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# Consensus Statement on Provision of Appropriate Nutritional Support in the Management of Childhood Malnutrition: A Turkey Perspective

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## ABSTRACT

This review by experts aimed to identify areas of consensus regarding the provision of appropriate nutritional support in the management of pediatric malnutrition that can be translated into a practical and implementable guidance document. Experts identified the "six rights" of pediatric malnutrition care to discuss, including the (1) right patient (appropriate identification of malnourished child); (2) right method (appropriate selection of type, site, route, and mode of delivery of nutrition); (3) right product (appropriate selection of the nutritional product); (4) right posology (appropriate calculation of required intake); (5) right duration (appropriate duration, discharge criteria, and monitoring); and (6) right information (providing the right information to the caregiver and raising public awareness about preventive strategies) and prevention of malnutrition.

**Keywords:** Pediatric malnutrition, consensus statement, diagnosis, nutritional support, enteral nutrition

## Introduction

Malnutrition in children typically develops between 6 and 18 months of age in accordance with accelerated growth and brain development specific to this period, whereas young children are also susceptible to malnutrition if complementary foods are introduced too early or too late or if the foods have low nutrient density and micronutrient bioavailability (1). Malnutrition during the early childhood period is associated not only with impaired growth but also with long-term adverse outcomes persisting into adulthood such as impaired motor skills, behavioral problems, attention deficits, learning disabilities, and increased incidence of impaired intelligence quotient (1-3).

Globally, data from 2011 revealed that an estimated 165 million (26%) children <5 years of age have stunted growth (height-for-age Z-score of ≤–2 based on the World Health Organization [WHO] Child Growth Standards), 101 million (16%) are underweight (weight-for-age Z-score < –2), and 52 million (8%) have wasting (weight-for-length/height or body mass index [BMI] Z-score < –2) (4). In Turkey, the evolution of the prevalence of stunting and wasting among children <5 years of age between 1990 and 1994 and between 2010 and 2016 revealed an absolute change of –14.6 and –2.1 percentage points, respectively (5). The Turkey Demographic and Health Survey from 2018 revealed that 6% of children <5 years of age are stunted or too short for age and 2% show wasting (6). Severe acute malnutrition (SAM), defined as a weight-for-height Z-score < –3, affects nearly 19 million (2.9%) children, whereas stunting, underweight, and wasting are considered to be the cause of 14.7%, 14.4%, and 12.6% of deaths among children <5 years of age, respectively (4).

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Preventing all grades of malnutrition is considered an effective strategy for improving child survival as well as for reducing the significant economic burden placed on the healthcare system because of malnutrition (7-12). Accordingly, in an effort to reduce the malnutrition-related child mortality, the WHO global targets for infant and young child nutrition entail achieving a 40% reduction in the number of stunted children <5 years of age by 2025 and reducing childhood wasting (acute malnutrition) to <5% and maintaining it at that level (1, 13).

However, although pediatric malnutrition is not an uncommon entity, it is frequently underdiagnosed or underestimated in the clinical practice, leading to an increased risk of morbidity and mortality, impaired recovery and convalescence, prolonged treatment duration, and increased treatment costs (1, 14, 15). Given that proper nutritional care can effectively ameliorate the malnutrition and related adverse outcomes in children, nutritional assessment is considered an essential part of every medical examination for early recognition of risk of malnutrition or current malnutrition and to initiate timely nutritional therapy (1, 15).

Unfortunately, only a small percentage of malnourished patients receive nutritional therapy largely because of the poor awareness of healthcare professionals about the importance of nutritional screening and the role of nutritional intervention in prevention, diagnosis, or early management of malnutrition and related adverse outcomes (1, 15).

**Main Points**

- This review by experts aimed to identify areas of consensus regarding the provision of appropriate nutritional support in the management of pediatric malnutrition that can be translated into a practical and implementable guidance document.
- Experts identified the "six rights" (right patient, right method, right product, right posology, right duration, and right information) of pediatric malnutrition care.
- The experts reached consensus on certain claims to improve pediatric malnutrition care, which includes screening for nutritional status and malnutrition at every visit, accurate identification of type and severity of malnutrition and related nutritional support requirement, timely and appropriate provision of nutritional support in accordance with overall and disease-specific indications, and criteria for the appropriate route, product, posology, duration, discharge criteria, and monitoring.
- This consensus report encourages provision of enteral nutrition with preference to oral tube feeding and if tube feeding is needed for gastric to postpyloric access whenever possible.
- Providing useful support for caregivers in terms of identification of the most advantageous way of integrating pediatric nutritional care into the daily psychosocial environment of the unique caregiver and family is of utmost importance for improving the caregiving role to thus achieve better social, emotional, physical, and cognitive development of the malnourished child.

