

Blended Tube Feeding: Summary Paper

Developed for: Real Food Blends • Kristen N Smith, PhD RDN LD

Purpose

The purpose of this paper is to provide evidence to help support the use of blenderized real food tube feeding (BTF) and the use of commercial BTF products for persons requiring longer-term home enteral nutrition (HEN).

The History of Blended Tube Feeds

Utilizing blended and non-oral-feeding routes is not a new concept. As far back as 3500 years ago, there were reports feeding practices and medical treatments utilizing non-oral routes. The ancient Greeks and Egyptians performed enemas to “infuse nutrients to preserve health, protect an inflamed bowel source or treat diarrhea.” These compounds consisted of blends of wine, milk, whey and wheat or barley broths.¹ In the 18th century, gastric feedings consisted of mixtures of jellies, eggs, wine, milk, beef and tea and it wasn’t until the 19th century that rubber tubing was used for feeding access.¹ Major developments took place as the complexity of the feeding formulas evolved over time (with the addition of specific amino acids and protein hydrolysate formulations)¹ and new medical care practices allowed for feeding directly into the stomach or small bowel (duodenum or proximal jejunum) via nasally-introduced weighted tubes.² Continuing advances were made with the inception of infant formula in the 1940s and the development of the first enteral feeding pump soon after.³ Overall, use of modern enteral feeding practices have been accepted due to evidence of fewer complications, lower costs and safer access (compared with parenteral feeding).¹

The formulas themselves have also progressed from a blend of whole food and beverage items to more modular formulas (allowing for the potential modification of existing products or the development of a new blend) to allow for specific formulations to meet disease- or condition-essential requirements. However, many long-term users of formula tube feedings and their caregivers are transitioning to a “whole-food” tube feeding (“blenderized tube feeding”) approach for a variety of reasons, which are summarized briefly in the tables below.

The transition in enteral feeding practices from the utilization of whole-food-based feedings to formula parallels the trends that have also taken place in infant feeding practices. With the mass commercialization of infant formula, manufacturers began to influence physicians and others through wide-reaching advertising campaigns. These physicians then, in turn, passed this recommendation on to mothers and caregivers. By the 1940s and 50s, both physicians and consumers considered formula feeding to be a “popular and safe substitute for breastmilk.”⁴ During this same time period, rates of breastfeeding declined significantly even though researchers had noted discrepancies between breastfed babies and those receiving formula. In the 1970s, groups in the United States, such as the National Council of Churches’ Interfaith Center on Corporate Responsibility and the Infant Formula Action Coalition worked to increase public awareness on the importance (and benefits) of breastfeeding.⁵ Groups such as these are still working to educate mothers and caregivers on the benefits of breastfeeding (when this type of feeding is an option).

The patterns of evolution are similar between enteral feeding practices and infant feeding practices and both types of feeding appear to be gaining momentum towards an inclusion of whole- or “natural” sources of nutrition for its respective populations.

Personal beliefs regarding food and nutrition as well as a growing understanding of the psychosocial impacts associated with feeding are some of the factors that have helped drive the transition away from formula feeding to the “whole-food” blends that are increasing in popularity. For example, in some cases, patients and/or their families want to utilize this method because of the perceived benefits from consuming food in its natural state. However, in the following tables, several of the most common reasons for transitioning away from commercial enteral formula to BTF are summarized. Of interest is are the reported perspectives of both the people receiving the feeding and the similarities with the opinions and the comments of their caregivers. Overall, the reasons for moving towards a more whole-foods approach appears to be based on the wealth of science supporting an intake of quality, nutritious foods and the resulting benefits that occur as a result of following this type of dietary pattern.

Table 1: Reasons for Increased Usage of Blenderized Tube Feeding Practices⁶

Reasons	Supporting Details
Nutrition benefits	<ul style="list-style-type: none"> ▪ Can be prepared using organic or GMO*-free foods ▪ Can be tailored to satisfy specific diets (e.g., vegetarian, vegan) ▪ Can be developed to avoid food allergens or sensitivities
Improvement in feeding tolerance	<ul style="list-style-type: none"> ▪ Reduction in reflux ▪ Reduction in retching / gagging ▪ Reduction in constipation ▪ Improved volume tolerance ▪ Reduction in oral aversion
Psychosocial aspects	<ul style="list-style-type: none"> ▪ Normalizes meal times ▪ Allows patients to participate in food preparation ▪ Allows caregiver(s) to have a sense of nurturing their loved one
Financial consideration	<ul style="list-style-type: none"> ▪ Less expensive if commercial formula is not covered by insurance

Table adapted from Bobo et al.⁶ *GMO = genetically modified organism.

