UDC 613.2.032.33+616.33-083.2-053.2
DOI: 10.56871/CmN-W.2024.50.45.003

PRACTICAL ASPECTS OF ORGANIZATION OF ENTERAL NUTRITION IN PEDIATRIC INTENSIVE CARE UNIT PATIENTS. PART 1. CHOOSING A NUTRITIONAL STRATEGY

© Ivan A. Lisitsa, Anna N. Zavyalova, Yurii S. Alexandrovich, Valeria P. Novikova, Oleg V. Lisovskii, Maksim V. Gavshchuk, Alexandra A. Bassanets, Milena N. Yakovleva, Maria A. Koleboshina, Alexey V. Meshkov, Milad M. Al-Hares

Saint Petersburg State Pediatric Medical University. 2 Lithuania, Saint Petersburg 194100 Russian Federation

Contact information:
Ivan A. Lisitsa — Assistant of the Department of General Medical Practice. E-mail: ivan_lisitsa@mail.ru
ORCID: https://orcid.org/0000-0003-3501-9660 SPIN: 4937-7071

For citation: Lisitsa IA, Zavyalova AN, Alexandrovich YuS, Novikova VP, Lisovskii OV, Gavshchuk MV, Bassanets AA, Yakovleva MN, Koleboshina MA, Meshkov AV, Al-Hares MM. Practical aspects of organization of enteral nutrition in pediatric intensive care unit patients. Part 1. Choosing a nutritional strategy. Children's Medicine of the North-West. 2024;12(4):39–57. DOI: https://doi.org/10.56871/CmN-W.2024.50.45.003

Received: 25.09.2024 **Revised: 15.11.2024** **Accepted: 16.12.2024**

ABSTRACT. The provision of enteral nutrition is an important component of a multimodal system of therapy. Failure to meet the energy needs of patients in critical conditions against the background of hypercatabolism leads to a more severe course of diseases, increased hospitalization time and lethality. Lack of independent nutrition in pediatric intensive care units (PICU) leads to the need for artificial nutrition, mainly enteral nutrition through special devices (probes, feeding stomas). Anatomo-physiological features of children of different ages necessitate a differentiated approach to the choice of devices and algorithms of general and special care. The article substantiates the necessity of using an individualized approach in the organization of enteral nutrition of children hospitalized in intensive care units with the help of special devices.

KEYWORDS: *enteral nutrition, nutritional support in PICU, tube-feeding*

ПРАКТИЧЕСКИЕ АСПЕКТЫ ОРГАНИЗАЦИИ ЭНТЕРАЛЬНОГО ПИТАНИЯ ПАЦИЕНТОВ ПЕДИАТРИЧЕСКИХ ОРИТ. ЧАСТЬ 1. ВЫБОР СПОСОБА ПИТАНИЯ

© Иван Александрович Лисица, Анна Никитична Завьялова, Юрий Станиславович Александрович, Валерия Павловна Новикова, Олег Валентинович Лисовский, Максим Владимирович Гавщук, Александра Александровна Бассанец, Милена Николаевна Яковлева, Мария Александровна Колебошина, Алексей Владимирович Мешков, Милад Мтанусович Аль-Харес

Санкт-Петербургский государственный педиатрический медицинский университет. 194100, г. Санкт-Петербург, ул. Литовская, д. 2

Контактная информация:
Иван Александрович Лисица — ассистент кафедры общей медицинской практики. E-mail: ivan_lisitsa@mail.ru
ORCID: https://orcid.org/0000-0003-3501-9660 SPIN: 4937-7071

Для цитирования: Лисица И.А., Завьялова А.Н., Александрович Ю.С., Новикова В.П., Лисовский О.В., Гавщук М.В., Бассанец А.А., Яковлева М.Н., Колебошина М.А., Мешков А.В., Аль-Харес М.М. Практические аспекты организации энтерального питания пациентов педиатрических ОРИТ. Часть 1. Выбор способа питания. Children's Medicine of the North-West. 2024. Т. 12. № 4. С. 39–57. DOI: https://doi.org/10.56871/CmN-W.2024.50.45.003

Поступила: 25.09.2024 **Одобрена: 15.11.2024** **Принята к печати: 16.12.2024**

РЕЗЮМЕ. Обеспечение энтерального питания является важным компонентом мультимодальной системы терапии. Неудовлетворение энергетических потребностей пациентов в критических состояниях на фоне гиперкатаболизма приводит к более тяжелому течению заболеваний, увеличению длительности лечения в стационаре и летальности. Отсутствие возможности самостоятельного питания в отделениях реанимации и интенсивной терапии (ОРИТ) у детей приводит к необходимости проведения искусственного питания, преимущественно энтерального, через специальные устройства (зонды, питательные стомы). Анатомо-физиологические особенности детей разного возраста трактуют необходимость дифференцированного подхода к выбору таких устройств и алгоритмов общего и специального ухода. В статье обоснована необходимость использования индивидуализированного подхода при организации энтерального питания детей, госпитализированных в отделения реанимации и интенсивной терапии, с помощью специальных устройств.

КЛЮЧЕВЫЕ СЛОВА: *энтеральное питание, нутритивная поддержка в ОРИТ, tube-feeding*

INTRODUCTION

Providing enteral nutrition to patients hospitalized in intensive care units (ICU) is an integral part of any multimodal therapeutic strategy for disease treatment [1–3]. Children, unlike adults, are more sensitive to starvation due to insufficient reserves of energy substrates in the body and increased metabolic needs [4]. Nutritional support has an undoubted positive effect on the condition of the gastrointestinal mucosa, affecting the microbiota. In the absence of maldigestion, nutritional support ensures the supply of substances necessary not only for recovery, but also for maintaining the physical and mental development of a child [5–7]. It is especially important to ensure energy needs in patients hospitalized in ICU, given that most of them have varying degrees of protein-energy malnutrition or are at high risk of its development [8, 9]. Organization of enteral nutrition for patients with dysphagia is of great importance [10–12]. Enteral nutrition using a special device (tube-feeding) not only ensures the satisfaction of nutritional needs, but in some cases can lead to a reduction in the risk of aspiration syndrome [13, 14].

AIM

To propose effective practical recommendations for organizing enteral nutrition for children hospitalized in intensive care units.

CHOOSING A METHOD OF ENTERAL NUTRITION

Providing nutritional support to ICU patients is associated with a number of difficulties. The most common problems are associated with the inability to eat independently or the presence of contraindications to it.

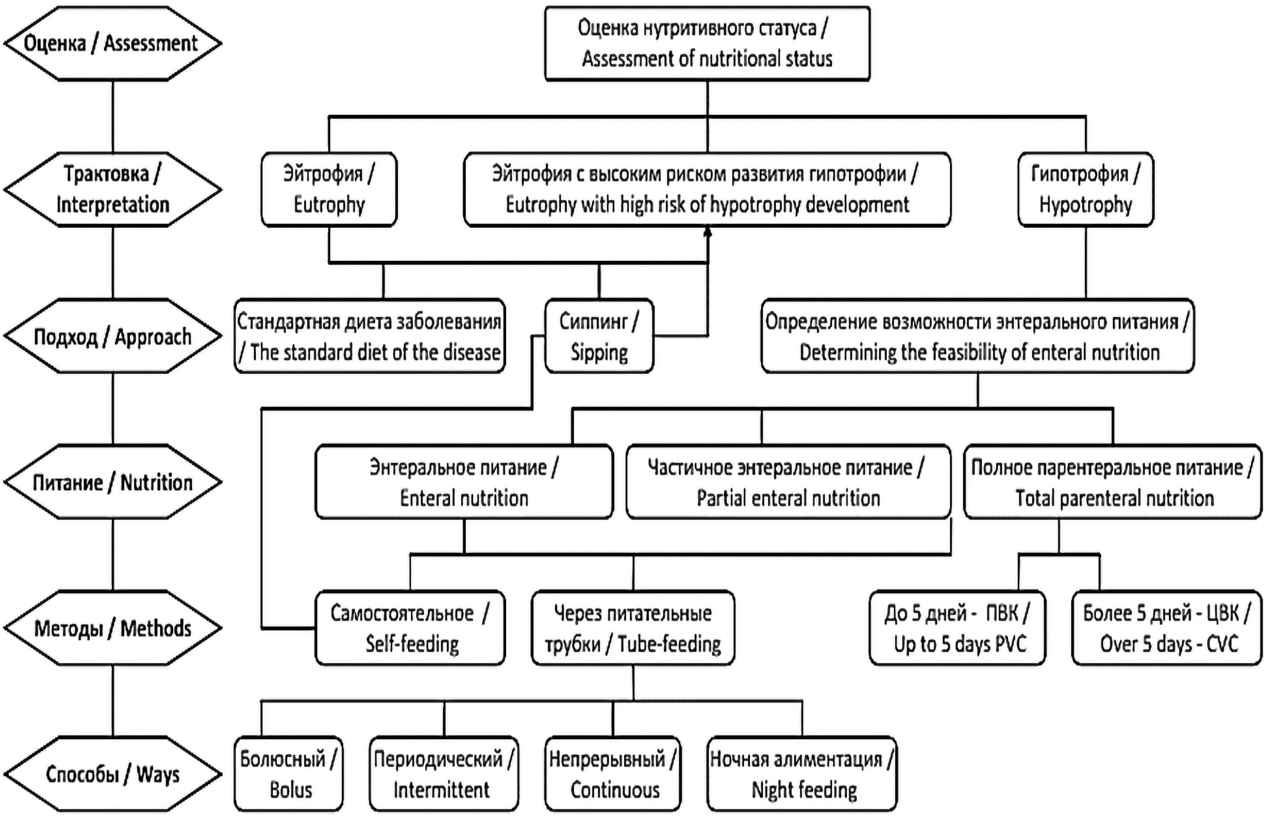

Fig. 1. Algorithm for selecting a nutritional support method. PVC — peripheral venous catheter; CVC — central venous catheter

Рис. 1. Алгоритм выбора метода нутритивной поддержки. ПВК — периферический венозный катетер; ЦВК — центральный венозный катетер

In diseases accompanied by acute cerebral, respiratory, cardiovascular failure, and artificial ventilation, independent nutrition is impossible [15]. Another group includes not only patients in the early postoperative period after facial interventions, but also patients with severe forms of cardiovascular or respiratory failure, in which physical activity during meals leads to increased hypoxia [15]. In diseases that were previously considered absolute contraindications to the start of enteral nutrition, such as necrotizing enterocolitis, toxic megacolon, Ogilvie's syndrome, peritonitis, gastrointestinal bleeding and high intestinal fistulas, it is now possible to use trophic nutrition in a volume of 0.1–20 ml/kg per day [16–19].