Therefore, this review by experts aimed at identifying areas of consensus regarding the provision of appropriate nutritional support in the management of pediatric malnutrition, which can be translated into a practical and implementable guidance document. The main topics addressed in this paper are the "six rights" of pediatric malnutrition care, including the (1) right patient (appropriate identification of malnourished child); (2) right method (appropriate selection of type, site, route, and mode of delivery) of nutrition; (3) right product (appropriate selection of the nutritional product); (4) right posology (appropriate calculation of required intake); (5) right duration (appropriate duration, discharge criteria, and monitoring); and (6) right information (providing the right information and appropriate support to the caregiver and raising public awareness about preventive strategies) and prevention of malnutrition.

## Right Patient: Appropriate Identification of the Malnourished Infant and Child and Nutritional Needs

### Definition of malnutrition

Pediatric malnutrition is defined by the American Society for Parenteral and Enteral Nutrition as an imbalance between nutrient requirement and intake, leading to cumulative deficits in energy, protein, or micronutrients that may negatively affect growth, development, and other relevant outcomes (16).

Malnutrition is classified based on its etiology (primary, secondary), duration (acute, chronic), anthropometric measurements (stunting, wasting, and underweight), and severity (mild, moderate, and severe) (16).

Primary malnutrition is cause by the combined effect of several factors including poverty, poor maternal nutrition, low birthweight, poor breastfeeding, inappropriate complementary feeding, lack of adequate food, repeated infections, and environmental enteropathy (4). Secondary malnutrition is cause by the direct or indirect adverse effects of an underlying disease on growth, such as prolonged severe infections, some neurological diseases, malignancies, congenital heart diseases (CHD), chronic kidney diseases (CKD), chronic liver diseases (CLD), malabsorption, immune deficiencies, and cystic fibrosis (4).

Although primary malnutrition is most commonly seen in low- and middle-income countries, secondary malnutrition is more commonly seen in developed countries, and cases with delayed diagnosis or no treatment are associated with an increased risk for infection, delayed wound healing, and an overall poor response to treatment for the underlying disease (4).

Based on anthropometric measurements, malnutrition can be classified as stunting, wasting, and underweight. Height or length-for-age is a criterion used for assessing stunting, which is caused by chronic malnutrition, whereas weight-for-height or length is used to assess wasting, which is caused by acute malnutrition. Weight-for-age is used to indicate underweight, indicating the combined effect of acute and chronic malnutrition (4).

In children aged 6–59 months, moderate and acute malnutrition is defined as moderate wasting (i.e., weight-for-length/height Z-scores between –3 and –2 of the WHO Child Growth Standards median) and/or a mid-upper arm circumference (MUAC) from 115 to 125 mm. Infants (1–6 months of age) and children (6–59 months of age) who have an MUAC of <115 mm (fails to detect SAM in many children) or a weight-for-height/length Z-score < –3 on the WHO growth standards, or have any degree of bilateral edema are considered to have SAM, which should be managed immediately (Table 1) (1, 17).

Anthropometric assessments based on the weight-for-height Z-score using the WHO growth standards are considered likely to identify a larger population with SAM than the National Center for Health Statistics (NCHS) growth reference values depending on the age group (1, 18). In addition, although low values of weight-for-height Z-score and MUAC both identify children with an increased risk for SAM (1), the criterion of a weight-for-height Z-score < –3 is considered more likely to identify SAM than the criterion of an MUAC of <115 mm, which reportedly failed to detect SAM in 75% of children with SAM as defined by a low weight-for-height Z-score (19).

In infants aged 1–6 months, the presence of bilateral pitting edema or confirmed weight loss of >10% and a weight-for-height Z-score < –3 and/or evidence of insufficient food intake are indications for hospitalization, whereas satisfactory clinical status, absence of acute infection plus weight gain of 10–15 g/kg per day, and ability to sustain appropriate feeding are indications for outpatient management (Table 1) (17).

Mild or moderate malnutrition make up the majority of malnourished cases, and the vast majority of malnutrition-related deaths (83%) are attributable to mild to moderate, rather than severe, malnutrition (12, 20). Hence, given the challenging diagnosis and mortality risk of moderate malnutrition (12), close monitoring of nutritional status and neonatal growth and supporting breastfeeding are considered crucial for controlling disease progression, mortality risk, and public disease burden (4, 20).

**Indications for nutritional support**

Nutritional support involves the provision of nutrition beyond that provided by normal food intake and has two basic goals, which are the restoration of the cellular function (short-term goal) and repletion of the lost tissue (long-term goal) (9, 15, 21).

