I. Introduction

Blenderized tube feedings, or the provision of food that has been pureed using a blender through a patient's feeding tube, is a practice that has recently been gaining in popularity despite the availability of commercially prepared, nutritionally complete formulas. While many health professionals may prefer to use the chemically defined formulas that have been prepared to maximize safety and provide appropriate nutrition to a variety of patients, there has been an increase in patient interest in the use of blenderized tube feeds, particularly in pediatric patients.

As reliance on the internet as a source of family health solutions increases, more parents are discovering and requesting the use of blenderized diets for a variety of reasons, including a growing interest in natural foods for their child's diet. With books such as *The Homemade Blended Formula Handbook*, and websites such as www.foodfortubies.com, it is clear that interest in this feeding method will continue to increase over the next few years. Further, the use of blenderized tube feedings may actually provide benefits to some patients, and may be advantageous over the use of commercial preparations in certain populations. Anecdotal reports of clinical improvement in children whose parents have decided to make the switch are numerous and detail parental and clinician observations of improved outcomes. Thus, it would improve the safety and efficacy of this treatment if dietitians were able to develop nutritionally adequate blenderized diets and appropriately monitor the pediatric patients whose parents choose to use them.

The purpose of this paper is to provide a comprehensive review of the use of blenderized tube feeds in pediatric populations and to describe the currently available evidence supporting its use in specific patient populations. This paper will describe the advantages and disadvantages of the blenderized diet, define key parameters in determining the appropriate candidates for blenderized tube feeds, and develop nutritionally complete recipes for use with patients who have been approved for the transition to a blenderized diet. As interest in this technique is likely to grow in the coming years, it is critical for dietitians to understand why and how a blenderized diet should be used in order to guide interested patients in a safe and effective way.

II. A Brief History of Enteral Feeding

The use of enteral feeding has existed since the time of the ancient Egyptians and Greeks, when enemas containing solutions of wine, milk, whey, and grain broths were used to provide nutrients, protect an inflamed bowel, or treat diarrheal disease (Chernoff 2006). Rectal feeding was used for thousands of years due to the difficulty in accessing the upper gastrointestinal tract with rudimentary tubes, and the first tubes for oro- or nasogastric feedings were developed during the 16th through 18th centuries. Enteral feeds continued to be made from common foods such as milk, eggs, beef broth, mashed potatoes, and even whiskey or brandy (Chernoff 2006).

In the 1940s, the first infant formula was developed for babies with allergies, diarrhea, and other GI dysfunctions. At the same time, the first studies demonstrating the benefits of using enteral rather than parenteral feeds were published; thus the use of tube feedings started to become more common in hospitals where blended formulas were created to provide tolerable nutrition support to patients (Campbell 2006). These tube feedings expanded to include elemental formulas originally designed for space travel (in an unsuccessful attempt to develop a residue-free formula for astronauts) and special formulas for specific diseases. The support for enteral feedings expanded as evidence accumulated for its cost-effectiveness and safety.

In the 1950s, Barron and colleagues published a series of papers advocating for the use of tube feedings prepared in hospital kitchens as being better tolerated and more medically sound than the commercially prepared formulas available at the time. In their research, they suggested, "accumulating evidence stresses more and more the complexity of nutritional needs of the human body... Up to the present time, we know of no manufactured preparation which can surpass or even equal such natural foods as beef steak, liver, eggs, milk, fruit, and vegetables" (Barron and Fallis 1953). Barron and his colleagues even developed a pump to be used to help push strained, blenderized feeds through a patient's feeding tube to help facilitate these feedings (Harkness 2002).

In the late 1960s and early 1970s, proprietary commercial formulas began to infiltrate the marketplace as advocates for chemically defined liquid diets praised their use, suggesting that these formulas could be easily modified to meet the needs of individual patients while providing precise levels of nutrients required for human health (Harkness 2002). As the cost of expensive commercial formulas dropped, hospitals weighed the costs of producing their own blenderized formulas against the use of expensive commercial formulas, including sanitary and tolerance concerns (Harkness 2002). As commercial formulas became more widely available, safer, and more affordable, blenderized food became a less attractive option for institutional use.

The use of blenderized tube feedings in a hospital setting has now become a rare occurrence, and the use of commercial medical formulas is now standard practice in hospitals. There are few food-based enteral commercial products available for use in hospitals today as the majority of formulas used in hospitals are made of casein hydrolysates, maltodextrin and/or sucrose, and vegetable oils to provide the protein, carbohydrate, and fat ratio found in the standard diet, with some fluctuations depending on the purpose of the formula (Harkness 2002).

III. The Use of Enteral Nutrition in Pediatric Patients

In the last 25 years, the number and variety of enteral formulas that are available for use has increased significantly, including the development of pediatric-specific formulas (Malone 2005). Pediatric formulas were created to address the problems that come with using an adult formula in a pediatric patient, including vitamin and mineral deficiencies or excesses, osmotic diarrhea, and an excess renal solute load (Booth 2004). The creation of pediatric-specific formulas has made it easier to provide the right balance of nutrients required to optimally support children's growth while preventing these potential complications from enteral feeding.

While a nasogastric tube is an option for patients requiring short-term enteral nutrition, a gastrostomy tube (g-tube) is typically placed via percutaneous endoscopic gastrostomy (PEG) when a patient is unable to adequately feed orally for an extended period of time. A PEG provides enteral access that is more conducive to long-term use (greater than 3 months) than a nasogastric tube; estimates suggest that 11,000 PEGs are performed annually in US children (Fortunato and Cuffari 2011). These tube-fed children can be given pediatric enteral formulas for either partial or exclusive enteral feeding in order to provide adequate nutrition for proper growth and development when complete oral feeding is insufficient to meet the child's needs.

Pediatric patients who require a g-tube for feeding are typically unable to consume adequate calories orally to maintain growth. Problems that may preclude oral feeding include an inability to chew and swallow adequately due to neurological impairment or airway abnormalities, inborn errors of metabolism, limited digestive and absorptive capacity, frequent vomiting, oropharyngeal and esophageal dysmotility, severe gastroesophageal reflux, acquired injury such as head trauma and caustic ingestion, and any other clinical intolerance to oral feeding (Booth 2004, Frohlich, Richter et al. 2010, El-Matary 2011). Certain patients with increased caloric requirements need supplemental enteral nutrition to meet their needs; these patients include those with congenital heart disease, chronic renal failure, chronic lung disease, and cystic fibrosis (Frohlich, Richter et al. 2010. Conway, Morton et al. 2012).

Enteral feeding through a g-tube is a commonly used means of improving the nutritional status of children with severe neurological disabilities, such as cerebral palsy and severe mental retardation (Fortunato and Cuffari 2011). In children diagnosed with Crohn’s disease, the use of exclusive enteral feeding can induce remission 50 to 85% of patients, possibly due to mucosal anti-inflammatory effects and changes to the intestinal microflora (Day, Whitten et al. 2008, Heuschkel 2009, Critch, Day et al. 2012). These are just a few of the reasons that many children are given enteral feeds via nasogastric tube or PEG tubes to ensure adequate growth and nutrition with the goal of improving their prognosis.

Enteral feeding through a g-tube is not without risks and complications (Table 1). One of the most commonly seen nonsurgical complications is gastroesophageal reflux (GER). Common symptoms of GER in children from ages 1 to 5 include regurgitation, vomiting, abdominal pain, anorexia, and feeding refusal (Lightdale, Gremse et al. 2013). This can lead to the development of a stimulus-response related feeding aversion, resulting in poor growth and malnutrition. GER is often present prior to PEG placement, though it can also develop after the tube has been placed (Truby, Cowlishaw et al. 2009).

While it is unclear if the placement of a PEG actually causes GER exacerbation, children who are fed via g-tube are at higher risk for reflux symptoms, particularly those who are neurologically impaired or who have conditions such as cystic fibrosis, as they frequently have associated gut dysmotility leading to reflux and an increased aspiration risk (Noble, Dalzell et al. 2012). Because of this, a g-tube placed operatively in conjunction with Nissen fundoplication is frequently recommended for children with severe neurologic impairment; this is a common surgical treatment for GER that results in a significant reduction in reflux symptoms for up to 97% of patients (Axelrod, Kazmerski et al. 2006, Salminen 2009).

The Nissen fundoplication procedure involves wrapping the upper part of the stomach around the lower end of the esophagus to reinforce the closing function of the lower esophageal sphincter and reduce the tendency for gastric acid to reflux into the esophagus (Horgan and Pellegrini 1997). The complications of fundoplication surgery include worsening of feeding problems, dumping syndrome, bloating, and abnormal gastric motility (Pentiuk, O'Flaherty et al. 2011). One particularly common post-fundoplication complication is the development of gagging and retching. This can affect the child’s acceptance of oral feeding and promote oral aversions. If persistent, this retching can lead to an undoing of the fundoplication itself and a need for a surgical revision (Pentiuk, O'Flaherty et al. 2011).