The choice of the method of nutritional support depends on the clinical and nutritional status of a child, the expected duration of artificial feeding and the need to use special devices for delivering a formula (Fig. 1) [16, 20]. In addition, there are various problems associated with the degree of swallowing disorder. For non-invasive detection of dysphagia and its severity in children depending on age, the functional oral intake scale (FOIS) is used (Table 1) [21–23]. Daily assessment using the FOIS allows not only timely detection of dysphagia and its severity, but also the determination of therapeutic strategies, in particular, the use of compensatory techniques associated with modification of the food texture, as well as the use of special devices. In this case, texture is determined not only by the consistency of food, but also by the rheological (viscosity) and structural (density, surface tension for liquids) properties of food, as well as the type of cooking.

Table 1. The functional oral intake scale

Таблица 1. Функциональная шкала приема пищи через рот

<table>
<tr><th>Дети менее 1 года / Infants</th><th>Уровень / Level</th><th>Дети 1–18 лет / Children aged 1–18 years</th></tr>
<tr><td>Ничего через рот / Nil per os</td><td>1</td><td>Ничего через рот / Nil per os</td></tr>
<tr><td>Искусственное питание через зонд с минимальными попытками приема пищи или жидкости / Tube dependent with minimal attempts of food or liquids</td><td>2</td><td>Искусственное питание через зонд с минимальными попытками приема пищи или жидкости / Tube dependent with minimal attempts of food or liquids</td></tr>
<tr><td>Искусственное питание через зонд с параллельным постоянным пероральным прием пищи или жидкости / Tube dependent with consistent oral intake of food or liquids</td><td>3</td><td>Искусственное питание через зонд с параллельным постоянным пероральным прием пищи или жидкости / Tube dependent with consistent oral intake of food or liquids</td></tr>
<tr><td rowspan="3">Расширение перорального приема с постепенным изменением текстуры пищи (от жидкой до густой и твердой в зависимости от возраста) / Expanding oral intake with gradual changes in food texture (from liquid to thick and solid depending on age)</td><td>4</td><td>Пероральная диета одной пюреобразной консистенции / Total oral diet of a single consistency</td></tr>
<tr><td>5</td><td>Полный пероральный рацион различной консистенции, но требующий специальной подготовки или компенсации / Total oral diet with multiple consistencies, but requiring special preparations or compensations</td></tr>
<tr><td>6</td><td>Полный пероральный рацион различной консистенции без специальной подготовки, но с определенными ограничениями в еде / Total oral diet with multiple consistencies without special preparation, but with specific food limitations</td></tr>
<tr><td>Полный пероральный прием с постепенным расширением диеты от жидкой до густой и твердой в зависимости от возраста / Full oral intake with gradual expansion of the diet from liquid to thick and solid depending on age</td><td>7</td><td>Полный пероральный рацион без ограничений / Total oral diet with no restrictions</td></tr>
</table>

Inextricably linked to consistency, food texture is a broader concept defined by mechanical, tactile, and in some cases visual and auditory receptors. Enteral nutrition is carried out by introducing a nutritional formula into the stomach (gastric method) or small intestine (jejunal or postpyloric method), depending on the clinical situation and technical capabilities of the medical organization.

ADMINISTRATION OF NUTRITION FORMULA INTO THE STOMACH

When providing nutritional support for up to 30 days and implementing a night alimentation program, an oro-/nasogastric tube is used [24–26]. If long-term artificial nutrition is required, independent food intake is impossible, gastroesophageal reflux disease (GERD) is present and progresses, and aspiration syndrome occurs, gastrostomy is recommended [16, 20, 25, 27, 28], including percutaneous endoscopic (PEG) and laparoscopic gastrostomy [24, 28–34].

The introduction of less invasive gastrostomy techniques has improved the efficiency of nutrition in seriously ill children [35]. In particular, laparoscopic methods are a safe alternative in cases of severe scoliosis, obesity, strictures and other congenital or acquired diseases of the esophagus with stenosis of its lumen, and other contraindications to endoscopic gastrostomy. In cases of severe GERD, recurrent aspiration pneumonia, and uncontrollable vomiting, gastrostomy is recommended to be performed simultaneously with fundoplication [36–38]. An indication for early gastrostomy is initially severe dysphagia in patients with cerebral palsy IV–V according to the EDACS (Eating and Drinking Ability Classification System). A feeding duration of more than 4 hours per day or more than 30 minutes per feeding, as well as any duration of feeding with progression of nutritional deficiency are indications for gastrostomy [39].

The advantages of gastric access include maintaining the cyclic release of intestinal hormones, which has a positive effect on the regeneration of the intestinal mucosa [16, 40]. In addition, being more physiological, the method reduces the risk of developing osmotic diarrhea. The method is cheap and available in all medical organizations [40].

In case of absolute contraindications to the installation of an oro- or nasogastric tube, nutrition is provided through a tube inserted into the jejunum (nasojejunal tube, jejunostomy). Postpyloric methods of introducing enteral formula are recommended in cases of high risk of aspiration, uncontrolled GERD, ineffectiveness of nutritional correction, and refusal of parents or legal representatives from fundoplication. To prevent regurgitation of food into the stomach, the distal end of the tube should be located more than 40 cm distal to the ligament of Treitz [41]. Complications of this method of nutritional support include the development of osmotic diarrhea and maladaptation of gastric motility.

Enteral tube feeding can be performed as a bolus, intermittently or continuously [15, 42]. Bolus feeding has a number of important advantages: imitation of physiological reactions of the endocrine system, free feeding regime, ensuring the required temperature of the nutritional mixture. However, it is not recommended for postpyloric feeding methods due to the high risk of developing dumping syndrome and diarrhea [43]. Intermittent administration allows the rate to be adjusted depending on food tolerance. Continuous feeding can be used throughout the day, separately during the day or night (night alimentation), and is recommended in cases of intolerance to the formula, and jejunal feeding [26, 44]. A combination of continuous night feeding with boluses is possible when there is a need to meet high energy needs or intolerance to food volume [24]. In this case, bolus feeding can be carried out using mixtures whose consistency, according to the International Dysphagia Diet Standardisation Initiative (IDDSI) scale, corresponds to 0–1, since mixtures with a higher viscosity require more pressure for insertion into a probe or gastrostomy tube, often causing obstruction of their lumen [45, 46]. Thicker formulas (IDDSI 1–3) can be administered using special enteral feeding pumps — enteromats [46]. The rate of introduction of the mixture depends on the age and weight of the child, while at the beginning of enteral support, the initial rate is set, and when the volume of food is absorbed, and there are no complications or adverse effects, the rate of introduction is increased to the maximum (Table 2) [16]. However, the assignment of the food volume must correspond to the anatomical

Table 2. Age-specific features of the rate of nutrition introduction

Таблица 2. Возрастные особенности скорости введения питания

Тип введения / Type of introduction	Болюсное введение / Bolus feeding			Непрерывное введение / Continuous feeding		
Возраст, лет / Age, years	0–1	1–6	>7	0–1	1–6	>7
Начальный объем / Initial feeding volume	10–15 мл/кг каждые 2–3 часа / 10–15 ml/kg every 2–3 hours	5–10 мл/кг каждые 2–3 часа / 5–10 ml/kg every 2–3 hours	90–120 мл/кг каждые 3–4 часа / 90–120 ml/kg every 3–4 hours	1–2 мл/кг каждый час / 1–2 ml/kg every hour	1 мл/кг каждый час / 1 ml/kg every hour	25 мл/кг каждый час / 25 ml/kg every hour
Увеличение объема / Increased nutritional intake	10–30 мл на каждое кормление/ 10–30 ml per feeding	30–45 мл на каждое кормление / 30–45 ml per feeding	60–90 мл на каждое кормление / 60–90 ml per feeding	1–2 мл/кг каждые 2–8 часов / 1–2 ml/kg every 2–8 hours	1 мл/кг каждые 2–8 часов / 1 ml/kg every 2–8 hours	25 мл/кг каждые 2–8 часов / 25 ml every 2–8 hours
Допустимый объем одного кормления / Suggested tolerance volumes	20–30 мл/кг каждые 3–4 часа / 20–30 ml/kg every 4–5 hours	15–20 мл/кг каждые 4–5 часов / 15–20 ml/kg every 4–5 hours	330–480 мл каждые 4–5 часов / 330–480 ml every 4–5 hours	6 мл/кг каждый час / 6 ml/kg every hour	1–5 мл/кг каждый час / 1–5 ml/kg every hour	100–150 мл каждый час / 100–150 ml every hour

and physiological characteristics of the sizes of the gastrointestinal tract organs. The need to ensure energy needs that exceed the ability to be absorbed by volume is the basis for using hypercaloric formulas.

In the prospective multicenter observational study by E.E. Martinez et al. (2022), when analyzing the effectiveness of continuous and bolus feeding in 1375 critically ill children on mechanical ventilation, no differences were found between the methods in providing energy and protein needs, as well as the development of infectious complications [47]. Similar results were obtained in a systematic review by P. Rohani et al. (2022) [14].

Conducting artificial nutrition through special devices leads to the “switching off” of the oral cavity from the digestion process and a number of negative consequences. On the one hand, the influence of nutrition on the excitation of receptors of the oral mucosa and sensory fibers of the V, IX and X pairs of cranial nerves has been proven [20]. On the other hand, there is a lack of wetting of the food bolus with saliva, which contains more than 50 enzymes that promote not only the initial digestion of food, but also the protection of the mucous membrane of the oral cavity and esophagus [20]. In addition, prolonged absence of oral nutrition leads to the development of dysphagia due to oral inactivity as one of the components of the “learned non-use” phenomenon, in which there is a disconnection of the sensorimotor processes of food consumption from the intake of the nutritional formula [11]. Therefore, oral feeding should always be encouraged, provided that safety conditions for the child are met and there is no severe dysphagia [48].

The decision to administer enteral nutrition using special tubes installed in the stomach or intestine is made not only in accordance with the anatomical and physiological characteristics, but also taking into account the presence of GERD, gastroparesis of any etiology, and the risk of developing aspiration syndrome [43]. In 2023, the European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) prepared guidelines for healthcare professionals on infant feeding, which demonstrated the positive effect of mixed foods, including blended or pureed forms [45].