Accordingly, nutritional support is provided to pediatric patients under the following two possible conditions (21-23):

1. Children who fail to receive less than 60% to 80% of the nutritional requirements for >10 days, those with a total feeding time of 4 to 6 h per day, and those with a likelihood of insufficient oral intake for >5 days (>1 year of age) or >3 days (<1 year of age).
2. Wasting and stunting status in children are identified as follows:
   - Lack of weight gain or improved height during monthly follow-up for children <2 years of age.
   - Failure to gain weight or presence of weight loss during follow-up visits in 3 months for children >2 years of age.
   - Drop in weight of >2 percentile on the growth charts.
   - Triceps skinfolds consistently below the fifth percentile of age.
   - Decreased height velocity by ≥0.3 standard deviation per year, or by >2 cm per year during puberty.

**Nutritional support for primary malnutrition**

Most children with primary and moderate malnutrition can be managed at home with nutrition-specific interventions such as counseling of parents about the proper diet with emphasis on continued breastfeeding and the appropriate complementary feeding, micronutrient supplementation, and ensuring household food security. Ideally, these children should receive 25 kcal/kg per day of energy in excess of that recommended for their healthy peers, and their diets should contain animal-source foods that are rich in essential fatty acids, essential amino acids, and micronutrients including vitamin A, iron, and zinc (Table 1) (4, 24).

Different approaches are available to address moderate malnutrition with prepared foods such as providing lipid-based nutrient supplements or blended foods either as a full daily dose or in a low dose to complement the regular diet (25).

Children with severe, acute, and primary malnutrition and complications require hospitalization, whereas those without complications can be treated at home with ready-to-use therapeutic food (RUTF) (4).

| Table 1. Definitions of Pediatric Malnutrition in Infants Aged 1–6 months and Children Aged 6–59 months (1, 17, 18) | | | |
|---|---|---|---|
| **Children aged 6–59 months** | | | |
| **Classification** | **Signs** | **Treatment** | **Discharge** |
| No acute malnutrition | Weight-for-height Z-score ≥ –2 or MUAC ≥ 125 mm; no signs of anemia (palmar pallor) | If child is <2 years of age, assess the child's feeding and counsel the caregiver or mother about feeding according to feeding recommendations. If there is any feeding problem, schedule a controlled visit in 7 days. | — |
| Moderate acute malnutrition | Weight-for-height Z-score between –2 and –3; MUAC of 115–125 mm. | Assess the child's feeding and counsel the caretaker or mother about feeding recommendations. Assess for possible TB infection. Schedule a follow-up visit after 7 days. Tell the caretaker or mother when to come back immediately. Follow-up in 30 days. | Absence of edema for at least 2 weeks; MUAC ≥125 mm on two consecutive visits; Weight-for-height/length Z score ≥ –2 on two consecutive visits. |
| Severe acute malnutrition | Weight-for-height Z-score < –3; MUAC <115 mm (risk of failure to diagnose SAM in many children); bilateral pitting edema | Give oral antibiotics for 5 days. Give RUTF for a child aged >6 months. Assess the child's feeding and counsel the mother. Assess for possible TB infection. Schedule a follow-up visit after 7 days. Tell the mother when to come back immediately. | |
| Complicated severe acute malnutrition | Edema in both feet; Weight-for-height Z-score < –3; MUAC <115 mm; With a medical complication or not able to finish RUTF or a breastfeeding problem | Refer immediately to hospital. Give first dose of an appropriate antibiotic. Treat the child to prevent low blood sugar. | |
| **Infants aged 1–6 months** | | | |
| **Nutritional status criteria** | **Hospitalization;** | **Outpatient.** | **Discharge;** |
| | Presence of bilateral pitting edema or confirmed weight loss of >10%; Weight-for-height Z-score < –3 and/or evidence of insufficient food intake. | Satisfactory clinical status and absence of acute infection; Weight gain of 10–15 g/kg per day for 5 consecutive days in stage 3 plus ability to sustain appropriate feeding. | Weight-for-height/length Z score > –2 on two consecutive visits; weight is following the growth curve; Postdischarge follow-up until the age of 6 months for growth monitoring, mother support, and the provision of infant formula if needed. |
| MUAC: mid-upper arm circumference; TB: tuberculosis; RUTF: ready-to-use therapeutic food | | | |

Management of SAM involves the stabilization, active catch-up, and nutritional rehabilitation phases. During the stabilization phase, a cautious approach is required when initiating feeding as soon as possible, decreasing the feeding frequency gradually, and using a nasogastric feeding tube in anorexic children or in those with oral intake of <80 kcal/kg per day (<5 years of age) or <80% of the recommended energy intake (4). Catch-up growth starts when the energy intake is >150 kcal/kg per day with use of RUTF or WHO-recommended formula in young children (Table 1) (4).

**Nutritional support in secondary malnutrition**

The prevalence of secondary malnutrition is 40% in patients with neurologic diseases, 34.5% in those with infectious disease, 33.3% in those with cystic fibrosis, 28.6% in those with cardiovascular disease, 27.3% in oncology patients, and 23.6% in those with gastrointestinal and liver diseases (16, 26).