Patient Perspectives

The table below summarizes the self-reported reasons for the choice to use blenderized tube feedings from a study of 54 patients by Pattinson et al.⁷

Patient Perspectives: Reasons for Using Blenderized Tube Feedings (survey results⁷)

Reasons	Number of Patients (%)
It makes me feel “normal.”	9 (24%)
I can tolerate it better.	11 (30%)
I like eating what my family eats.	12 (32%)
It is more natural.	17 (46%)
I don't like the ingredients of commercial formulas.	9 (24%)
I have food allergies.	2 (5%)
Other reasons	6 (16%)

*Adapted from Pattinson et al.

The following table outlines the results of a survey completed by parents and caregivers who transitioned their children to a BTF program.

Caregiver Perspectives: Thoughts and Opinions on the Use of BTF

Theme	Statements (answered / commented on by caregivers)	Strongly Agree or Agree (n=18)
Satisfaction	<ul style="list-style-type: none"> ▪ The BTF were successful for my child ▪ You would recommend BTF to other parents of tube feeding children 	<ul style="list-style-type: none"> ▪ 94% ▪ 100%
Health & Well-Being	<ul style="list-style-type: none"> ▪ Your child appears happier on BTF ▪ Your child appears healthier on BTF ▪ Do your family members / other caregivers see BTF as being beneficial? ▪ Do your family members / other caregivers feel the effort to make BTF is worth it over commercial formula? 	<ul style="list-style-type: none"> ▪ 94% ▪ 94% ▪ 83% ▪ 94%
Time & Cost	<ul style="list-style-type: none"> ▪ BTF were expensive compared with a regular diet ▪ BTF were time-consuming compared with preparing a regular meal 	<ul style="list-style-type: none"> ▪ 44% ▪ 61%
Level of Acceptance	<ul style="list-style-type: none"> ▪ You will continue to give your child BTF after the study is finished 	<ul style="list-style-type: none"> ▪ 94%

Clinical Evidence

Research on BTF is limited, often based on case reports and anecdotal experiences, but the evidence is growing as the popularity increases. Of the available scientific literature, much of it focuses on GI symptoms, patient / caregiver satisfaction, nutritional quality, food safety and growth. A few of the key papers in this have been outlined in the table below.