TUBE FEEDING

Enteral tube feeding is the most commonly used method. The access of choice is often through the nasal passages, however, in some cases, it is possible to place it through the mouth. Insertion of a gastric tube is a standardized invasive procedure that is most often performed blindly by nurses, attending physician. When inserting the tube, it is necessary to achieve the correct position of the distal end, which normally reaches the stomach (3–10 cm below the lower esophageal sphincter). If the insertion depth is insufficient, the end and side holes of the probe end up in the esophagus, which increases the risk of aspiration. If the tube is inserted too deeply, it may become kinked in the stomach, become knotted, bend upwards into the esophagus, or, after passing through the pyloric section, the distal section, be installed into the duodenum, which increases the risk of developing dumping syndrome.

Several techniques are used to determine the length to which the tube will be installed. The most common is the "nose-earlobe-xiphoid process" technique, proposed in 1951 [49–51]. This technique allows accurate length determination in approximately 72.4% of cases [52]. A prospective study by Taylor et al. (2014) found increased risks of transpyloric or transesophageal positioning when using the nose-earlobe-xiphoid process + 10 cm technique in adults and older children [53].

A.J. Csaldo et al. (1992) suggested calculating the depth of insertion of an orogastric tube based on a length equal to 9.7 cm + 0.226 × patient height (cm), and a nasogastric tube equal to 8 cm + 0.252 × height (cm) [54, 55]. Taking into account the identified difficulties, A.J. Csaldo et al. (2002) suggested calculating the depth of probe insertion by the length calculated as the sum of the measurements of the distances from the nose or corner of the mouth to the earlobe and from the earlobe to the point midway between the xiphoid process and the navel [56].

Taking into account the anatomical and physiological characteristics of children, I.M. Vorontsov and A.V. Mazurin pointed out the need to determine the length of the probe placement based on the length of the esophagus (Table 3) [57]. In addition, to calculate the distance from teeth to the stomach entrance, the formula 20±n is used, where n is the child's age in years. The length of the esophagus can be calculated using the formula: height (cm) × 0.2 + 6.3 cm [58].

In full-term newborns, the formula for calculating the length of nasogastric tube insertion is based on a child's length: 1.95 cm + 0.372 × length (cm) [59]. In addition, in 2011, M.L. Cirgin Ellett et al. proposed a table of predictive length of nasogastric tube insertion for newborns (Table 4) [59].

K.J. Gallaher et al. in 1993 proposed minimum values for the depth to which the tube is inserted, corresponding to 13 cm for infants weighing <750 g, 15 cm for infants weighing 750–999 g, 16 cm for infants weighing 1000–1249 g, and 17 cm for infants weighing 1250–1499 g [60]. For children over 1 month and up to 18 years old, formulas proposed by M.L. Ellett et al. in 2012 can be used (Table 5) [55].

To determine the tube diameter, a scale proposed by Joseph Frederic Benoit Charrière is used, where 1 F,

Table 3. Esophageal length as a function of age [57]

Таблица 3. Длина пищевода в зависимости от возраста [57]

Возраст, годы / Age, years	**Длина, см / Length, cm**	**Расстояние от зубов до входа в желудок, см / Distance from teeth to stomach entrance, cm**
Новорожденный / Newborn	8–10	16–20
1	12	20–22
2	13	22,5–24
5	16	26–27,9
10	18	27–33
15	19	34–36
Взрослые / Adults Мужчины / Men Женщины / Women	 25 (23–30) 23 (20–26)	40

Table 4. Length of nasogastric tube insertion from birth to 1 month of age [59]

Таблица 4. Длина введения назогастрального зонда от рождения до 1 месяца [59]

Длина новорожденного, см / Newborn length, cm	Длина введения трубки, см / Tube insertion length, cm	Длина новорожденного, см / Newborn length, cm	Длина введения трубки, см / Tube insertion length, cm
35,0–35,5	15,0	47,0–47,5	19,5
36,0–37,0	15,5	48,0–49,0	20,0
37,5–38,0	16,0	49,5–50,5	20,5
38,5–39,5	16,5	51,0–51,5	21,0
40,0–41,0	17,0	52,0–53,0	21,5
41,5–42,0	17,5	53,5–54,5	22,0
42,5–43,5	18,0	55,0–55,5	22,5
44,0–45,0	18,5	56,0–56,5	23,0
45,5–46,5	19,0		

Table 5. Formula for calculating the length of probe placement depending on age [55]

Таблица 5. Формула расчета длины постановки зонда в зависимости от возраста [55]

Возраст, месяцев / Age, months	Вид зонда / Type of tube	Формула расчета по длине тела, см (L) / Formula for calculating body length, cm (L)
1–28	Назогастральный / Nasogastric	= 14,8 + 0,19 × L
	Орогастральный / Orogastric	= 13,3 + 0,19 × L
29–100	Назогастральный / Nasogastric	= 18,3 + 0,19 × L
	Орогастральный / Orogastric	= 16,8 + 0,19 × L
>100	Назогастральный / Nasogastric	= 16,6 + 0,22 × L
	Орогастральный / Orogastric	= 15,1 + 0,22 × L

Fr or Ch (Charrière) is equal to 0.33 mm. For visual differentiation, tube connectors are color-coded according to diameter size. To select the correct tube, it is necessary to take into account its diameter at the point with the narrowest (projection of the upper edge of the 3rd thoracic vertebra) and widest (projection of the upper edge of the 7th thoracic vertebra) lumen [61]. It is especially important to determine anatomical changes in the region of the upper point in the presence of esophageal dysphagia [62].

When placing a nasogastric tube, the structural features and dimensions of the lower nasal passage should be taken into account. It has been shown that the diameter of the inferior nasal passage in 78.7% of children of the first year of life is less than 2.0 mm, in toddlers — 2.0 mm, in children 4 to 6 years old — 2.7 mm, in children over 7 years old — 2.7–3.3 mm [63]. Similar data were obtained using craniometry with a detailed study of the width of the inferior nasal passage. It was determined that the width of the inferior nasal passage at the level of an anterior edge of the inferior turbinate at the age of 1–1.5 years is 2.5±0.1 mm, at the level of the posterior edge — 2.3±0.1 mm, by 2–3 years — 3.2±0.1 mm and 3.1±0.1 mm, respectively, with a subsequent increase in the inferior nasal passage by 0.2–0.3 mm in each age group of children, reaching 3.9±0.1 mm at the level of the anterior edge of the inferior turbinate and 4.0±0.4 mm at the level of the posterior edge of the inferior turbinate at 13–16 years [64]. Additionally, soft tissue structures narrow the lumen.

Thus, the diameter of the probe should be minimal to prevent trophic complications, sinusitis, and nosebleeds. However, given the high probability of probe occlusion during blender feeding, it should be no less than 18–24 Fr [76].

The main methods for monitoring the correct installation of the probe are:

1) "gold standard" – X-ray /computed tomography of the abdominal organs [43, 55, 65-68];
2) ultrasound examination of the stomach [69, 70];
3) pH-metry of gastric aspirate using test strips or standard laboratory tests (normal pH should be ≤5) [71–74];
4) colorimetric capnometry or capnography [68, 75];
5) aspiration test;
6) test with the introduction of air and simultaneous auscultation of sounds in the projection area of the stomach.

When using the tube for a long time, the material from which it is made is of significant importance [77]. Polyvinyl chloride tubes are the cheapest, and due to their appropriate rigidity they can be inserted without a conductor. Low adhesion of the nutrient mixture and medicinal substances prevents rapid obturation of the tube lumen. However, low biocompatibility with tissues, corrosion by gastric and intestinal contents, leading to hardening during prolonged use, as well as the presence of phthalates and plasticizers in the composition determine the period of use of the tube no more than 3–7 days. Silicone tubes are the softest and most flexible, which determines the best tolerance by patients when using them, and rarely cause allergic reactions and trophic disorders. However, the absence of a semi-rigid frame leads to both difficulties during placement, which determines the need to use conductors, and to complications in the form of kinks during use. Polyurethane tubes have sufficient rigidity when installed. The walls soften after implantation when the patient's body temperature is reached. This makes it possible to install polyurethane probes without conductors. Such probes are somewhat inferior to silicone ones in terms of ensuring patient comfort during use. The technology for producing probes has made it possible to reduce the wall thickness, which relatively increases the internal lumen compared to tubes made of other materials. In addition, in some cases it is possible to install tubes in the postpyloric sections, which is achieved not only by the appropriate length of the tube, but also by the presence of olives. Polyurethane tubes also have good biocompatibility, do not change their physical characteristics when interacting with gastric and intestinal contents. Silicone and polyurethane tubes can be used for up to 4–6 weeks if care requirements are met.

NUTRITION THROUGH STOMA

Children with initial protein-energy malnutrition, aggravated by the premorbid background, are often admitted to ICU already with a gastrostomy tube. In some cases, gastrostomy is performed in ICU, especially during long-term hospitalization, the presence of oropharyngeal or esophageal dysphagia of various etiologies, as part of the preparatory stage for surgical interventions. Care of a gastrostomy tube in children requires special attention, since it is a technological device that requires specific procedures: careful attachment of the tube to the body; fixation of the outer part and prevention of dislocation of the elements of the gastrostomy tube. The placement of gastrostomy tubes with a diameter greater than 18–20 Fr should be avoided due to the increased incidence of complications [68, 76].

After gastrostomy, it is necessary to control and eliminate pain. Traditionally, feeding is preferred to be postponed for up to 24 hours after gastrostomy due to concerns about suture failure and food leakage from the stomach into the abdominal cavity. However, the possibility of starting feeding 3 hours after the operation, depending on the severity of the condition, has been confirmed [78–80].

Daily inspection of the postoperative wound makes it possible to promptly identify signs of inflammation and other complications. To prevent infectious complications, dressings are applied using aseptic bandages. After the wound has completely healed, it is necessary to rotate the gastrostomy tube by 180–360° and move it up and down by approximately 1–2 cm at the stoma site to prevent granulation. To prevent obstruction, it is necessary to select the consistency of the formula (according to IDDSI no more than 0–3) with the diameter of the tube.

Studies on enteral nutrition in adults have shown that percutaneous endoscopic gastrostomy in the areas of the posterior wall or along the greater curvature of the stomach are significant risk factors for both early and late complications [81]. This may be due to the relatively large distance between the walls of the stomach and the abdominal wall, which increases the tension of the gastrostomy tube during gastric contraction, causing slow or incomplete fistula formation, increasing the risk of perforation, bleeding, peritonitis. The anatomical and physiological features of the stomach in children suggest a similarly high risk of developing such complications.

PRINCIPLES OF ORGANIZING CHILDREN'S NUTRITION IN THE ICU

A child's serious condition is not a reason to stop feeding if the child has effective breathing and swallowing and can be fed orally. In some cases, sipping therapy is prescribed in addition to independent feeding (see Fig. 1). If the patient's condition is stable and organizational and technical capabilities are available, it is recommended to involve trained parents in feeding the child. When eating, regardless of the method, the following rules must be observed.

