Optimizing enteral feeding for pediatric and adult patients when using blenderized tube feeding

Introduction

Despite increasing global popularity of blenderized tube feeding (BTF) among enteral nutrition (EN) patients, families and caregivers across the care continuum, patients who require an enteral feeding pump to administer their feedings still face challenges. Standard enteral feeding pumps are not designed for the viscosity of BTF, which can lead to increased pump alarms, longer feeding administration times and compromised accuracy of delivery. Additionally, the lack of education and clinical support of healthcare professionals (HCPs) may be contributing to the slow adoption and under-prescription of BTF in patients who may benefit from it.

The purpose of this paper is to provide an overview of the global interest in BTF, the clinical benefits as well as potential risks, and relative contraindications for its use with an emphasis on overcoming unnecessary barriers. Various methods of BTF administration will be discussed, highlighting advantages and disadvantages of each technique. The challenges of using standard enteral feeding pumps and feeding sets with BTF and associated clinical "work arounds" will be covered, as well as a new generation of enteral feeding pumps and feeding sets designed to overcome these obstacles. The International Dysphagia Diet Standardisation Initiative (IDDSI) Framework will be identified as an objective and reliable method of evaluating BTF viscosity. Finally, the education of HCPs to promote the appropriate use of BTF will be emphasized as a critical need with the goal of optimizing patient clinical outcomes.

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Overview of BTF clinical benefits, potential clinical risks and relative contraindications

The growing interest in BTF among both adult and pediatric patients reflects the same principles that apply to the food choices that are made by individuals who eat by mouth, including nutritional, cultural, religious, ethical and personal choices.[1] Two major types of BTF include commercial BTF, which is manufactured with whole food-based ingredients or pureed foods and prepackaged for use, and prepared BTF, which is made in a home or hospital blender with whole food-based ingredients or pureed foods for individual use.[1] Both commercial and prepared BTF must be prescribed by a HCP.[1]

Globally, it is estimated that 40-56% of adult home EN patients use BTF to some extent.[2, 3] Up to 85% of children with severe developmental disabilities have feeding-related disorders requiring EN,[4] and the parents of these children desire BTF instead of standard formulas, citing their interest in a more physiologic feeding that may improve gastrointestinal (GI) symptoms.[4]

The demand for BTF is not only about having a choice in enteral formula selection, but also about improving clinical outcomes and quality of life for patients and families. For example, the use of BTF in pediatric patients with GI medical complexity is associated with reduced or eliminated need for GI medications,[4, 5] decreased hospitalization rates and emergency department visits, reduced GI symptom burden and improved quality of life.[6, 7] There are many clinical benefits of using BTF in both pediatric and adult patients as referenced in **Table 1**.

It is imperative that HCPs are involved in the prescription and monitoring of BTF to identify and resolve any possible clinical risks related to their use (**Table 2**) as well as account for any relative contraindications (**Table 3**). If HCPs become knowledgeable and confident about the clinical indications, potential risks and relative contraindications of BTF in the care of their patients, the use will be more likely to be appropriate, it could help reduce the likelihood of nutrition-related complications and it could promote positive clinical outcomes.

Table 1. Clinical benefits and improved outcomes associated with BTF

- Improved GI tolerance and reduced adverse GI symptoms, promoted physiologic gastric motility and bowel regularity without adverse effects, reduced GERD, gagging, retching, emesis, diarrhea and constipation in children and adults.[1, 2, 4, 6-20]
- Increased patient and caregiver satisfaction, quality of life, wellbeing and empowerment.[1, 2, 5, 7, 10-13, 15, 20-23]
- Fulfills the patient and caregiver's desire for more natural EN formulas made from whole-food ingredients as well as reduces total added sugar, artificial flavors and additives in food consumption.[2, 5, 7, 8, 11, 14, 16, 22-24]
- Allows clinicians the ability to individualize EN prescriptions to meet specific dietary needs such as food allergies, ketogenic, vegetarian, cultural, ethical and religious preferences.[1, 2, 4-11, 16, 17, 21, 22]
- Improves psycho-social connections and normalization around mealtime and promotes parent empowerment.[2, 5, 8, 11, 12, 15, 16, 21-23]
- Promotes oral intake and decreases food aversions in pediatric patients.[1, 4, 5, 10, 12-14, 17, 19, 20, 24]
- Reduces or eliminates the need for GI medications.[4, 5]
- Promotes gut microbiome diversity.[4, 5, 10, 12, 16]
- Supports growth goals in pediatric and mitigates weight loss in adult home EN patients.[4, 9, 13, 16, 19, 20]
- Associated reduction in healthcare costs: fewer visits to the Emergency Department per year (43% reduction), decreased total hospital admissions (53% reduction) and respiratory-related admissions (67% reduction).[7, 12, 16]