Reference	Objective	Study Design and Demographics	Results	Conclusions
Gallagher K, et al. JPEN 2018 ⁸	To evaluate the feasibility of using BTFs in a medically complex pediatric population and assess their impact on clinical outcomes, as well as the microbiota.	Clinical trial N=20 pediatric patients; G-tube dependent, receiving ≥ 75% of daily energy requirements from commercial formula. 17 of the 20 patients transitioned to BTF.	Patients needed 50% more calories to maintain BMI while on BTF vs. formula. BTF micronutrient content was superior to formula. BTF: significant ↓ in vomiting and use of acid-suppressive medications. No change in stool consistency or frequency but stool softener use ↑ in BTF. ↑ in bacterial diversity in stool samples with BTF, relative amounts of Proteobacteria ↓. Caregivers: more satisfied with BTF and “unanimously indicated they would recommend BTF.”	Use of BTF was found to be beneficial in a medically complex pediatric population and may have contributed to improvements in clinical outcomes.
Epp L, et al. NCP 2017 ⁹	To investigate the use of BTF (frequency, tolerance and volume) in adult and pediatric populations on home enteral nutrition (HEN)	Cross-sectional study and survey n=216 (125 pediatric, 91 adults)	Of pediatric patients, 112 (89.6%) used BTF for an average of 71% of total daily intake; 93 (83%) reported BTF >50% of daily EN, 12 (10.7%) reported 25%–50% of daily intake, and 7 (6.3%) reported BTF < 25% of daily intake. Adults: 60 (65.9%) used BTF for average of 56% of daily intake; 41 (68.4%) BTF >50% of daily intake, 11 (18.3%) reported 25%–50%, and 8 (13.3%) had BTF <25% of daily intake.	Most of the pediatric and adult patients surveyed use BTF as some portion of their enteral intake, making it essential that clinicians expand their knowledge related to BTF to appropriately care for this patient population.
Johnson TW, et al. NCP 2015 ¹⁰	To elicit experiences of pediatric dietitians with blenderized food by gastrostomy tube (BFGT).	Survey study n=242 dietitians in the subgroup “Pediatric Nutrition Practice Group”	Over half (58%) of respondents use / recommend BFGT. Reasons for use: parent request (70.2%), TF intolerance (22.9%), inability to obtain commercial formula (6.1%). 79% reported overall positive outcome with BFGT. Older RDs were more familiar with BFGT but ↓ likely to use it compared with younger RDs who use BFGT or wanted more information (<i>P</i> = .007). 12% did not use or recommend BFGT due to concerns about bacterial contamination, unknown nutrient composition, inability to provide follow-up, and/or facility policy violations. 28% were familiar with BFGT but wanted more information.	Interest in BFGT is largely parent-driven or explored as an option for children with tube feeding intolerance. Almost 80% of RDs using this feeding substrate report overall positive outcomes, but 28% indicate they want more information on using BFGT in clinical practice.

Reference	Objective	Study Design and Demographics	Results	Conclusions
Pattinson A, et al. ⁷ 2015 (poster)	To understand blenderized tube feeding (BTF) prevalence and use in patients on home enteral nutrition	Prospective, cross-sectional survey n = 54 patients, mean age = 58.9±13.7 years, 23 (42.5%) female	16 (30%) patients were on HEN greater than 1 yr, 21 (21%) for more than 6 m, 3 (6%) for less than 1 m. Patients in cohort used BTF for a median of 4d/wk ranging from 1-7 d. Patients provided various reasons for using BTF including 13 (43%): being more natural, 10 (33%): they like eating what their family eats, 9 (30%): they can tolerate BTF better. In patients on BTF, 17 (56.6%) patients reported it made up ~ 50% of daily enteral feedings. 79.3% of patients on BTF reported maintaining body weight. 67% reported no symptoms (i.e. nausea, vomiting, fever, diarrhea) on BTF. A comparison of patients using BTF & commercial tube feeding showed ↓ reported nausea, vomiting, gas/ bloating, diarrhea, constipation, and pain with BTF.	More than 50% of patients surveyed use BTF and close to 90% expressed a desire to use BTF if provided with adequate information about the appropriate preparation and storage practices.
Pentiuk S, et al. JPEN 2011 ¹¹	To investigate the use of pureed by gastrostomy tube (PBGT) diet given directly into the G-tube of patients who had experienced gagging and retching post-fundoplication surgery and note the impacts on stomach emptying and tolerance.	Investigation – patient records retroactively reviewed to identify children with symptoms of retching and gagging after fundoplication surgery and started on a PBGT diet. Families offered choice: continue on current diet, try an alternative formula, and modify the feeding rate, try jejunal feedings or use PBGT diet. n = 33 children, mean age = 34.2 months	17 children (52%) were reported to have a 76%–100% ↓ in gagging and retching. 24 children (73%) were reported to have a ≥50% ↓ in symptoms. No child had worsened symptoms on the PBGT diet. 19 children (57%) were reported to have ↑ in oral intake on the PBGT diet.	A PBGT diet is an effective means of providing nutrition to children with feeding disorders. In children post–fundoplication surgery, a PBGT diet may ↓ gagging and retching behaviors.

While ongoing research is documenting some of the beneficial outcomes associated with BTF *and* both patients and caregivers are reporting increased satisfaction with this feeding method, there are noted points of hesitation (albeit not confirmed) which will be outlined below.