1. Prepare the child's favorite dishes.
2. Maintain a 5–6 meal regimen, more often if necessary.
3. When feeding independently, initially prepare a small portion.
4. Do not serve the dish too hot or cold.
5. The temperature of the administered formula should be 37–37.5 °C [15, 76, 84].
6. Isolate the child from food odors if they cause nausea.
7. Ventilate the ward or box after eating.
8. Carefully monitor hygiene when feeding the child (hand washing rituals before and after eating, oral hygiene, hand hygiene of those feeding).
9. During feeding, place the child in a sitting or semi-sitting position with the head end raised to prevent choking and aspiration.
10. When feeding in bed, it is necessary to place absorbent napkins under the head and on chest to ensure hygiene of the body and bed linen.
11. If possible, create conditions that remind the child of a "normal" meal: put cutlery in his hands, use a change of plates, etc.
12. When feeding with a spoon, use a chair to sit on, do not stand over the child, do not sit on the child's bed without his permission.
13. If the child refuses to eat, do not force-feed, if necessary, consult a nutritionist or pediatrician in a timely manner on dietary adjustments.
14. In children who maintain independent feeding and have a decreased chewing/swallowing speed, it is advisable to use homogeneous thick liquids (IDDSI level 4) [82].
15. When administering artificial nutrition, in order to optimize the speed and volume of the administered nutritional formula, among other things, the dynamics of intra-abdominal pressure should be taken into account [85].

EXCUSION FROM TUBE-FEEDING

After stabilization of the condition, restoration of nutritional status and effective breathing and swallowing, patients are transferred to independent feeding. In some cases, the transfer to oral feeding is postponed until transfer to a specialized department or until discharge from the hospital. H. Clouzeau et al. developed criteria for possible weaning from the tube [86, 87]:

1) stable course of the underlying disease;
2) absence of short- or medium-term planned interventions that may cause or increase the risk of nutritional deficiency;
3) satisfactory nutritional status in accordance with age-standard or disease-specific centile corridors, growth charts;
4) safe and functional swallowing;
5) readiness of health care staff and family.

When transferring a patient from artificial to independent feeding, it is extremely important to take into account the time of oral inactivity. Long-term artificial enteral feeding can lead to the formation of unwanted oral triggers (tube insertion procedure, reflux, vomiting, silent aspirations), lack of taste and texture sensations, disruption of parent-child interaction during feeding, and decreased appetite [87–89]. Several methods have been developed for weaning formula-fed infants [90, 91]. Some of these are based on a rapid reduction in caloric intake to induce hunger and wean patients off formula over several weeks during hospitalization under the supervision of health care workers [90].

FIMATHO and GFHGNP have published key recommendations for weaning children from tube feeding [86]. A multimodal strategy that combines caloric restriction with psychobehavioural and/or sensorimotor treatment is recommended. Psychological and behavioural characteristics of children and caregivers related to nutrition are considered in conjunction with cultural practices in psychological interventions [92]. Sensorimotor interventions based on afferentation or reafferentation of the oropharynx have been developed to correct tactile hypersensitivity. Restoration of normal circadian rhythm is achieved using sensory oral stimulation even before switching to oral nutrition, during tube feeding. The acquisition of sucking, chewing and swallowing skills is achieved by oral motor interventions, which are divided into compensatory interventions (head turns and tilts, chin tucks, changes in viscosity, texture and volume of food), special exercises (tongue retention, neck flexion, supraglottic swallowing, supra-supraglottic swallowing, enhanced swallowing, Mendelsohn and Masako Maneuvers), alternative methods (passive gymnastics of the tongue, lips, vocal exercises). The criteria for effectiveness are jaw strength, lateral movements of the tongue, spiral movements of the lower jaw and sufficient lip tone.

CONCLUSION

Organization of enteral nutrition of children hospitalized in the intensive care unit is an important link in the multimodal therapeutic strategy. Providing enteral nutrition in accordance with the severity of the patient's condition, his ability to take food independently or to receive it with the help of special devices is the key to meeting the energy needs necessary for recovery. The developed scale for assessing the ability to independently eat FOIS and IDDSI allow for personalization of the therapy.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

Funding source. This study was not supported by any external sources of funding. The work was carried out as part of the research work (number of state registration of NIOKTR AAAA-A18-118113090077-0 dated 11/30/18) “Screening of the nutritional status in children with somatic, surgical and neurological pathology, the possibility of correction”.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования. Работа выполнена в рамках НИР (номер госучета НИОКТР АААА-А18-118113090077-0 от 30.11.18) «Скрининг нутритивного статуса у детей с соматической, хирургической и неврологической патологией, возможности коррекции».

REFERENCES

1. Mara J., Gentles E., Alfheeaid H.A. et al. An evaluation of enteral nutrition practices and nutritional provision in children during the entire length of stay in critical care. BMC Pediatric. 2014;14:186. DOI: 10.1186/1471-2431-14-186.
2. Tume L.N., Valla F.V., Joosten K. et al. Nutritional support for children during critical illness: European Society of Pediatric and Neonatal Intensive Care (ESPNIC) metabolism, endocrine and nutrition section position statement and clinical recommendations. Intensive Care Med. 2020;46:411–425. DOI: 10.1007/s00134-019-05922-5.
3. Leyderman I.N., Gritsan A.I., Zabolotskikh I.B. i dr. Perioperative nutritional support. Clinical practice recommendations of the national “Federation of Anesthesiologists and Reanimatologists”. Bulletin of Intensive Care named after A.I. Saltanov. 2021;4:7–20. DOI: 10.21320/1818-474X-2021-4-7-20. (In Russian).
4. Kratochvíl M., Klučka J., Klabusayová E. et al. Nutrition in Pediatric Intensive Care: A Narrative Review. Children (Basel, Switzerland). 2022;9(7):1031. DOI: 10.3390/children9071031.

5. Irving S.Y., Albert B.D., Mehta N.M. et al. Strategies to optimize enteral feeding and nutrition in the critically ill child: a narrative review. Pediatr Med. 2022;5:9. DOI: 10.21037/pm-21-6.
6. Zamberlan P., Delgado A.F., Leone C. et al. Nutrition therapy in a pediatric intensive care unit: indications, monitoring, and complications. J Parenter Enteral Nutr. 2011;35(4):523–529. DOI: 10.1177/0148607110386610.
7. Sorvacheva T.N., Evdokimova T.A., Pyr'eva E.A. i dr. Malnutrition in young children. Principles of nutritional support. Rossiiskii Pediatricheskii Zhurnal. 2015;18(2):47–53. (In Russian).
8. Zakharova I.N., Dmitrieva Yu.A., Sugyan N.G., M.A. Malnutrition in pediatric practice: differential diagnosis and possibilities for nutritional support. Meditsinsky Sovet. 2019;2:200–208. DOI: 10.21518/2079-701X-2019-2-200-208. (In Russian).
9. Iping R., Hulst J.M., Joosten K.F.M. Research developments in pediatric intensive care nutrition: A research intelligence review. Clin Nutr ESPEN. 2022;50:1–7. DOI: 10.1016/j.clnesp.2022.06.015.
10. Durvasula V.S., O'Neill A.C., Richter G.T. Oropharyngeal Dysphagia in children: mechanism, source, and management. Otolaryngol Clin North Am. 2014;47(5):691–720. DOI: 10.1016/j.otc.2014.06.004.
11. Lisitsa I.A., Aleksandrovich Yu.S., Zavyalova A.N., Lisovskii O.V., Razumov S.A. Dysphagia in pediatric intensive care unit patients (review). Vestnik anesteziologii i reanimatologii. 2023;20(6):97–105. DOI: 10.24884/2078-5658-2023-20-6-97-105. (In Russian).
12. Zavyalova A.N., Novikova V.P. Dysphagia in children: review. University Therapeutic Journal. 2023;5(1):64–84. DOI: 10.56871/UTJ.2023.15.64.004. (In Russian).
13. Bence C.M., Salazar J.H., Flynn-O'Brien K.T. et al. Outcomes of gastrostomy placement with and without concomitant tracheostomy among ventilator dependent children. J Pediatr Surg. 2021;56(7):1222–1226. DOI: 10.1016/j.jpedsurg.2021.03.028.
14. Rohani P., Alimadadi H., Mirrahimi B. et al. Nutrition Section Position Statement and Clinical Practice Recommendations for Children Admitted to Intensive Care Unit. Iran J Pediatr. 2022;32(3):e119824. DOI: 10.5812/ijp-119824.
15. Shmakov A.N., Aleksandrovich Yu.S., Stepanenko S.M. Protocol nutrition therapy of critically ill children. Anesteziologiya i reanimatologiya. 2017;62(1):14–23. DOI: 10.18821/0201-7563-2017-62-1-14-23. (In Russian).
16. Yi D.Y. Enteral Nutrition in Pediatric Patients. Pediatr Gastroenterol Hepatol Nutr. 2018;21(1):12–19. DOI: 10.5223/pghn.2018.21.1.12.
17. Hay W.W. Optimizing nutrition of the preterm infant. Zhongguo Dang Dai Er Ke Za Zhi. 2017;19(1):1–21. DOI: 10.7499/j.issn.1008-8830.2017.01.001.
18. Wu G.H., Wu Z.H., Wu Z.G. Effects of bowel rehabilitation and combined trophic therapy on intestinal adaptation in short bowel patients. World J Gastroenterol. 2003;9(11):2601–2604. DOI: 10.3748/wjg.v9.i11.2601.
19. Skvortsova V.A., Borovik T.Je., Netrebenko O.K. Malnutrition in low birth weight infants (literature review). Vestnik sovremennoi klinicheskoi mediciny. 2013;6(6):90–95. (In Russian).
20. Zavyalova A.N., Gostimskii A.V., Lisovskii O.V. et al. Enteral nutrition in palliative medicine in children. Pediatrician (St. Petersburg). 2017;8(6):105–113. DOI: 10.17816/PED86105-113. (In Russian).
21. Crary M.A., Mann G.D.C., Groher M.E. Initial psychometric assessment of a functional oral intake scale for dysphagia in stroke patients. Archives of physical medicine and rehabilitation. 2005;86(8):1516–1520. DOI: 10.1016/j.apmr.2004.11.049.
22. Coppens C.H., van den Engel-Hoek L., Scharbatke H. et al. Dysphagia in children with repaired oesophageal atresia. Eur J Pediatr. 2016;175(9):1209-1217. DOI: 10.1007/s00431-016-2760-4.
23. Yi Y.G., Shin H.I. Psychometrics of the Functional Oral Intake Scale for Children With Dysphagia. J Pediatr Gastroenterol Nutr. 2020;71(5):686–691. DOI: 10.1097/MPG.0000000000002861.
24. Dipasquale V., Gottrand F., Sullivan P.B., Romano C. Top-ten tips for managing nutritional issues and gastrointestinal symptoms in children with neurological impairment. Ital J Pediatr. 2020;46(1):35. DOI: 10.1186/s13052-020-0800-1.
25. Romano C., van Wynckel M., Hulst J. et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment. J Pediatr Gastroenterol Nutr. 2017;65(2):242–264. DOI: 10.1097/MPG.0000000000001646.
26. Zavyalova A.N., Lisitsa I.A., Lisovskii O.V. i dr. Patient with Costello syndrome: literature review and clinical case. Children's medicine of the North-West. 2023;11(4):99–109. DOI: 10.56871/CmN-W.2023.61.17.012. (In Russian).
27. Pars H., Çavuşoğlu H. A Literature Review of Percutaneous Endoscopic Gastrostomy: Dealing With Complications. Gastroenterol Nurs. 2019;42(4):351–359. DOI: 10.1097/SGA.0000000000000320.
28. Homan M., Hauser B., Romano C. et al. Percutaneous Endoscopic Gastrostomy in Children: An Update to the ESPGHAN Position Paper. J Pediatr Gastro-

