CE 1.5 Contact Hours

Nursing Care and Management of Gastrostomy and Gastojejunostomy Tubes in the Pediatric Population

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KEY WORDS: children, feeding tube, gastrojejunostomy, gastrostomy, orogastric, pediatric

Pediatric surgical nurses care for children with enteral feeding devices, which include nasogastric (NG), orogastric (OG), gastrostomy (G-tube), gastrojejunostomy (G-J tube), and jejunostomy tubes (J-tube), on a daily basis. The purpose of this article is to provide updated information regarding care and management specifically for G-tubes and G-J tubes.

Eating is instinctual; feeding is learned. The skills necessary to eat successfully are fully acquired by the age of 3 years (Edwards et al., 2016). However, these skills may be impaired by several conditions including but not limited to prematurity, pulmonary disease, congenital anomalies, cerebral palsy, genetic syndromes, neoplastic conditions, or trauma. If the child cannot take enough nutrition or fluids by mouth, the feeding tube may be used to supplement and provide fluids or medications as well as decompress the stomach and gastrointestinal tract. Children with severe neurological impairment often have failure to thrive and aspiration because of dysphagia and gastroesophageal reflux; conditions that may lead to acute and chronic lung disease. These children are often offered either fundoplication with G-tube or feedings with a G-J tube (Stone et al., 2017).

A parent(s) decision to have an enteral device—G-tube or G-J tube—placed in their child is difficult. A study done by Craig and Scrambler (2006) described conflict with mothers' expectations of "good mothering" and the ideal child. Sleigh (2005) reported descriptions of oral feedings as central for mothers and their relationship to the child. Mothers spend an enormous amount of time struggling with feedings; however, Wilken (2012) describes relief felt by mothers after tube insertion.

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DOI: 10.1097/JPS.0000000000000229

TYPES OF TUBES

Many times, enteral feeding (tube feeding) may be short term (less than 4 weeks) and better served by temporary feeding access such as NG or OG tubes. An NG tube is passed through a nostril and through the esophagus into the stomach. NG tubes are used in any age. An OG tube is used more in infants or premature babies with small nasal passages or in a child who has sustained facial trauma. Long-term feeding access is best achieved by utilizing a G-tube or a G-J tube. A gastrostomy is an opening from the outside of the abdomen's skin to the inside of the stomach. Gastrostomies are used for enteral feeding or decompressing the stomach (Figure 1). A gastrostomy is one of the most common procedures performed in the United States in children (Denning et al., 2018). A gastrojejunostomy (G-J tube) is used for venting or decompressing the stomach while feeding is delivered into the jejunum (Figure 2). This type of tube is used to prevent tracheal aspiration of gastric contents, treatment of gastroparesis, gastric outlet dysfunction, or previous gastric surgery. In these cases, a G-J tube may be an alternative to fundoplication of the stomach (e.g., Nissen fundoplication; Livingston, Shawyer, Rosenbaum, Jones, & Walton, 2015).

TYPES OF PROCEDURES

A gastrostomy procedure can be performed as a percutaneous endoscopic gastrostomy (PEG), a pull technique as described by Gauderer (2001), which is performed under direct visualization with general anesthesia. A

FIGURE 1. MIC-KEY low-profile button.

PEG may also be performed by an interventional radiologist in the radiology suite where the procedure is performed by a blind stick through the abdominal wall into the stomach, which may increase the complication rate. Perforation of the transposed bowel with the percutaneous needle is the most common complication. This results in pneumoperitoneum and peritonitis. Transcutaneous illumination of the stomach can minimize this complication (Avitsland et al., 2006).

An operative laparoscopic or open gastrostomy performed by a pediatric surgeon offers improved visualization of anatomic structures, which may prevent complications. The original Stamm procedure, first performed in 1981, is performed most often today with only a few modifications. Depending on the institution, the G-J tube may be placed through a mature gastrostomy by interventional radiology (IR). Pediatric surgeons also can place G-J tubes primarily.

A J-tube is placed from the outside of the abdomen's skin into the jejunum for feeding with or without a G-tube. The J-tube also may be placed as a low-profile (LP) button in the operating room. Potential complications of the J-tube relate to the fragility of the jejunal wall and that the small intestine can volvulize internally around the point of fixation (J-tube) to the abdominal wall (Hui, Gerstle, Weinstein, & Connolly, 2004).

TYPES OF TUBES

A standard G-tube consists of a high-profile (long) tube with an external retention ring, an external balloon port, a feeding port, a medication port, an external safety plug, and an internal balloon. The tube diameter ranges from 12 to 24 French. The internal balloon usually contains 3–5 ml of sterile or distilled water based on French diameter to maintain correct tube position in the stomach. Graduated measurements are marked on the tube, which are helpful in determining stoma length. The G-tube can be placed primarily or through any mature stoma tract and is usually changed every 3 months or as directed by the practitioner (Hannah & John, 2013).

LP G-Tubes

LP G-tubes (buttons) are categorized as balloon or nonballoon style. LP balloon buttons have an external feeding port, a balloon port, and an external safety cap. An interlock center is always present to facilitate connecting the feeding set. The external valve is a one-way valve to prevent the backward flow of gastric contents when the extension set is not attached. The diameter of a button ranges from 10 to 24 French with stoma lengths from 0.8 to 6.5 cm. Buttons have an internal balloon, which is inflated with sterile water at initial placement, to maintain placement. Buttons can be easily deflated, removed, replaced, and

FIGURE 2. Mini-ONE gastrojejunal low-profile tube.