For the management of secondary malnutrition, it is crucial to identify the underlying disease because management is impossible without treating the underlying cause (4). The nutritional support principles of the management of SAM are similar in primary and secondary malnutrition (4).

In children with CLD, malnutrition occurs because of vomiting, poor appetite, infection, gastroesophageal reflux, and the compressive effects of ascites or hepatosplenomegaly. The diet should contain a combination of lipids and carbohydrates with a controlled amount of protein to prevent hyperammonemia, whereas the use of medium-chain triglycerides (MCTs) (which does not depend upon bile acids for absorption) as the source of dietary fat is considered to counter the risk of malabsorption of fats and fat-soluble vitamins owing to decreased excretion of bile salts into the small intestine in CLD, especially with accompanying cholestasis. Water-soluble forms of the fat-soluble vitamins (A, D, E, and K) should be used when available (4).

In a child with severe neurological impairment, the indications for nutritional support are deviations in weight gain and growth from the defined pattern, low weight-for-height ratio, prolonged or stressful oral feeding or signs of aspiration or dehydration, micronutrient deficiency, and overweight or obesity (27, 28). Establishing a target weight as the weight at which the triceps and/or subscapular skinfolds are between the 10$^{th}$ and 50$^{th}$ percentile is considered clinically useful alongside measures to optimize the child's oral intake. Age-appropriate standard enteral products are sufficient for these patients with no need for the use of elementary products in the absence of a definite indication. In severely impaired children aged <1 year, such nutritional support should be started via high calorie, high protein, and fiber-rich nutritional products, whereas in children aged >1 year, enteral products with a calorie content of 1 kcal/mL or 1.5 kcal/mL with close monitoring of fluid intake can also be used (27).

In children with CKD, malnutrition and growth delays are common and associated with a greater risk for morbidity and mortality. Nutritional care plans individualized according to the child's age, development, residual kidney function, and mode of kidney replacement therapy are considered as vital components of the multidisciplinary management of children with CKD (29-31).

In children with CHDs, malnutrition and failure to thrive are common systemic consequences of the underlying cardiac abnormality with adverse effects attributable to postoperative outcomes and neurodevelopment. In the postoperative period, the enteral route should be preferred in hemodynamically stable patients, whereas parenteral feeding should be started immediately in hemodynamically unstable patients (32). In children with CHD, especially with cyanotic heart defects, energy intake should be 50% higher than that recommended for healthy children whereas protein intake should range from 2 to 4 g/kg, and these children should consume 55% to 60% of their caloric intake from carbohydrates and 30% to 35% from fat (32, 33).

Among pediatric oncology patients, malnutrition is common with an estimated prevalence ranging up to 60% during the course of cancer therapy (34), and it is associated with a decreased treatment response to chemotherapy and radiotherapy and an increased risk for morbidity and mortality. The indications for nutritional support are malnutrition at the time of diagnosis, loss of >5% bodyweight during treatment, weight-for-height ratio of <90%, a drop in weight across 2 percentiles or triceps skinfold thickness of <5$^{th}$ percentile (4, 34). The increase in energy and protein requirement when undergoing chemotherapy should be taken into consideration with frequent, low volume, protein-rich, and high-fiber feeding and energy intake of 120% that of the recommended intake for healthy children (4, 34, 35).

In children with cystic fibrosis, malnutrition is both a frequent feature and comorbidity and strongly associated with pulmonary function and survival. Energy intake in patients with cystic fibrosis is recommended to range from 120% to 200% of the energy needs for the healthy population of similar age, sex, and size (36). Enteral tube feeding is considered for infants ≤2 years of age who have persistent failure to thrive with their weight and length at <10$^{th}$ percentile and for children of 2 to 18 years of age who persistently are in a low BMI percentile (≤10 p) or who show weight loss of 2 percentile points since last visit and stunting of growth (36-38).

## Right Method: Appropriate Selection of the Type, Site, Route, and Mode of Delivery of Nutritional Support

**Type, site, and route of nutritional support**

Following the assessment of the nutritional status and need for nutritional support via nutritional counseling, the most appropriate type of nutritional intervention is de-