enterol Nutr. 2021;73(3):415–426. DOI: 10.1097/MPG.0000000000003207.
29. McSweeney M.E., Smithers C.J. Advances in Pediatric Gastrostomy Placement. Gastrointest Endosc Clin N Am. 2016;26(1):169–85. DOI: 10.1016/j.giec.2015.09.001.
30. Franco Neto J.A., Liu P.M.F., Queiroz T.C.N. et al. Percutaneous endoscopic gastrostomy in children and adolescents: 15-years' experience of a tertiary center. Arq Gastroenterol. 2021;58(3):281–288. DOI: 10.1590/S0004-2803.202100000-49.
31. Kumar A.S., Bani Yaghoub M., Rekab K. et al. Pediatric multicenter cohort comparison of percutaneous endoscopic and non-endoscopic gastrostomy technique outcomes. J Investig Med. 2020;68(2):413–418. DOI: 10.1136/jim-2019-001028.
32. Civan H.A., Bektas G., Dogan A.E. et al. Percutaneous Endoscopic Gastrostomy Feeding in Children with Cerebral Palsy. Neuropediatrics. 2021;52(4):326–332. DOI: 10.1055/s-0041-1731007.
33. Durakbasa C.U., Ozumut S.H., Orhon Z.N. et al. Percutaneous endoscopic gastrostomy in small infants unable to swallow safely. Pediatr Int. 2020;62(12):1369–1373. DOI: 10.1111/ped.14351.
34. Ayala Germán A.G., Ignorosa Arellano K.R., Díaz García L. et al. Nutritional benefits in pediatric patients with percutaneous endoscopic gastrostomy placement. Rev Esp Enferm Dig. 2022;114(11):680. DOI: 10.17235/reed.2022.8866/2022.
35. Bawazir O.A. Percutaneous endoscopic gastrostomy in children less than 10 kilograms: A comparative study. Saudi J Gastroenterol. 2020;26(2):105–110. DOI: 10.4103/sjg.SJG_525_19.
36. Kozlov Ju.A., Novozhilov V.A., Rasputin A.A. i dr. Laposcopic button gastrostomy in children. Endoscopic Surgery. 2014;20(4):39–45. (In Russian).
37. Dzhilavyan M.G., Kuzenkova L.M., Podkletnova T.V. i dr. Surgical treatment of gastroesophageal reflux disease in children with neurological disorders accompanied by impaired swallowing. Pediatric pharmacology. 2013;10(5):104–110. DOI: 10.15690/pf.v10i5.834. (In Russian).
38. Ng K., Lefton-Greif M.A., McGrath-Morrow S.A. et al. Factors That Impact the Timing and Removal of Gastrostomy Placement/Nissen Fundoplication in Children with Bronchopulmonary Dysplasia. Am J Perinatol. 2023;40(6):672–679. DOI: 10.1055/s-0041-1730432.
39. Zavyalova A.N., Novikova V.P., Klikunova K.A. Nutritional status and feeding problems in children with dysphagia and cerebral palsy in diff erentsocial settings. Experimental and Clinical Gastroenterology. 2022;198(2):21–29. DOI: 10.31146/1682-8658-ecg-198-2-21-29. (In Russian).
40. Erpuleva Ju.V., Lekmanov A.U., Gribakin S.G. i dr. Modern technologies of enteral nutrition in critically ill children. Rossijskij vestnik detskoj hirurgii, anesteziologii i reanimatologii. 2014;4(1):80–87. (In Russian).
41. Broekaert I.J., Falconer J., Bronsky J. et al. The Use of Jejunal Tube Feeding in Children: A Position Paper by the Gastroenterology and Nutrition Committees of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition 2019. J Pediatr Gastroenterol Nutr. 2019;69(2):239–258. DOI: 10.1097/MPG.0000000000002379.
42. Kratochvíl M., Klučka J., Klabusayová E. et al. Nutrition in Pediatric Intensive Care: A Narrative Review. Children (Basel). 2022;9(7):1031. DOI: 10.3390/children9071031.
43. Vermilyea S., Goh V.L. Enteral Feedings in Children: Sorting Out Tubes, Buttons, and Formulas. Nutr Clin Pract. 2016;31(1):59–67. DOI: 10.1177/0884533615604806.
44. Dunitz-Scheer M., Scheer P.J. Tube Management and Maintenance. In: Child-led Tube-management and Tube-weaning. Springer, Cham. 2022. DOI: 10.1007/978-3-031-09090-5_11.
45. Köglmeier J., Assecaira I., Banci E. et al. The Use of Blended Diets in Children With Enteral Feeding Tubes: A Joint Position Paper of the ESPGHAN Committees of Allied Health Professionals and Nutrition. J Pediatr Gastroenterol Nutr. 2023;76(1):109–117. DOI: 10.1097/MPG.0000000000003601.
46. Zavyalova A.N., Novikova V.P., Gavshhuk M.V. i dr. Dysphagia: diagnosis, modern methods of diet therapy. Pediatric Nutrition. 2022;20(6):51–62. DOI: 10.20953/1727-5784-2022-6-51-62. (In Russian).
47. Martinez E.E., Bechard L.J., Brown A.M. et al. Intermittent versus continuous enteral nutrition in critically ill children: A pre-planned secondary analysis of an international prospective cohort study. Clin Nutr. 2022;41(12):2621–2627. DOI: 10.1016/j.clnu.2022.09.018.
48. Larina O.D., Rudometova Ju.Ju., Novikova T.V. Teaching staff the rules of feeding is an obligatory aspect of speech therapy work to overcome post-stroke dysphagia. Lechaschi Vrach. 2022;5-6:64–69. DOI: 10.51793/OS.2022.25.6.012. (In Russian).
49. Royce S., Tepper C., Watson W. et al. Indwelling polyethylene nasogastric tube for feeding premature infants. Pediatrics. 1951;8(1):79–81.
50. Zhang H., Wang H., Fan X. et al. Study on Influencing Factors Analysis of Gastric Tube Insertion Length and Construction of Estimation Method. Front Surg. 2022;9:942881. DOI: 10.3389/fsurg.2022.942881.
51. Beckstrand J., Cirgin Ellett M.L., McDaniel A. Predicting internal distance to the stomach for positioning nasogastric and orogastric feeding tubes in children.

