Google Scholar piśmiennictwa wyselekcjonowano opracowania, które zdaniem autorów byłyby najbardziej użyteczne w przygotowaniu niniejszego opracowania.

Wnioski. Żywnienie pozajelitowe jest obecnie częstą formą leczenia chorych dzieci, które nie mogą być odżywiane drogą przewodu pokarmowego. Żywnienie w warunkach domowych jest kontynuacją leczenia szpitalnego. Dla rodzin dzieci przewlekle chorych żywnienie w warunkach domowych jest dużym wyzwaniem zarówno organizacyjnym jak i medycznym. Żywnienie musi być podawane codziennie w wymiarze od kilku do kilkunastu godzin (podaż cykliczna) a w przypadku niektórych dzieci nawet w ciągu 18-22. godzin (podaż ciągła).

Słowa kluczowe – żywnienie pozajelitowe u dzieci.

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- A. The idea and the planning of the study
- B. Gathering and listing data
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I. DEFINITION AND DISCUSSION

Parenteral nutrition consists in providing all necessary nutrients - absorbed by the organism from the gastrointestinal tract - directly to the circulatory system, excluding the digestive tract. The individual nutrients: protein, carbohydrates, fats, electrolytes, trace elements and vitamins are mixed together in the form of solutions - nutrient mixtures. They should be as simple as possible so that they can be used by all the tissues they reach. They must be sterile due to the intravenous route of administration. Nutrition that does not contain trace elements or vitamins or one of the nutrients is called parenteral incomplete nutrition [1-5].

Mixtures are administered through venous catheters, which are implanted into large veins supplying blood directly to the heart (central parenteral nutrition) or through cannulas inserted into thinner peripheral veins located e.g. on upper limbs (peripheral parenteral nutrition). It may also be administered through an arterio-venous fistula produced in parenteral nutrition patients [1,2,6].

Parenteral nutrition is used in patients where gastrointestinal feeding is totally impossible or insufficient.

In these cases, all the nutrients must be supplied parenterally and then total parenteral nutrition is carried out [3,5,7].

When the digestive tract is capable of absorbing, digesting and absorbing nutrients in an amount insufficient to meet demand, then the missing part of the nutrients must be administered intravenously. This is a partial or complementary parenteral nutrition.

A number of diseases are associated with increased metabolism and thus a greater need for energy and nutrients. Patients may develop or worsen malnutrition. This has an adverse effect on the overall condition of the patient and on the course and effectiveness of the therapy provided. It may also increase the risk of complications. In such situations parenteral nutrition is often the only chance of survival. [3,5-7]

Parenteral nutrition is currently a common form of treatment for sick children who cannot be fed through the digestive tract. Nutrition at home is a continuation of hospital treatment. For families of chronically ill children, nutrition at home is a major challenge, both in organisational and medical terms. Nutrition must be administered daily for several to several hours (cyclic supply) and in the case of some children even within 18-22 hours (continuous supply) [3,4,7,8].

II. INDICATIONS FOR PARENTERAL NUTRITION IN CHILDREN

In Poland domestic parenteral nutrition is currently provided for about 200 children. Out of that number, 120 to 150 children a year are under constant care of the "Monument - Children's Health Centre" Institute in Warsaw-Międzylesiu [9].

The most common causes of implementation of parenteral nutrition (total or complementary) are [2,4,10-12]:

- short bowel syndrome (about 70%);
- disorders of gastrointestinal motility and Crohn's disease (about 20%);
- Surgical procedures concerning gastrointestinal tract;
- necrotizing enteritis;
- acute pancreatitis;
- a period of radiotherapy or chemotherapy;
- extensive burns (especially in the digestive system);
- coma and vegetative state;
- congenital defects of the digestive system;
- prematurity (children whose digestive tract is not sufficiently developed);
- malnutrition and cachexia (e.g. anorexia, bulimia).

Before a patient is qualified for treatment, his or her nutritional status and need for nutrients must be assessed. It is also necessary to determine the time of nutrition and to make a choice on how to administer the nutrients.

At this stage of the procedure, the child's parents/guardians should be informed about the benefits and dangers of this treatment procedure.

Before starting treatment, a nutrition plan should also be drawn up with its objectives and the way it is to be achieved. The plan may of course change as the treatment progresses [5,6].

Children are eligible for home parenteral nutrition [2-4,7,12]:

- in which the expected feeding time exceeds 3 months;
- in a stable overall state;
- have no other indication for hospitalization;
- having responsible parents;
- with adequate home social conditions.

Preparing a patient for home parenteral nutrition is a very complex medical procedure and requires the cooperation of the patient, his parents/guardians, doctor, nurse, pharmacist and nutritionist. It usually lasts from several weeks to several months. It requires an individual approach to each patient so that a treatment plan can be developed and monitored at the patient's home.