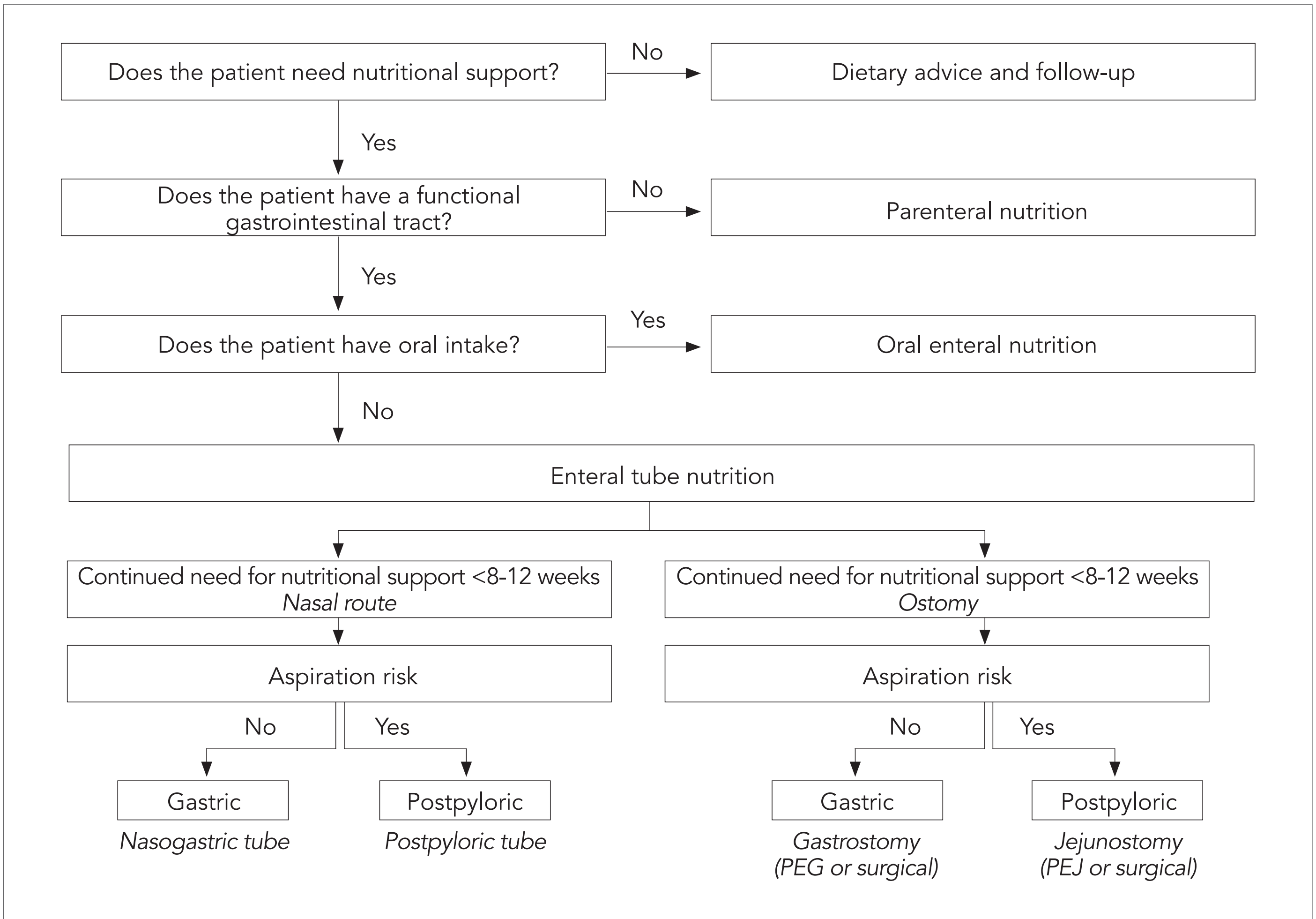


Figure 1. Flowchart of the decision-making process for enteral nutrition support

termined based on the patient's age, clinical condition, gastrointestinal function, the opportunity for oral intake, feasibility, dietary habits, and costs (21, 22, 39).

Accordingly, patients may receive dietary advice only or nutritional support with addition of enteral nutrition (EN) with oral nutritional supplements (ONS) or parenteral nutrition (PN) depending on the decision-making process (Figure 1) (21, 22, 39).

Oral nutrition via special diets and supplements is usually considered the first line therapy in managing malnutrition, whereas tube feeding is needed when oral intake is limited or swallowing is unsafe (22). EN is usually preferred in the context of a normally functioning gastrointestinal tract because it represents the physiological process more closely, is cheaper, and may help maintain gut-barrier function (9, 22). EN can be provided by access to the stomach or small intestine, preferably to the jejunum. Stomach is the preferred site unless there is a contraindication (22).

The decision about the site and route of EN administration is mainly based on the patient's disease status, the structural and functional status of the gastrointestinal tract, the purpose and duration of EN, and the risk for aspiration (21). Hence, EN delivery may be gastric or postpyloric and provided by replaceable tubes (nasogastric, nasoduodenal, nasojejunal) or via gastrostomy or enterostomy (Figure 1) (22).