Table 1. *Gastrointestinal-related complications with the use of enteral feeding, possible causes, and standard medical treatment. Adapted from the Philadelphia Coordinated Health Care "Feeding Tube Resource Packet" (PCHC 2009).*

GI Complication	Possible Causes	Typical Treatment
Aspiration	GERD, delayed stomach emptying	Acid reducing medication, change in formula
Constipation	Inadequate fluid and/or fiber intake, decreased bowel motility, inactivity	Motility agent, stool softener or laxative, additional fiber or fluids, increase in activity
Diarrhea	Intolerance to formula, allergy to formula, too high feeding rate, contaminated formula, GI disorder	Adjustment of tube feeding rate, change of formula, proper tube feeding hygiene, anti-diarrheal medication
Fluid/Electrolyte Imbalance	Inadequate or excessive fluid intake, excessive fluid loss from vomiting or diarrhea	Adjusting water flushes, monitor input and output, add Pedialyte
Nausea/Vomiting	Intolerance to formula, allergy to formula, rate too high, contaminated formula, constipation, bowel obstruction	Anti-emetic medication, adjustment of tube feeding rate, change of formula, proper tube feeding hygiene
Tube Obstruction/Blockage	Inadequate flushing, poor medication administration technique, defective tubing, formula not mixed properly	Flush per instructions, administer medications per instructions

These symptoms may continue even after employing such management strategies as changing the formula or adjusting the rate of feeding. These changes can negatively impact the child's and parents' quality of life, because children often require continuous feeds that restrict daily life activities and necessitate overnight feeding (Mahant, Pastor et al. 2011). Recently, blenderized tube feeds are being reconsidered for the management of the gagging, retching, vomiting, and reflux that frequently accompanies PEG placement or Nissen fundoplication, as several researchers have published preliminary evidence supporting the benefits of these diets.

IV. The Use of Blenderized Feeds in Enteral Nutrition

In the late 2000s, the interdisciplinary feeding team at Cincinnati Children's Hospital Medical Center (CCHMC) studied the use of pureed foods administered directly into the g-tube of patients who had experienced gagging and retching post-fundoplication surgery (Pentiuk, O'Flaherty et al. 2011). This was the first clinical trial using blenderized gastrostomy tube feeds to manage the complications associated with enteral feeding. Their theory was that pureed foods might positively affect stomach emptying and thus be better tolerated. The team designed patient-specific pureed-by-gastrostomy-tube (PBGT) diets and instructed parents how to prepare and administer the formulas using 60 mL syringes.

The team found significant reduction in the symptoms of post-fundoplication patients on the PBGT diet (Pentiuk, O'Flaherty et al. 2011). The parents of 17 of 33 children (52%) reported a 76% to 100% decrease in gagging and retching after their child started the PBGT diet, and 19 of 33 (57%) children were reported to have an increased oral intake. The authors suggest that the increased intake may have been due to the amelioration of gagging and retching symptoms contributing to an oral aversion. They found that parents were highly satisfied with the PBGT diet and the daily cost of the diet was lower compared to the standard commercial formula ($6.20 compared with $8.00 per day). The researchers did not discuss if these costs took the parents' time and labor into account, and in some cases the cost was higher because insurance covered the commercial formula.

Since the publication of those results, a number of other medical teams have experimented with the use of pureed or blenderized diets to help increase feeding tolerance and reduce gagging, retching, and vomiting in patients with feeding tubes. For example, at CCHMC, dietitians in the pulmonary division have used the PBGT diet to help improve enteral tolerance in their pediatric patients with cystic fibrosis who have had a feeding tube placed to ensure adequate nutritional intake (Santoro 2013). The success of this program was described at the 27th Annual North American Cystic Fibrosis Conference in Salt Lake City, UT in October 2013. Blenderized or food-based formulas have also been used to improve the treatment outcomes of children with chronic diarrhea or epilepsy and adults with major burns or cancer-related cachexia (Block, Chlebowski et al. 1981, Bailey, Carnazzo et al. 1982, Kolacek, Grguric et al. 1996, Zupec-Kania, Aldaz et al. 2011). These findings demonstrate the range of potential patients who might benefit from receiving blenderized feeds.

In 2009, the feeding team at the Pasadena Child Development Feeding Team (PCDA) in California participated in a roundtable style discussion recorded in *ICAN: Infant, Child, & Adolescent Nutrition* (Novak, Wilson et al. 2009). The group, which included two registered dietitians, a speech therapist, and a physician, described their experiences using a blenderized enteral diet for their patients as well as their decision-making process for how to choose good candidates for the diet. The team noted greater volume tolerance and improvements in reflux and constipation in their pediatric patients after switching from commercial formula to blenderized tube feeding. They also suggested that the use of a blenderized diet facilitates the transition from tube feeding to oral feeding, as children often consume the same foods through the tube as they are being offered by mouth.

The team discussed the non-medical reasons why parents request to change their child's diet to a blenderized one. Beyond improvements in feeding tolerance and in transitioning to oral feedings, the use of blenderized family foods can provide greater inclusion in family meals and acclimatization to the gastrostomy tube feedings (Novak, Wilson et al. 2009). The team also suggests that many families enjoy providing their child with a blenderized diet, as preparing and administering a blenderized feed allows the parent to take a more active role in feeding their child (Novak, Wilson et al. 2009). For parents with the time, ability, and interest in preparing homemade tube feeds, the normalcy of the feeding experience can be greatly enhanced.

One recent example of a documented success was a 5-year-old boy with bronchopulmonary dysplasia, hypotonia, and feeding difficulty, who had a gastrostomy tube and a Nissen fundoplication surgery that failed to improve his feeding intolerance (Johnson, Spurlock et al. 2013). The patient refused to take any food or liquid orally and experienced increased vomiting, retching, and constipation along with poor growth, despite several changes made to his formula type and delivery. The patient's mother decided (independently) to introduce small boluses of pureed foods and noticed the patient did not react adversely to these feedings as he did to his formula. Noting the improvement in tolerance, the feeding team then offered to aid in the child's transition to a blenderized diet. The patient's retching, vomiting, constipation, and oral food refusal resolved with the complete transition to the blenderized diet. His progress was followed for three years and outlined in the referenced publication, and the clinic dietitian continued to work with the patient and his mother to ensure that the formulas being used were meeting the patient's needs. In this case, the blenderized diet clearly contributed to a significant improvement in the patient's outcome, demonstrating the potential value of the diet when used in an appropriate candidate.

A major caveat to the use of the blenderized or pureed tube feed is that there is little published evidence available to support the efficacy of this technique. While lack of evidence is not evidence against, there are only a handful of studies demonstrating the benefits of using this feeding technique for a limited number and variety of patients. Currently, there are no studies that have verified the efficacy and safety of the use of blenderized tube feeds in a hospital setting; in fact, some studies have demonstrated a risk of bacterial contamination from using blenderized feeds institutionally (Sullivan, Sorreda-Esguerra et al. 2001, Mokhalalati, Druyan et al. 2004). The potential for bacterial contamination is a key reason most hospitals have switched from homemade blenderized feeds to commercially-prepared formulas; food-borne pathogens in homemade feeds can cause nausea, vomiting, diarrhea, fever and abdominal cramps, and may be linked to chronic diseases such as hepatitis, septic and aseptic arthritis, and Guillain-Barré syndrome (Mokhalalati, Druyan et al. 2004). Immunocompromised and critically ill patients are at especially high risk for contracting these food-borne illnesses.

There are other, more practical reasons why most institutions have switched from blenderized enteral formulas to commercially prepared, ready-to-use enteral formulas. Hospital-prepared blenderized tube feedings can provide unpredictable levels of micronutrients and macronutrients and may deliver inadequate amounts of some nutrients (Mokhalalati, Druyan et al. 2004, Sullivan, Sorreda-Esguerra et al. 2004). The viscosity of these feedings may also be unsuitable for reliable infusion through feeding tubes, and makes continuous feeds more challenging. Blenderized feeds are also difficult to customize. While commercially prepared formulas are available in disease-specific formulations, the individualizing of blenderized recipes to meet patient needs is time and labor intensive, and may not actually be feasible in institutional settings (Mokhalalati, Druyan et al. 2004).

More studies are needed to test the nutritional adequacy, safety, and clinical outcomes when using a blenderized diet in a variety of populations and settings. While these diets have been demonstrated as useful for post-fundoplication patients with gastrostomy tubes, little is known about the efficacy of these diets for other diagnoses, including inflammatory bowel disease, major developmental delays, cystic fibrosis, and other conditions that typically require supplemental or exclusive tube feeding. How these blenderized feeds compare in cost to the standard enteral formulas can be a major factor for many families when choosing a treatment option, and little is known about their expense compared to commercial formulas (Singer, Couper et al. 2011). Evidence is also lacking on the safety of homemade tube feeds when created in the patient's home in regards to the prevalence of food-borne illness in these patients. This makes it difficult to make evidence-based recommendations to parents and patients who inquire about the benefits of homemade tube feeds.

However, if parents express strong interest in a blenderized diet, and care is taken in determining the suitability of the candidate, it is possible for a blenderized tube feed to meet the nutritional needs of the patient while addressing safety concerns. While there are no formal guidelines for the development and administration of a blenderized diet, several publications have described criteria for patient selection, recommendations for caretaker education, and methods for developing a nutritionally appropriate blenderized diet (Novak, Wilson et al. 2009, O'Flaherty, Santoro et al. 2011). These recommendations have been safely and successfully used with numerous patients, as suggested by the medical professionals that have developed them (O'Flaherty, Santoro et al. 2011, Pentiuk, O'Flaherty et al. 2011).

