

Review Article

Nutritional Issues and Management in Children with Cerebral Palsy

Durga Prasad DM¹, and Arpita Bhriuvanshi MD^{2*}¹Department of Pediatric Gastroenterology, Medanta Super Speciality Hospital, India²Department of Pediatrics, King George's Medical University, India

*Corresponding author

Arpita Bhriuvanshi MD, Associate Professor,
Department of Pediatrics, King George's Medical
University Lucknow 226003, Uttar Pradesh, India, Email:
arpime84@gmail.com

Submitted: 08 April 2022

Accepted: 27 April 2022

Published: 30 April 2022

ISSN: 2373-9312

Copyright

© 2022 Prasad D, et al.

OPEN ACCESS

Keywords

• Nutrition; Cerebral palsy; Children; Rehabilitation

Abstract

Nutritional issues limit the growth and development in children with cerebral palsy (CP). Impaired nutrition results in malnutrition, growth failure, micronutrients deficiencies, osteopenia, and overall brain development. Various reasons for their poor nutrition may be their lack of communication, inadequate oral intake and gastrointestinal issues. Gastrointestinal issues can be gastroesophageal reflux disease, dysphagia, constipation, motility disorders and fecal evacuation disorders which affects their growth and quality of life. Hence, introduction of an adequate nutritional support and monitoring should always be considered an integral part of their care. Placement of gastrostomy tube and supplementation of various formulas in early stage of management have good impact on health. A multidisciplinary approach involving physicians, nurses, dieticians, occupational and speech therapists, psychologists, and social workers is essential to improve the outcome. Currently, there is a lack of a definite guideline and systematic approach for the care for this vulnerable population. In addition there are issues regarding mode of feeding, enteral nutrition, size of enterostomy tube and selection and availability of different formulas. Hence, the aim of the present review is to discuss a practical approach for the assessment of nutritional status in order to identify individuals at risk for malnutrition to optimize an adequate and personalized nutritional support. The role of enteral feeding, indications, access of feeding and formula selection in this subset of children will also be highlighted.

INTRODUCTION

Nutrition in children with neurologically impairment (NI), is a big challenge which influences their overall development and quality of life. It has been seen that majority of published literature on nutrition in NI children has focused on the population with cerebral palsy (CP), wherein malnutrition has been observed in 46%–90% of cases [1, 2]. Malnutrition adversely affects their physical development and increases the burden on health resources. There are several factors responsible for malnutrition such as poor communication, low caloric intake, gastrointestinal problems, lack of awareness and knowledge in this subset of population [1]. In addition, assessment and interventions of nutrition in neurologically impaired children are another challenge. Nevertheless, nutritional rehabilitation has been associated with improvement of overall and bone health, peripheral circulation, decubitus ulcers, spasticity, irritability and gastrointestinal issues [2]. Hence, nutritional rehabilitation should be an integral part of comprehensive care. The aim is not only to optimize weight and height but also to secure improved physiological and functional capacity. Nutritional problems in these children arise from a variety of causes; hence one or more of possible interventions (positioning, rehabilitation, tube feeding, diet modification and different kind of formulas) may be required.

NUTRITIONAL ASSESSMENT

A multidisciplinary team including a dietitian, nurse, physician, speech therapist, physiotherapist, psychologist,

and occupational-therapist should ideally perform nutritional evaluation. It includes a thorough medical and social history; nutritional growth and anthropometric measurements; a complete physical examination; meal observation; and selected diagnostic tests. There are various methods to assess the nutritional status ranging from simple to complex methods but they are not without limitations [3].

Assessment should not be based solely on weight, height and body mass index (BMI) measurements. Measurement of height in them is far more challenging due to presence of contracture or inability to stand, scoliosis limits their actual height assessment hence segmental measures can be used. It has been widely demonstrated that BMI has only a moderate correlation with body fat percentage in ambulatory child with CP [3,4]. So, to overcome this problem, body composition assessment is essential. Body composition includes dynamics of fat, lean tissue mass and water content, are more difficult to ascertain in this population. Abnormalities in body composition frequently present such as increased total body water, severely depleted fat stores and decreased bone density. The accepted method for the evaluation of body composition is dual energy X-ray absorptiometry (DEXA) [4-6]. Nevertheless, DEXA assessment is not always easy to perform due to requirement of specialized centre and equipment and cost factors. Easiest and cost effective methods to estimate body composition is skin fold thickness (SFT). Triceps and subscapular SFT measurements have been a fairly sensitive and specific predictor of malnutrition [6]. The routine measurement of triceps SFT is recommended in all subjects with CP, and in

those with a value $<10^{\text{th}}$ centile for age as measured on standard WHO charts [6].