Points of Hesitation Regarding BTF Practices

- Limited peer-review publications
- “Not complete” nutrition

There are other points of concern that will not be addressed in this report including: potential microbial contamination, increase in clinician’s time, potential increase in cost / loss of reimbursement, impact on supplies (possible tube clogging or the tube wears out more quickly), impacts on travel, and the facility / hospital may or may not support it.

Point of Hesitation: Lack of Peer-Review Publications (Research)

While working to determine the best feeding practices for a person who requires an alternative feeding method, the nutritional composition of the meals and / or formulas may be called to question, however, in the case of BTF, a point of contention has been the lack of scientific data in this area. Health practitioners are trained to utilize the scientific literature to help support or dissuade a particular practice and the absence of data in this area may initially deter practitioners from recommending its use. However, in persons with adequately functioning gastrointestinal health, it is essential to note that there are no studies showing a benefit of a commercial formula over a ‘real food diet.’ The assumption that just because a person utilizes a tube-feeding device means they will automatically requires formula over blended whole foods is not based on scientific evidence and requires additional conversation between healthcare practitioner and the patient and/or caregiver.

However, **it is well-known and medically factual that (in the absence of certain diseases or conditions that may impact nutritional needs) diets made up of whole foods contributing a range of naturally-occurring vitamins, minerals, phytochemicals, macronutrients and fiber is the gold standard.** In the case of a person requiring ‘standard nutrition’ in the form of a tube feeding, a comparison between whole foods in a BTF versus a standard formula is unnecessary –

the whole food option ‘wins’ in nearly every example. It is in this clear-cut outcome that the need for additional peer-reviewed publications is negated.

Point of Hesitation: Incomplete Nutrition

One of the main benefits of utilizing BTF is that the user is able to participate in a more ‘typical’ meal experience and in fact, may be able to eat what the family is eating. If clinically appropriate to participate in this style of feeding, then all aspects of the meal and responding supplementation may be equivalent as well, including the fact that ‘typical’ meals may not always total 100% of a person’s nutrient needs, however, in many cases there is little risk of deficiency or insufficiency (when a variety of healthy and balanced meals are consumed).

Formulas that are developed to be “nutritionally complete” must provide 100% of the recommended values for carbohydrates, protein, fat, vitamins, and minerals and can be used as a sole source of nutrition. This means that, at least in the short term, a person using formula is likely getting the basics of nutrition that are required for survival. However, a person’s nutritional or medical needs may change over time and in the case of formula tube feeding, the nutritional intake does not adjust to accommodate these needs. There are cases (and conditions) that require a person to need higher (or lower) levels of macronutrients and micronutrients. The use of a static enteral formula does not allow for the specific tailoring of this nutrition plan to meet the individual needs of each person requiring feeding via a tube. Also, use of commercial enteral formulas are often associated with gastrointestinal upset, nausea, diarrhea, etc. While the goal of the nutritionally complete formula is to ensure that a person’s needs are met, in practice, they may not consume the entire dosage due to GI disturbances.

Additionally, there are significant differences in nutritional ‘completeness’ vs. nutritional variety and balance. An enteral formula that meets the criteria to be considered nutritionally complete is reliable and must contain certain specifically determined ingredients to support life and function. However, with the ongoing consumption of a commercial enteral formula comes some potential health risks associated with monotonous nutrition. As scientists and dietitians learn more about nutrition, the evidence mounts supporting the benefits of variety – inclusion of a wide range of fruits, vegetables, grains, legumes, dairy, lean proteins, fats, etc. may carry with them a plethora of benefits that are just starting to be identified. Without a way to incorporate nutritional variety into traditional tube feeding practices, the potential synergistic effects and benefits associated

with the consumption of various types of whole foods together may be impossible. Fortunately, when medically and clinically appropriate, BTF does allow for the participation in nutritional variety and balance.

Benefits of BTF

Mounting evidence is showing an increase in acceptance of BTF in place of enteral feeding or as an adjunctive feeding practice. The following sections outline some of the benefits associated with transitioning towards a more whole-foods approach. Intake of BTF utilizes whole foods and ingredients instead of commercial formula and supplements. Below some of the key benefits associated with BTF are reviewed.