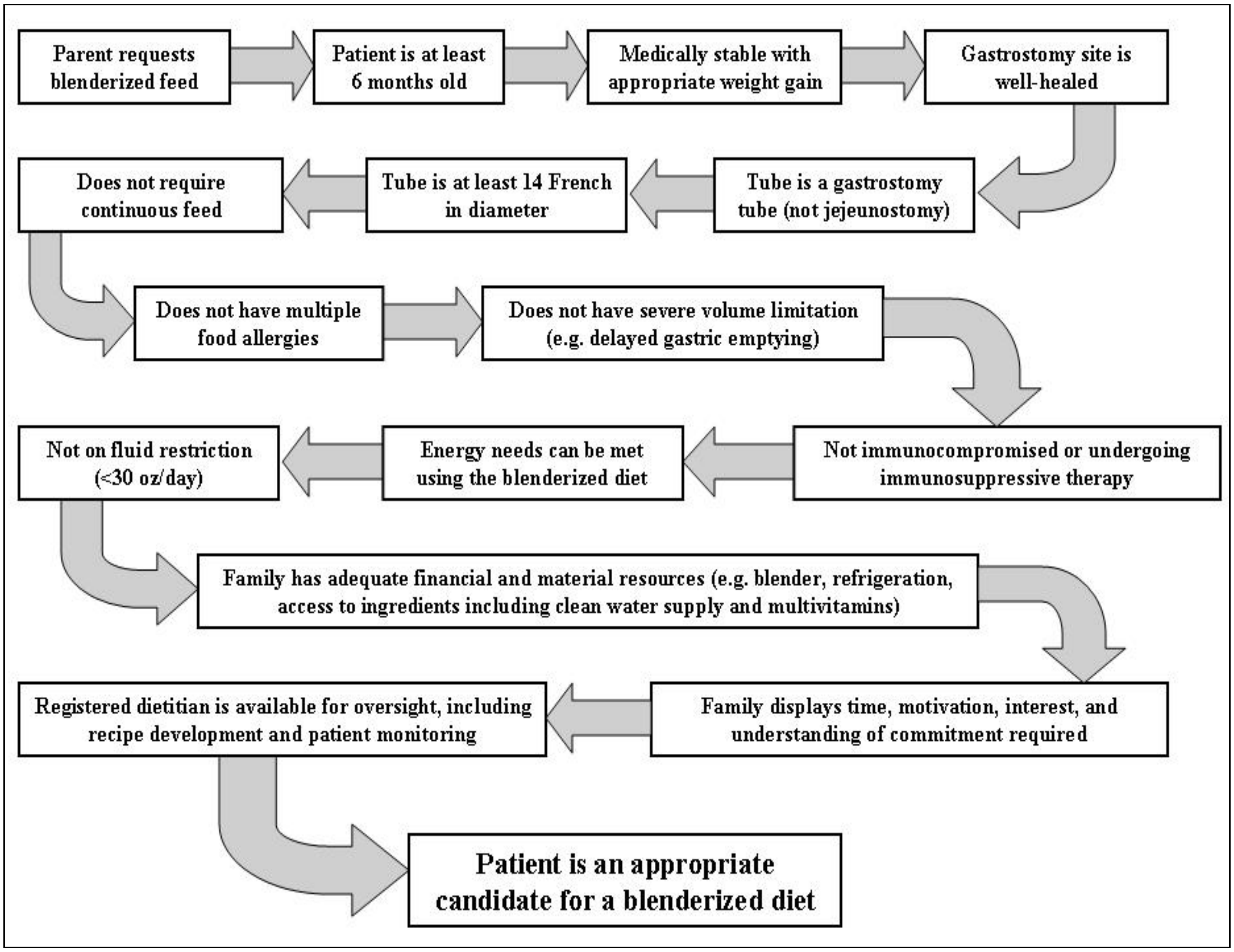
V. Determining Good Candidates for Blenderized Tube Feeding

Based on what is currently understood about the use of blenderized tube feeds, the best candidates for this method are children with gastrostomy tubes who are experiencing retching, gagging, or vomiting from their current enteral formula but who are growing appropriately. While post-fundoplication surgical patients are the primary population that has been studied using this diet, there are several case studies documenting successful use of the blenderized diet to manage a variety of other symptoms (Mortensen 2006, Johnson, Spurlock et al. 2013). These include children with severe reflux, food allergies, constipation, developmental delays, and oral aversions. However, patients with other unstudied conditions may also be considered for this diet, and guidelines for choosing an appropriate candidate have been suggested by practitioners experienced in using a blenderized diet. (Novak, Wilson et al. 2009, O'Flaherty, Santoro et al. 2011, Pentiuk, O'Flaherty et al. 2011).

Before initiating a blenderized tube-feeding regimen, the dietitian must determine whether a patient is a good candidate for a blenderized tube feed. Because the use of a blenderized diet is not currently the standard of practice, the healthcare practitioner is encouraged to provide parents with a waiver that protects against liability in the case of a poor outcome. Until there are more studies supporting the efficacy and safety of this treatment, blenderized tube feeds should only be used with patients whose caretakers have requested the change to a blenderized formula and who thoroughly understand benefits and risks.

The key parameters for determining whether a child is a good candidate for a blenderized tube feed are depicted in Figure 1. The steps included in this figure are frequently cited by experienced practitioners as the minimum requirements for the consideration of switching to a blenderized diet; there may be additional considerations that require clinical judgment. The child must be at least 4 months of age; 6 months is the recommended minimum age when solid foods can start to be introduced (Johnson, Spurlock et al. 2013) The patient must be medically stable with appropriate weight gain and a well-healed gastrostomy site (Novak, Wilson et al. 2009). If the child has a jejunostomy (feeding tube inserts directly into the jejunum) rather than a gastrostomy, they should not be given a blenderized diet; these patients typically require continuous feeds with elemental or semi-elemental formulas that have been predigested for absorption by the small intestine (Niv, Fireman et al. 2009).

Figure 1. *Decision tree for choosing an appropriate candidate for blenderized tube feeding based on minimum requirements. Adapted from Johnson, Spurlock et al. 2013.*



Children with a tube size less than 10 French are poor candidates, as the smaller tube is more likely to get clogged when using a blenderized diet; the recommended tube size is 14 French or larger (Novak, Wilson et al. 2009, O'Flaherty, Santoro et al. 2011, Mortensen 2006). Children with multiple food allergies may also be poor candidates, due to the greater difficulty of creating a tolerable and nutritionally complete blenderized formula for these patients (Novak, Wilson et al. 2009). Children with immunosuppression or undergoing immunosuppressive therapy, as in cases of organ transplants or certain types of cancer treatment, should not use blenderized feeds, as risk of infection by a contaminated enteral formula is significantly higher than when using commercial formulas (Moe 1991).

A child who is unable to tolerate bolus feeds or has a severe volume limitation due to delayed gastric emptying will not likely be able to rely exclusively on a blenderized diet. However, adding small boluses of a blenderized formula throughout the day is an option for these patients (Novak, Wilson et al. 2009). It is not recommended to use blenderized formulas for children needing continuous feeds (i.e. feeds lasting longer than 2 hours) which requires the formula to be refrigerated to reduce contamination risk (Mortensen 2006). Children with extremely high energy demands (e.g. from the hypertonia seen in cerebral palsy) or with fluid restrictions below 30 ounces per day (e.g. in chronic kidney disease) may not be able to meet their needs using blenderized food alone (Mortensen 2006, Novak, Wilson et al. 2009).

There are also non-medical reasons why some patients may not be good candidates for a blenderized formula. Children whose families receive formula funded by public agencies may not be able to afford a change to a blenderized diet, or may not have access to the nutrition professional that can design the appropriate diet to ensure nutritional adequacy and follow up on growth and formula tolerance (Novak, Wilson et al. 2009). Any family who lacks access to adequate refrigeration, electricity, or clean water should not be considered for a change to a blenderized diet (Mortensen 2006). The child's care providers must demonstrate strong motivation and appropriate understanding of the planning, preparation, and overall time requirements associated with a blenderized diet (Novak, Wilson et al. 2009). The family must be capable of preparing the blenderized feeds in a safe and nutritionally-appropriate manner, with access to the required ingredients (including additional multivitamins) and equipment required for preparation, such as a high quality blender (Novak, Wilson et al. 2009) Finally, it is crucial that the family is completely in agreement with and interested in the change to a blenderized diet; caretakers should not feel that the diet change is being forced upon them by a medical or feeding team (Novak, Wilson et al. 2009).

In some cases, the motivation for switching to a blenderized diet may not be medical but rather social or psychological in nature. If the child is not experiencing any significant negative effects from their current formula but their caretakers are simply interested in feeding their child what they perceive to be "real" food, the child may be a good candidate provided they do not have any of the contraindicating factors listed above (Johnson, Spurlock et al. 2013). This is increasingly likely to be a factor in the decision to switch to a blenderized diet, as recent research suggests that 50% of Americans look for natural ingredients on their food labels, 18% are concerned with their ability to pronounce the ingredients listed, and 28% are now purchasing more natural or organic foods as a result of information they had heard or read about chemicals in food (IFIC 2011). These trends suggest that interest in foods with whole, "natural" ingredients will continue to grow; an interest likely shared by patients who rely on tube feeding as their primary source of nutrition. A parent or caretaker with a personal interest in feeding their child a blenderized diet should be supported the medical team, provided the child is a good candidate for a homemade enteral formula.

Even if a patient's family has requested the change to a blenderized diet, the caretakers must be thoroughly educated on the use of blenderized diets before a decision is made to proceed with the formula change. The family must have considered the advantages and disadvantages of a blenderized diet and must understand the significant time and energy required for the preparation of the homemade formula. They must also understand the potential risks including allergic response, food-borne illness, clogging of the tube, and the potential for weight loss and inadequate nutrition due to parent or dietitian error in recipe design and preparation. The caretakers must demonstrate understanding of the commitment required before making the decision to proceed with a blenderized diet.