GROWTH CHARTS

The growth patterns of CP children may be notably differ from those of an average child, and that growth is influenced by functional and feeding ability, it is advisable not to compare their anthropometric parameters to standard growth charts [1]. For this reason, Brooks et al. developed CP-specific growth charts stratified by functional ability defined according to the Gross Motor Function Classification System, which is also endorsed by European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) [7].

Estimating nutritional requirement

There is currently no clear-cut guideline and standard method for estimating the energy requirements in CP children due to heterogeneity, high variability in motor activity, and variations in body composition. Energy requirements depend upon severity of motor function and disease and vary with the severity of their disability, mobility, the presence of feeding difficulties, and the degree of altered metabolism. So it should be assessed on individual basis. Children who can walk require similar energy while those dependent on a wheelchair require 60%-70% of that required by their healthy age-matched peers. It is unclear whether muscle spasticity and dyskinesia increase or decrease the energy requirements; it is a matter of debate [3,8]. These factors were once thought to increase caloric needs, yet new findings shows that it may not affect it as much as once believed. Ideally, indirect calorimetry can be used to assess such needs in this situation. However, in regular clinical practice, this is difficult, time-consuming, and often unavailable. Thus, most clinicians use the dietary reference intake (DRI) [3,8].

Estimating Fluid Requirements

Determining fluid needs is critical as many have fluid loss (sensible and insensible) through drooling of saliva, sweating, respiratory distress and are unable to consume adequate quantities of fluids and communicate thirst. Actual body weight is used to estimate it using the conventional Holliday-Segar equation. However, the calculated fluid needs may not be adequate; therefore, in real life scenario, a goal of 90% of total fluid intake is more feasible [6].

When to start nutritional intervention

Nutritional intervention should be started as early as possible when the risk population is identified. Indications to start a nutritional intervention in them as per North American Society for Pediatric Gastroenterology, Hepatology And Nutrition (NASPGHAN), if there are evidence of oral motor feeding difficulties along with under nutrition (weight-for-height $<80\%$ of expected; BMI $<5^{\text{th}}$ percentile), Growth failure (height-for-age $<90\%$ of expected), overweight (BMI $>95^{\text{th}}$ percentile) and individual nutrient deficiencies [9,10].

NUTRITIONAL SUPPORT

Oral feeding

Intervention plan should be individualized that accounts child's nutritional status, feeding ability, and comorbidities like

GER and risk of aspiration must be determined. Route of access for feeding can be oral or enteral feeding. Possibly nutritional support is provided by enteral route rather than parenteral, assuming competency of the gut. The goal is to optimize the health, functional status, and quality of life while maintaining adequate growth and nutritional status. As per ESPGHAN recommendations, oral feeding should be preferred in all children including children with NI [7]. Enteral tube feeding needs to be considered in select situation; if despite oral nutritional support, weight gain continues to be inadequate. Adequate trial of oral feeding support should be done before considering enteral access. The appropriate length of time for a trial of oral nutritional support will vary depending on the age of the child and the degree to which their nutritional status is compromised. Initial follow-up in 1-3 months is usually sufficient; however, younger children, such as infants and those with a poor nutritional status should be reviewed more frequently. Older children should be seen at least annually [7].