When short-term enteral feeding (less than 8–12 weeks) is considered, nasogastric and postpyloric tubes are used in patients without and with aspiration risk, respectively. When a continued need for nutritional support is likely to be more than 8–12 weeks, enteral feeding using a gastrostomy (percutaneous endoscopic gastrostomy [PEG] or surgical gastrostomy) or jejunostomy (percutaneous endoscopic jejunostomy [PEJ] or PEG-jejunostomy or surgical jejunostomy) are considered for patients without or with aspiration risk, respectively (Figure 1) (9, 22).

### Mode of delivery

Modes used to deliver enteral feeding can be intermittent, continuous, or combined. Intermittent bolus feeding is the preferred mode of delivery, because it more closely represents the physiological process, is cheaper, and is less restrictive than continuous feeding (21, 40). Intermittent bolus feeding provides a cyclic surge of gastrointestinal hormones with a trophic effect on the intestinal mucosa and enables the feeding patient to freely perform activities (21, 22, 41). However, in patients with severely impaired gastrointestinal function, continuous feeding is more beneficial because of a lower thermogenic effect enabling enhanced weight gain and improved substrate utilization (40). A constant infusion of nutrients at a rate below 3 kcal/min and optimization of nutrient concentration and osmotic load are required to avoid vomiting, which occurs in patients in which the infusion rate exceed the gastric emptying rate or in which the nutrient content slows gastric emptying (40). An appropriate and constant flow can be ensured by the use of a peristaltic pump. In children capable of oral intake, a combined method of feed delivery with tube feeding overnight for 10 to 12 h and oral intake during the day may be considered and suggested to be beneficial for the preservation of sensory and motor oral functions (40).

### Pros and cons of different methods

Whenever possible, gastric feeding is preferred over postpyloric feeding because it resembles the physiological process more closely with easier achievement of a secure tube position alongside other advantages over postpyloric access such as bactericidal role, improved nutrient absorption, possibility of intermittent bolus feeding, no need for a feeding pump, and low cost (21, 22, 42). However, gastric feeding carries the risk of gastroesophageal reflux, pulmonary aspiration, and osmotic diarrhea and is disabled in jejunal feeding (21).

Postpyloric access is indicated only in clinical conditions challenging gastric feeding such as aspiration, gastroparesis, gastric outlet obstruction, or previous gastric surgery. Bolus feeds and hyperosmolar solutions should not be delivered postpylorically because of the risk of inducing diarrhea (21, 22). Continuous feeding delivered through infusion at a constant rate has certain advantages over intermittent feeding such as facilitated intestinal adaptation and optimal absorption via constant mucosal stimulation, a lower probability of emesis, and higher efficacy in enteral balance and weight gain (21, 43).

## Right Product: Appropriate Selection of the Nutritional Product

Factors that should be considered when selecting an appropriate formula include nutrient and energy requirements adjusted for the age and clinical condition of the child, history of food intolerance or allergies, intestinal function, site and route of delivery (tube and oral vs. tube only), formula characteristics (i.e., osmolality, viscosity, nutrient content, complexity, fat, fiber, lactose, micronutrient content, and nitrogen source), taste preference, and cost (40).

EN products, predominantly offered as ready-to-feed liquid formulations, supply an adequate amount of nutrients in a form and volume that the child can tolerate.

EN products are classified as monomeric (elemental; amino acid-based), oligomeric (semi-elemental; hydrolyzed), and polymeric (complete protein) based on protein structure, whereas the isocaloric and hypercaloric classification is based on the energy content (22).

### Polymeric products

For the majority of pediatric patients, the standard pediatric polymeric enteral formula derived from cow's milk protein with or without fiber is sufficient and well tolerated with the best cost to benefit ratio and is, therefore, the most frequent choice for both in-hospital and in-home settings (22, 40). Polymeric formulas contain macronutrients in the form of intact proteins, triglycerides, and carbohydrate polymers (22, 40). Their caloric density ranges between 1 and 2 kcal/mL and they may be used for oral and bolus feeding as well as for tube feedings (40).

Variations of polymeric formulas include high energy formulas, high protein formulas, and fiber-containing formulas (44).

High-energy formulas are energy dense that contain >1.2 kcal/mL and less water (70%–77%) than standard diets. Indications for the use of these diets include the need for fluid restriction, such as in cardiac and renal disease, and because of their higher lipid concentration, they may also be suitable for patients with pulmonary disorders and cystic fibrosis. High-protein formulas derive 20% or more of the total energy from proteins and are mainly used for patients in catabolic states with severe malnutrition and problems with wound healing (i.e., Crohn's disease, hemodialysis, or HIV infection) (44). High energy and protein feeds are hypertonic and, therefore, should be introduced with caution initially to avoid osmotic diarrhea (25, 45).

Fiber-containing formulas comprise plant-based carbohydrates that remain undigested and metabolically active in the colon such as non-starch polysaccharides, inulin and oligosaccharides, resistant starch, and lignin (44, 46). Fiber and its fermentation products (short-chain fatty acids) have potential beneficial effects for the intestinal physiology and enable prevention of both diarrhea and constipation, with hydrolyzed guar gum and pectin being superior to soy polysaccharides. The use of a mixture of bulking and fermentable fiber has been suggested as the preferred approach (22).