J Adv Nurs. 2007;59(3):274–89. DOI: 10.1111/j.1365-2648.2007.04296.x.
52. Torsy T., van Noort H.H.J., Taylor S. et al. The accuracy of methods for determining the internal length of a nasogastric tube in adult patients: a systematic review. Am J Clin Nutr. 2022;116(3):798–811. DOI: 10.1093/ajcn/nqac146.
53. Taylor S.J., Allan K., McWilliam H. et al. Nasogastric tube depth: the 'NEX' guideline is incorrect. Br J Nurs. 2014;23(12):641–4. DOI: 10.12968/bjon.2014.23.12.641.
54. Scalzo A.J., Tominack R.L., Thompson M.W. Malposition of pediatric gastric lavage tubes demonstrated radiographically. J Emerg Med. 1992;10(5):581–6. DOI: 10.1016/0736-4679(92)90142-g.
55. Ellett M.L., Cohen M.D., Perkins S.M. et al. Comparing methods of determining insertion length for placing gastric tubes in children 1 month to 17 years of age. J Spec Pediatr Nurs. 2012;17(1):19–32. DOI: 10.1111/j.1744-6155.2011.00302.x.
56. Klasner A.E., Luke D.A., Scalzo A.J. Pediatric orogastric and nasogastric tubes: a new formula evaluated. Ann Emerg Med. 2002;39(3):268–72. DOI: 10.1067/mem.2002.120124.
57. Vorontsov I.M., Mazurin A.V. Propaedeutics of childhood diseases. 3-e izd., dop. i pererab. Saint Petersburg; 2009. (In Russian).
58. Kel'cev V.A. Pediatric Diseases Propaediatrics: a textbook for students of paediatric faculties of medical sciences. Rostov n/Donu; 2011. (In Russian).
59. Cirgin Ellett M.L., Cohen M.D., Perkins S.M. et al. Predicting the insertion length for gastric tube placement in neonates. J Obstet Gynecol Neonatal Nurs. 2011;40(4):412–21. DOI: 10.1111/j.1552-6909.2011.01255.x.
60. Gallaher K.J., Cashwell S., Hall V. et al. Orogastric tube insertion length in very low birth weight infants. J Perinatol. 1993;13(2):128–31.
61. Loff S., Diez O., Ho W. et al. Esophageal Diameter as a Function of Weight in Neonates, Children and Adolescents: Reference Values for Dilatation of Esophageal Stenoses. Front Pediatr. 2022;10:822271. DOI: 10.3389/fped.2022.822271.
62. Manuilova D.S., Meshkov A.V., Al-Hares M.M. Esophageal dysphagia: clinical picture, diagnosis, treatment. Literature review. Children's Medicine of the North-West. 2024;12(1):65–74. DOI: 10.56871/CmN-W.2024.12.93.006. (In Russian).
63. Baranov K.K., Bogomilsky M.R., Kotova E.N. et al. Age features of the lower nasal passage according to endoscopy in children. Bulletin of Otorhinolaryngology. 2021;86(5):70 74. DOI: 10.17116/otorino20218605170. (In Russian).
64. Markeeva M.V., Alyoshkina O.U., Tarasova N.V. i dr. Age-related variability of the width of the nasal meatuses according to data of the craniometry. Morphological Newsletter. 2020;28(3):21–27. DOI: 10.20340/mv-mn.2020.28(3):21-27. (In Russian).
65. Boeykens K., Holvoet T., Duysburgh I. Nasogastric tube insertion length measurement and tip verification in adults: a narrative review. Crit Care. 2023;27(1):317. DOI: 10.1186/s13054-023-04611-6.
66. Metheny N.A., Krieger M.M., Healey F. et al. A review of guidelines to distinguish between gastric and pulmonary placement of nasogastric tubes. Heart Lung. 2019;48(3):226–235. DOI: 10.1016/j.hrtlng.2019.01.003.
67. Keyte E., Roe G., Jeanes A. et al. Immediate chest radiograph interpretation by radiographers improves patient safety related to nasogastric feeding tube placement in children. Pediatr Radiol. 2021;51(9):1621–1625. DOI: 10.1007/s00247-021-05032-9.
68. Preiser J.C., Arabi Y.M., Berger M.M. et al. A guide to enteral nutrition in intensive care units: 10 expert tips for the daily practice. Crit Care 2021;25:424. DOI: 10.1186/s13054-021-03847-4.
69. Tamhne S., Tuthill D., Evans A. Should ultrasound be routinely used to confirm correct positioning of nasogastric tubes in neonates? Arch Dis Child Fetal Neonatal Ed. 2006;91(5):F388. DOI: 10.1136/adc.2005.088476.
70. Tsujimoto H., Tsujimoto Y., Nakata Y. et al. Ultrasonography for confirmation of gastric tube placement. Cochrane Database Syst Rev. 2017;4(4):CD012083. DOI: 10.1002/14651858.CD012083.pub2.
71. Fernandez R.S., Chau J.P., Thompson D.R. et al. Accuracy of biochemical markers for predicting nasogastric tube placement in adults — a systematic review of diagnostic studies. Int J Nurs Stud. 2010;47(8):1037–46. DOI: 10.1016/j.ijnurstu.2010.03.015.
72. Metheny N.A., Gunn E.M., Rubbelke C.S. et al. Effect of pH Test-Strip Characteristics on Accuracy of Readings. Crit Care Nurse. 2017;37(3):50–58. DOI: 10.4037/ccn2017199.
73. Earley T., Young A., Pringle S. et al. Fibre-optic, electronic pH test device compared with current NHS guidance to confirm nasogastric tube placement. BMJ Nutr Prev Health. 2022;5(2):306–312. DOI: 10.1136/bmjnph-2022-000506.
74. Ellett M.L., Croffie J.M., Cohen M.D. et al. Gastric tube placement in young children. Clin Nurs Res. 2005;14(3):238–252. DOI: 10.1177/1054773805275121.
75. Chau J.P., Thompson D.R., Fernandez R. et al. Methods for determining the correct nasogastric tube placement after insertion: a meta-analysis. JBI Libr Syst Rev. 2009;7(16):679–760. DOI: 10.11124/01938924-200907160-00001.
76. Gavshchuk M.V., Klikunova K.A., Zavyalova A.N. i dr. Study of the feeding tube optimal diameter for enteral nutrition

in a model experiment. Experimental and Clinical Gastroenterology. 2022;1:80–86. DOI: 10.31146/1682-8658-ecg-197-1-80-86. (In Russian).
77. Gavshhuk M.V., Zorin I.M., Vlasov P.S. i dr. Comparison of different gastrostomy tubes materials resistance to the effects of damaging factors in vitro model experiment. Pediatrician. 2021;12(5):47–52. DOI: 10.17816/PED12547-52. (In Russian).
78. Bechtold M.L., Matteson M.L., Choudhary A., Puli S.R., Jiang P.P., Roy P.K. Early versus delayed feeding after placement of a percutaneous endoscopic gastrostomy: a meta-analysis. Am J Gastroenterol. 2008;103(11):2919–24. DOI: 10.1111/j.1572-0241.2008.02108.x.
79. Rahnemai-Azar A.A., Rahnemaiazar A.A., Naghshizadian R. et al. Percutaneous endoscopic gastrostomy: indications, technique, complications and management. World J Gastroenterol. 2014;20(24):7739–51. DOI: 10.3748/wjg.v20.i24.7739.
80. Wiernicka A., Matuszczyk M., Szlagatys-Sidorkiewicz A. et al. The protocol for a randomised-controlled trial of the evaluation of the tolerance and safety of early enteral nutrition in children after percutaneous endoscopic gastrostomy placement. (protocol version 09.01.2015). BMC Pediatr. 2016;16(1):163. DOI: 10.1186/s12887-016-0705-8.
81. Suzuki H., Joshita S., Nagaya T. et al. Relationship of early acute complications and insertion site in push method percutaneous endoscopic gastrostomy. Sci Rep. 2020;10(1):20551. DOI: 10.1038/s41598-020-77553-6.
82. Sellers D., Mandy A., Pennington L. et al. Development and reliability of a system to classify the eating and drinking ability of people with cerebral palsy. Developmental medicine and child neurology, 2014;56(3):245–251. DOI: 10.1111/dmcn.12352.
83. Gavshhuk M.V., Klikunova K.A., Zavyalova A.N. i dr. Physiological temperature of nutrient mixture through gastrostomy drip feeding. Preventive and clinical medicine. 2022;2(83):61–65. DOI: 10.47843/2074-9120_2022_2_61. (In Russian).
84. Lisitsa I.A., Klikunova K.A., Prudnikova M.D. i dr. The significance of enteral feeding temperature in feeding through a gastrostomy. Forcipe. 2022;5(Suppl. 2):305–306. (In Russian).
85. Tretiakova E.P., Shen N.P., Suchkov D.V. Estimation of the readiness of the patients of the childhood for the growth of the volume of enteral nourishment with the gastrointestinal disfunction. Medicinski al'manah. 2019;5–6(61):36–38. DOI: 10.21145/2499-9954-2019-5-36-38. (In Russian).
86. Clouzeau H., Dipasquale V., Rivard L. et al. Weaning children from prolonged enteral nutrition: A position paper. Eur J Clin Nutr. 2022;76(4):505–515. DOI: 10.1038/s41430-021-00992-5.
87. Dipasquale V., Aumar M., Ley D. et al. Tube Feeding in Neurologically Disabled Children: Hot Topics and New Directions. Nutrients. 2022;14(18):3831. DOI: 10.3390/nu14183831.
88. Edwards S., Davis A.M., Bruce A. et al. Caring for Tube-Fed Children: A Review of Management, Tube Weaning, and Emotional Considerations. J Parenter Enteral Nutr. 2016;40(5):616–22. DOI: 10.1177/0148607115577449.
89. Wilken M., Bartmann P., Dovey T.M. et al. Characteristics of feeding tube dependency with respect to food aversive behaviour and growth. Appetite. 2018;123:1–6. DOI: 10.1016/j.appet.2017.11.107.
90. Krom H., de Meij T.G.J., Benninga M.A. et al. Long-term efficacy of clinical hunger provocation to wean feeding tube dependent children. Clin. Nutr. 2020;39:2863–2871. DOI: 10.1016/j.clnu.2019.12.021.
91. Dipasquale V., Lecoeur K., Aumar M. et al. Weaning children from prolonged enteral nutrition: A survey of practice on behalf of the French Society of Paediatric Gastroenterology, Hepatology, and Nutrition. J. Parenter. Enteral. Nutr. 2022;46:215–221. DOI: 10.1002/jpen.2100.
92. Sobotka S.A., Laudon S., Jackson A.J. et al. A Literature Review of Feeding Disorders in Children with Tracheostomies and Ventilators. Pediatr Ann. 2022;51(7):e291–e296. DOI: 10.3928/19382359-20220504-05.

ЛИТЕРАТУРА

1. Mara J., Gentles E., Alfheeaid H.A. et al. An evaluation of enteral nutrition practices and nutritional provision in children during the entire length of stay in critical care. BMC Pediatric. 2014;14:186. DOI: 10.1186/1471-2431-14-186.
2. Tume L.N., Valla F.V., Joosten K. et al. Nutritional support for children during critical illness: European Society of Pediatric and Neonatal Intensive Care (ESPNIC) metabolism, endocrine and nutrition section position statement and clinical recommendations. Intensive Care Med. 2020;46:411–425. DOI: 10.1007/s00134-019-05922-5.
3. Лейдерман И.Н., Грицан А.И., Заболотских И.Б. и др. Периоперационная нутритивная поддержка. Методические рекомендации Федерации анестезиологов и реаниматологов. Вестник интенсивной терапии им. А.И. Салтанова. 2021;4:7–20. DOI: 10.21320/1818-474X-2021-4-7-20.
4. Kratochvíl M., Klučka J., Klabusayová E. et al. Nutrition in Pediatric Intensive Care: A Narrative Review. Children (Basel, Switzerland). 2022;9(7):1031. DOI: 10.3390/children9071031.