Table 2. Possible clinical risks of BTF

- Prepared BTF can lead to caregiver stress/burnout in relation to food safety and preparation time.[1]
- Concern about microbial contamination and food-borne illness with prepared BTF, including questionable sanitary home environments and limited caregiver education. However, judicious use of BTF and adherence to safe food handling practices provide a safe equivalent to standard enteral formula.[1, 12, 15, 22, 24-26]
- Growth and adequate nutrition delivery with prepared BTF; however, the impact of BTF on patient anthropometrics is variable. BTF alone may not provide sufficient energy to certain patient populations with high caloric requirements.[1, 2, 22, 27]
- Need for healthcare provider involvement in prescribing and monitoring tolerance of both prepared and commercial BTF.[1, 6, 7, 11, 15, 24, 25, 28]
- Prepared BTF may not be permitted for inpatient use secondary to risk of microbial contamination.[1, 15, 23, 24]
- Increased preparation time with prepared BTF, limits in shelf stability and decreased hangtime of two hours or less.[1, 23, 24, 26]
- Lack of clinical support, training and knowledge among HCPs (dietitians, physicians and advanced practice clinicians) may hinder adoption and use of BTF.[2, 4, 5, 7-9, 11, 12, 15, 16, 21, 22, 29, 30]
- Barriers to use of BTF: perceived risk of increased feeding tube clogging (however, no published study has found an association between BTF and higher rates of feeding tube occlusion or infection related to microbial contamination), need for a specialized blender, cost of food, inadequate food safety practices and lack of insurance coverage.[4, 5, 12, 15, 22-24, 29]
- Concern about standard enteral feeding pump accuracy with BTF (range of 14-30% accuracy of delivery).[27, 31]

Table 3. Relative contraindications to the use of BTF

- Children at risk of infection secondary to a known immunodeficiency or receiving immunosuppressive medications.[12]
- Patients who require precise administration of specific nutrients may be at risk of nutrient imbalances and must be monitored closely.[12]
- Patients with an underlying metabolic instability or endocrine disease that would compromise their safety without intense monitoring and follow up.[12, 24]
- Critically ill patients with hemodynamic instability (mean arterial pressure <60 mm Hg) or a non-functioning GI tract.[24, 28]
- Patients with small bore feeding tubes (defined in the literature as less than 14 French), immature gastrostomy sites, or post-pyloric enteral access.[1, 25]
- Infants less than 6 months of age.[32]

Table 4. Advantages and disadvantages of bolus, intermittent and continuous feeding methods[33]

Advantages	Disadvantages
Bolus	
• More physiologic digestion compared to continuous • No need for feeding pump • Inexpensive and easy to administer • Minimal feeding time • Patient is free to move about and participate in activities such as appointments, school and work • More likely to receive full volume of prescribed formula	• Increased risk of aspiration • Delayed gastric emptying • Osmotic diarrhea
Intermittent	
• More physiologic digestion compared to continuous • May be better tolerated than bolus feeding • Feeding pump not needed but can be used • May improve quality of life • As with Bolus method, allows greater mobility between feedings	• Increased risk of aspiration • Delayed gastric emptying
Continuous	
• May improve GI tolerance • Allows lower volume of formula to delivered at a consistent rate during administration with more time for nutrient and fluid absorption • May reduce risk of aspiration	• Enteral feeding pump and feeding sets required which can lead to higher costs compared to bolus or intermittent • Increased time for feeding administration may restrict ambulation