Enteral tube feeding

Indication of enteral tube feeding in children with CP with a functional gastrointestinal tract who are: 1) unable to meet their nutritional requirements orally; 2) undernourished despite oral nutritional support; 3) having significant feeding and swallowing dysfunction (resulting in risk of pulmonary aspiration or prolonged and stressful oral feeding) [11-14]. There are many accesses for tube feedings: nasogastric (NG), nasojejunal, gastrostomy, gastro-jejunostomy and jejunostomy tube. NG tube feeding is suitable for short-term, as they are relatively easy and less invasive. It may be utilized before gastrostomy tube insertion to allow for nutritional rehabilitation before surgery and as a 'trial run' to assess tolerance and efficacy of enteral tube feeding. However, long-term use is not recommended as they are easily dislodged, blockages may occur and cause nasopharyngeal discomfort and irritation [15]. For long-term feeding, gastrostomy is the preferred route because of improved comfort, easy to administer the feed and reduced need for frequent tube changes [16].

These feeding tubes are easily available, soft, patient friendly and can be left in-situ for longer duration. Percutaneous endoscopic gastrostomy (PEG) has become the preferred method in children with insufficient oral intake. However, the timing of gastrostomy placement in children remains unclear, however, the timing of gastrostomy placement in children remains unclear ranging from 21 to 52 months with a growing trend towards younger age and parents seem to support earlier gastrostomy placement [15,16]. A recent report from United Kingdom, stated that gastrostomy insertion before 18 month of age resulted in greater increase in z-score for weight in these children [16]. The minimum weight limit to insert a PEG tube safely has been reported to be as low as 2.3 Kg [15]. PEG is often associated with an increased prevalence of gastro-esophageal reflux. Patients should be evaluated at least clinically to determine the presence of gastro-esophageal reflux disease (GERD) before PEG placement. In symptomatic children with GERD, relevant lab tests like esophageal impedance \pm pH-metry and endoscopy should be performed, however asymptomatic children do not require any investigations. Symptomatic children should be

given adequate trial of medical therapy. There is no role of a prophylactic fundoplication (anti reflux procedure) if a PEG placement is required in a child with clinical reflux. The ESPGHAN recommends that fundoplication be considered in cases of failure of optimized medical therapy for GERD. It should be considered in cases where significant preexisting reflux (persistent vomiting, erosive esophagitis) or reflux in the presence of an unsafe swallow, chronic respiratory disease like cystic fibrosis requiring lung transplant, or progressive neurological deterioration. Anti-reflux surgery needs to be discussed at the time of gastrostomy insertion. Post-pyloric feeding (nasojejunal, gastro-jejunosomy and jejunostomy) may be indicated in those with severe GER and vomiting resulting in growth failure and in increased risk of aspiration. Its use, however, is limited by the high frequency of complications and tube replacements. Gastric feeding remains the preferred route when possible as it is physiological, easier and bolus feeds may be utilized.

DIET COMPOSITION

Macronutrients

There are no evidence based guidelines for nutritional requirements in CP children. Caloric requirements of CP children are estimated 60%-70% of their normally developing children [7-10]. Most enteral feeds are designed to meet all essential nutrient requirements [8]. The initial feed of choice is usually a standard energy density (1.0 kcal/mL) polymeric feed. In children with severe malnutrition, an intake of 2 g/kg/day of protein and an additional 15-20% increase of caloric intake should be sufficient to ensure catch up growth. In children with an increased energy requirement or poor tolerance of large volumes of feed, a small frequent, high energy dense formula (1.5 kcal/mL), or dietary supplementation with glucose polymers and/or long-chain triglycerides to increase calorie intake may be useful. However, in children with less energy requirements, such as those that gain weight too rapidly, a lower-energy density formula can be used (0.75 kcal/ml) [9]. Addition of extra fats to the diet can significantly increase the energy intake without increasing the volume of feed, because of the higher energy density of fat per gram (9 kcal/g) compared with protein and carbohydrate (4 kcal/g). Extra fats and oils may be added to the meal during cooking or upon serving [10]. High fat spreads can be used including nut spreads or avocado. Moreover, milk drinks can be fortified with milk powders, cream or ice cream as well as flavorings to boost energy and protein density. Protein intake can be further improved by adding protein rich foods, such as soft diced or puree meats, dairy products, eggs, lentils and legumes. Nutritional assessment should be performed periodically, if no improvement in nutritional status is seen after a suitable time period, supplementation with commercially available oral supplements and/or enteral tube feeding should be considered. Commercially available modular products like carbohydrate polymers, protein powders, combined carbohydrate and fat supplements may be added to food and fluids to increase energy and protein density. Various oral supplements (sip feeds) are available in the market including milk or juice based products. There are formulas of higher energy density with added fiber are also available depending on the needs of the child. However, it is important to ensure that the child's total intake of nutrients does not exceed the recommended upper limit.