Preparation in a specialist centre usually consists of several stages [13]:

- preparing the patient for home parenteral nutrition;
- clinical and metabolic stabilisation;
- the establishment of permanent vascular access;
- Establishing a home parenteral nutrition programme.

III. PRINCIPLES OF PARENTERAL NUTRITION

The parenteral nutrition of children - especially newborns and infants - poses specific challenges because of the need to ensure the best possible development and growth for the young patient. It should therefore provide all the necessary macro nutrients (carbohydrates, fats and amino acids) and micro-nutrients (vitamins, trace elements and electrolytes) necessary for the proper functioning of its body [14].

Parenteral nutrition may be conducted through peripheral access to the veins of the limbs, through central access to the superior vena cava directly or with the use of longer catheters through the subclavian or internal jugular vein [2,4,5,10].

Tunnel catheters in subcutaneous tissue or vascular ports can also be used.

The use of one of these methods depends on the expected duration of feeding [2-4]:

- up to 7 days - a perimeter puncture;
- 7 days - 3 weeks - central puncture;
- over 3 weeks - tunnel catheter or vascular port.

Access through the vascular port is considered to be most advantageous as [4,5]:

- its durability is at least several years;
- the patient is able to lead a fully active life without fear of damage to the port;
- requires the least maintenance compared to other accesses.

Currently, two main ways of parenteral nutrition are used [15]:

- multi-bottle procedure, or
- "all in one".

The multi-bottle method is based on conducting an infusion from several different bottles containing separately placed solutions of carbohydrates, proteins and fat emulsion. Due to the lack of trace elements and vitamins in the mentioned preparations, they are added separately - trace elements for carbohydrates and proteins and vitamins for fat emulsions, due to vitamins A, D, E and K present there. The infusion of amino acids and carbohydrates should be

carried out continuously around the clock, with particular emphasis on the continuity of glucose administration. Interruption of this continuity may lead to very dangerous sudden states of hypoglycaemia. In order to prevent fluctuations of glycaemia, it is recommended to use infusion pumps which enable precise control of the rate of inflow. The method of many bottles is relatively cumbersome and one of its few advantages is the possibility of flexible and easy adjustment of the nutritional mixture composition to rapidly changing patient's needs [6].

The "all-in-one" procedure is based on connecting a patient's container with a properly prepared preparation containing the right proportions of water, carbohydrates, proteins, fat emulsion, electrolytes and vitamins. Injections are usually conducted continuously around the clock. If necessary, specific ingredients can be added to the prepared preparations, such as drugs, insulin and antibiotics or cyto-stats.

The 'all-in-one' method seems to be the most advantageous solution at present, as fewer disposable equipment is used. It provides a better balance, use and assimilability of nutrients [36].

There is also less risk of septic and metabolic complications than with multiple-bottle feeding. Containers with nutritional preparations are prepared in special, sterile rooms, which ensures appropriate asepsis of the supplied preparations [3,4,13].

According to the current guidelines, preparations for parenteral nutrition using the "All-In-One" method must be [3,4]:

- appropriately selected for the patient in therapeutic and pharmacological terms;
- free from all microbiological contamination and pyrogens;
- properly mixed and dosed;
- correctly labelled, stored and administered.

In home parenteral nutrition, the majority of parenteral mixtures are prepared individually for each patient - based on the assessment of their needs - in hospital pharmacies [8]. The stock of mixtures for 7 days is delivered by special transport in sealed containers. Parents are only obliged to inject preparations with short shelf life [7].

IV. PARENT/GUARDIAN EDUCATION AND DISCHARGE FROM THE HOSPITAL

For several years now, the procedure of discharging a child home and continuing this treatment at home has been

used in nutritional treatment. This protects patients from the need to stay permanently in hospital, gives them the opportunity to live a normal childhood, ensures better contact with their peers and attending school in their place of residence.

The procedure of treatment in this mode requires proper medical preparation of the patient, training of parents/guardians in the issues of intravenous access, connection of devices and principles of food mixture transfusion as well as recognition of the risk and proper response to it [8].

The training of parents/guardians, closest family members and sometimes the patient himself or herself is a very important segment of the home nutritional treatment process. Each nutrition centre usually has its own training system and tries to start as early as possible. The level of education should be adapted to the intellectual and manual skills of the people being trained. Sometimes it is necessary to repeat some stages of training until they are mastered in a way that guarantees full effectiveness and safety of procedures while the patient stays at home [13].