Methods of BTF administration

In general, EN including BTF can be administered by three different methods: bolus via syringe, gravity using a bag that is hung to drip formula into the patient's feeding tube and intermittently or continuously via an enteral feeding pump.[33] Each of these methods has advantages and disadvantages (**Table 4**). For some patients, the use of an enteral feeding pump is required for feeding, such as those individuals with small bowel enteral access. Indications for small bowel enteral access include intolerance to bolus or gravity feedings, gastroparesis, gastroesophageal reflux disease (GERD) and history of aspiration.[34]

Enteral feeding pumps have the functionality to perform bolus, intermittent and continuous feedings, but are the only method able to perform continuous hourly small volume feedings.[35, 36] This is relevant to patients who cannot tolerate larger volumes of formula and must be fed continuously over longer periods of time. Another advantage of using an enteral feeding pump in acute, extended and home care settings is the ability of the device to monitor and record the volume of delivered feeding and fluid over time to aid in assessing nutritional adequacy. This is critical in EN patients who require careful monitoring of their fluid and nutritional intake to ensure they consume their prescribed daily requirements.

The challenges of using BTF with enteral feeding pumps

Despite the value of enteral feeding pumps when indicated for patients, they are not without challenges. These include restriction of mobility when attached to a pump, which has led to a desire for a smaller, more portable device. Furthermore, pumps often emit light and sound and therefore may disrupt sleep when feeding is performed overnight. Please see published whitepapers on Nighttime Enteral Feeding and Pediatric Nighttime Enteral Feeding. Malfunction of the device can also result in inaccurate delivery of prescribed nutrition.[35, 36]

Unfortunately, technological characteristics of standard enteral feeding pump motors and feeding sets were not designed, nor cleared by the Food and Drug Administration (FDA) within their instructions for use (IFU), to adequately handle the viscosity of administering prepared BTF. Therefore, it is considered off-label to use standard enteral feeding pumps for this purpose. The inefficiency of these standard pumps and feeding sets with the increased viscosity of prepared vs. commercial BTF can result in both increased risk of feeding tube clogging and under delivery of BTF to the patient.[11, 37]

Knowing the BTF viscosity and consistency, and avoiding lumps, chunks and seeds, helps ensure safe administration through a feeding tube without increasing the risk of clogging it. An objective and reliable method, supported by the American Society for Parenteral and Enteral Nutrition (ASPEN) BTF practice recommendations, to standardize the assessment of BTF viscosity and promote its successful use, is to measure the thickness of formula using the IDDSI Framework (**Figures 1 and 2**).[1] IDDSI is an internationally recognized standard that objectively quantifies the thickness of various foods and drinks consisting of eight levels. Drinks are categorized over 5 levels ranging from thinnest at level 0 (Thin) to thickest at level 4 (Extremely Thick) (www.IDDSI.org). Many BTF fall in the range of IDDSI levels 2-4 (Mildly Thick to Extremely Thick) drinks but can have significant variability whether prepared commercially or in a blender on an individualized and customized basis. Other factors influencing the viscosity of BTF are listed in **Table 5**.

Figure 1. The IDDSI Framework

Providing a common terminology for describing food textures and drink thickness to improve safety for individuals wih swallowing difficulties.