VI. Creating a Blenderized Enteral Formula

Once it has been established that the patient is a good candidate for a blenderized diet, there are several important steps to take when designing an appropriate formula. As the blenderized diet is designed for the child's individual nutritional needs and caretaker preferences, an experienced dietitian must calculate and modify the diet to meet these needs (O'Flaherty, Santoro et al. 2011). The following recommendations have been adapted from the guidelines created by Therese O'Flaherty, MS, RD and her colleagues at the Cincinnati Children's Hospital Medical Center, who have developed a "Pureed By Gastrostomy Tube" (PBGT) diet for treating pediatric patients who experience gagging and retching post-Nissen fundoplication (O'Flaherty, Santoro et al. 2011).

The first step in designing a formula is to conduct a thorough review of the child's medical history, including current anthropometric data (e.g. height and weight) that will be used to estimate the child's nutritional needs including calories, protein, fluid, and micronutrients. It is recommended to use a computerized program such as The Food Processor Program® by ESHA Research or ProNutra® by Viocare to analyze the levels of these nutrients in any recipe that is developed. These programs allow the dietitian to save the data for future reference, adjust recipes based on follow-up results, and provide documentation to families and other members of the medical team.

Other factors to consider when designing a diet are the patient's ethnic or religious preferences, documented allergies or intolerances, and characteristics of the current formula being used. The current formula can also be used as a liquid base for the initial blenderized diet, as this can help ensure nutritional adequacy of the formula while transitioning. Some medical professionals recommend starting with pureed commercialized stage 2 baby foods for the first recipe, to provide consistent nutritional content and eliminate the need for a blender (O'Flaherty, Santoro et al. 2011). Once these stage 2 baby food recipes have been well tolerated, the diet may be advanced to include blenderized table foods as desired.

After nutritional needs and preferences have been established, the dietitian should begin formula development by choosing an appropriate protein source. Some protein should be from a liquid source to form the base of the blenderized formula and ensure proper consistency. The liquid protein source can be cow, soy, nut, or rice milk, or even the patient's original commercial formula, depending on the patient's tolerance, cost considerations, or allergies. Though counterintuitive, using the patient's original formula as the base in a blenderized recipe has been found effective for producing a reduction in gagging and retching symptoms (O'Flaherty, Santoro et al. 2011). A minimum of four to eight ounces of the selected liquid protein source should be used to ensure adequate fluidity. A second, solid source of protein can be used to meet the patient's overall protein goals, which are calculated using the age-appropriate estimated Dietary Reference Intakes (DRIs) (IOM 2005). This solid protein is usually meat (e.g. beef, chicken, fish) or yogurt, and should meet 80-90% of the patient's daily protein needs. The child needs between 12% and 15% of his or her calories from protein (O'Flaherty, Santoro et al. 2011)

Next, the dietitian can choose a carbohydrate source to include in the recipe, which typically comes from fruits, vegetables, and grains. The formula should use plant foods that the child has been previously exposed to, to avoid potential allergic reactions. The recipe(s) should include both green and red/orange vegetables to provide both vitamin A and vitamin C in the recipe. Non-starchy vegetables and most fruits add to total volume without contributing significant calories, and therefore should be kept less than 8 to 12 ounces total for the entire recipe. Grains are used to add calories, carbohydrates, and fiber, and commonly used, well-tolerated varieties include rice, barley, and oats. The child should be getting 55% to 60% of his or her calories from carbohydrates if not on a ketogenic or carbohydrate-restricted diet (O'Flaherty, Santoro et al. 2011).

The dietitian can then choose a fat source to add to meet the child’s total calorie needs. Most recipes contain 1 to 2 tablespoons of added fat, and it is important to use a fat that provides adequate amounts of the essential omega-3 and omega-6 fats required for health. Canola oil is commonly used as it contains both omega-3 and omega-6 fats, though a blend of olive oil and fish (or cod liver) oil can also be used if preferred by the dietitian or parent. If choosing the latter option, limit fish/cod liver oil to one half of a teaspoon, and use olive oil for the remainder of the required added fat. Fish/cod liver oil should be kept refrigerated to prevent oxidation of the oil. The child should be getting 30% to 35% of his or her calories from fat unless specifically on a higher fat and/or ketogenic diet (O'Flaherty, Santoro et al. 2011).

Once the initial recipe has been developed, the dietitian should use recipe analysis software (Food Processor, ProNutra, etc.) to review the nutritional adequacy of the recipe for the individual patient. It is important to ensure adequate calories, protein, fluid, and micronutrients, and to appropriately balance the macronutrient ratios as recommended above. The dietitian can further adjust the recipe to the desired composition, typically by providing additional fat or carbohydrate sources, or a commercial calorie supplement if desired. Once the base formula has been developed, the micronutrient composition of the recipe should be reviewed and compared to the DRIs for the child’s age and size. The major micronutrients to consider are calcium, iron, and sodium, and many of the child’s needs can be met by adding a commercial children’s multivitamin to the mixture (O'Flaherty, Santoro et al. 2011).

Sodium and electrolyte supplementation protocols are typically developed by individual institutions, but additional sodium may be supplemented using normal saline or Pedialyte® flushes between formula boluses. O’Flaherty and her colleagues have recommended calculating the free water content of the recipe by multiplying the total volume of the formula by 0.75, under the assumption that most infant foods contain an average of 75% free water (O'Flaherty, Santoro et al. 2011). If the formula’s free water does not meet the child’s fluid needs, additional free water should be given as either a flush or as a bolus in between formula boluses, with enough time between boluses to prevent any volume overload and exacerbation of retching, gagging, or vomiting. Five milliliters of water at most should be used to flush the tube after pushing the formula, to avoid administering excess fluid volume at each feeding (O'Flaherty, Santoro et al. 2011). Monitoring the patient’s hydration status and urine output can be helpful in determining the adequacy of fluid intake over time.

These formula recommendations have been developed by O’Flaherty and her colleagues under the assumption that caretakers will eventually be bolusing the entire blenderized formula via 60-mL catheter tip syringes using slow, small pushes over several feedings (O'Flaherty, Santoro et al. 2011). The feeding schedule is typically determined by using the patient’s current intake, feeding history, age, and size as a guide, with initial bolus sizes starting at 1 ounce and given spaced throughout the day, and increased in volume as tolerated (O'Flaherty, Santoro et al. 2011). To facilitate the transition, it is suggested to use stage 2 baby food recipes to start with, and advance to whole food, blenderized recipes once tolerance has been established. Depending on the patient's tolerance, dietitians can start by providing 50% of calories from the blended diet and 50% from commercial formula, then advance to 75% blended and 25% formula, and finally to 100% blended. Patients will have varying levels of tolerance. The transition to a 100% blenderized diet will take differing lengths of time and should not be rushed.

O'Flaherty and her team do not recommend using a pump to administer these formulas continuously. If a child requires overnight continuous feeding to meet his or her calorie needs, it is recommended that dietitians use a commercial formula to provide 50% of the child's caloric intake at night and the other 50% of calories via small boluses of the blenderized formula spaced throughout the day as tolerated. When the tolerated bolus size is large enough and the frequency of boluses is manageable, the remainder of the overnight commercial formula calories can be converted to the pureed mixture, and a new feeding schedule can be developed (O'Flaherty, Santoro et al. 2011). Ultimately, the goal is to wean the child off of the overnight formula feeds, and O'Flaherty and her team have successfully transitioned many patients to a diet consisting solely of pureed foods bolused across several intervals during the day.

Precautions must be taken by dietitians to ensure hygienic practices by caretakers and minimization of food-borne illness risk (Moe 1991, Sullivan, Sorreda-Esguerra et al. 2001). Uncontaminated (boiled, bottled, or distilled) water must be used, and recipe components should be thoroughly cooked and properly refrigerated to prevent contamination by pathogens. During the preparation of these formulas, established food safety guidelines must be followed by thoroughly washing hands, using properly cleaned blending equipment and syringes, disinfecting any work surfaces used such as a cutting board, and storing any unused ingredients or formula batches in a refrigerator or freezer to prevent the growth of bacteria. Any formula not used within 24 hours after creation should be thrown away (O'Flaherty, Santoro et al. 2011). Using commercial baby food as the primary ingredients for these mixtures can help reduce contamination risk, and are ideal to use if refrigeration or safe food preparation is not available, such as while traveling.

Tube obstruction is a potential problem for any enterally fed patient, but even more so for those using a blenderized diet. Flushing the tube with at least 30 mL of water every 4 hours can help prevent clogging (Kohn and Keithley 1989). Thoroughly blending the formula using a high-powered blender and straining with a mesh strainer can help prevent clogging by removing any larger food particles from the blended recipe (Mortensen 2006). Recommended brands of blenders include Blendtec® and Vitamix®, though a lower cost blender may work just as well. Using a tube at least 14 French in diameter or larger can also help reduce the risk of clogging.

After the formula has been designed and the patient has been transitioned, monitoring the patient requires the same parameters as a normal enterally fed pediatric patient (Szeszycki 2010). Growth velocity should be monitored carefully to ensure the patient is continuing to gain in both height and weight appropriately and any weight changes should be documented and addressed. Calorie, protein, vitamin, mineral, and fluid intake must be assessed initially and then monitored regularly as the child's individual needs change (Szeszycki 2010). Laboratory monitoring for enterally-fed patients includes serum electrolytes, glucose, blood urea nitrogen (BUN), creatinine, calcium, phosphorus, magnesium, albumin, prealbumin, complete blood count with differential, iron indices, and an assessment of acid-base status. Routine monitoring of laboratory values is not indicated for stable patients receiving a complete blenderized formula at advised levels and achieving adequate growth (Szeszycki 2010). Frequent nutrition re-evaluations should be scheduled to assess the family's satisfaction with the blenderized diet and alter the feeding plan as needed based on the child's response and overall health (Mortensen 2006).