5. Irving S.Y., Albert B.D., Mehta N.M. et al. Strategies to optimize enteral feeding and nutrition in the critically ill child: a narrative review. Pediatr Med. 2022;5:9. DOI: 10.21037/pm-21-6.
6. Zamberlan P., Delgado A.F., Leone C. et al. Nutrition therapy in a pediatric intensive care unit: indications, monitoring, and complications. J Parenter Enteral Nutr. 2011;35(4):523–529. DOI: 10.1177/0148607110386610.
7. Сорвачева Т.Н., Евдокимова Т.А., Пырьева Е.А. и др. Недостаточность питания у детей раннего возраста. Принципы нутритивной поддержки. Российский педиатрический журнал. 2015;18(2):47–53.
8. Захарова И.Н., Дмитриева Ю.А., Сугян Н.Г. и др. Недостаточность питания в практике педиатра: дифференциальная диагностика и возможности нутритивной поддержки. Медицинский Совет. 2019;2:200–208. DOI: 10.21518/2079-701X-2019-2-200-208.
9. Iping R., Hulst J.M., Joosten K.F.M. Research developments in pediatric intensive care nutrition: A research intelligence review. Clin Nutr ESPEN. 2022;50:1–7. DOI: 10.1016/j.clnesp.2022.06.015.
10. Durvasula V.S., O'Neill A.C., Richter G.T. Oropharyngeal Dysphagia in children: mechanism, source, and management. Otolaryngol Clin North Am. 2014;47(5):691–720. DOI: 10.1016/j.otc.2014.06.004.
11. Лисица И.А., Александрович Ю.С., Завьялова А.Н. и др. Дисфагия у пациентов педиатрических отделений реанимации и интенсивной терапии (обзор литературы). Вестник анестезиологии и реаниматологии. 2023;20(6):97–105. DOI: 10.24884/2078-5658-2023-20-6-97-105.
12. Завьялова А.Н., Новикова В.П. Дисфагия у детей: обзор. University Therapeutic Journal. 2023;5(1):64–84. DOI: 10.56871/UTJ.2023.15.64.004.
13. Bence C.M., Salazar J.H., Flynn-O'Brien K.T. et al. Outcomes of gastrostomy placement with and without concomitant tracheostomy among ventilator dependent children. J Pediatr Surg. 2021;56(7):1222–1226. DOI: 10.1016/j.jpedsurg.2021.03.028.
14. Rohani P., Alimadadi H., Mirrahimi B. et al. Nutrition Section Position Statement and Clinical Practice Recommendations for Children Admitted to Intensive Care Unit. Iran J Pediatr. 2022;32(3):e119824. DOI: 10.5812/ijp-119824.
15. Шмаков А.Н., Александрович Ю.С., Степаненко С.М. Протокол. Нутритивная терапия детей в критических состояниях. Анестезиология и реаниматология. 2017;62(1):14–23. DOI: 10.18821/0201-7563-2017-62-1-14-23.
16. Yi D.Y. Enteral Nutrition in Pediatric Patients. Pediatr Gastroenterol Hepatol Nutr. 2018;21(1):12–19. DOI: 10.5223/pghn.2018.21.1.12.
17. Hay W.W. Optimizing nutrition of the preterm infant. Zhongguo Dang Dai Er Ke Za Zhi. 2017;19(1):1–21. DOI: 10.7499/j.issn.1008-8830.2017.01.001.
18. Wu G.H., Wu Z.H., Wu Z.G. Effects of bowel rehabilitation and combined trophic therapy on intestinal adaptation in short bowel patients. World J Gastroenterol. 2003;9(11):2601–2604. DOI: 10.3748/wjg.v9.i11.2601.
19. Скворцова В.А., Боровик Т.Э., Нетребенко О.К. Нарушения питания недоношенных детей (обзор литературы). Вестник современной клинической медицины. 2013;6(6):90–95.
20. Завьялова А.Н., Гостимский А.В., Лисовский О.В. и др. Энтеральное питание в паллиативной медицине у детей. Педиатр. 2017;8(6):105–113. DOI: 10.17816/PED86105-113.
21. Crary M.A., Mann G.D.C., Groher M.E. Initial psychometric assessment of a functional oral intake scale for dysphagia in stroke patients. Archives of physical medicine and rehabilitation. 2005;86(8):1516–1520. DOI: 10.1016/j.apmr.2004.11.049.
22. Coppens C.H., van den Engel-Hoek L., Scharbatke H. et al. Dysphagia in children with repaired oesophageal atresia. Eur J Pediatr. 2016;175(9):1209–1217. DOI: 10.1007/s00431-016-2760-4.
23. Yi Y.G., Shin H.I. Psychometrics of the Functional Oral Intake Scale for Children With Dysphagia. J Pediatr Gastroenterol Nutr. 2020;71(5):686–691. DOI: 10.1097/MPG.0000000000002861.
24. Dipasquale V., Gottrand F., Sullivan P.B., Romano C. Top-ten tips for managing nutritional issues and gastrointestinal symptoms in children with neurological impairment. Ital J Pediatr. 2020;46(1):35. DOI: 10.1186/s13052-020-0800-1.
25. Romano C., van Wynckel M., Hulst J. et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment. J Pediatr Gastroenterol Nutr. 2017;65(2):242–264. DOI: 10.1097/MPG.0000000000001646.
26. Завьялова А.Н., Лисица И.А., Лисовский О.В. и др. Пациент с синдромом Костелло: обзор литературы и клинический случай. Children's Medicine of the North-West. 2023;11(4):99–109. DOI: 10.56871/CmN-W.2023.61.17.012.
27. Pars H., Çavuşoğlu H. A Literature Review of Percutaneous Endoscopic Gastrostomy: Dealing With Complications. Gastroenterol Nurs. 2019;42(4):351–359. DOI: 10.1097/SGA.0000000000000320.
28. Homan M., Hauser B., Romano C. et al. Percutaneous Endoscopic Gastrostomy in Children: An Update to the ESPGHAN

Position Paper. J Pediatr Gastroenterol Nutr. 2021;73(3): 415–426. DOI: 10.1097/MPG.0000000000003207.
29. McSweeney M.E., Smithers C.J. Advances in Pediatric Gastrostomy Placement. Gastrointest Endosc Clin N Am. 2016;26(1):169–85. DOI: 10.1016/j.giec.2015.09.001.
30. Franco Neto J.A., Liu P.M.F., Queiroz T.C.N. et al. Percutaneous endoscopic gastrostomy in children and adolescents: 15-years' experience of a tertiary center. Arq Gastroenterol. 2021;58(3):281–288. DOI: 10.1590/S0004-2803.202100000-49.
31. Kumar A.S., Bani Yaghoub M., Rekab K. et al. Pediatric multicenter cohort comparison of percutaneous endoscopic and non-endoscopic gastrostomy technique outcomes. J Investig Med. 2020;68(2):413–418. DOI: 10.1136/jim-2019-001028.
32. Civan H.A., Bektas G., Dogan A.E. et al. Percutaneous Endoscopic Gastrostomy Feeding in Children with Cerebral Palsy. Neuropediatrics. 2021;52(4):326–332. DOI: 10.1055/s-0041-1731007.
33. Durakbasa C.U., Ozumut S.H., Orhon Z.N. et al. Percutaneous endoscopic gastrostomy in small infants unable to swallow safely. Pediatr Int. 2020;62(12):1369–1373. DOI: 10.1111/ped.14351.
34. Ayala Germán A.G., Ignorosa Arellano K.R., Díaz García L. et al. Nutritional benefits in pediatric patients with percutaneous endoscopic gastrostomy placement. Rev Esp Enferm Dig. 2022;114(11):680. DOI: 10.17235/reed.2022.8866/2022.
35. Bawazir O.A. Percutaneous endoscopic gastrostomy in children less than 10 kilograms: A comparative study. Saudi J Gastroenterol. 2020;26(2):105–110. DOI: 10.4103/sjg.SJG_525_19.
36. Козлов Ю.А., Новожилов В.А., Распутин А.А. и др. Лапароскопическая кнопочная гастростомия у детей. Эндоскопическая хирургия. 2014;20(4):39-45.
37. Джилавян М.Г., Кузенкова Л.М., Подклетнова Т.В. и др. Хирургическое лечение гастроэзофагеальной рефлюксной болезни у детей с неврологической патологией, сопровождающейся нарушением глотания. Педиатрическая фармакология. 2013;10(5):104–110. DOI: 10.15690/pf.v10i5.834.
38. Ng K., Lefton-Greif M.A., McGrath-Morrow S.A. et al. Factors That Impact the Timing and Removal of Gastrostomy Placement/Nissen Fundoplication in Children with Bronchopulmonary Dysplasia. Am J Perinatol. 2023;40(6):672–679. DOI: 10.1055/s-0041-1730432.
39. Завьялова А.Н., Новикова В.П., Кликунова К.А. Нутритивный статус и проблемы при кормлении у детей с дисфагией и детским церебральным параличом, находящихся в разных социальных условиях. Экспериментальная и клиническая гастроэнтерология. 2022;198(2):21–29. DOI: 10.31146/1682-8658-ecg-198-2-21-29.
40. Ерпулева Ю.В., Лекманов А.У., Грибакин С.Г. и др. Современные технологии энтерального питания у тяжелобольных детей. Российский вестник детской хирургии, анестезиологии и реаниматологии. 2014;4(1):80–87.
41. Broekaert I.J., Falconer J., Bronsky J. et al. The Use of Jejunal Tube Feeding in Children: A Position Paper by the Gastroenterology and Nutrition Committees of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition 2019. J Pediatr Gastroenterol Nutr. 2019;69(2):239–258. DOI: 10.1097/MPG.0000000000002379.
42. Kratochvíl M., Klučka J., Klabusayová E. et al. Nutrition in Pediatric Intensive Care: A Narrative Review. Children (Basel). 2022;9(7):1031. DOI: 10.3390/children9071031.
43. Vermilyea S., Goh V.L. Enteral Feedings in Children: Sorting Out Tubes, Buttons, and Formulas. Nutr Clin Pract. 2016;31(1):59–67. DOI: 10.1177/0884533615604806.
44. Dunitz-Scheer M., Scheer P.J. Tube Management and Maintenance. In: Child-led Tube-management and Tube-weaning. Springer, Cham. 2022. DOI: 10.1007/978-3-031-09090-5_11.
45. Köglmeier J., Assecaira I., Banci E. et al. The Use of Blended Diets in Children With Enteral Feeding Tubes: A Joint Position Paper of the ESPGHAN Committees of Allied Health Professionals and Nutrition. J Pediatr Gastroenterol Nutr. 2023;76(1):109–117. DOI: 10.1097/MPG.0000000000003601.
46. Завьялова А.Н., Новикова В.П., Гавщук М.В. и др. Дисфагия: диагностика, современные методы диетотерапии. Вопросы детской диетологии. 2022;20(6):51–62. DOI: 10.20953/1727-5784-2022-6-51-62.
47. Martinez E.E., Bechard L.J., Brown A.M. et al. Intermittent versus continuous enteral nutrition in critically ill children: A pre-planned secondary analysis of an international prospective cohort study. Clin Nutr. 2022;41(12):2621–2627. DOI: 10.1016/j.clnu.2022.09.018.
48. Ларина О.Д., Рудомётова Ю.Ю., Новикова Т.В. Обучение персонала правилам кормления — обязательный аспект логопедической работы по преодолению постинсультной дисфагии. Лечащий Врач. 2022;5-6:64–69. DOI: 10.51793/OS.2022.25.6.012.
49. Royce S., Tepper C., Watson W. et al. Indwelling polyethylene nasogastric tube for feeding premature infants. Pediatrics. 1951;8(1):79–81.
50. Zhang H., Wang H., Fan X. et al. Study on Influencing Factors Analysis of Gastric Tube Insertion Length and Construction of Estimation Method. Front Surg. 2022;9:942881. DOI: 10.3389/fsurg.2022.942881.