Micronutrients

Micronutrient and dietary fiber provision should always be considered during nutritional rehabilitation, as enteral formulas are usually deficient in it [5]. Supplementation to meet the DRI for vitamins and minerals are required while on enteral feeding. Sip feeds have the benefit of significantly contributing to micronutrient intake as well as providing additional energy and protein. These children have deficient bone growth and an increased propensity for non-traumatic fractures especially in the lumbar spine and lower extremities. Therefore, calcium and vitamin-D should be supplemented adequately. The suggested dose of vitamin D is 800-1000 IU/day. Fiber intake is the same as for an average developing child (age plus 5 g/day in children older than 2 years) [10].

FORMULA SELECTION

Selection of enteral formula depends not only on age of child, but also on their energy requirements and mode of enteral access. There are two types of enteral feeding blenderized food and commercial available formula. Blenderized tube feeding (BTF), continues to increase in popularity, among people of all ages and across the globe. However, its use is less attractive due to risk of bacterial contamination and labor intensity [7]. This may be used in place of or in addition to combination with commercially available enteral formulas. Commercial enteral formulas (CEF), have precise amounts of both micronutrients and macronutrients and are prepared in a sterile manner unlike BTF. Commercial formulas are premade, more attractive and have become more widely available, cost effective, convenient for caregivers, easily quantifiable for healthcare professionals, and safer for patients [17]. There is a wide variety of commercial available enteral feeds including polymeric, semi-elemental, elemental and disease specific formulations tailored for different age groups based on the changing nutritional requirements throughout the lifespan. ESPGHAN recommends using human milk, a standard infant formula, or nutrient dense infant enteral formula as per clinical indication [7]. Most children above one year will tolerate a polymeric formula, but some children may require a semi-elemental or elemental formula. Children with poor feed tolerance because of delayed gastric emptying, whey-based formulas can be beneficial. These formulas significantly reduce acid GER episodes in children with severe NI and a 50% whey formula significantly reduces gagging and retching. The addition of modular nutrients, however, should be made with the help of a dietitian to ensure that the final composition of the diet is adequate and avoids preparation errors.

ROLE OF NUTRITION FOR CORRECTIVE SURGERY

Spinal deformity with severe neurological handicaps can affect their ability to sit and cause significant back pain or pain due to rib impingement. Surgical correction followed by spinal arthrodesis is indicated when progressive deformities interfere with their level of function and quality of life [17,18]. Poor nutritional status predisposes the patients to delayed wound healing and a poor immunological response to infection. A significantly lower infection rate, a shorter period of endotracheal intubation and less hospitalization time after spinal arthrodesis has been reported in CP children with good preoperative

nutritional status. Feedings through a nasogastric or gastrostomy tube can optimize nutritional state before surgery.

FOLLOW-UP AND MONITORING

The effectiveness of any nutrition intervention must be determined through regular follow up and nutrition monitoring. Monitoring may involve measures of actual nutrient delivery of energy, protein and micronutrients in comparison with estimated needs. A more sensitive and reliable indicator that the child is receiving adequate energy and protein, is adequacy of weight gain. In general, follow-up and monitoring of nutrition interventions will involve ensuring the nutritional status of the child is improving and managing difficult feeds, feed tolerance, ensuring safety of feeds and nutrient intake, balancing tube feeding with oral intake and working towards weaning off tube feeding where appropriate. The frequency of nutritional monitoring depends upon the severity of clinical condition, age, baseline nutritional status and existing nutrient deficiencies. Once a child is established on nutrition support and weight gain is occurring at desired rates, follow-up in 6–12 months has been suggested.