Dietitians must educate caretakers about potential side effects to watch for after changing to a blenderized formula. Symptoms of enteral formula intolerance include a worsening of gagging, wretching or vomiting, diarrhea, abdominal distention, constipation, and cramping or dumping syndrome (Kohn and Keithley 1989, Szeszycki 2010). These intolerance symptoms are often related to specific components of the formula, such as dairy or lactose, and can be addressed by changing the specific ingredients of the recipe (for example, by switching from a cow's milk base to a nut milk base). These symptoms are typically less of a concern for patients on blenderized diet and often decrease after the change in formula is made. In the few blenderized diet studies that have been conducted, no families reported that their child's symptoms worsened or that any reduction in oral intake after starting the blenderized diet was observed (Pentiuk, O'Flaherty et al. 2011, Johnson, Spurlock et al. 2013).

VII. Sample Recipes for a Blenderized Enteral Formula

Recipe Development and Analysis

To meet the need for a standard blenderized recipe that closely matches the standard commercial pediatric enteral formulas currently on the market, nine recipes were developed using either baby food or regular food ingredients; three of these recipes are dairy-free. The program used to design the following recipes was ProNutra®, developed by Viocare, Inc., which uses the USDA Standard Reference 21 database to analyze nutrients of each ingredient chosen. This database was the most recent available and was used to analyze each ingredient included in the recipes, with the exception of the milk alternatives (almond milk and rice milk) which were manually entered into the program from the USDA Standard Reference 26 database. The recipe creation was conducted at the NC TraCS Institute in cooperation with the Nutrition Research and Biometabolism Team in Chapel Hill, North Carolina.

Table 2 provides two sample recipes of the nine created, which are included in Appendix I of this paper. The recipes provide approximately 1000 calories per batch, and contain by calories approximately 55% carbohydrate, 15% protein, and 30% fat. While the micronutrient levels vary between recipes (see Appendix II), this can be corrected by the addition of a children's complete multivitamin to ensure adequate intake of all the essential vitamin and minerals. Macronutrient ratios were based on the recommendations of O'Flaherty et al., who suggested recipes meet the following goals: 12% to 15% of calories from protein, 30% to 35% of calories from fat, and 55% to 60% of calories from carbohydrates (O'Flaherty, Santoro et al. 2011). The recipes were designed using the instructions in O'Flaherty et al.'s published guidelines for calculating and preparing a pureed-by-gastrostomy-Tube (PBGT) diet for pediatric patients with retching and gagging post-fundoplication.

Table 2. *Two sample recipes. First recipe uses jarred baby food; second recipe uses standard whole food ingredients. All nine recipes including instructions are provided in Appendix I. Full nutrient composition is provided in Appendix II.*

Recipe							
Chicken Baby Food Blend							
Calories	995	%CHO	54%	%FAT	31%	%PRO	15%

Ingredient	Measure (grams)	Easy Measure
Whole Milk (3.25% fat)	488	2 cups
Baby food, chicken, strained	71	1 jar
Baby food, carrots, strained	339	3 jars
Baby food, peas, strained	285	2 jars
Baby food, apple and blueberry, strained	452	4 jars
Olive oil	9	2 teaspoons
Cod liver oil	2.25	1/2 teaspoon

Recipe							
Beef and Brown Rice							
Calories	1000	%CHO	55%	%FAT	31%	%PRO	14%

Ingredient	Measure (grams)	Easy Measure
Whole Milk (3.25% fat)	488	2 cups
Rice, brown, medium-grain, cooked	195	1 cup
Beef, ground, 85% lean, cooked	35	2.5 tablespoons
Spinach, boiled, drained, no salt	120	2/3 cup
Sweet potato, cooked, boiled, without skin	246	3/4 cup
Cod liver oil	2.25	1/2 teaspoon
Olive oil	9	2 teaspoons
Apples, raw, with skin	180	1 1/2 cups
Salt, table	0.5	1/12 teaspoon
Water, tap, municipal	350	12 ounces

The recipes using baby food are recommended as starting point recipes for patients transitioning to a blenderized diet, as they do not require a blender to prepare, while the recipes using whole food ingredients can be used for a variety of patients. Non-dairy recipes were included to meet the needs of dairy intolerant patients. When prepared using a Blendtec® blender, the recipes created between 1.5 and 2 liters of volume per 1000 calories. Using the Blendtec® high-powered blender allowed recipes to be blended to a nectar-thick viscosity; the formula did not need to be strained as the ingredients were totally liquefied. Baby food recipes required no blending and were easily mixed using a whisk, creating a formula slightly thinner than that created using the blender.

Using Standard Blenderized Recipes In Patient Care

In order to meet the exact calories and macronutrients as analyzed, these recipes must be prepared by weighing individual ingredients and meeting the amount of grams specified in the

"Measure" column of the recipe tables. Parents can use the "Easy Measure" category to estimate rather than weigh ingredients for easier preparation of these recipes. Preparing recipes using the "Easy Measure" guidelines will not provide the exact calories and macronutrients as analyzed; these measures have been estimated to come within a close range of each ingredient. Using the "Easy Measure" ingredients will help caretakers to quickly but confidently provide adequate calories and macronutrients to the patient. Ideally, however, caretakers should use a digital kitchen scale to weigh each ingredient in grams as indicated in the recipes to ensure nutritional adequacy of the recipe as developed. "Nutrition Facts" labels have been created for easy reference for parents and caretakers that prefer to have more information on the general nutrients they are providing their child in each standardized recipe (see Appendix III).

Most patients will require more or less than 1000 calories per day to meet their needs. Once daily calorie needs have been established, the dietitian working with the patient must multiply the ingredients in these recipes by the number of calories the child needs divided by 1000. For example, if a patient's estimated needs are 1500 calories per day, the dietitian should multiply the ingredients by 1500/1000, (or by a factor of 1.5). This will allow the parent to prepare a recipe that meets the daily caloric needs of the child while meeting the appropriate macronutrient ranges. The dietitian can also adjust these recipes by providing additional fat or carbohydrate calories depending on their clinical assessment of the patient's needs.

As the micronutrient levels of each recipe vary (see Appendix II), it is recommended that patients also be given a children's complete multivitamin to ensure appropriate levels of essential vitamins and minerals. Caretakers can either crush a chewable tablet or use a liquid supplement, and add to the blenderized mixture. Options for complete multivitamins to use include Nature's Plus® Animal Parade®, Garden of Life® Vitamin Code Kids®, or Flintstones® Complete Chewable Tablets; the dietitian may recommend any complete multivitamin brand using clinical judgment and may choose to add additional vitamins or minerals depending on the child's individual health requirements. It is important to note that the cod liver oil used in these recipes (Carlson®) provides some vitamin A, D, and E. Rotating the recipes on a regular basis will improve the diversity of the diet and should provide a greater range of nutrients.

Sodium needs vary depending on age and health status. The recipes included in this document contain comparable sodium to commercial pediatric enteral formulas such as Nestlé's Nutren Junior 1.0®, however it is recommended that the dietitian determine the individual sodium requirements of the patient and adjust sodium as needed. The Institute of Medicine (2004) recommends an Adequate Intake of 1000 mg sodium for children 1-3 years of age, 1200 mg sodium for children 4-8 years of age, and 1500 mg sodium for children 9-18 years of age. Sodium needs can be met by adding measured amounts of salt to the recipes or by providing a standardized saline solution either as a flush or by adding to the recipe. Sodium tablets can also be crushed and added to recipes to meet the child's sodium needs. The method of providing adequate sodium will vary between clinics, and dietitians should use clinical judgment to determine how much sodium and which type of supplement to use. Data on each recipe's sodium content can be found in Appendix II and Appendix III.

Fluid needs will also vary between patients, and dietitians should make recommendations based on the estimated needs of each patient. The recipe analyses from ProNutra® included in Appendix II of this document describe the water content (in grams) of each recipe when prepared as instructed. However, dietitians should ensure that patients are meeting their fluid needs by adding additional free water flushes throughout the day for children who are unable to take any fluids by mouth. This is similar to what must be done when a patient is using a commercial formula, and the dietitian should use clinical judgment when determining how much additional water to add to the child's regimen. It is recommended to provide this additional fluid as a flush rather than adding it to a recipe to avoid excessive volume, but some water may be added to a recipe to decrease viscosity as needed. The dietitian should monitor patients for signs of dehydration as is done with all enteral feedings.

As mentioned earlier, proper food safety precautions must be taken to prevent bacterial contamination of the blenderized formula. All meat and grain items should be thoroughly cooked before blending and all produce (fruit and vegetables) must be thoroughly washed. Care must be taken to acquire uncontaminated water by boiling or filtering tap water, or by purchasing bottled and/or distilled water. Dairy products must be pasteurized and all packaged items must be used before their expiration dates. It is also important to instruct caretakers in equipment cleaning technique in addition to safe food-handling practices (Novak, Wilson et al. 2009). All syringes and the blender need to be completely dismantled, washed, and air-dried after each use. Preparation surfaces should be kept clean and hands should be properly washed to minimize bacterial contamination risk.

Monitoring Patients on a Standard Blenderized Formula

Due to the potential for measurement error, a caretaker preparing these recipes may not be administering the child the same amount of calories and nutrients as analyzed in these recipes. Variability in the recipe preparation should be expected, as this is one of the known issues with using a blenderized rather than a commercial formula (Novak, Wilson et al. 2009). Therefore, a dietitian must closely monitor the patient and assess weight and height velocity, changes in symptoms such as gagging, retching, or vomiting, changes in oral feeding habits, any nutritionally relevant lab values for blood markers such as electrolytes, vitamin status, blood lipids and proteins, and urine sodium to monitor clinical outcomes in individual patients.