### Oligomeric products

Oligomeric low-molecular feeds are hypoallergenic oligopeptide feeds derived from protein hydrolysates, and most of these have higher MCT ratios and are more costly than polymeric feeds. These feeds are used only in selected patients, including those with cow's milk protein allergy, multiple food allergies, food intolerance, or impaired intestinal absorption and/or digestion (22, 40, 47). Because low-molecular feeds are hyperosmolar, the total daily volume and the concentration of the delivered solution should be increased gradually (40).

### Monomeric or elemental products

Monomeric or elemental formulas are nutritionally complete solutions containing a nitrogen source in the form of amino acids, carbohydrates (as oligosaccharides), and fats as a mixture of long-chain triglycerides (LCTs) and MCTs (40). Owing to the unpalatability and high osmotic load limits, these feeds are used for tube feeding of patients with specific clinical indications, such as patients with severe multiple food allergies non-responsive to oligomeric formulas, eosinophilic esophagitis, anaphylaxis, and patients with severely impaired digestion and absorption (47). Because of the high osmolarity (500−900 mOsmol/L), these formulas may cause osmotic diarrhea, particularly if delivered directly into the jejunum in the form of a bolus or by too rapid infusion (40).

### Specialized and disease-specific pediatric enteral formulas

Specialized and disease-specific pediatric enteral formulas may be beneficial in certain circumstances, such as for the use in patients with renal disease or hyperammonemia (feeds with reduced protein contents), severe cholestasis (feeds with part of the lipid content provided by MCTs and increased contents of lipid-soluble vitamins), short bowel syndrome (feeds with MCTs), galactosemia or glucose and galactose malabsorption (carbohydrate-modified formulas), and cow's-milk protein or multiple food allergies (formulas based extensively on hydrolyzed protein or amino acids) (22, 40, 48, 49).

## Right Posology: Appropriate Calculation of the Nutritional Need

Mild to moderate malnutrition generally is treated on an outpatient basis by increasing the amount of energy intake by 50% to 100% that of the recommended energy requirement for age-matched healthy children (50-52).

**Table 2. Recommended Energy Intake (REE) for Healthy Children (58, 59)**

| Age | REE, kcal/kg/day |
|---|---|
| 0–3 month | 102–110 |
| 4–6 month | 82–84 |
| 6–12 month | 78–82 |
| 13–35 month | 81–83 |
| Boy, 3–8 year | 60–85 |
| Girl, 3–8 year | 60–85 |
| Boy, 8–19 year | 36–47 |
| Girl, 8–19 year | 34–40 |

The recommended energy intake for healthy children is summarized in Table 2 (51, 52). In infants, breastfeeding is continued along with enriched supplementary feeding and addition of an enteral product when necessary (50).

The daily energy requirement for catch-up growth in children with primary malnutrition is calculated based on the condition of the malnourished child with a 1.2- to 2.0-fold higher energy intake requirement than recommended for the healthy children (51, 52).

In children with secondary malnutrition, the energy requirement is determined based on the underlying disease with consideration for higher energy intake in cases with hypermetabolic conditions (i.e., chronic disease and severe infection) and lower energy need in those with minimal activity (i.e., children with neurological disease and bed-ridden children) (4).

Children with severe malnutrition should be hospitalized for treatment. Refeeding syndrome, a potentially fatal condition that occurs with initiation of high calorie feeding in severely malnourished children with prolonged nutritional deprivation, should be considered carefully (22, 53). To reduce its risk, the initial enteral feeding regimen should be limited in terms of volume and energy content to provide around 50% to 75% of the requirements at onset and meeting the energy needs within 7 to 10 days of initiation of nutrition support. A high carbohydrate diet should be avoided along with sodium restriction. Close monitoring of biochemical parameters, specifically the levels of phosphorus, potassium, magnesium, and glucose, should be performed daily for the first week along with phosphorus, potassium, magnesium, and thiamine supplementation (22, 53).

## Right Duration: Appropriate Duration, Discharge Criteria, and Monitoring of Nutritional Support

The main objective of monitoring nutrition support is to review the objectives of nutritional support, to determine the efficacy of the implemented nutritional intervention via measures of actual nutrient delivery, to assess the need for altering the type of nutritional support to improve the effectiveness or minimize metabolic risk, to ensure safety and optimal growth, and to detect and treat clinical complications as quickly as possible (22, 27).

Although the type and frequency of monitoring will depend on the nature and severity of the underlying disease, intake, weight, height, general clinical state, wellbeing, biochemical and hematological indices, gastrointestinal function, tube integrity, and any tube-related complications are also factored in (22).