Benefit: Vitamins and Nutrients from Whole Food Sources vs. Synthetics

Whole fruits, vegetables, whole grains, and other foods contain hundreds or even thousands of phytochemicals and fibers that are beneficial to health and gastrointestinal function.^{12,13}

Conversely, commercial enteral formulas often contain processed ingredients such as¹⁴:

- Corn syrup
- Maltodextrin
- Sucrose
- Casein
- Whey protein
- Soy protein
- Soy and corn oil
- Limited amounts and types of fiber

Additionally, the Dietary Guidelines for Americans notes that nutritional needs should be met through diet (i.e., whole foods) when possible.¹⁵ Supplemental formulations and enteral nutrition products are necessary for hospital use and in the cases of certain conditions because they contain set amounts of calories, macro- and micronutrients in a convenient and safe format.¹⁴

However, when whole foods are eliminated from a diet, there are bound to be potentially lacking components. The inclusion of whole foods offers three major benefits over supplements¹⁶:

- **Greater overall nutrition** – whole foods are complex and contain a range of the micronutrients that the body requires

- **Essential fibers** – whole foods (including whole grains, fruits, vegetables, and legumes are a source of dietary fiber which can help prevent certain diseases (like type 2 diabetes and heart disease and can also help manage constipation).
- **Protective substances** – many foods that are generally considered ‘healthy’ are also good sources of antioxidants – compounds that help slow down a natural process in the body that may lead to both cell damage and tissue damage. What is currently unclear is whether antioxidant supplements provide the same benefit as naturally occurring antioxidants in food (in some cases, use of high-dose antioxidant supplements have been associated with specific health risks).

Benefit: Ability to Control or Tailor Meal / BTF Formulation:

Utilizing a home or commercial BTF has many advantages but a key distinction is that the consumer has complete control over exactly what they are being fed through the tube. By adapting the recipe (and likely with the help of a Dietitian), the person can assess a single meal, a single day’s worth of meals or create an ongoing analysis of their nutrient intake. By relying on the use of foods (and not commercially derived ingredients or supplements), the amount of certain macro- or micronutrients can be more easily controlled while still providing the other benefits associated with BTF use. Outlined below are a handful of medical conditions in which extra amounts of specific vitamins, minerals, macronutrients or food ingredients may be harmful to the consumer. In these specific cases, there are well-defined diet plans that must be followed to ensure the management of or prevention of additional potentially detrimental health outcomes.

Benefit: Ability to Mitigate Potential Risks Associated with Nutrient Insufficiency or Deficiency

Whether a person is on a commercial enteral formula or a BTF, they should be closely monitored by a team of health care professionals to ensure overall adequacy of nutrition. In the case of transitioning from a commercial enteral formula to BTF, a dietitian can calculate the person’s individual macro- and micronutrient needs and help to develop a blend around these values, and supplement with additional vitamins, minerals and electrolytes when medically appropriate.

However, a key benefit of BTF is the practice of “eating what the family eats.” In these cases, one must also look at the other members of the family and meal / nutritional behaviors.

Assuming there are no nutrition-dependent diseases or conditions present, a person consuming a plated-meal would not supplement at each eating occurrence to be sure their needs are met at 100%. Instead, that person might consider the consumption of whole foods as their primary source of vitamins and minerals. IF the person became concerned about nutritional inadequacies or insufficiencies, then the next steps may involve supplementation of key nutrients. This practice should transition nearly equivocally to persons utilizing BTF. Food is fuel, and in this case, the food is simply blended but the nutrient composition remains intact.

Benefit: Able to Mitigate Risks Associated with Excess Levels of Certain Nutrients

In certain populations, the intake of high levels of nutrients (vitamins, minerals, even macronutrients) can be detrimental to health. The vast majority of ready-to-feed commercial enteral formulas contain 100% of the RDIs, and no ability to customize if a patient’s condition needs less than that. In this section, we outline a handful of conditions that may be experienced with elevated levels of food compounds. A benefit of using a BTF protocol is that these nutrients can be limited or intake can be avoided altogether.