Growth velocity is most commonly used to assess nutritional adequacy of a child's diet, and should be monitored throughout the course of the transition to a blenderized diet, as well as on routine intervals once the patient's diet is stabilized. If the child requires long term or indefinite tube feeding, the dietitian should reassess the patient's needs regularly. This will ensure that proper steps are taken to make adjustments to the diet as needed as time goes on and the child's needs change. If the child is maintaining or improving his or her growth trajectory as measured on appropriate growth charts, the dietitian can feel confident that the recipes she or he has provided are nutritionally adequate for the patient. If excessive weight gain is observed, the caloric level of the formula can be adjusted.

VIII. Conclusion

When dietitians and caretakers take adequate care in developing and administering nutritionally complete blenderized tube feeding recipes, these diets can be both safe and effective for children requiring enteral nutrition to grow appropriately. Blenderized diets can provide adequate essential vitamins and minerals and possibly reduce the complications of g-tube feeding that make tolerance and oral feeding advancement difficult. The few studies that have been conducted using this dietary approach have demonstrated positive outcomes in pediatric patients including cessation of gagging and retching, recovery from oral feeding aversions, and overall improvements in formula tolerance and patient comfort.

In order to improve understanding and aid clinical decision-making, more research is needed on the use of blenderized tube feeds. Currently, supportive evidence is limited to the use of the therapy in post-fundoplication pediatric patients. It is currently unknown whether a blenderized tube feed can be helpful in other conditions, such as pediatric Crohn's disease or cystic fibrosis. These two conditions in particular have recently been shown to improve when enteral nutrition is utilized, either exclusively or as a supplement to oral feeding. It would help inform clinical decision making if trials were conducted investigating the use of a blenderized diet in these patient populations.

Much of the research that currently exists is underpowered due to small sample size; other evidence is simply based on individual case studies. Additional research using larger sample sizes with matched control groups would help to determine the potential benefits or harm from using a blenderized diet instead of a commercial diet. Even if a blenderized diet does not cause harm or malnutrition, it is unclear whether the cost of preparing a blenderized diet (including time, ingredients, tools, and labor) provides sufficient benefits to make this a preferred method of feeding. A cost-benefit analysis would allow clinicians to assess the value of a blenderized diet and determine if the clinical results are significant enough to justify the use of this resource-intensive dietary strategy.

Finally, it would be ideal to test the recipes included in this document using a laboratory-based nutrient analysis to determine the actual nutritional content of the recipes as prepared. Even though the estimated nutrient content is based on published USDA food and nutrient data, there is potential for variation between the estimated and actual nutrient content of the recipes. While individual patients can be monitored to ensure they are meeting their nutritional needs, it would be useful to know if a prepared recipe could reliably provide the level of calories, macronutrients, and micronutrients as estimated by the nutrition analysis software used to create it. If blenderized recipes were shown to reliably contain the nutrients as intended when the recipe was developed, dietitians could be confident they were providing patients with a similar level of nutrition that commercial formulas provide. This would allay fears that a blenderized diet could be nutritionally inferior to a commercial formula diet.

Enteral feeding was originally developed over thousands of years using whole food ingredients, and a return to whole food ingredients is a desirable option for many parents of children with feeding tubes. By using meticulously prepared blenderized recipes, providing multivitamins and additional fluid, and monitoring the growth and feeding tolerance of the patient, dietitians can feel confident that they are providing a nutritionally replete diet to children with feeding tubes.

Works Cited

Axelrod, D., K. Kazmerski and K. Iyer (2006). "Pediatric enteral nutrition." JPEN J Parenter Enteral Nutr **30**(1 Suppl): S21-26.

Bailey, R. T., Jr., A. J. Carnazzo and C. H. Organ, Jr. (1982). "Nutritional evaluation of a blenderized diet in five major burn patients." Am J Surg **144**(6): 655-659.

Barron, J. and L. S. Fallis (1953). "Tube feeding with liquefied whole food." Surg Forum **4**: 519-522.

Block, J. B., R. T. Chlebowski and J. N. Herrold (1981). "Continuous enteric alimentation with a blenderized formula in cancer cachexia." Clin Oncol **7**(2): 93-98.

Campbell, S. M. (2006). "An anthology of advances in enteral tube feeding formulations." Nutrition in clinical practice **21**(4): 411-415.

Chernoff, R. (2006). "An overview of tube feeding: from ancient times to the future." Nutr Clin Pract **21**(4): 408-410.

Conway, S., A. Morton and S. Wolfe (2012). "Enteral tube feeding for cystic fibrosis." Cochrane Database Syst Rev **12**: CD001198.

Critch, J., A. S. Day, A. Otley, C. King-Moore, J. E. Teitelbaum and H. Shashidhar (2012). "Use of enteral nutrition for the control of intestinal inflammation in pediatric Crohn disease." J Pediatr Gastroenterol Nutr **54**(2): 298-305.

Day, A. S., K. E. Whitten, M. Sidler and D. A. Lemberg (2008). "Systematic review: nutritional therapy in paediatric Crohn's disease." Alimentary Pharmacology & Therapeutics **27**(4): 293-307.

El-Matary, W. (2011). "Percutaneous endoscopic gastrojejunostomy tube feeding in children." Nutr Clin Pract **26**(1): 78-83.

Fortunato, J. E. and C. Cuffari (2011). "Outcomes of percutaneous endoscopic gastrostomy in children." Curr Gastroenterol Rep **13**(3): 293-299.

Frohlich, T., M. Richter, R. Carbon, B. Barth and H. Kohler (2010). "Review article: percutaneous endoscopic gastrostomy in infants and children." Aliment Pharmacol Ther **31**(8): 788-801.

Harkness, L. (2002). "The history of enteral nutrition therapy: from raw eggs and nasal tubes to purified amino acids and early postoperative jejunal delivery." J Am Diet Assoc **102**(3): 399-404.

Heuschkel, R. (2009). "Enteral nutrition should be used to induce remission in childhood Crohn's disease." Dig Dis **27**(3): 297-305.

Horgan, S. and C. A. Pellegrini (1997). "Surgical Treatment Of Gastroesophageal Reflux Disease." Surgical Clinics of North America **77**(5): 1063-1082.

IFIC. (2011). "2011 Food & Health Survey." Retrieved November 1, 2013, from http://www.foodinsight.org/Resources/Detail.aspx?topic=2011_Food_Health_Survey_Consumer_Attitudes_Toward_Food_Safety_Nutrition_Health.

IOM (2005).” Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.” Panel on Macronutrients. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Institute of Medicine.

IOM (2004). “Dietary Reference Intakes: Water, Potassium, Sodium, Chloride, and Sulfate.” Panel on Dietary Reference Intakes for Electrolytes, and Water. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Institute of Medicine.

Johnson, T. W., A. Spurlock and P. Galloway (2013). "Blenderized Formula by Gastrostomy Tube: A Case Presentation and Review of the Literature." Topics in Clinical Nutrition **28**(1): 84-92.

Kohn, C. L. and J. K. Keithley (1989). "Enteral nutrition. Potential complications and patient monitoring." Nurs Clin North Am **24**(2): 339-353.

Kolacek, S., J. Grguric, M. Percl and I. W. Booth (1996). "Home-made modular diet versus semi-elemental formula in the treatment of chronic diarrhoea of infancy: a prospective randomized trial." Eur J Pediatr **155**(12): 997-1001.

Lightdale, J. R., D. A. Gremse, H. Section on Gastroenterology and Nutrition (2013). "Gastroesophageal reflux: management guidance for the pediatrician." Pediatrics **131**(5): e1684-1695.

Mahant, S., A. C. Pastor, L. DeOliveira, D. B. Nicholas and J. C. Langer (2011). "Well-Being of Children With Neurologic Impairment After Fundoplication and Gastrojejunostomy Tube Feeding." Pediatrics **128**(2): e395-e403.

Malone, A. (2005). "Enteral formula selection: a review of selected product categories." Practical Gastroenterology **29**(6): 44.

Moe, G. (1991). "Enteral feeding and infection in the immunocompromised patient." Nutr Clin Pract **6**(2): 55-64.

Mokhalalati, J. K., M. E. Druyan, S. B. Shott and G. M. Comer (2004). "Microbial, nutritional and physical quality of commercial and hospital prepared tube feedings in Saudi Arabia." Saudi Med J **25**(3): 331-341.

Mortensen, M. J. (2006). "Blenderized Tube Feeding Clinical Perspectives on Homemade Tube Feeding." PNPG Post **17**(1): 1-4.

Niv, E., Z. Fireman and N. Vaisman (2009). "Post-pyloric feeding." World J Gastroenterol **15**(11): 1281-1288.

Noble, L. J., A. M. Dalzell and W. El-Matary (2012). "The relationship between percutaneous endoscopic gastrostomy and gastro-oesophageal reflux disease in children: a systematic review." Surg Endosc **26**(9): 2504-2512.

Novak, P., K. E. Wilson, K. Ausderau and D. Cullinane (2009). "The use of blenderized tube feedings." ICAN: Infant, Child, & Adolescent Nutrition **1**(1): 21-23.

O'Flaherty, T., K. Santoro and S. Pentiuk (2011). "Calculating and Preparing a Pureed-by-Gastrostomy-Tube (PBGT) Diet for Pediatric Patients With Retching and Gagging Post-fundoplication." ICAN: Infant, Child, & Adolescent Nutrition **3**(6): 361-364.