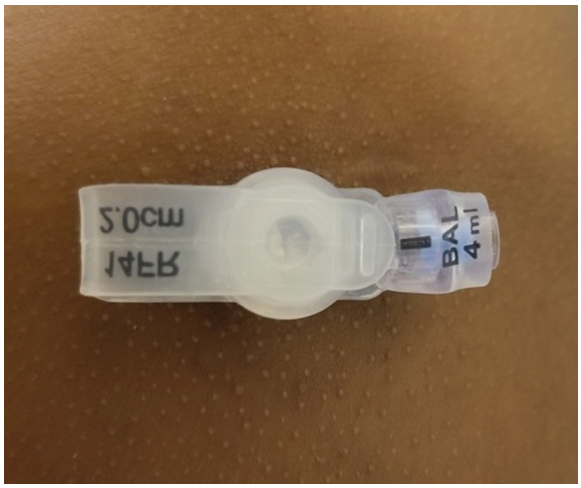

FIGURE 3. Mini-ONE low-profile balloon button.

inflated with water per the manufacturer's recommendations (Figure 3).

A stoma measuring device is a small tube with a balloon on the end. It is inserted into the stoma tract from the outside of the skin to the inside of the stomach, and the balloon is inflated with tap water. The disc is moved down the tube until it is flush with the abdomen to determine correct stoma length. All styles of balloon and nonballoon buttons can be measured utilizing this technique. The external base of the tube should rest only above the skin surface 1–2 mm above the skin about the thickness of a dime. Use only water-soluble lubricant for insertion. Petroleum-containing products can degrade the tube.

Many balloon extension sets are right angle to the device, bolus feeding connectors are upright (straight), and both connect when the black line on the feeding set is connected with the corresponding black line on the gastric port. Locking the set is performed by pushing in and rotating the connector until resistance is felt at a three-fourths turn. Various nonballoon buttons may connect with no locking mechanism.

When buttons are placed as a primary procedure, the stoma tract must be mature, at least 6 weeks, to remove and replace the button for the first time. By this time, many children have outgrown their original size because of weight gain and are ready to have the button changed to one with increased stoma length. In many pediatric surgery offices, this is the perfect time to teach a hands-on tube change with parents. There are no current national guidelines for safely removing and replacing this type of tube (Cunningham & Best, 2013). Current recommended manufacturer replacement is every 3 months.

LP nonballoon buttons (LP buttons) have an external safety plug, a glow green feeding port, and a soft external bolster with a tapered transition allowing air to circulate around the stoma site. The LP button has a fenestrated bolster and a dome-shaped internal bumper. The smaller internal bolster is smaller than a balloon, occupies less gastric space, and is less likely to block the pylorus. There are more distal openings in the tube for better feeding and venting. The LP button is replaced with an obturator. Once attached and stretched, it can be removed or replaced. The manufacturer recommends replacement every 6 months. LP buttons are placed primarily in the operating room by a surgeon, in endoscopy by a gastroenterologist, or in IR with analgesia and/or anesthesia. In this author's experience, this tube may be replaced in the outpatient office setting as well with analgesia, an experienced practitioner, and, ideally, child life therapy. LP button diameter sizes offered are 14–28 French with stoma tract lengths from 1.0 to 4.4 cm. The LP button is ideal for children who do not tolerate balloon buttons because of anatomy or from repeated balloon failures due to medications or the gastric environment as well as repeated dislodgements (Figure 4).

G-J Tubes

G-J tubes are classified as standard or LP. The standard G-J tube is a high-profile external tube with a gastric port, a jejunostomy port, and a balloon port. There is an external disc that sits at the skin level to hold the tube in place. The balloon holding the tube in the stomach is inflated with sterile or distilled water per manufacturer recommendations. The tube's gastric openings are located immediately distal to the balloon in the stomach to provide gastric-only access through the gastric port. The diameters of the tube are 14–24

FIGURE 4. Mini-ONE low-profile nonballoon button.

FIGURE 5. High-profile gastrojejunal feeding tube.

French. There is an additional length of tubing that continues internally from the balloon through the pylorus into the jejunum based on the child's size; lengths are 15–45 cm. This internal length can be the same diameter of the tube (14 French will have a 14-French diameter from the outside of the tube to the jejunum) and have openings for jejunal access near the distal end of the tube on either side. Alternatively, the G-J tube may taper to a smaller diameter distal to the balloon (e.g., 14 French will have an 8-French jejunal diameter) with lengths of 15–45 cm. G-J tubes may be placed in the operating room by a pediatric surgeon through an existing or newly created stoma utilizing fluoroscopy. Typically, G-J tubes are removed and replaced per manufacturer recommendations every 6 months and are typically replaced in the IR suite (Figure 5).

LP-style G-J tubes have a skin level bolster with an external gastric port, a jejunal port, and a balloon port. The external bolster keeps the tube in place. A properly filled device should not fit snugly against the skin. Instead, ensure there is a one-eighth inch (3-mm) gap between the external bolster and the skin surface to provide room for air circulation.

Both the standard high-profile G-J tube and the LP G-J tubes have a jejunal segment distal to the internal gastric balloon, which is of the same diameter as the tube. In the near future, a new G-J-style tube with an LP 14-French stoma tract tapering to an 8-French jejunal segment with variable lengths of 15–22 cm will be available, which is ideal for premature infants. The external gastric port can be used for venting or decompressing the stomach and administering medications. The external jejunal feeding port contains a valve to prevent backflow of feeding and is accessed through a gastric-only extension port with one manufacturer. The jejunal port can be accessed with the typical feeding extension set (Figure 6).

TUBE REPLACEMENT

Balloon-style tubes are replaced routinely every 3 months as recommended by the manufacturer. Nonballoon-style tubes are replaced every 6 months. Many surgical practices use LP balloon-style buttons in jejunostomies and recommend replacement every 3 months as well. When commercial or home-blended diets are utilized, the tubes are replaced more often; balloon-style tubes are replaced every 2 months and nonballoon tubes are replaced every 6 months to prevent fungal growth on the device due to the bacterial content in the food (Trevisani et al., 2005). Many children are on proton pump inhibitors that lower the acid content in the stomach, which may increase bacterial growth (Figure 7; Freedberg, Lebwohl, & Abrams, 2014).