Children aged 6–59 months with acute malnutrition should only be discharged from treatment when their weight-for-height/length Z-score is ≥–2 or when their MUAC is ≥125 mm and they have had no edema for at least 2 weeks (1). In infants aged 1–6 months, the discharge criteria are a weight-for-height Z-score ≥ –2 on two consecutive visits and weight following the growth curve, whereas postdischarge follow-up is continued until the age of 6 months for growth monitoring, maternal support, and the provision of infant formula if needed (Table 1) (22). However, although most malnourished children have improved by the time of discharge, the child usually remains stunted and mental development is delayed, in addition to the high risk for postdischarge relapse of malnutrition (1, 54). Planned follow-ups of the child at regular intervals is essential along with an efficient strategy for tracing children who fail to attend follow-up appointments and, thus, are at increased risk for recurrence of malnutrition or of developing other serious illnesses (1, 54).

Accordingly, after discharge or recovery, periodic monitoring during week 1, week 2, and month 1 visits is required because the risk for relapse is greatest soon after discharge, followed by regular 3- to 6-month interval visits during the first 2 years (1, 54-56).

In children who achieved a weight-for-height ≥–1 Z-score or ≥90% of the median NCHS or WHO reference values, the progress is considered (54). At each visit, the mother should be asked about the child's recent health, feeding practices, and play activities, and the child should be examined, weighed, and measured with provision of any vaccines, vitamins, or medicines when needed (1, 54).

## Right Information: Providing the Right Information and Appropriate Support to the Caregiver and Raising Public Awareness about Preventive Strategies

Given the direct impact of caregiving and consistent daily management of pediatric nutritional care on the child's growth and development, the wellbeing of the caregiver is vital to providing comprehensive care for the enterally fed child (57-59). Inability to cope with the role can lead to substandard caregiving and an undernourished child, which may negatively affect the social, emotional, physical, and cognitive development of the child (53).

Providing useful support to caregivers is of utmost importance to improve the wellbeing of the caregiver, with an increased ability to cope with the stressful and demanding situations inherent to the caregiving role being associated with an increase in the likelihood of better social, emotional, physical, and cognitive development of the malnourished child (59, 60).

Problems encountered during caregiving should be assessed carefully with appropriate modifications to enable the most advantageous way of integrating pediatric nutritional care into the daily routine of the caregiver and family. The three main factors underlying the psychological consequences that should be considered by healthcare professionals when evaluating the role of the caregiver are (59):

1. External factors (i.e., home care, family social support, economic resources, medical services coordination, doctor-patient relationship, knowledge of the disease, nutritional support, and ease to obtain equipment and materials)
2. Patient-dependent factors (i.e, illness severity, poor short-term prognosis, patient–caregiver relationship, psychological status, ability to communicate with the family, aggressiveness, difficulty in handling owing to weight or deformities)
3. Caregiver-dependent factors (i.e., basic lifestyle, anxiety, fear of leaving the child with another caregiver, preparation to perform technical tasks, work, and grief for not having a healthy child)

Malnutrition is a global public health concern with suboptimal detection rates and a significant burden to patients and healthcare systems even though simple corrections to the patient's nutritional statuses can ameliorate the poor nutritional status and related adverse outcomes (9). Potential measures suggested for prevention of malnutrition within a healthcare system are (4, 14, 54, 56):

- Education of women
- Improved family planning activities with wider use of contraceptive methods or prevention of unwanted pregnancies.
- Prepared and safe motherhood experience
- Appropriate antenatal care
- Emphasizing the value of exclusive breastfeeding for the first 6 months of life and encouraging the introduction of proper complementary feeding around the 6th month along with breastfeeding until the end of the second year of life.
- Emphasizing proper feeding or intake relationships with the recognition and support of family members with positive attitudes, especially that of the caregiver toward the infant or child.
- Early recognition of risk factors such as poverty, sensory and affection deprivation at home, or problematic feeding or intake relationships.
- Follow-up of the infant or child by the same healthcare team on a regular basis.
- Appropriate assessment of the growth via weight and height measurements and percentile definitions at each visit.

## Conclusion

This review by experts from Turkey aimed to provide a practical guidance document regarding the provision of appropriate nutritional support in the management of pediatric malnutrition to assist clinicians in managing malnutrition. This consensus report emphasizes the "six rights" of nutritional care in pediatric malnutrition, including the right patient (appropriate identification of malnourished child), right method (appropriate selection of type, site, route, and mode of delivery), right product (appropriate selection of the nutritional product), right posology (appropriate calculation of required intake), right duration (appropriate duration, discharge criteria, and monitoring of nutritional support), and right information (providing the right information and appropriate support to the caregiver and raising public awareness about preventive strategies), which are critically important in proper implementation of nutritional support in the management of pediatric malnutrition.

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