In conclusion, nutritional assessments and interventions are cornerstone in management of neurologically impaired children. High risk children for poor nutrition should be recognized and intervened early and adequately to optimize their functional capacity. Gastrostomy tube feeding is preferred mode of feeding in long term. Close monitoring and follow up is essential component during nutritional rehabilitation.

SOURCE OF FUNDING

This work did not receive any grant from funding agencies in the public, commercial, or not-profit sectors.

Potential Conflicts of Interest (Financial and Non-Financial)

The authors declare that they have no conflict of interest.

REFERENCES

- Brooks J, Day S, Shavelle R, Strauss D. Low weight, morbidity, and mortality in children with cerebral palsy: new clinical growth charts. *Pediatr*. 2011; 128: e299-e307.
- Dahl M, Thommessen M, Rasmussen M, Selberg T. Feeding and nutritional characteristics in children with moderate or severe cerebral palsy. *Acta Paediatr*. 1996; 85: 697-701.
- Krick J, Murphy PE, Markham JF, Shapiro BK. A proposed formula for calculating energy needs of children with cerebral palsy. *Dev Med Child Neurol*. 1992; 34: 481-487.
- Rieken R, van Goudoever JB, Schierbeek H, Willemsen SP, Calis EAC, Tibboel D, et al. Measuring body composition and energy expenditure in children with severe neurologic impairment and intellectual disability. *Am J Clin Nutr*. 2011; 94: 759-766.
- Bell K, Owens J. Cerebral palsy. In: Stewart R (ed.) *Paediatric Nutrition and Dietetics*. Campbell House: Brisbane, Australia. 2012.
- Azcue MP, Zello GA, Levy LD, Pencharz PB. Energy expenditure and body composition in children with spastic quadriplegic cerebral palsy. *J Pediatr*. 1996; 129: 870-876.
- Romano C, Von Wynckel M, Hulst J, Broekaert I, Bronsky J, Dalloglio N, 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 Nutrition*. 2017; 65: 242-264.
- Culley WJ, Middleton TO. Caloric requirements of mentally retarded children with and without motor dysfunction. *J Pediatr* 1969; 75: 380-384.
- Motil KJ. Enteral nutrition in the neurologically impaired child. In: Baker SB, Baker RD Jr, Davis A, eds. *Pediatric Enteral Nutrition*. New York: Chapman & Hall. 1994: 217-237.
- Campanozzi A, Staiano A. Impact of malnutrition on gastrointestinal disorders and gross motor abilities in children with cerebral palsy. *Brain Dev*. 2010; 32: 168.
- Dabydeen L, Thomas JE, Aston TJ. High-energy and -protein diet increases brain and corticospinal tract growth in term and preterm infants after perinatal brain injury. *Pediatrics*. 2008; 121: 148-156.
- WHO/FAO/UNU Expert Committee. *Protein and Amino Acid Requirements in Human Nutrition* Geneva, Switzerland. 2007.
- ESPGHAN Committee on Nutrition. Practical approach to paediatric enteral nutrition: a comment by the ESPGHAN committee on nutrition. *J Pediatr Gastroenterol*. 2010; 51: 110-122.
- ASPEN Board of Directors the Clinical Guidelines Task Force. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *J Parenter Enteral Nutr*. 2002; 26: 1SA-138SA.
- Pentiuk S, O'Flaherty T, Santoro K, Willging P, Kaul A. Pured by gastrostomy tube diet improves gagging and retching in children with fundoplication. *J Parenter Enteral Nutr*. 2011; 35: 375-379.
- Vernon-Roberts A, Wells J, Grant H, Alder N, Vadamalayan B, Eltumi M, Sullivan PB. Gastrostomy feeding in cerebral palsy: enough and no more. *Dev Med Child Neurol*. 2010; 52: 1099-1105.
- Elia M, Engfer MB, Green CJ, Silk DBA. Systematic review and meta-analysis: the clinical and physiological effects of fibre-containing enteral formulae. *Aliment Pharmacol Ther*. 2008; 27: 120-145.
- Brun AC, Stordal K, Johannesdottir GB, Bentsen BS, Medhus AW. The effect of protein composition in liquid meals on gastric emptying rate in children with cerebral palsy. *Clin Nutr*. 2012; 31: 108-112.