PREPARATION FOR TUBE PLACEMENT

Once the decision has been made to place a feeding tube, the surgeon, health care team, family, and child, if developmentally appropriate, discuss the procedure

FIGURE 6. MIC-KEY low-profile gastrojejunal tube (G-J button).

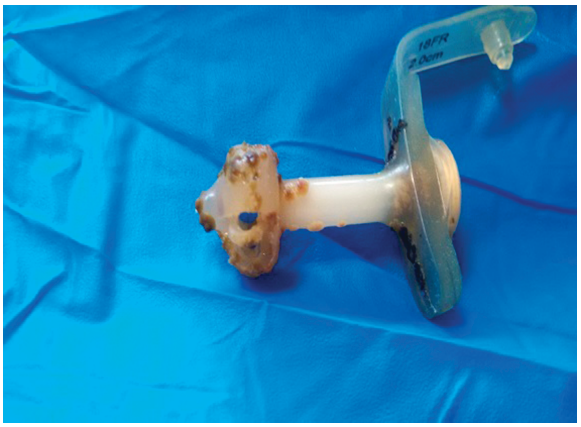

FIGURE 7. Mini-ONE nonballoon button with fungal growth.

and educational needs. Ideally, educating the child/family begins with the recommendation for gastrostomy placement. Education includes what to expect, tube and skin care, and types of feedings. Appropriate resources are shared with the child/family. Professional health care videos and written materials on tube placement, replacement, and site care are available from tube manufacturers as well as individual hospitals; education from these sources is evidence based and family appropriate. Although social media sites are readily accessible, their information may not be research based. (See article by Albin and McCormick [*JPSN*, *8*(4) pp 91-96] for education and information for parents on gastrostomy tube placement).

A team approach is recommended (Abdelhadi, Rahe, & Lyman, 2016). The postoperative diet plan is formulated by the dietician. Child life prepares the child/family for the hospital experience with videos, tours, and hands-on experiences with the surgical hat, mask, gloves, gowns, and stethoscope as well as a tour of the operating room environment before the procedure. Preparation of the child and family is equally important. Nursing participation is vital with preoperative teaching. Skills necessary to care for the stoma site will include caring for the tube and skin, connecting and disconnecting the extension tubing from the device, and venting or burping the child with the tube, as well as enteral feeding using the tube and administering medications. Practicing hands-on skills with the feeding pump is essential for the family. Discussing the steps to follow if the tube becomes dislodged and practice replacement with a medical simulation doll empowers the child/family and leads to success. Providing a team resource member for the family to call with questions is important as well. Preoperative teaching is vital to ensure knowledge and skill, decrease apprehension, and ensure a smooth hospitalization.

G-TUBE AND STOMA CARE

Developing a normal routine for gastrostomy site care is essential. General guidelines for the first 6 weeks after tube placement include cleaning the skin around the tube with sterile water or saline for the first several days or as instructed by the practitioner and then transitioning to soap and water. Supplies needed to perform daily care typically include normal saline, water, soap, 2 × 2 split gauze dressings, tape, Q-tips, specialty dressings as ordered, water-soluble lubricant, and adhesive remover. Routine stoma care varies from practice to practice. Follow guidelines specific to your practice.

New stoma sites should be protected from accidental trauma and excessive tube movement. Secure the tube site with a single 2 × 2 dressing and hypoallergenic tape to limit moisture and friction at the stoma site. This allows the stoma to heal and minimizes hypergranulation tissue. When the extension set is connected to the device, secure it by looping the tube and taping it to the skin to remove tension from the extension tube on the device. Securement devices, such as a cinch, can be helpful to prevent the tube from becoming caught in clothing and dislodged. Apply tape to the ends of the tube and the skin for stability. Disconnect the feeding extension set once the tube can be clamped. Cleanse extension sets between each use and replace per manufacturer recommendations. When cleaning the stoma site, rinse and allow to dry. Do not apply creams unless instructed by the practitioner. Rotate the LP button once or twice a day as the site heals. Before the first tube change, it is important to remember not to touch the balloon port, deflate or inflate the balloon, or change the volume in the balloon unless performed by the practitioner. Once the operative sites have healed, bathing in a tub or shower may be done safely. Wash the stoma site with soap and water. Apply a 2 × 2 split gauze if desired (Figure 8).

FIGURE 8. Gastrostomy tube securement.

Venting

The terms "venting" and "burping" the stomach are used to describe attaching a 60-ml open catheter tip syringe with the plunger removed and connected to the end of the extension set, which is attached to the a standard gastrostomy or button to allow gas and, occasionally, stomach contents to pass freely up and down the tubing. A venting bag or other device may be used as well. Venting relieves the pressure in the stomach with or without a feeding in progress. Venting the stomach while feeding the jejunum through a G-J tube is common. Typically, the jejunum is not vented.

Medications

Delivering medications through the tube can be challenging. Only liquid medications should be given in the G-tube with an extension set or given directly with a Luer slip tip syringe directly into the center of the button as directed per manufacturer. Flush with at least 5 ml of water after medication administration to prevent clogging the button with medication remains. If the medication is in a capsule, dissolve capsule contents in approximately 5-ml warm water. To crush and mix a medication in water, crush the pill with a pill crusher, add 5-ml warm water, and mix until dissolved. Each medication should be given separately. Do not crush or mix medications together. It is best not to mix medications with formula or put medications in the feeding bag or syringe. If the medication needs to be given on an empty stomach, administer 1 hour before or 2 hours after a feeding if possible. Flush with water before and after each medication to prevent clogging of the tube. Administration of some medications is site specific. Check with the pharmacist, practitioner, or nurse to determine which medications can be administered in the gastrostomy or jejunal limb of the G-J tube to prevent tube clogging and which site is best for absorption.