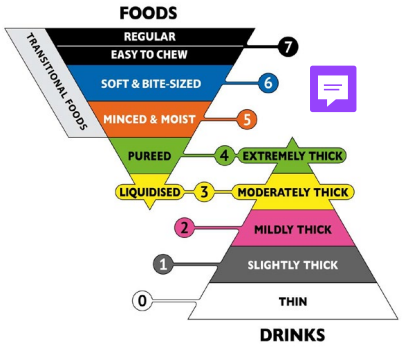
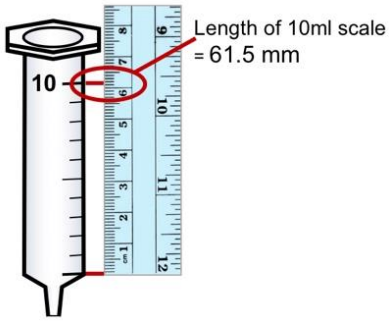
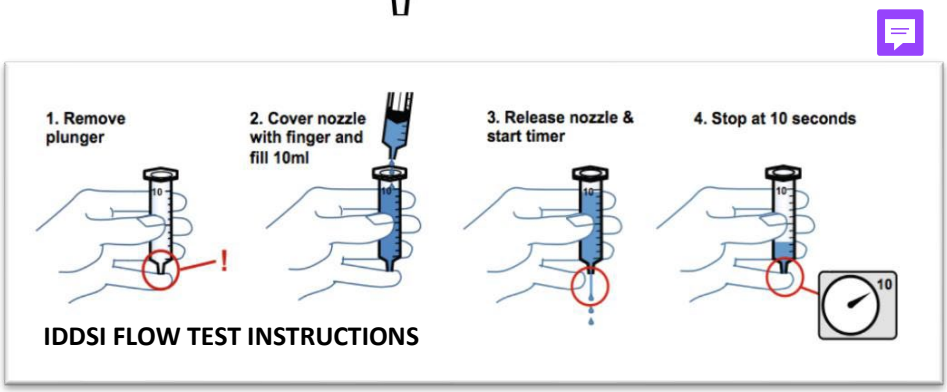
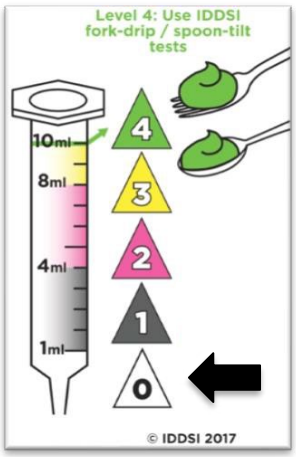


Figure 2. IDDSI Flow Test Instructions (IDDSI.org)

#Before you test...
You *must check* your syringe length because there are differences in syringe lengths. Your syringe should look like this







In addition to the limitations of the enteral feeding pump motor and risk of feeding tube clogging when BTF formulas are used with standard enteral feeding pumps, two peer-reviewed studies have evaluated the accuracy of standard enteral feeding pumps with BTF formulas in a head-to-head fashion.[27, 31] These two studies concluded that, when delivering moderately and extremely thick formulas (IDDSI level 3-4), the accuracy of delivery ranged from 14-30%[27] and 22.5%[31] respectively, which raises concern for the ability of standard pumps to ensure nutritional adequacy with BTF during feedings.

Another global challenge faced by EN receiving BTF in the home setting involves the rising costs of healthcare. For example, in the United States (U.S.), insurance reimbursement is driven by the Healthcare Common Procedure Coding System (HCPCS). There are primary HCPCS codes for enteral formulas, enteral feeding pumps and feeding sets with pumps. This means that a new generation of specialized enteral feeding pumps and feeding sets available on the market designed for the administration of BTF is required to use these primary HCPCS codes which may result in suboptimal reimbursement by insurance companies and third-party payers. The creation of new HCPCS codes specific to these specialized enteral access devices and feeding sets may make their use more feasible and sustainable.

Standard enteral feeding pump limitations with BTF results in clinical "work arounds"

In response to the barriers that can arise when administering BTF with standard enteral feeding pumps, several clinical "work arounds" to overcome these problems and provide solutions have been reported in the literature and recommended by HCPs.[27, 31, 38] The HCP and caregiver may need to make multiple changes in formula or feeding regimens to resolve feeding issues and mitigate alarm fatigue, which can put a burden on HCPs, patients and caregivers. If patients and caregivers cannot rely on their enteral feeding pump to administer the prescribed feeding, trust in the nutrition care plan may become compromised, potentially leading to suboptimal patient outcomes.[38]

HCPs and caregivers may need to lengthen the number of hours required to deliver the full prescribed volume.[38] Longer hang times to administer the prescribed volume of formula may expose the patient to risk of bacterial contamination.[38] Also, extending the feeding time to administer the full BTF volume may interfere with pump-free time and other activities of daily living which may compromise quality of life.[38] Finally, dilution of thick formula with water to decrease viscosity may undermine the clinical benefits of thick formula on feeding intolerance and GI symptoms.[6]