Pentiuk, S., T. O'Flaherty, K. Santoro, P. Willging and A. Kaul (2011). "Pureed by gastrostomy tube diet improves gagging and retching in children with fundoplication." JPEN J Parenter Enteral Nutr **35**(3): 375-379.

PCHC. (2009). "Tube Feeding Potential Problems/Complications." Feeding Tube Resource Packet Retrieved November 6, 2013, from http://www.pchc.org/Documents/Publications/PDFs/FeedingTube/Section 3, a/4-Tube Feeding Potential Problems Complications.pdf.

Salminen, P. (2009). "The laparoscopic Nissen fundoplication--a better operation?" Surgeon **7**(4): 224-227.

Santoro, K. (2013). Managing Post-fundoplication Retching/Gagging: Pureed GT Feedings. 27th North American CF Conference, Cincinnati Children's Hospital Medical Center, Division of Pulmonary Medicine.

Singer, E., M. P. Couper, A. Fagerlin, F. J. Fowler, C. A. Levin, P. A. Ubel, J. Van Hoewyk and B. J. Zikmund-Fisher (2011). "The role of perceived benefits and costs in patients' medical decisions." Health Expect.

Stephenson, A. L., L. A. Mannik, S. Walsh, M. Brotherwood, R. Robert, P. B. Darling, R. Nisenbaum, J. Moerman and S. Stanojevic (2013). "Longitudinal trends in nutritional status and the relation between lung function and BMI in cystic fibrosis: a population-based cohort study." Am J Clin Nutr **97**(4): 872-877.

Sullivan, M. M., P. Sorreda-Esguerra, M. B. Platon, C. G. Castro, N. R. Chou, S. Shott, G. M. Comer and P. Alarcon (2004). "Nutritional analysis of blenderized enteral diets in the Philippines." Asia Pac J Clin Nutr **13**(4): 385-391.

Sullivan, M. M., P. Sorreda-Esguerra, E. E. Santos, B. G. Platon, C. G. Castro, E. R. Idrisalman, N. R. Chen, S. Shott and G. M. Comer (2001). "Bacterial contamination of blenderized whole food and commercial enteral tube feedings in the Philippines." J Hosp Infect **49**(4): 268-273.

Szeszycki, E., Cruse, W., and Strup, M. (2010). "Evaluation and Monitoring of Pediatric Patients Receiving Specialized Nutrition Support." Retrieved November 11, 2013, from http://nutritioncare.org.

Truby, H., P. Cowlishaw, C. O'Neil and C. Wainwright (2009). "The long term efficacy of gastrostomy feeding in children with cystic fibrosis on anthropometric markers of nutritonal status and pulmonary function." Open Respir Med J **3**: 112-115.

Zupec-Kania, B. A., V. Aldaz, M. E. Montgomery and K. C. Kostas (2011). "Enteral and Parenteral Applications of Ketogenic Diet Therapy: Experiences From Four Centers." ICAN: Infant, Child, & Adolescent Nutrition **3**(5): 274-281.

Appendix I: *Standardized recipes for blenderized tube feeding. Created using ProNutra® by Viocare, Inc. at the NC TraCS Institute in cooperation with the Nutrition Research and Biometabolism Team in Chapel Hill, North Carolina.*

Recipe							
Beef Baby Food Blend							
Calories	1003	%CHO	54%	%FAT	32%	%PRO	14%

Ingredient	Measure (grams)	Easy Measure
Whole Milk (3.25% fat)	488	2 cups
Baby food, beef, strained	71	1 jar
Baby food, sweet potatoes strained	339	3 jars
Baby food, fruit, pears, strained	339	3 jars
Baby food, fruit, peaches, strained	190	2 jars
Olive oil	13.5	3 teaspoons
Cod liver oil	2.25	1/2 teaspoon

Recipe							
Chicken Baby Food Blend							
Calories	995	%CHO	54%	%FAT	31%	%PRO	15%

Ingredient	Measure (grams)	Easy Measure
Whole Milk (3.25% fat)	488	2 cups
Baby food, meat, chicken, strained	71	1 jar
Baby food, carrots, strained	339	3 jars
Baby food, peas, strained	285	2 jars
Baby food, apple and blueberry, strained	452	4 jars
Olive oil	9	2 teaspoons
Cod liver oil	2.25	1/2 teaspoon

Recipe							
Chicken Dairy-Free Baby Food Blend							
Calories	1000	%CHO	57%	%FAT	30%	%PRO	13%

Ingredient	Measure (grams)	Easy Measure
Rice drink, unsweetened, with added calcium, vitamins A and D	488	2 cups
Baby food, meat, chicken, strained	71	1 jar
Baby food, carrots, strained	339	3 jars
Baby food, peas, strained	285	2 jars
Baby food, apple and blueberry, strained	452	4 jars
Olive oil	9	2 teaspoons
Cod liver oil	2.25	1/2 teaspoon

Recipe							
Beef and Brown Rice							
Calories	1000	%CHO	55%	%FAT	31%	%PRO	14%

Ingredient	Measure (grams)	Easy Measure	Instructions
Whole Milk (3.25% fat)	488	2 cups	
Rice, brown, medium-grain, cooked	195	1 cup	
Beef, ground, 85% lean, cooked	35	2.5 tablespoons	Fill a shot glass for quick measuring
Spinach, boiled, drained, without salt	120	2/3 cup	
Sweet potato, cooked, boiled, without skin	246	3/4 cup	Mashed
Cod liver oil	2.25	1/2 teaspoon	
Olive oil	9	2 teaspoons	
Apples, raw, with skin	180	1 1/2 cups	Chopped
Salt, table	0.5	1/12 teaspoon	Easier to weigh out, may be adjusted as needed by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Recipe							
Beef, Rice Milk, and Brown Rice							
Calories	1005	%CHO	57%	%FAT	31%	%PRO	12%

Ingredient	Measure (grams)	Easy Measure	Instructions
Rice drink, unsweetened, with added calcium, vitamins A and D	488	2 cups	
Rice, brown, medium-grain, raw	100	1/2 cup	Cook with 1 cup water; May also use 1 2/3 cup cooked brown rice
Broccoli, boiled, drained, without salt	100	2/3 cup	
Beef, ground, 85% lean, cooked	60	5 tablespoons	Can use 2 ounces cooked
Cauliflower, boiled, drained, without salt	100	3/4 cup	
Cod liver oil	2.25	1/2 teaspoon	
Olive oil	13.5	2 teaspoons	
Blueberries, raw	100	2/3 cup	
Salt, table	0.5	1/12 teaspoon	Adjusted by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Recipe							
Chicken and Oats							
Calories	1001	%CHO	55%	%FAT	30%	%PRO	15%

Ingredient	Measure (grams)	Easy Measure	Instructions
Whole Milk (3.25% fat)	488	2 cups	
Broccoli, boiled, drained, without salt	100	2/3 cup	
Oats, regular and quick and instant, dry	81	1 cup	
Cauliflower, boiled, drained, without salt	100	3/4 cup	
Chicken, breast, skinless, meat only, roasted	15	1 tablespoon	
Cod liver oil	2.25	1/2 teaspoon	
Olive oil	13.5	2 teaspoons	
Bananas, raw	150	2/3 cup	Mashed
Blueberries, raw	150	1 cup	
Salt, table	0.5	1/12 teaspoon	May be adjusted by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Recipe							
Chicken, Oats, and Almond Milk							
Calories	999	%CHO	55%	%FAT	33%	%PRO	12%

Ingredient	Measure (grams)	Easy Measure	Instructions
Beverages, almond milk, sweetened, vanilla	480	2 cups	
Broccoli, boiled, drained, without salt	100	2/3 cup	
Oats, regular and quick and instant, dry	81	1 cup	
Cauliflower, boiled, drained, without salt	100	3/4 cup	
Chicken, breast, skinless, meat only, roasted	35	2.5 tablespoon	Fill a shot glass for easy measuring
Cod liver oil	2.25	1/2 teaspoon	
Olive oil	13.5	2 teaspoons	
Bananas, raw	150	2/3 cup	Mashed
Blueberries, raw	150	1 cup	
Salt, table	0.5	1/12 teaspoon	Adjusted by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Recipe							
Sardines and Buckwheat							
Calories	1004	%CHO	56%	%FAT	30%	%PRO	14%

Ingredient	Measure (grams)	Easy Measure	Instructions
Whole Milk (3.25% fat)	488	2 cups	
Spinach, boiled, drained, no salt	100	1/2 cup	
Buckwheat groats, roasted, dry	100	2/3 cup	Can also use 2 1/4 cups cooked
Sardines canned in oil, drained solids with bone	20	1 1/2 tablespoons	Fish only
Olive oil	13.5	2 teaspoons	
Bananas, raw	150	2/3 cup	Mashed
Strawberries, raw	150	1 cup	Halved
Salt, table	0.5	1/12 teaspoon	May be adjusted by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Recipe							
Tuna and Buckwheat							
Calories	1003	%CHO	55%	%FAT	31%	%PRO	14%

Ingredient	Measure (grams)	Easy Measure	Instructions
Whole Milk (3.25% fat)	488	2 cups	
Buckwheat groats, roasted, dry	82	1/2 cup	
Tuna, light, canned in water, drained	20	1 1/2 tablespoons	Fish only
Brussels sprouts, boiled, drained, without salt	80	1/2 cup	
Carrots, boiled, drained, no salt	150	1 cup	
Avocado, raw	100	2/3 cup	Sliced or cubed
Pears, raw	200	1 1/2 cup	Sliced
Raspberries, raw	50	1/2 cup	
Olive oil	2.25	1/2 teaspoon	
Salt, table	0.5	1/12 teaspoon	May be adjusted by dietitian
Water, tap, municipal	350	12 ounces	Add to recipe or flush throughout day