Oral Care

Oral care is important, even if the child is not eating or drinking by mouth, to minimize dry mouth, gum disease, and cavities. Oral care routines are dependent on the age of the child. Before teeth erupt, a baby's gums need to be massaged. As teeth develop, they are to be brushed and flossed.

Activities

Activities such as occupational therapy, physical therapy, rolling, crawling, and walking should resume as soon as the child is comfortable. Placing a soft sponge over the gastrostomy allows for a cushion and more comfortable "tummy time." This can be achieved by taking a kitchen-sized sponge and cutting a circle opening out of the center. Place the sponge over the gastrostomy and use a "onesie" garment to hold the sponge protection in place.

Traveling with the child to appointments or daily activities such as a daycare, school, and family outings can be stressful. Extra supplies to care for the tube and provide feedings are important considerations. A "to-go" bag should be assembled and sent to school or daycare with the child daily. A special health care plan should be developed by the provider and the parent, including feeding and flushing instructions. The school staff should know what to do and who to call in the event of problems or tube dislodgement. Adequate supplies typically include a replacement button (same-size) kit, which contains a new button, a catheter tip syringe, a Luer-slip tip syringe, and extension sets. Water-soluble lubricant and a small bottle of sterile water or distilled water per manufacturer recommendations are needed to inflate the balloon. Feeding supplies include a feeding bag, a venting device if needed, a feeding pump and a formula catheter tip syringe, 2×2 slit gauze dressings, and tape to secure the tube, along with any other special dressings with instructions from the practitioner's office, as well as wet wipes (must not contain alcohol) and dish detergent to clean the extension set after each use. Typically, schools and daycares do not replace tubes (see Dislodgement section).

NUTRITION FOR TUBES

Nutrition delivered through a G-tube or a G-J tube is necessary when the child is unable to consume sufficient nutrition to maintain adequate body composition and growth. The body requires specific amounts of carbohydrates, protein, fat, and vitamins and minerals depending on body weight, age, and other factors. Caregivers are taught how to prepare and administer formula by the dietician and nurse. The nurse provides technical education and supervises feedings using the "teach-back" method (Martin & Gardner, 2017). Health literacy and comprehension of the information are evaluated and incorporated into the educational plan. In many institutions, postoperative feedings are initially managed by the surgical team. An understanding of basic nutritional principles and feeding methods is essential to facilitate advancement to goal feeding safely.

Feeding Delivery Methods

Feeding delivery methods include gravity, syringe, and pump feedings. Gravity feedings are delivered from a feeding bag through an extension set into an open syringe. The flow is controlled by a roller clamp. Syringe feedings are administered directly into the open syringe

in small amounts, usually no more than 0.5–1 ounce at a time. Place no higher than 18 inches above the tube site (Fuchs, 2017). Blended whole-food feedings can be administered through a syringe slowly by pushing the feeding through an extension set attached to the tube.

Pump feedings are administered from the feeding bag through the extension set. The feeding bag may also be connected to a venting device or be plugged straight into the extension set without a vent. Nighttime feedings should be elevated 6–8 inches above the child's head (Fuchs, 2017). Although convenient for mobility and the family, continuous feeding at night either by gastrostomy or G-J tube may be susceptible to adverse effects such as lower oxygen consumption as well as shifts in nitrogen and cortisol balance (Stenvers, Jonkers, Fliers, Bisschop, & Kalsbeek, 2012).

Optimal positioning for tube feeding is important to prevent choking and aspiration. To minimize the risk of aspiration, they should be fed sitting upright or at a 30°–45° semirecumbent position. This can be best achieved by elevating the head of the bed, unless contraindicated (Serena, 2006). For those children who are restless sleepers, a sling or other device to inhibit sliding down in the crib can be useful. Ensure safety by positioning the pump tubing through the leg of a sleeper or securing it away from their upper body.

Rapid infusion with a pump or bolus feedings with an open syringe are not recommended with the "J" port of the G-J tube. This can result in dumping syndrome and diarrhea characterized by an unpleasant reaction caused by sudden arrival of a high volume of refined carbohydrates into the small bowel. Continuous feedings in at least 6- to 8-hour intervals at a slower rate provide constant mucosal stimulation to aid intestinal adaptation, which enables absorption and decreases vomiting (Stenvers et al., 2012).

Feedings may be initiated within 4–6 hours of initial tube placement as long as the child is stable and without the need for a clear liquid test. If the child previously tolerated 4-hour bolus feedings, they should also be successful with a gastrostomy. The type of feeding selected will depend on whether the child was tolerating preoperative nutrition supplementation by an NG tube. In this case, feedings may be advanced more rapidly. The choice of feeding depends on age, degree of supplementation, history of feeding intolerance, severity of preexisting gastroesophageal reflux, and potential risk of aspiration (McClave & Heyland, 2009).

Types of Formulas

There are a number of formulas available for tube feeding. Infants can be fed breastmilk or formula. There are formulas made specifically for certain disorders. Children with malabsorptive and maldigestive processes such as severe protein allergy tolerate monomeric formulas better and are made from predigested proteins and simple carbohydrates with a fat source from oil or medium-chain triglycerides. A monomeric formula gives the gastrointestinal tract a chance to rest because minimal digestive function is needed; they can also be used for G-J tube feedings.

Children with abnormal nutrient absorption, digestion, and transport; severe intractable diarrhea; and protein–calorie malnutrition may benefit from semielemental formulas. These formulas are partially predigested and contain varying lengths of amino acids as well as simple carbohydrates and medium-chain triglycerides. They are more efficiently absorbed than whole proteins and contain casein and lactalbumin, which stimulate jejunal absorption of electrolytes and water (Makola, 2005).

Children with malabsorptive disorders as well as those weaning from total parenteral nutrition tolerate modular formulas best. They contain only one of the macronutrients and contain unaltered proteins, fats, and carbohydrates. They are an incomplete supplement that includes specific nutrients that may be used for a singular macronutrient.

