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Management of Enteral Tube Feeds in Neurologically Impaired Children: A Mini Review

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Received Date: June 15, 2022**Published Date: June 23, 2022****Abstract**

Guidelines pertaining to the management of tube fed children with neurological impairment (NI) are not specific due to the variable phenotypes of children with NI. Feeding regimens need to be tailored to each individual patient. Key aspects of managing enteral tube feedings in children with NI includes the diagnosis and treatment of gastrointestinal disorders associated with feeding intolerance, recognizing signs of undernutrition, choosing an adequate formula, and monitoring patients long-term for adequate growth and nutrition.

Keywords: Neurologically impaired children; Malnutrition; Tube feeding

Introduction

Children with neurodevelopmental disabilities often grapple with feeding problems. A survey of 268 children with neurological impairment (NI) showed 89% of patients needed help with feeding and 20% of caregivers reported feeding times as stressful and unenjoyable [1]. Feeding difficulties in this population are multifactorial and place children at high risk for undernutrition and malnutrition. Malnutrition in children with NI increases comorbidities including pneumonia, pathological bone fractures, and pressure ulcers [2]. A study by Kilpinen-Loisa et al. assessed nutritional intake of 54 children with motor disability by using a 3-day food diary and revealed energy intake to be <80% of goal in more than half of the children [3]. Early initiation of enteral tube feedings in children with NI is important to prevent and address poor nutritional outcomes and help reduce lung infections in

patients who are at risk for aspiration. This article focuses on reviewing management of tube feeds in children with NI.

Gastrointestinal Disorders in Children with NI

Feeding and swallowing difficulties in children with NI may affect all phases of feeding (oral, pharyngeal and esophageal) impairing their ability to safely eat by mouth and placing them at risk for malnutrition and aspiration [4,5]. Children with NI often need placement of gastrostomy tubes which have been reported to improve their health, reduce time spent feeding, and improve overall quality of life [1,6,7]. Dysphagia, gastroesophageal reflux disease (GERD), delayed gastric emptying, and constipation commonly occur in children with NI and may interfere with their ability to tolerate enteral feeds. GERD, reported to occur in about 2/3 of children with NI, may present atypically delaying diagnosis

and treatment and leading to the development of complications such as esophagitis, strictures, and Barrett esophagus [8]. The risk factors leading to GERD include abnormal posture, increased intrabdominal pressure secondary to spasticity, hiatal hernia, scoliosis, and esophageal dysmotility [9]. Patients with early onset NI, abnormal electroencephalography, and mitochondrial diseases are particularly at risk for severe GERD [10]. Medical and/or surgical treatment of GERD is needed to prevent these complications [11]. Abnormal antroduodenal motility and delayed gastric emptying have also been reported in children with NI and affects feeding tolerance [12,13]. Constipation is another common disorder in children with NI (prevalence 74%) and should be diagnosed and treated as it can contribute to abdominal pain and feeding intolerance [14,15]. Ambulatory function has been correlated with risk for constipation and abnormal colonic transit motility [15]. Physicians need to have a high index of suspicion for these disorders that may affect feeding tolerance as children with NI often do not present with typical symptoms and may have difficulty communicating what they are feeling.

Recognizing Undernutrition in Children with NI

Nutrition requirements for children with NI are disease specific. Many of these children are at risk for malnutrition, especially those with severe gross motor impairment and limited oral motor skills [16,17]. In typically developing children weight-for-length (WFL) or body mass indexes (BMI) are used to assess growth and nutritional status however, in children with NI, WFL or BMI may be difficult to obtain due to difficulties measuring length in children unable to stand or with severe joint contractures. In these cases, it is often recommended to measure knee height or tibial length as a proxy for height [18]. Obtaining weights may also be difficult in wheelchair and bed bound children and often require hoist or wheelchair scales which are not always readily available. Furthermore, interpretation of WFL and BMI is not straightforward as a low WFL, or BMI may be indicative of low muscle mass secondary to the child's underlying condition vs. malnutrition. Growth charts are available to reference in some neurologic conditions such as cerebral palsy (CP) and Rett's disease, but many other diseases and genetic disorders do not have reference growth charts available. Taking into consideration the challenges of obtaining and interpreting WFL and BMI in children with NI and the lack of representative growth charts the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) recommends using 1 or more of the following red flag warning signs to recognize undernutrition in children with NI: physical signs of undernutrition such as decubitus, skin problems, and poor peripheral circulation; weight for age (z score <-2); triceps skinfold thickness <10th percentile for age and sex; mid-upper arm fat or muscle area <10th percentile; and faltering weight and/or failure to thrive [19]. As nutritional interventions are

based on these anthropometric measurements, these need to be compared with available normative data however, it is important to highlight that applying these standards to children with NI can overestimate their energy expenditure as it depends on the degree of disability [20-23].

Choosing the Right Formula

A 5-year retrospective study by Dipasquale et al. assessing nutritional outcomes of gastrostomy tube fed malnourished children with NI showed that for the majority of patients an age-appropriate standard polymeric formula that is isocaloric, iso-osmolar (300-350mOsm/kg), gluten and lactose free is sufficient and well tolerated for long-term nutrition [24]. Although standard polymeric formulas are adequate for many patients there are certain cases where these formulas are not tolerated or where a different type of formula may meet nutritional needs and simultaneously address other medical concerns such as GERD or constipation making alternative formulas a more favorable choice.