Appendix II: *Nutrient analysis for standardized recipes using USDA Standard Database 21. Analyzed using ProNutra® by Viocare, Inc. (*indicates insufficient data for specific nutrient.)*

Recipe	Energy (kcal)	Pro (g)	Fat (g)	Carb (g)	Water (g)	Fiber (g)
Beef Baby Food Blend	1002.54	35.97	37.20	138.73	1446.30	22.13
Chicken Baby Food Blend	994.70	38.38	35.19	139.97	1423.97	19.60
Chicken Dairy-Free Baby Food Blend	990.65	33.51	33.87	143.48	1382.63	19.00
Beef and Brown Rice	1000.41	36.26	34.60	140.85	1404.72	16.86
Beef, Rice Milk, and Brown Rice	1005.43	30.00	34.69	145.97	1089.75	12.84
Chicken and Oats	1001.39	37.89	34.78	144.18	1220.15	21.28
Chicken, Oats, and Almond Milk	998.83	29.94	37.96	142.72	1205.39	21.90
Sardines and Buckwheat	1004.24	37.89	35.56	146.54	1140.98	19.60
Tuna and Buckwheat	1002.91	36.97	36.39	146.95	942.70	31.18

Recipe	Alcohol (g)	Na (mg)	K (mg)	Ca (mg)	P (mg)	Fe (mg)
Beef Baby Food Blend	0.00*	343.48	2945.67	768.67	708.50	6.04
Chicken Baby Food Blend	0.00*	383.17	2076.46	740.93	759.41	6.06
Chicken Dairy-Free Baby Food Blend	0.00*	406.37	1530.41	796.86	643.96	7.66
Beef and Brown Rice	0.00*	581.49	2295.27	829.07	833.80	8.44
Beef, Rice Milk, and Brown Rice	0.00*	615.88	1141.30	689.02	779.40	5.78
Chicken and Oats	0.00*	474.63	2120.59	679.02	960.38	5.60
Chicken, Oats, and Almond Milk	0.00*	704.92	1535.11	1030.68	589.30	7.05
Sardines and Buckwheat	0.00*	584.76	2333.42	823.10	986.08	7.85
Tuna and Buckwheat	0.00*	578.96	2412.30	684.02	916.56	5.20

Recipe	Vit C (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B5 (mg)	B6 (mg)
Beef Baby Food Blend	195.64	0.46*	1.60	8.47	4.23	0.77
Chicken Baby Food Blend	147.90	0.63	1.48	8.13	4.01	0.78
Chicken Dairy-Free Baby Food Blend	117.69	0.53	1.33	11.66	2.55	0.89
Beef and Brown Rice	51.53	0.71	1.42	7.21	4.46	1.36
Beef, Rice Milk, and Brown Rice	118.90	0.71	1.05	11.06	3.22	1.38
Chicken and Oats	136.80	0.80	1.38	6.08	4.63	1.35
Chicken, Oats, and Almond Milk	132.45	0.66	1.32	8.33	2.89	1.12
Sardines and Buckwheat	111.05	0.63	1.59	8.77	3.96	1.43
Tuna and Buckwheat	86.50	0.70	1.46	11.19	5.02	1.25

Recipe	Zn (mg)	Mg (mg)	Cu (mg)	Mn (mg)	Se (mcg)	Fluoride (mcg)
Beef Baby Food Blend	5.51	217.68	0.74	0.08*	29.28	0.00*
Chicken Baby Food Blend	4.79	150.55	0.65	0.64	28.64	68.37
Chicken Dairy-Free Baby Food Blend	4.29	160.39	0.57	0.62	17.94	68.37
Beef and Brown Rice	6.81	303.49	0.76	4.00	27.45	343.00
Beef, Rice Milk, and Brown Rice	7.26	249.11	0.50	4.41	15.38	301.31
Chicken and Oats	6.14	247.94	0.69	4.19	49.46	291.16
Chicken, Oats, and Almond Milk	7.33	225.04	0.61	4.05	36.42	290.07
Sardines and Buckwheat	5.83	428.10	1.11	3.57	40.60	331.56
Tuna and Buckwheat	5.70	320.42	1.07	2.33	43.97	86.38

Recipe	Folate (mcg)	B12 (mcg)	Vit A (IU)	Vit E (mg ATE)	Vit D (IU)	Betaine (mg)
Beef Baby Food Blend	230.15	3.16	0.00*	0.00*	420.20*	3.70*
Chicken Baby Food Blend	175.26	2.43	0.00*	0.00*	420.20	12.60
Chicken Dairy-Free Baby Food Blend	158.07	3.59	302.40	0.00*	426.60	17.91
Beef and Brown Rice	230.36	3.13	54142.56	0.00*	420.20*	698.04*
Beef, Rice Milk, and Brown Rice	194.20	4.74	4862.40	0.00*	426.60	5.57
Chicken and Oats	241.92	2.20	4487.91	0.00*	420.20*	4.52
Chicken, Oats, and Almond Milk	213.12	6.12	4960.75	13.49	426.60	2.79
Sardines and Buckwheat	280.80	3.94	11114.36	0.00*	249.60	582.99
Tuna and Buckwheat	234.14	2.75	26887.16	0.00*	195.20	7.41

Recipe	Saturated Fat (g)	Mono-unsaturated Fat (g)	Poly-unsaturated Fat (g)	Cholesterol (mg)	Phytosterols (mg)	Ash (g)
Beef Baby Food Blend	13.52	16.57	3.56	82.21	29.83*	10.48
Chicken Baby Food Blend	12.66	14.35	4.83	104.93	19.89	8.53
Chicken Dairy-Free Baby Food Blend	5.60	19.18	7.13	99.44	29.83	5.28
Beef and Brown Rice	13.22	14.30	3.51	91.72	41.49	9.41
Beef, Rice Milk, and Brown Rice	7.04	19.61	5.22	66.22	29.83	4.70
Chicken and Oats	12.26	13.56	5.10	74.38	43.89	8.77
Chicken, Oats, and Almond Milk	5.17	22.68	6.68	42.58	65.72	5.48
Sardines and Buckwheat	12.10	15.53	4.68	77.20	71.83	10.73
Tuna and Buckwheat	12.22	16.24	4.33	54.8	20.97	10.2

Appendix III. *"Nutrition Facts" labels for each of the standard blenderized recipes. Measurements have been rounded to the nearest whole number.*

Beef Baby Food Blend:

Nutrition Facts		
Amount Per Serving		
Calories	1003	
Total Fat	37	g
Saturated Fat	14	g
Trans Fat	0	g
Cholesterol	82	mg
Sodium	343	mg
Total Carbohydrates	139	g
Dietary Fiber	22	g
Protein	36	g

Chicken Baby Food Blend:

Nutrition Facts		
Amount Per Serving		
Calories	995	
Total Fat	35	g
Saturated Fat	13	g
Trans Fat	0	g
Cholesterol	105	mg
Sodium	383	mg
Total Carbohydrates	140	g
Dietary Fiber	20	g
Protein	38	g

Chicken Dairy-Free Baby Food Blend:

Nutrition Facts		
Amount Per Serving		
Calories	991	
Total Fat	34	g
Saturated Fat	6	g
Trans Fat	0	g
Cholesterol	99	mg
Sodium	406	mg
Total Carbohydrates	143	g
Dietary Fiber	19	g
Protein	34	g

Beef and Brown Rice:

Nutrition Facts		
Amount Per Serving		
Calories	1000	
Total Fat	35	g
Saturated Fat	13	g
Trans Fat	0	g
Cholesterol	92	mg
Sodium	581	mg
Total Carbohydrates	141	g
Dietary Fiber	17	g
Protein	36	g

Beef, Rice Milk, and Brown Rice:

Nutrition Facts		
Amount Per Serving		
Calories	1005	
Total Fat	35	g
Saturated Fat	7	g
Trans Fat	0	g
Cholesterol	66	mg
Sodium	616	mg
Total Carbohydrates	146	g
Dietary Fiber	13	g
Protein	30	g

Chicken and Oats:

Nutrition Facts		
Amount Per Serving		
Calories	1001	
Total Fat	35	g
Saturated Fat	12	g
Trans Fat	0	g
Cholesterol	74	mg
Sodium	475	mg
Total Carbohydrates	144	g
Dietary Fiber	21	g
Protein	38	g

Chicken, Oats, and Almond Milk:

Nutrition Facts		
Amount Per Serving		
Calories	999	
Total Fat	38	g
Saturated Fat	5	g
Trans Fat	0	g
Cholesterol	43	mg
Sodium	705	mg
Total Carbohydrates	143	g
Dietary Fiber	22	g
Protein	30	g

Sardines and Buckwheat:

Nutrition Facts		
Amount Per Serving		
Calories	1004	
Total Fat	36	g
Saturated Fat	12	g
Trans Fat	0	g
Cholesterol	77	mg
Sodium	585	mg
Total Carbohydrates	147	g
Dietary Fiber	20	g
Protein	38	g

Tuna and Buckwheat:

Nutrition Facts		
Amount Per Serving		
Calories	1003	
Total Fat	36	g
Saturated Fat	12	g
Trans Fat	0	g
Cholesterol	55	mg
Sodium	579	mg
Total Carbohydrates	147	g
Dietary Fiber	31	g
Protein	37	g