When children can digest and absorb nutrients without difficulty, polymeric formulas may be used. They contain unaltered proteins, carbohydrates, and fats. They are long-chain triglycerides and can include blended whole food. A tube with a 14-French diameter is adequate for administration of this food (Boullata et al., 2017). Disease-specific formulas vary in content based on the disease process. Children with kidney disease need a formula with less protein, potassium, and phosphorous to treat their specific condition. The practitioner will choose the best source of nutrition for the child (Nelms, 2018).

Safe Food Delivery

Safe delivery systems for liquid diets are essential. The potential for problems between small-bore connectors of an unrelated delivery system has resulted in fatal and near-fatal outcomes. Reports of misconnections where enteral nutrition has been delivered intravenously or in the airway have been documented (Food and Drug Administration, 2015). The International Organization for Standardization noted Leur Lock allows functions between unrelated delivery systems such as vascular, enteral nutrition, respiratory, epidural, urologic, and intrathecal devices (Martin & Gardner, 2017). Rollout in the United States has been delayed because of lack of availability of compliant syringes. Preliminary testing by

the global enteral device supplier association, Kimberly Clark (Avenos), and the American Society for Parenteral and Enteral Nutrition measured the amount of pressure needed to push the formulas through the ENFit connectors. They also measured gravity flow. No differences were found in either pressure or flow delivering water, formula, applesauce, and blended formula through this delivery system (Guenter, 2014). The Joint Commission has provided an educational offering to increase awareness and preparedness for clinicians and health care organizations (Joint Commission on Accreditation of Healthcare Organizations, 2016). The American Society for Parenteral and Enteral Nutrition has an enteral connectors and misconnections module as well to train and provide guidance during the transition to promote safe connections (American Society for Parenteral and Enteral Nutrition, 2016).

COMMON G-TUBE AND STOMA PROBLEMS

Although G-tubes and G-J tubes provide nourishment for children unable to eat by mouth or consume enough calories by mouth to thrive, they also share common problems. This author frequently tells parents: "The perfect tube is the one you do not need to have."

Skin is the largest organ in our body and provides protection for our immune system. Occasionally, there is some breakdown at the stoma site because of moisture and friction. Drainage is frequently seen at the stoma site. Routine care with soap and water daily and placement of a 2 × 2 split gauze dressing keep the site clean (Table 1).

Leakage

Some leakage around the site is commonly seen and may have many etiologies. There may be a problem with the balloon patency. If there is excessive leakage around the first initial tube that has not been changed, the caretaker is encouraged to call their practitioner for instructions. The interlok of the device may also be malfunctioning, causing leakage when the extension set is removed and the device lid is not closed. Leakage may also be seen if there is a delay in gastric emptying, intestinal dysmotility, excessive volume of feedings, illness, weight loss, constipation, and kyphoscoliosis. When troubleshooting leakage, ensure that the tube is secured with tape to prevent the tube from moving around in the tract. It is not advised to exchange the tube for a tube with a larger diameter to prevent leakage. This will enlarge the stoma site and increase drainage.

If leakage is within the first few weeks after tube placement, a tube study should be performed to rule out migration of the tube from the stomach back into the tract (Farber, 2013). If balloon failure is suspected, the balloon is checked only after the first tube change and on the advice of the practitioner. Most tubes have 2.5–5 ml of water in the balloon. With leakage from an established stoma tract, consider changing the water and recheck the balloon volume the next day. If volume remains low, change the tube. Venting or decompressing the stomach allows gas and excess stomach contents to be expelled. Adjust the volume of feedings by switching to smaller, more frequent feedings. A small group of children poorly tolerate feedings in the stomach and tend to leak, even with continuous feedings. These children may be helped by converting to a gastrojejunostomy temporarily (Crawley-Coha, 2004). Weight loss decreases the fat pad on the abdomen and can contribute to leakage. Use a sodium chloride dressing to wick up fluid or a calcium alginate dressing designed to absorb heavy drainage levels and aid in the management of bacterial burden. These are changed twice a day or more often if needed.

Crusting may be used to treat leakage, which has caused denuded or weeping skin around a gastrostomy stoma. This produces a dry surface and absorbs moisture from broken skin through an artificial scab created by using stoma powder. After the powder is applied, dust off the excess. Dab a skin polymer over the powdered area and allow to dry for a few seconds. A whitish crust will appear; it will feel rough but dry. Repeat the procedure two to four times to achieve a crust. Discontinue the procedure when the skin is healed and dry to the touch (Bryant & Best, 2016).

Constipation may also cause stoma leakage. The gastroenterologist or pediatrician may be the best person to manage this problem. Seeking too many opinions can make multiple treatments ineffective. Kyphoscoliosis can cause partial or complete intrathoracic positioning of the stomach (Siméon-Gélu et al., 2003) and can limit positioning options. This prevents the balloon from making contact with the abdominal wall, resulting in leakage. In some cases, the high-profile tube with the disc is the best treatment because it is adjustable. Illness contributes to a delay in emptying as well as an intestinal ileus. In the author's 20-year experience, before the illness is evident, a red ring develops around the stoma site, and then leakage appears. Other symptoms such as fever, upper respiratory symptoms, vomiting, and/or diarrhea may be seen as well. Any irritation of the stomach will be seen at the stoma site.