The first steps in the parenteral nutrition programme are taken in hospital conditions. Patients, their parents or caregivers take part in specialist training, which usually includes [3-5,13]:

- techniques and principles of aseptic operation of the central catheter;
- conditions of storage of medicines and food mixture and control of their suitability;
- techniques for the aseptic preparation of the dietary mixture and the principles of mixing its components;
- operation of the infusion pump;
- observation of symptoms in terms of complications and a specific procedure;
- rules for contact with the nutrition team;
- principles of oral nutrition and medication intake;
- waste disposal rules.

The process of this training usually takes place according to an agreed arrangement:

- 1 stage - theoretical training (lectures, talks, brochures, etc.);
- stage 2 - exercise of practical skills (on phantom and devices);
- Stage 3 - real participation in the patient's activities;
- stage 4 - passing the examination and issuing a certificate.

The training is considered to be completed at the moment when the trainees are able to properly and independently perform the most important activities of this

procedure, i.e.: connecting and disconnecting the food mixture, changing the dressing at the catheter exit point, rinsing the catheter and changing the plug [13].

Throughout the whole process of parenteral nutrition, especially the chronic one lasting for years, it is very important to control it properly and continuously [2,3,15].

It is associated with periodically repeated tests to assess whether the supply of ingredients is appropriate for the current treatment process. In the case of long-term nutrition, attention should be paid to the need for constant supervision of other parameters evaluating particular systems or organs of the patient. This is necessary to constantly modify the process in order to avoid complications [16]. An important component of the success of the treatment programme is also the precise cooperation of hospital nutrition team members with the patient's parents. The training of the patient and his parents/guardians is the basic principle guaranteeing the safe process of parenteral nutrition at home.

V. REFERENCES

- [1] Rampertab D.(ed.) Encyclopedia of Human Nutrition. New York; Elsevier Ltd. All, 2013.
- [2] American Gastroenterological Association. Medical position statement: parenteral nutrition. *Gastroenterology* 2001; Oct,121(4): 966-9.
- [3] Sobotka L, Schneider SM, Berner YN *et al.* ESPEN Guidelines on Parenteral Nutrition: geriatrics. *Clin Nutr* 2009; 28 (4): 461-6.
- [4] Yaworski JA. Total Parenteral Nutrition (TPN) Frequently Asked Questions. Pittsburgh; Children's Hospital of Pittsburgh, 2014.
- [5] Matysiak-Luźnia K. Standardy żywienia dojelitowego i pozajelitowego. Kraków; Scientifica, 2019.
- [6] Kłęk S, Korta T, Łyszczowska M. Podstawy żywienia klinicznego Kraków; Scientifica, 2013.
- [7] Chrzanowska K, Chrzanowski K, Kaczmarski M *i wsp.* Żywnienie enteralne i parenteralne chorych dzieci w warunkach domowych. *Pediatrics* 2012; 14(1): 20- 23.
- [8] Książek J. Standardy leczenia żywieniowego w pediatrii. Warszawa; Wydawnictwo PZWL, 2017.
- [9] Tobota K, Popińska K, Danko M *i wsp.* Ropne zapalenie stawów w przebiegu posocznicy odcewnikowej u dzieci w programie Domowego Żywienia Pozajelitowego w Warszawie. *Stand Med Pediatr* 2019; 16: 253- 262.
- [10] Ciborowska H, Rudnicka A. Dietetyka Żywnienie zdrowego i chorego człowieka. Warszawa; Wydawnictwo PZWL, 2014.
- [11] Chrzanowska K, Chrzanowski K, Kaczmarski M *i wsp.* Żywnienie pozajelitowe – leczenie w wybranych stanach chorobowych dzieci i młodzieży. *Pediatr Współcz* 2012; 14(1): 21-24.
- [12] Różycka K, Jakubczyk M, Baranowski P *i wsp.* Żywnienie pozajelitowe w warunkach domowych pacjentów z zaawansowaną chorobą nowotworową. *Post Żyw Klin* 2016; 4(41): 7-12.

- [13] Karwowska K, Kunecki M, Zmarzły A. Domowe żywienie pozajelitowe. Wrocław; Wydawnictwo Continue, 2015.
- [14] Żydek J., Popińska K.: Dożylne emulsje lipidowe w żywieniu pozajelitowym dzieci. *Stand Med Pediatr* 2009; 6: 278-283.
- [15] Matysiak-Luśnia K, Ciszewska-Jędrasik M, Gabrowska E *i wsp.* Żywienie pozajelitowe w domu. Podręcznik dla pacjentów. Kraków; Krakowskie Wydawnictwo Scientifica, 2016.
- [16] Łyszkowska M. Skąd się biorą powikłania leczenia żywieniowego? Wady ukryte (na pierwszy rzut oka). *Stand Med Pediatr* 2009; 6: 242-249.