Table 5. Factors that can influence the viscosity of BTF[1]

- Type of blender used
- Hydration content of specific types of ingredients
- Seasonal variation of ingredients
- Caloric and fluid composition
- Method of preparation
- Temperature of formula at time of delivery
- Environmental temperature
- Manufacturing date with commercial BTF (product can thicken over time)

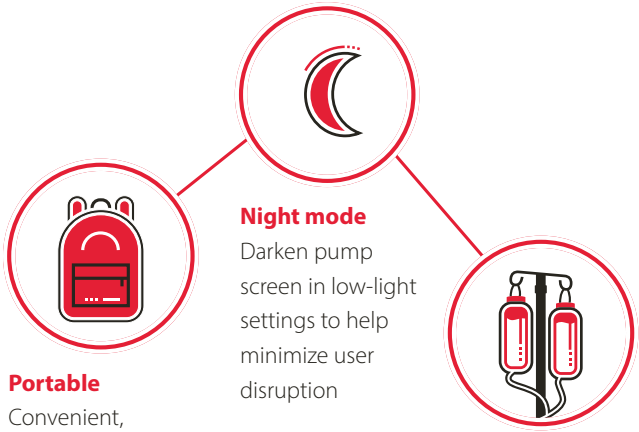
A new generation of enteral feeding devices to optimize BTF delivery

To fill an unmet medical need related to the use of BTF in EN patients that use enteral feeding pumps, respond to feedback from HCPs and resolve these clinical "work arounds," an enteral feeding pump and feeding sets capable of delivering thick formula is commercially available for patients from infant to adult in all care settings. In 2023, the **Cardinal Health Kangaroo OMNI™ Enteral Feeding Pump and Feeding Sets** entered the market with an indication for delivering thick formula up to an IDDSI level 4 (Extremely Thick) in addition to standard formula for infants, children, adolescents and adults. The Kangaroo OMNI™ Enteral Feeding Pump and Kangaroo OMNI™ Feeding Sets are intended to be used in hospital and acute care settings, as well as long term and home care settings. It is intended for stationary and ambulatory settings including ground and air transport while using a backpack accessory.

The Kangaroo OMNI™ Enteral Feeding Pump and Kangaroo OMNI™ Feeding Sets address the problem of accurately delivering thick formula , defined as enteral fluids of smooth consistency that would be categorized as level 2 (Mildly Thick), 3 (Moderately Thick) or 4 (Extremely Thick) drinks within the IDDSI framework. Unlike previous generations of the Kangaroo™ Feeding Pumps and other commercially available standard feeding pumps on the market, which are indicated only for commercial BTF administration and can under-deliver formula by as much as 30%,[27, 31] the Kangaroo OMNI™ Enteral Feeding Pump and thick formulas feeding sets are able to deliver both commercial and home-prepared BTF with an accuracy of +/- 10%.*

In addition to the accuracy with which the device delivers BTF, the Kangaroo OMNI™ Enteral Feeding Pump was designed with several other features to address challenges noted above with previous generations of feeding pumps (**Figure 3**). For example, it includes feed-flush technology, automating the delivery of water flushes at programmed intervals, which has been shown to improve adherence to flushing orders, reduce nursing work load and decrease the risk of feeding tube clogs.[39-41] This pump also has a night mode feature that reduces screen brightness by changing from full color display to black and amber, and is a smaller and lighter pump than previous generations of Kangaroo™ Feeding Pumps.

Figure 3. Features of new generation enteral feeding devices



The Kangaroo OMNI™ Enteral Feeding Pump is the first pump of its kind to enter the commercial market that can deliver both commercial and prepared BTF up to IDDSI Level 4 (Extremely Thick) with +/- 10% accuracy of delivery. As other enteral feeding pumps come to the market with the capability of delivering thick formula, it will be crucial for HCPs, patients and families to understand how BTF is defined by the pump manufacturer and to follow the device's IFU. Notably, there are many variables contributing to BTF viscosity and how thick formulas are defined, which must be taken into consideration (**Table 5**).