Candidiasis

Irritation and redness can lead to a red rash with satellite lesions, pustules, or a dry scaly look. With candidiasis, use an antifungal powder and/or a moisture

Table 1: Common Stoma Problems for Gastrostomy and Gastrojejunostomy Tubes

	Causes	Treatment
Leakage	*Balloon failure *Broken interlock *Delayed gastric emptying *Dysmotility *Increased volume of feedings *Constipation *Weight loss *Scoliosis *Illness *Enlarged stoma	*Check balloon volume (after first tube change) *Change tube if >6 weeks and tract is established *Venting/decompression *Adjust volume of feedings temporarily *Treat constipation *Consult practitioner for resizing *May need a long external tube *Position on the right side with feeding *Secure tube *Vent tube, while feeding *Use sodium chloride dressing *Use hydrofiber silver-impregnated dressing with mild drainage *Use alginate dressing *Use ostomy powder/zinc oxide cream *Use hypochlorous acid (Vashe) *Treat illness *Probiotics
Infection/ candidiasis	*Warm, moist site *Illness *Proton pump inhibitors	*Wash with soap and water *Antifungal cream/powder *Use hydrofiber silver-impregnated dressing *Change tube after treatment is completed (after first tube change) *Use hypochlorous acid (Vashe)
Redness/Irritation	*Moisture *Tube too short *Illness *Lotion	*Wash with soap and water *Hydrofiber silver-impregnated dressing *Resize tube *Treat illness *Use hypochlorous acid (Vashe) *Use ostomy powder/zinc oxide cream
Hypergranulation tissue	*Moisture, friction *Trauma to site *Illness *Tube too short	*Wash with soap and water *Apply split 2 × 2 dressing *Consult practitioner for tube resizing *Secure tubing *Sodium chloride dressing (Mesalt) *Use alginate dressing (Maxsorb) *Hydrofiber silver-impregnated dressing *Use hypochlorous acid (Vashe) *GranuLotion *Silver nitrate *Triamcinolone 0.1%–.05% cream *Surgical excision

wicking hydrofiber dressing impregnated with silver. These products' antimicrobial properties decrease the bioburden around the gastrostomy site (Crawley-Coha, 2004; Glavan & Jonjić, 2015) and are bactericidal against gram positive, negative and aerobic and anaerobic bacteria. These products manage drainage and heal the skin. The dressing is cut in a ¼-inch strip to place under the bumper of the tube. Change every 3 days or when moist. Systemic antifungal treatment is rarely recommended. Limit the application of the silver-impregnated dressing to 2 consecutive weeks in neonates, to decrease the risk of toxicity (August, Ireland, & Benton, 2015). Once the infection has cleared, change the G-tube.

Cellulitis

Cellulitis is an infection of the skin and soft tissues beneath. It occurs when bacteria enter a break in the skin and spread. This infection can cause a red, tender, swollen, warm, or foul-smelling area. The most common etiology is an infection caused by methicillin-resistant *Staphylococcus aureus*. Other causes can be methicillin-sensitive *S. aureus*, normal skin flora, or Group B streptococci (Goldberg, Barton, Xanthopoulos, Stettler, & Liacouras, 2010; Radhakrishnan et al., 2006).

Resizing

The tube should be evaluated for appropriate fit at least every 3–6 months for children less than 2 years old and more often with noticeable growth. With newly placed G-tubes and increased weight gain, pressure injuries at the stoma site can occur. This is typically seen with increased weight because a longer tube cannot be placed until the tract matures at least 6 weeks or longer. Prevention includes rotating the tube after the first few weeks to prevent pressure injuries. To rotate, apply a water-soluble lubricant to the stoma site, lift up the tube, push it down, and then turn it around. Perform this procedure once or twice a day.

Self-Discovery

Self-discovery of the tube by the developing child is normal; however, it may result in repeated tube dislodgements. Use of a protective device such as an ace wrap—wrapping it around the child's body once, cutting off excess, and taping the ends together—may help. You may also use a Velcro-ended ace wrap safely. Cloth belts are cute and can be obtained through online shopping sites. Abdominal binders have also been used. Ensure that the wrap does not restrict respirations and chest expansion. Another commercially available option is a belt made from neoprene that stretches. There is an opening for the button to protrude and a cover called a "turtle shell dome," which is attached with Velcro

over the button. This protects the site and prevents the ability to dislodge as often. A waist measurement is taken for sizing.

Hypergranulation Tissue

Hypergranulation tissue or "proud flesh" is frequently seen around G-tubes and is caused by moisture, friction, and trauma to the site. It is the most common problem seen with G-tubes (Crawley-Coha, 2004). Fuchs (2017) evaluated emergency department visits for the first 30 days after gastrostomy placement and showed that 39% of G-tubes were not sealing due to drainage from hypergranulation tissue. Warmth and moisture increase bacteria. This red, pink tissue is moist and contains capillaries, connective tissue, fibroblasts, and inflammatory cells, which cause bleeding. Hypergranulation tissue is irregular and bumpy, suggestive of a heavy bioburden (Figure 9).

TREATMENTS

Treatments include cleaning the stoma site with soap and water a few times a day, ensuring the tube is of the proper size, securing tubing and/or removing between feedings, and using a moisture wicking dressing such as a 2 × 2 split gauze, a dried sodium chloride dressing, or a silver-impregnated dressing. Vashe, a hypochlorous acid liquid, kills invading pathogens as part of the natural human immune inflammatory response, disrupts biofilms, and removes debris and microorganisms from wounds, resulting in faster healing. It has been tested against many common pathogens, including fungi, spores, and multidrug-resistant bacterial strains (Niezgoda, Sordi, & Hermans, 2010). To apply, saturate a 2 × 2 split gauze and place under the bumper of the tube for approximately 10 minutes. The medication is cool but painless. Do not wash it off after application. Vashe decreases the bioburden at the stoma site. GranuLotion is an over-the-counter salt cream used at least twice a day and shrinks the granulation tissue. This is not recommended for children on a ketogenic diet because it contains glucose. It is also not recommended to use on an infected site with open skin.

FIGURE 9. MIC-KEY low-profile button with hypergranulation tissue.