Casein vs. whey-based formulas

Commercial formulas are available with varying concentrations of whey: casein protein. Multiple studies have demonstrated increased gastric emptying time with whey predominant vs. casein predominant formulas suggesting whey predominant formulas may be better tolerated in patients with delayed gastric emptying [25-27]. In vitro digestion models investigating the digestibility of infant formulas have shown increasing the casein: whey protein ratio increases the coagulability of the formula in acidic environments and decreases gastrointestinal protein and fat digestion [28]. It is speculated the increased solubility of whey predominant formulas contributes to improved protein and fat digestion through increased accessibility of gastric enzymes to the substrates and may help increase gastrointestinal emptying time [28]. A study by Fried et al. reported significantly less episodes of emesis in gastrostomy fed children with spastic quadriplegia fed whey predominant vs. casein predominant formulas however, multiple studies with larger numbers of children with NI have failed to show significant decreases in GERD symptoms or pH probe results [25-27].

Oligomeric and monomeric formulas

Oligomeric formulas consist of hydrolyzed casein or whey proteins while monomeric formulas contain free amino acids. These types of formulas are typically more expensive than polymeric formulas and may be unpalatable if fed orally. In practice, these formulas are often used in patients with poor weight gain on standard formulas as it may improve feeding intolerance associated with food allergies, gastroesophageal reflux, or delayed gastric emptying. Some studies have shown the use of monomeric

formulas may accelerate gastric emptying and decrease the risk of aspiration however, other studies have not shown a benefit to using oligomeric or monomeric peptide formulas in the treatment of GERD in children with NI [29,30]. Certain oligomeric and monomeric formulas are available with a higher percentage of medium chain triglycerides (MCT) than standard polymeric formulas. As MCTs are passively absorbed into enterocytes without the need for bile acid or lipases, they are a good source of energy for patients with fat malabsorption [31].

Blenderized formulas

Blenderized tube feeding refers to using whole foods to provide nutrition. In the past, homemade blenderized diets have been used with caution due to the inability to accurately assess nutritional content due to variability in preparation as well as concerns regarding bacterial contamination. More recently, the popularity of blenderized formulas has been increasing among pediatric and adult patients on enteral nutrition and there are now multiple commercial blenderized formula options [32]. A recent survey of registered dietitians (RDs) showed most RDs agree the use of blenderized formulas was positive for the family, patient and practice overall [33]. A prospective cohort study comparing 70 tube fed children receiving standard formulas vs. blenderized formulas showed significantly decreased rates of emergency department visits, total admissions, and respiratory-related admissions as well as significantly lower scores on GERD symptom questionnaires [34]. A study by Gallagher et al. examining the transition from standard formula to blenderized formula in 17 medically complex pediatric patients found similar results with a decrease in the prevalence of vomiting and use of antacid medications for children who transitioned to a blenderized formula [35]. The study also examined the stool microbiota of children on standard formulas vs blenderized formula [35]. The bacterial diversity and richness of stool samples increased while the relative abundance of Proteobacteria (typically associated with dysbiosis) decreased when children were transitioned from standard formula to blenderized formula [35]. The increased viscosity of blended formulas may cause clogging of gastrostomy tubes and the current recommendation is for patients to have a 14 French gastrostomy tube or larger in order to decrease the risk of clogs [36]. The higher viscosity of blended formulas may contribute to the decrease in reported GERD symptoms. Adding pectin to thicken standard formula was found to decrease GERD measured by esophageal pH monitoring in 18 children with CP [37]. Other thickeners such as oatmeal, carob bean gum, and xanthan gum have been used to increase formula viscosity in an attempt to reduce GERD symptoms however, this alters the nutritional and caloric composition of the formula [38]. Blenderized formulas have the advantage of naturally increased viscosity without the need for additives. Concern for bacterial contamination of blenderized formulas has been perceived as a pitfall in their use however, when blenderized formulas were

compared to standard polymeric formulas left at room temperature for up to 4 hours there was no difference in bacterial contamination [39].

Other formulas: high-energy density, added fiber

Other types of formula preparation available include high-energy density formulas useful in providing nutrition in volume restricted patients. Standard polymeric formulas with added fiber are used to help lessen constipation although it may aggravate intestinal bloating and discomfort if fiber content is increased rapidly.

Long-Term Follow up

Children with NI reliant on tube feeds often have multiple comorbid conditions that need to be considered when formulating a nutrition regimen. Children with NI have altered body composition (reduced lean body mass and fat-free mass), reduced physical activity and had variable resting energy expenditures (REE) difficult to predict and often overestimated. Some children may have conditions contributing to REE above that of a typically developing child their age while others may have much lower REE. It is important to closely monitor anthropometrics as children with NI and lower REE are at risk of becoming overweight when consuming similar calories to a typically developing child their age due to consuming energy intakes per unit of body weight that are more than their predicted REE [40]. In cases where patients are overweight, the feeding regimen needs to be adjusted to prevent complications related to overweight and obesity. Low REE could be an adaptation to low energy intake and can be normalized with improved nutrition [41]. REE have been reported to increase after gastrostomy placement resulting in significant weight gain [41]. Children with lower REE than a typically developing child may not receive adequate vitamin and micronutrients from formulas even if they are prescribed a nutritionally complete formula as their intake is not that of a typical child [42]. Both the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and ESPGHAN guidelines recommend checking vitamin and micronutrient levels at least annually [43,44]. Anthropometrics should be obtained every 4-6 months to monitor weight gain and growth [44]. There is not a single blood test that provides an adequate reflection of nutritional status, but complete blood counts and metabolic panels may be reflective of nutrient deficiencies or poor bone health [9]. A multi-disciplinary approach including physicians, registered dietitians, and feeding therapists should be taken for the management of feeding in this population.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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