51. Beckstrand J., Cirgin Ellett M.L., McDaniel A. Predicting internal distance to the stomach for positioning nasogastric and orogastric feeding tubes in children. J Adv Nurs. 2007;59(3):274–89. DOI: 10.1111/j.1365-2648.2007.04296.x.
52. Torsy T., van Noort H.H.J., Taylor S. et al. The accuracy of methods for determining the internal length of a nasogastric tube in adult patients: a systematic review. Am J Clin Nutr. 2022;116(3):798–811. DOI: 10.1093/ajcn/nqac146.
53. Taylor S.J., Allan K., McWilliam H. et al. Nasogastric tube depth: the 'NEX' guideline is incorrect. Br J Nurs. 2014;23(12):641–4. DOI: 10.12968/bjon.2014.23.12.641.
54. Scalzo A.J., Tominack R.L., Thompson M.W. Malposition of pediatric gastric lavage tubes demonstrated radiographically. J Emerg Med. 1992;10(5):581–6. DOI: 10.1016/0736-4679(92)90142-g.
55. Ellett M.L., Cohen M.D., Perkins S.M. et al. Comparing methods of determining insertion length for placing gastric tubes in children 1 month to 17 years of age. J Spec Pediatr Nurs. 2012;17(1):19–32. DOI: 10.1111/j.1744-6155.2011.00302.x.
56. Klasner A.E., Luke D.A., Scalzo A.J. Pediatric orogastric and nasogastric tubes: a new formula evaluated. Ann Emerg Med. 2002;39(3):268–72. DOI: 10.1067/mem.2002.120124.
57. Воронцов И.М., Мазурин А.В. Пропедевтика детских болезней. 3-е изд., доп. и перераб. СПб.; 2009.
58. Кельцев В.А. Пропедевтика детских болезней: учебник для студентов педиатрических факультетов медицинских вузов. Ростов н/Дону; 2011.
59. Cirgin Ellett M.L., Cohen M.D., Perkins S.M. et al. Predicting the insertion length for gastric tube placement in neonates. J Obstet Gynecol Neonatal Nurs. 2011;40(4):412–21. DOI: 10.1111/j.1552-6909.2011.01255.x.
60. Gallaher K.J., Cashwell S., Hall V. et al. Orogastric tube insertion length in very low birth weight infants. J Perinatol. 1993;13(2):128–31.
61. Loff S., Diez O., Ho W. et al. Esophageal Diameter as a Function of Weight in Neonates, Children and Adolescents: Reference Values for Dilatation of Esophageal Stenoses. Front Pediatr. 2022;10:822271. DOI: 10.3389/fped.2022.822271.
62. Мануйлова Д.С., Мешков А.В., Аль-Харес М.М. Пищеводная дисфагия: клиника, диагностика, лечение. Обзор литературы. Children's Medicine of the North-West. 2024;12(1):65–74. DOI: 10.56871/CmN-W.2024.12.93.006.
63. Баранов К.К., Богомильский М.Р., Котова Е.Н. и соавт. Возрастные особенности нижнего носового хода по данным эндоскопии у детей. Вестник оториноларингологии. 2021;86(5):70–74. DOI: 10.17116/otorino20218605170.
64. Маркеева М.В., Алешкина О.Ю., Тарасова Н.В. и др. Возрастная изменчивость ширины носовых ходов по данным краниометрии. Морфологические ведомости. 2020;28(3):21–27. DOI: 10.20340/mv-mn.2020.28(3):21-27.
65. Boeykens K., Holvoet T., Duysburgh I. Nasogastric tube insertion length measurement and tip verification in adults: a narrative review. Crit Care. 2023;27(1):317. DOI: 10.1186/s13054-023-04611-6.
66. Metheny N.A., Krieger M.M., Healey F. et al. A review of guidelines to distinguish between gastric and pulmonary placement of nasogastric tubes. Heart Lung. 2019;48(3):226–235. DOI: 10.1016/j.hrtlng.2019.01.003.
67. Keyte E., Roe G., Jeanes A. et al. Immediate chest radiograph interpretation by radiographers improves patient safety related to nasogastric feeding tube placement in children. Pediatr Radiol. 2021;51(9):1621–1625. DOI: 10.1007/s00247-021-05032-9.
68. Preiser J.C., Arabi Y.M., Berger M.M. et al. A guide to enteral nutrition in intensive care units: 10 expert tips for the daily practice. Crit Care 2021;25:424. DOI: 10.1186/s13054-021-03847-4.
69. Tamhne S., Tuthill D., Evans A. Should ultrasound be routinely used to confirm correct positioning of nasogastric tubes in neonates? Arch Dis Child Fetal Neonatal Ed. 2006;91(5):F388. DOI: 10.1136/adc.2005.088476.
70. Tsujimoto H., Tsujimoto Y., Nakata Y. et al. Ultrasonography for confirmation of gastric tube placement. Cochrane Database Syst Rev. 2017;4(4):CD012083. DOI: 10.1002/14651858.CD012083.pub2.
71. Fernandez R.S., Chau J.P., Thompson D.R. et al. Accuracy of biochemical markers for predicting nasogastric tube placement in adults — a systematic review of diagnostic studies. Int J Nurs Stud. 2010;47(8):1037–46. DOI: 10.1016/j.ijnurstu.2010.03.015.
72. Metheny N.A., Gunn E.M., Rubbelke C.S. et al. Effect of pH Test-Strip Characteristics on Accuracy of Readings. Crit Care Nurse. 2017;37(3):50–58. DOI: 10.4037/ccn2017199.
73. Earley T., Young A., Pringle S. et al. Fibre-optic, electronic pH test device compared with current NHS guidance to confirm nasogastric tube placement. BMJ Nutr Prev Health. 2022;5(2):306–312. DOI: 10.1136/bmjnph-2022-000506.
74. Ellett M.L., Croffie J.M., Cohen M.D. et al. Gastric tube placement in young children. Clin Nurs Res. 2005;14(3):238–252. DOI: 10.1177/1054773805275121.
75. Chau J.P., Thompson D.R., Fernandez R. et al. Methods for determining the correct nasogastric tube placement

after insertion: a meta-analysis. JBI Libr Syst Rev. 2009;7(16):679–760. DOI: 10.11124/01938924-200907160-00001.
76. Гавщук М.В., Кликунова К.А., Завьялова А.Н. и др. Изучение оптимального диаметра питательной трубки для энтерального питания в модельном эксперименте. Экспериментальная и клиническая гастроэнтерология. 2022;(1): 80–86. DOI: 10.31146/1682-8658-ecg-197-1-80-86.
77. Гавщук М.В., Зорин И.М., Власов П.С. и др. Сравнение устойчивости различных материалов гастростомических трубок к воздействию повреждающих факторов в модельном эксперименте in vitro. Педиатр. 2021;12(5):47–52. DOI: 10.17816/PED12547-52.
78. Bechtold M.L., Matteson M.L., Choudhary A., Puli S.R., Jiang P.P., Roy P.K. Early versus delayed feeding after placement of a percutaneous endoscopic gastrostomy: a meta-analysis. Am J Gastroenterol. 2008;103(11):2919–24. DOI: 10.1111/j.1572-0241.2008.02108.x.
79. Rahnemai-Azar A.A., Rahnemaiazar A.A., Naghshizadian R. et al. Percutaneous endoscopic gastrostomy: indications, technique, complications and management. World J Gastroenterol. 2014;20(24):7739–51. DOI: 10.3748/wjg.v20.i24.7739.
80. Wiernicka A., Matuszczyk M., Szlagatys-Sidorkiewicz A. et al. The protocol for a randomised-controlled trial of the evaluation of the tolerance and safety of early enteral nutrition in children after percutaneous endoscopic gastrostomy placement. (protocol version 09.01.2015). BMC Pediatr. 2016;16(1):163. DOI: 10.1186/s12887-016-0705-8.
81. Suzuki H., Joshita S., Nagaya T. et al. Relationship of early acute complications and insertion site in push method percutaneous endoscopic gastrostomy. Sci Rep. 2020;10(1):20551. DOI: 10.1038/s41598-020-77553-6.
82. Sellers D., Mandy A., Pennington L. et al. Development and reliability of a system to classify the eating and drinking ability of people with cerebral palsy. Developmental medicine and child neurology. 2014;56(3):245–251. DOI: 10.1111/dmcn.12352.
83. Гавщук М.В., Кликунова К.А., Завьялова А.Н. и соавт. Физиологическая температура питания при капельном кормлении через гастростому. Профилактическая и клиническая медицина. 2022;2(83):61–65. DOI: 10.47843/2074-9120_2022_2_61.
84. Лисица И.А., Кликунова К.А., Прудникова М.Д. и соавт. Значение температуры энтерального питания при кормлении через гастростому. Forcipe. 2022;5 (Suppl. 2): 305–306.
85. Третьякова Е.П., Шень Н.П., Сучков Д.В. Оценка готовности пациентов детского возраста к наращиванию объема энтерального питания при гастроинтестинальной дисфункции. Медицинский альманах. 2019;5–6(61):36–38. DOI: 10.21145/2499-9954-2019-5-36-38.
86. Clouzeau H., Dipasquale V., Rivard L. et al. Weaning children from prolonged enteral nutrition: A position paper. Eur J Clin Nutr. 2022;76(4):505–515. DOI: 10.1038/s41430-021-00992-5.
87. Dipasquale V., Aumar M., Ley D. et al. Tube Feeding in Neurologically Disabled Children: Hot Topics and New Directions. Nutrients. 2022;14(18):3831. DOI: 10.3390/nu14183831.
88. Edwards S., Davis A.M., Bruce A. et al. Caring for Tube-Fed Children: A Review of Management, Tube Weaning, and Emotional Considerations. J Parenter Enteral Nutr. 2016;40(5):616–22. DOI: 10.1177/0148607115577449.
89. Wilken M., Bartmann P., Dovey T.M. et al. Characteristics of feeding tube dependency with respect to food aversive behaviour and growth. Appetite. 2018;123:1–6. DOI: 10.1016/j.appet.2017.11.107.
90. Krom H., de Meij T.G.J., Benninga M.A. et al. Long-term efficacy of clinical hunger provocation to wean feeding tube dependent children. Clin Nutr. 2020;39:2863–2871. DOI: 10.1016/j.clnu.2019.12.021.
91. Dipasquale V., Lecoeur K., Aumar M et al. Weaning children from prolonged enteral nutrition: A survey of practice on behalf of the French Society of Paediatric Gastroenterology, Hepatology, and Nutrition. J Parenter Enteral Nutr. 2022;46:215–221. DOI: 10.1002/jpen.2100.
92. Sobotka S.A., Laudon S., Jackson A.J. et al. A Literature Review of Feeding Disorders in Children with Tracheostomies and Ventilators. Pediatr Ann. 2022;51(7):e291–e296. DOI: 10.3928/19382359-20220504-05.