Silver nitrate is an organic compound used to remove hypergranulation tissue, treat wound edges, and cauterize bleeding. Silver nitrate can be effective; however, it is often painful when applied. Before applying this chemical cautery, consider pretreating the tissue with a topical lidocaine hydrochloride 2% jelly, a topical local anesthetic that can provide pain relief. Wait approximately 1 minute after administration and then apply silver nitrate to the tissue. Apply water after application to deactivate the silver nitrate treatment. Place a protective cream, such as zinc oxide, around the stoma site treated tissue to prevent staining or damage to surrounding healthy skin (Johnson, 2009). Avoid ointments with petroleum around the tube as they may cause degrading of the device.

Other pain modalities during silver nitrate application are available. Sucrose water 24%, used in neonates and children under 6 months old, can be given with a pacifier (Harrison, Beggs, & Stevens, 2012). Before administration, ensure the child is safe to drink by mouth. Older children may have pain relief from the use of a vibrating device and a cool pack to block pain pathways (Whelan, Kunselman, Thomas, Moore, & Tamburro, 2014). Topical steroid 0.1%–0.5% cream can be applied at home.

Surgical excision may be recommended if the granulation tissue persists and becomes epithelized. Timing varies based on surgical practices.

Abscess

Bacteria can wall itself off within the stoma tract, and pustules may be seen around the site. This may occur when the child scratches the site or a stitch works its way to the surface. Button covers may harbor

bacteria or make the button too tight, possibly causing an abscess. When using button covers, adjust the height of the button one size taller to accommodate fabric thickness. The button cover should be changed daily or when soiled. Systemic antibiotics may be needed, as well as drainage of the abscess. Stitch abscesses can occur as well; offending stitches should be removed (Figure 10).

Clogged Tubes

Clogged tubes can occur due to the type of food and delivery method, medication administration, and inadequate flushing. While administering continuous feedings, the G-tube should be flushed every 4 hours. When administering jejunostomy feedings via a G-J tube, flushing should occur every 4–6 hours as well. Dispense all medications as a liquid and flush before and after with at least 5 ml of water if possible. Do not flush with cranberry juice or sodas as they can lead to further congealing of formula and medication; these products also change the pH and thicken the clog (Dandeles & Lodolce, 2011). Flush with warm water using the push–pull method by alternating pushing and pulling on the 60-ml syringe. For severe blockages, you may use pancreatic enzymes; a 650-mg sodium bicarbonate tablet with Creon (Farber, 2013) is more successful than Viokase and sodium bicarbonate. Another option is Clog Zapper (www.mic-key.com) made with papain, alpha-amylase, and cellulase. These enzymes can digest protein and starch obstructions (Farber, 2013) and come with a stylet and syringe of powdered contents activated when water is added to the syringe. The substance is passed through a stylet and dwells for an hour. If these methods fail, tube replacement is recommended. The best treatment is prevention, and tube flushing is key.

FIGURE 10. Gastrostomy button cover.

Buried Bumper

Buried bumper can occur with PEG, LP, and non-balloon tubes. The internal bolster can be pulled into the submucosa of the gastric wall and cause peritonitis and/or an abscess (Fuchs, 2017). Signs and symptoms include difficulty infusing feedings or medications or difficulty rotating the tube. The tube must not be used until a contrast dye study is performed. Surgical intervention may be necessary. Prevention includes rotating the tube once a day to make sure the tube is not too tight and may be performed within the first few weeks after placement, with frequent checks for appropriate length by the surgical team. The LP tube with and without a balloon may appear extremely tight when the stomach is empty and contracting; the tube easily returns to normal with drinking or administering a feeding, allowing the stomach to relax. The tube may also appear tight when the tube is too close to the pylorus and causing intermittent obstruction.

Dislodgement

Dislodgement can occur at any time. A gastrostomy stoma opening will begin to close within 1–6 hours after dislodgement (Fuchs, 2017). Dislodgement may occur due to balloon failure, self-discovery, or trauma. If dislodgement occurs before the first tube change and a mature stoma tract is certain, advise the caretaker to cover the site and call their provider caring for the gastrostomy while proceeding to their pediatric emergency department. Teach the family to take their backup tube with them for replacement. Do not feed the child until the tube is replaced and verified to be in the lumen of the stomach by contrast study. An abdominal x-ray without contrast is not accurate. In the contrast study, contrast fills the stomach and the radiologist looks for leaks outside the stomach. After the first tube change, the caregiver can replace the tube at home as needed after teaching has occurred. Routine tube changes occur every 3 months. Stomach contents are returned to verify stomach placement. Caregivers are instructed to keep a backup tube replacement kit with them at all times.

After tube dislodgement, the stoma tract may appear closed. If there is any difficulty in replacing the tube, a dressing should be applied and the practitioner should be notified, with the child taken to the emergency department or outpatient surgery office for replacement. Various methods are used to dilate the stoma tract. A Foley catheter (usually smaller than the dislodged tube) may be

placed temporarily in the mature tract. This temporary catheter should be secured and taped down to prevent migration of the tube into the duodenum. IR or surgical replacement may be necessary.

Formula in the stomach of a child with a G-J tube is a sign that the jejunal limb has migrated into the stomach. Other symptoms include feeding intolerance, pain, and vomiting (Fortunato, Darbari, Mitchell, Thompson, & Cuffari, 2005). If present, the caregivers are instructed to contact their practitioner immediately and stop the feeding until evaluated. The external bumper of the G-J tube should not be rotated. This can cause kinking as well as retrograde tube migration into the stomach.

TUBE WEANING

A child who has been tube fed for an extended period may not want or know how to eat and drink. Oral sensorimotor stimulation with and without tastes can improve oral skills. Readiness for oral feeding includes tolerance of bolus feeding without gagging and retching. Children on continuous feedings at night and off during the day typically do not show signs of hunger, which is of primary importance in transitioning from tube to oral feeding. A child's nutrition status, overall medical and surgical status, and safe swallowing including close medical monitoring are important. Respiratory status must be stable. Frequent upper respiratory infections or repeated pneumonias and enlarged tonsils and adenoids can interfere with advancing oral feedings. Purposeful swallowing is essential for airway protection. Drooling is a sign of not swallowing. Some children do not realize they should swallow saliva. Purposeful stimulation can improve function.