Hemochromatosis: Hemochromatosis is a metabolic disorder affecting over 1 million people in America. This disorder is characterized by the body’s genetic propensity to load too much iron. If this condition is left untreated, it can cause irreparable damage to the joints, organs and eventually be fatal. In the case of Type 1 (also called Classic Hemochromatosis, HHC), people absorb extra amounts of iron from the diet and the body is unable to remove the extra iron. Aside from following necessary treatments (such as therapeutic phlebotomy), it is also important to follow a hemochromatosis-friendly diet or eating plan to ensure appropriate care is paid to the intake of iron-containing foods.¹⁷

Chronic Kidney Disease: Patients with chronic kidney disease (CKD) require adequate nutritional intake in order to help maintain good nutritional status, slow disease progression and to help treat potential complications. Special care must be taken to reduce protein intake (if excessive), control blood pressure through reduction in sodium intake, to closely monitor potassium levels (and reduce intake when appropriate) and to follow diabetes-related nutritional instructions to manage blood glucose profiles.^{18,19} These nutritional profiles and goals will also need to be further adjusted with the inception of dialysis treatments.

Cancer Treatment: For patients undergoing treatment for various forms of cancer, use of supplemental vitamins and minerals must be discussed with the oncologist, the oncology dietitian, and the treatment team. While the situations may vary based on the type of cancer being treated as well as the methods and techniques utilized for treatment, there is some evidence suggesting that vitamin and mineral supplements and/or antioxidant formulas may interfere with (or potentially counteract) the effects of chemotherapy or radiation treatment.²⁰ Some studies have noted that the use of antioxidant supplements may actually interfere with these treatment processes by reducing their effectiveness. Certain antioxidants may provide protection to tumor cells, as well as to healthy cells, thus reducing the beneficial effects associated with these treatments.^{21,22} Research outcomes are inconclusive regarding intake of vitamin D as well as antioxidant vitamin E while undergoing treatment for different types of cancer, as the efficacy of the cancer treatments may be impacted.^{23,24} In these instances, amounts of vitamin D from foods should be monitored closely and additional supplementation may need to be limited or avoided altogether.

Hypervitaminosis A: A diet that includes five servings a day of carotenoid-rich fruits and vegetables as well as milk and meat products generally provides enough vitamin A without food fortification or supplementation.^{25,26} Even in the U.S., however, some groups may not eat a sufficiently varied diet. American teenagers are a prime example of this discrepancy; fewer than half have an adequate intake of vitamin A.²⁷

However, with increasingly widespread fortification of vitamin A in foods and increasing use of dietary supplements, many Americans, especially younger children, have the opposite problem: consuming more vitamin A than the Institute of Medicine considers safe.^{25,28-30} Vitamin A is fat soluble and levels can accumulate leading to significant toxicity known as hypervitaminosis A.³⁰ Researchers have noted that although hypervitaminosis A can be a result of excessive dietary intakes, typically this condition results from too much preformed vitamin A from supplements or therapeutic retinoids and the tissue levels take a long time to decline once discontinuation of the supplement occurs. Results of observational studies have suggested an association between elevated intakes of preformed vitamin A (greater than 1,500 mcg per day, only slightly higher than the RDA) and detrimental physiological outcomes (i.e. increased fracture risk or reduced bone mineral density). Tube feeding products containing high levels of vitamin A that require multiple servings per day may potentially increase the risk of hypervitaminosis A and should be taken into account when deciding on feeding protocols for persons requiring feeding support.

Excess Zinc: Zinc is an essential nutrient but does carry with it risk with excessive intake.²⁶ In general, no adverse effects have been seen in the consumption of naturally occurring zinc from foods. However, excessive intake of zinc has been shown to suppress immune function due to zinc's interference on copper absorption (leading to copper deficiency, anemia, changes in white blood cells and lowered immunity).^{25,31} Clinical studies have documented that high zinc intake has been associated with increased hospitalizations for genitourinary causes.^{31,32} As a result, the German Federal Institute for Risk Assessment has proposed the limitation of zinc fortification.³²