Education of healthcare professionals regarding the use of BTF is a critical need

To date, BTF may be under-prescribed by HCPs due to lack of knowledge and confidence in applying this feeding option into real world practice even though there is growing evidence to support it, including at least five published international clinical recommendations.[1, 42- 46] Consequently, patients and families are resorting to resources that may not be evidence-based to obtain information. Researchers have reported that 61% of EN patients seek BTF information from social media, websites and blogs, which may not always be trusted resources.[21] Some of the reasons for this trend, outlined in **Table 2**, may be related to concerns from HCPs regarding the potential for adverse effects with the use of prepared BTF, such as the risk of microbial contamination and food-borne illness, but this can be overcome through heightening awareness and providing education to HCPs, patients and their families.[1, 9, 12, 15, 22, 24-26] Other major concerns include the potential for an allergic reaction to an ingredient, potential for clogged feeding tubes and variability in nutrient composition. [1, 9, 12, 15, 22, 24-26] However, none of these concerns have been cited as a significant problem unique to BTF.[4, 5]

Potential barriers to success can be mitigated by HCP involvement in commercial and prepared BTF prescribing as well as routine monitoring of nutrition parameters.[1, 2, 9,11,15, 24, 25, 28] This includes helping patients and families with strategies to address individual concerns. Some examples include troubleshooting time-consuming and potentially costly meal preparation with prepared BTF, finding motivation to deal with day-to-day routines, addressing the need for increased clinical nutrition monitoring, ensuring periodic BTF recipe nutrient analysis and reinforcing the importance of best practices in the care environment to prevent food-borne illness.[24]

Lack of clinical support, training and knowledge in HCPs may be hindering the adoption and use of BTF across care settings.[2, 4, 5, 7-9, 11, 12, 15, 16, 21, 22, 29, 30] According to Brown et al., only 16-49% of home EN patients rely on HCPs for BTF guidance.[21] Clinicians are willing to recommend BTF to their patients but lack awareness, training, confidence and resources.[25, 30]

The creation of education programs for HCPs who monitor EN patients closely will address lack of confidence and competence regarding the use of BTF in patient care. There is a need for HCP education to aid in the resolution of concerns regarding historical limitations such as the lack of health system policies and procedures for BTF use and to empower clinicians to overcome the imprecision and suboptimal performance of standard enteral feeding pumps with BTF by embracing new enteral feeding pump technology.

Summary

There is a growing demand and forward trajectory of EN patients, families, caregivers and HCPs desiring to use BTF across the care continuum as part of a cultural shift sparked by the desire for a more holistic and natural option when consuming nutrition. Although there are several administration methods that can be used with BTF, when an enteral feeding pump is indicated, there are reasonable concerns about the limited technological capabilities and efficacy of standard enteral feeding pumps and feeding sets with both commercial and prepared BTF. The clinical work arounds with such pumps highlight a pivotal barrier in healthcare and may compromise a patient's nutritional well-being and quality of life.

A new generation of enteral feeding pumps has entered the market that can deliver thick formulas; however, it is the FDA-cleared Kangaroo OMNI™ Enteral Feeding Pump and Kangaroo OMNI™ Thick Formula Feeding Sets that address the problem of suboptimal accuracy of delivering both commercial and prepared BTF. Using standard feeding pumps to deliver prepared BTF categorized as Levels 2 (Mildly Thick) to 4 (Extremely Thick) drinks within the IDDSI Framework is deemed off-label use and may compromise the accuracy of a patient's prescribed BTF delivery, which may have negative implications on nutritional adequacy over time.

In conclusion, to enable broader acceptance and adoption of BTF use, when indicated, the knowledge gap among HCPs needs to be addressed through training and evidence-based educational resources. This is vital to ensuring EN patients, families and caregivers are given the most appropriate clinical guidance for success with BTF. The Cardinal Health Kangaroo™ Enteral Feeding Portfolio aims to provide clinical solutions and educational resources to positively impact patient clinical outcomes and healthcare provider confidence.

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* Important information: Prior to use, refer to the instructions for use for indications, suggested procedure, warnings and cautions.