Many behavioral and physical characteristics must be present before an attempt to wean the child from their feeding tube, including the ability to sit at the table, accept a bite, and adhere to structured meal times. A combination of nutrition modification, behavioral techniques, and parent education is essential. The child's perceptions and interactions with food through play and handling are vital. Structured meals and positive reinforcement are keys to success. Ishizaki, Hironaka, Tatsuno, and Mukai (2013) compared tube-fed children before and after the age of 3 years and found that, if weaning occurred before the age of 3 years, weaning occurred more rapidly. A team approach to aid in transition from tube to oral feeds includes practitioners from pediatric surgery, nursing, nutrition, occupational therapy, speech and language, child life, gastroenterology, psychology, and pharmacology.

Readiness Criteria

Oral experiences should be happy times and not related to discomfort in any way. Before tube weaning, the child must have adequate nutrition and hydration, stable pulmonary status, and minimal to no gastroesophageal reflux symptoms. Evaluation of aspiration risks and oral skills is performed. Feeding is not forced, or spoons must not be overfilled, which can lead to oral aversions. The child (if developmentally able) should sit in a high chair for no longer than 10–15 minutes. Do not promote grazing and keep distractions minimal. Most importantly, do not try to wean alone.

G-Tube Removal

When the weaning process begins, so does the G-tube removal process. For the tube to be removed, the child needs to gain weight and grow appropriately without using the feeding tube for 3 months. The child's specialists and primary care physician must all agree to tube removal. Consider decreasing the G-tube size until the smallest size available is placed (usually a 10-French tube). Before removal, the stoma site is evaluated. No signs of granulation must be present or the stoma will not close. Khan et al. (2015) studied factors affecting spontaneous closure for children with intestinal failure and studied 59 patients. Duration of indwelling gastrostomy was predictive of failure of spontaneous closure as well as weight for age z score at the time of removal, which was not different between groups. Persistence of gastrocutaneous fistula after removal ranges from 5% to 45% of pediatric patients (Denning et al., 2018). Conservative therapy includes chemical cautery of the tract with silver nitrate, proton pump inhibitor, and prokinetic agents to increase emptying with some success.

Gastrocutaneous Fistula

A study by Wyrick et al. (2013) described an open surgical technique associated with a higher incidence of persistent gastrocutaneous fistula. There was no significant difference in patients who received a fundoplication. A younger age at gastrostomy placement increases the risk of gastrocutaneous fistula. Fuchs (2017) found that a Nissen fundoplication was an independent predictor of a gastrocutaneous fistula tract. Increased gastric pressure from delayed gastric emptying because of dysmotility, or the inability to empty the stomach, results in air and stomach contents escaping around the stoma site.

Alternative approaches have been described by Denning et al. (2018) and include reports of endoscopic clipping. An adult case series describes applying fibrin glue, endoscopic banding, endoscopic suturing, and hemoclips. Many of these procedures cannot be performed in children due to their small size.

Conservative measures are attempted before procedures involving general anesthesia. Avoiding unnecessary

anesthesia exposure in children already vulnerable is relevant as concerns over neurodevelopmental sequelae of anesthesia grow in the pediatric literature (Bjur, Payne, Nemergut, Hu, & Flick, 2017; Loepke & Soriano, 2008). In this author's unpublished experience, preparation for tube removal has brought hope to parents who have dealt with a gastrostomy for several months to years. The day of removal is similar to a "rite of passage" and is very emotional. Many families take the tube home in a specimen cup.

After tube removal, lidocaine jelly 2% is applied to the stoma tract before application of silver nitrate to the tract. Water is then applied. A pressure dressing is placed over the stoma, and parents are taught how to replace the dressing at home. After tube removal, children are given small frequent meals and drinks to prevent overfilling the stomach, causing pressure and stoma tract leakage. Families are taught to offer the child the same amount of calories and fluids in a day as they had consumed during tube feedings to prevent dehydration and weight loss. The first stoma dressing stays on for several days; one week is preferable, to prevent disruption of healing at the site. The child bathes with the dressing on and does not submerge or soak the site. After several days, the stoma dressing is changed. A proton pump inhibitor is prescribed for 1 month, and then this medication is weaned. After 2 weeks from tube removal, the stoma site is reevaluated for healing and possible reapplication of silver nitrate. Conservative measures demonstrate effective closure in 80% of patients overall in either preventing or treating a gastrocutaneous fistula, with some studies reporting 100% effectiveness with these therapies (Janik, Hendrickson, Janik, & Landholm, 2004; St-Louis, Safa, Guadagno, & Baird, 2018). If the stoma tract has not closed within 1–2 months spontaneously, surgical closure may be necessary. This varies from practice to practice (Figure 11).

Surgical Closure

When the decision is made for surgical closure, a pediatric surgeon is consulted and the child is taken to the operating room where a primary layered closure occurs. An elliptical incision is made in the skin and soft tissue around the opening. The abdominal cavity is entered, and the stomach is freed from the anterior abdominal wall. The gastrocutaneous tract is resected. The gastrostomy site is closed (Denning et al., 2018).

CONCLUSION

G-tubes and G-J tubes are commonly used in children who are not able to consume adequate calories and liquids by mouth to gain weight and grow. Many children need these types of tubes long-term, and families of medically complex children are increasingly expected to manage this technology at home. These devices have become a significant part of the lifestyle for many children and families. Nurses are involved in patient and family education early and collaborate with the health care team to provide optimal care. Understanding and becoming familiar with the types of tubes, basic methods of care, and complications associated with enteral feedings make nursing an invaluable resource for parents.

FIGURE 11. Closed gastrocutaneous fistula.

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