In the US, the intake of zinc in children has increased over the past couple of decades.^{33,34} Researchers at the University of California-Davis warned that "if zinc intake continues to increase because of the greater availability of fortified foods in the US food supply, the amount of zinc consumed by children may become excessive."³³ The Institute of Medicine (in 2005) reported that high intake of fortified zinc was becoming a cause for

concern for young children.²⁹ In 2010, Butte et al reported that 72% of 1-to-3 year old children were getting too much zinc from diet and supplementation. This excessive intake is particularly noticeable in families participating in the federal Women, Infants and Children (WIC) program and for those in a low socioeconomic status, due to diets often limited in fresh food and instead are comprised with more processed and fortified foods.²⁹

Excess Niacin: Like the other nutrients above, niacin is considered essential. It is a vital player in metabolic reactions and assists in the activity of many enzymes. In the early 20th century, niacin deficiency (called pellagra) was common in the United States and parts of Europe, where corn (low in both niacin and the amino acid tryptophan) was a staple of standard diets.³⁵ Today, niacin has all but disappeared in the developed world. Instead, there are increasing cases of excessive niacin, which can lead to flushing reactions, tingling, itching, and reddening of the skin, rashes, and nausea. Continued elevated intakes of niacin can cause liver toxicity, with effects such as jaundice, glucose intolerance and blurred vision.³⁶

Food Allergies / Sensitivities (i.e. Celiac Disease): Celiac disease is an autoimmune condition that can occur in genetically predisposed people in which the consumption of gluten-containing foods products can damage the small intestines. Dietary modifications are essential for the management of celiac disease and include the complete avoidance of gluten (a protein found in wheat, rye and barley) and gluten-containing foods.

Total Caloric / Energy Intake: In cases when a young child or a smaller person receives enteral formulations, they are, at times, receiving 1-1.5 times what their energy needs are per day (and thus greater intakes of certain nutrients) due to a higher caloric density of their prescribed formulation. This is another example in which having full control to create the nutritional profile of a BTF may be important.

While the research above is based on supplementation in foods, one may be able to theorize that if children are at risk of excessive nutrient intake based on typical dietary patterns of consumption (with fortified products) then someone on an enteral formula might be at a more pronounced risk due to high levels of the above mentioned nutrients present in many enteral formulations.

Benefits of Commercial BTF (Real Food Blends)

The benefits of BTF are to be able to consume whole foods, full meals and to utilize farm-grown and/or store-bought items to be specifically blended into a tube feed formula.

Convenient alternatives to home-made tube feedings are the whole-food-based commercial formulas that solely provide whole foods and meal composition without the added preservatives and synthetic vitamins and minerals found in commercial enteral formula. These products also are shelf-stable and portable.

Additional Points to Consider: Can Eating Too Much of Something Cause An Allergy?

The American College of Allergy, Asthma and Immunology states that there is no relationship between consuming large (or repetitive) quantities of a food and the development of a food allergy.³⁷ The regular consumption of a food is one way to maintain tolerance to that particular item. However, it is not unheard of to develop allergies to foods that have been previously tolerated in the past but the mechanism of how this occurs is unclear. The development of an allergy to a specific food may develop at any time but it is most common in childhood and less likely (but still possible) as an adult.

Additional Points to Consider: Plant vs. Animal Protein and Muscle Growth.

A 2018 review of enteral formulas noted that the protein source (and the level of hydrolysis) in an enteral formula may impact:

- Ease of absorption
- Gastrointestinal tolerance
- Contribution to osmolarity of the enteral formula
- Level of protein utilization.^{38,39}

This information is particularly relevant for someone on a tube feeding protocol. The basis of the protein source in the formula (commercial or BTF) should be carefully considered as well as the quality of the protein (determined by the presence of essential and non-essential amino acids).⁴⁰ Additionally, the source of the protein is of the utmost importance since animal-based proteins (egg or dairy) tend to be used more efficiently than vegetable-based protein⁴¹⁻⁴³ and benefits associated with nutrition may vary based on the presence of quality proteins.^{38,44} Savino et al. reported that high-quality protein (from animal sources) rate higher than vegetable protein in the following areas: protein efficiency ratio, biological value, net protein utilization, and protein digestibility-corrected amino acid score (PDCAAS).³⁸ These factors are important to understand because they help assess the overall quality of the protein which in turn may affect tolerance as well as absorption rate and how well the body is able to utilize the protein.⁴⁵⁻⁴⁷

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