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Enteral Access Devices

John C. Fang, MD, and Merin Kinikini, DNP, FNP, RD, CNSC

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Objectives

Define the patient and tube selection criteria for various enteral access devices.

Understand the insertion techniques for the different types of enteral access devices.

Describe proper care and maintenance of enteral access devices.

Know the complications of enteral access devices.

Test Your Knowledge Questions

1. If a nasoenteric feeding tube cannot be unclogged using water flushes, what is the next most reliable method for unclogging the tube before it is replaced?

A. Administer cola through the tube, and let it sit for a few hours.
B. Administer Clog Zapper (CORPAK MedSystems, Buffalo Grove, IL), and flush within 30 to 60 minutes.
C. Wait a few hours to see whether the clog dissolves spontaneously.
D. Administer a mixture of pancreatic enzymes and bicarbonate solution, allow it to sit for 1 to 2 hours (or longer), and then flush with warm water.

2. You perform a telephone evaluation of a patient who relates increased redness, pain, and swelling around his existing low-profile gastrostomy tube (G-tube). He has not been seen in the clinic for more than 6 months and, when asked, states that he has been doing quite well on his enteral tube feeds. In fact, the patient states he has gained over 20 pounds. You would proceed as follows:

A. Congratulate him on gaining the weight and tell him to continue his present tube feeding plan.
B. If possible, have him come to the clinic or call the clinician managing the tube to rule out buried bumper syndrome.
C. Direct him to put some triple antibiotic around the site and call back in a couple of weeks if the discomfort continues.
D. Tell him to put hot packs on it, take acetaminophen, and rest for a few days.

3. An 18-year-old female patient with cystic fibrosis had a standard-profile, solid internal bolster, 20-Fr percutaneous endoscopic gastrostomy (PEG) tube placed 1 year ago because of her inability to take in enough energy orally and weight loss. She has done very well, with her weight stabilizing and no complications of the PEG. The original tube is now getting stiff and cracking, and the patient wants a replacement tube. The patient has a very supportive family environment, is very active, and is concerned about the cosmetic appearance of the tube itself. What type of replacement tube would you recommend?

A. Standard-profile, 20-Fr percutaneous G-tube with solid internal bolster
B. Standard-profile, 20-Fr percutaneous G-tube with balloon internal bolster
C. Low-profile, 20-Fr percutaneous G-tube with solid internal bolster
D. Low-profile, 20-Fr percutaneous G-tube with balloon internal bolster

Test Your Knowledge Answers

1) The correct answer is D. Pancreatic enzyme solutions have been studied, and, in one report, this method of unclogging tubes had a 90% success rate when the tube was allowed to sit for 2 hours. The mixture of 1 tablet of a pancreatic enzyme (pancrelipase [Viokase] 6000 units, protease 19,000 units, amylase 30,000 units) and 325 mg sodium bicarbonate (half of a 650-mg tablet) is crushed and mixed with 5 mL of warm water and instilled into the feeding tube for 30 minutes to 2 hours. This method can be tried an additional time (for up to 24 hours), if the shorter waiting period is ineffective. However, if the clog is from a medication and does not clear the first time, the tube should be replaced. Answer A is a common misconception. Administering an acidic solution can actually worsen formula and many medication clogs. Clog Zapper is a commercial mixture of papain, α-amylase, and citric acid solution. It has a lower success rate than pancreatic enzyme solutions. Waiting longer will not help a tube become unclogged.
2) The correct answer is B. Whenever a patient with a low-profile feeding tube gains or loses a significant amount of weight, there is a risk that the tube is no longer sized correctly. This risk is greatest with weight gain, because that can cause abnormal internal pressure from the bolster or balloon (one that has deflated enough to be pulled into the abdominal wall), which can erode the gastric mucosa. If this process continues, buried bumper syndrome may develop. It results from growth of the gastric mucosa partially or completely over the internal bumper, or excess pressure on the tissues in-between the abdominal wall and gastric mucosa, usually because of excessive tension between the internal and external bumpers or a partially deflated balloon. Poor wound healing, significant weight gain without adjusting the external bumper or changing to a longer, low-profile feeding tube, or lack of routine changes with a balloon tube can contribute as well. Patients are often unaware of this problem until the tube site becomes extremely painful. As the skin becomes irritated and swells, it magnifies the problem. This patient needs to be evaluated soon and have the feeding tube exchanged for either a longer, low-profile tube or a standard tube. If the process has progressed too far, infection may also occur and more intensive treatment with antibiotics and tube removal may be required.

3) The correct answer is D. A low-profile, 20-Fr percutaneous G-tube with balloon internal bolster is appropriate for this patient. Because she is very active, standard-profile tubes are less appealing than low-profile, skin-level tubes. Because the patient is concerned about her appearance, a low-profile tube is also a better option. Solid internal bolsters last longer, but they cause significant discomfort when removed and therefore require a clinic or hospital visit to be replaced. Therefore, a low-profile, balloon internal bolster, percutaneous G-tube is the best replacement option. Because the patient and her family are so involved in her care and supportive, they can likely be trained to exchange a low-profile, balloon-type replacement PEG on their own, thus further minimizing future office visits to exchange the feeding tube.

Introduction

Enteral nutrition (EN) is the preferred method of feeding in the presence of a functional gastrointestinal (GI) tract when the patient cannot take in enough nutrition orally (see Chapter 10). Delivery of EN to the patient will require an enteral access device. To determine the type of enteral access device that is best for the patient, many factors must be evaluated. The underlying disease, gastric and small bowel function, short- and long-term goals, anticipated length of therapy, risk factors related to the method of tube placement, and ethical considerations are all considered when determining the type of enteral access device. To choose the appropriate feeding tube and location in the GI tract, nutrition support clinicians should involve the patient and family in the decision-making process and understand their own institution's specific resources and expertise. These factors are essential for the successful delivery of enteral feedings in the hospital or nonhospital setting. Nutrition support clinicians should also provide the appropriate postplacement care of feeding tubes to prevent and manage complications of enteral access devices.

Enteral Access Device Selection

Several factors help the clinician determine the optimal type of enteral access device to place. A clear rationale for enteral feedings, the potential length of EN therapy, and a plan for enteral access placement must be determined. Both a thorough history, including the patient's current and past medical and surgical conditions, and a focused physical assessment, including the anatomy and function of the upper airway, esophagus, and digestive tract, are imperative to select the appropriate enteral access device.

The estimated duration of EN therapy, or the desire for an enteral feeding trial to assess for tube feeding tolerance before an invasive procedure, are the main factors in determining nasal tube placement vs percutaneous enterostomy. Generally, tubes used for short-term therapy (less than 4 to 6 weeks) are placed nasally (or, in some cases, orally) at the bedside. Placement may be done blindly, with the aid of an electromagnetic tracking device (CORPAK MedSystems, Buffalo Grove, IL), endoscopically, or fluoroscopically in interventional radiology.1 These tubes include nasogastric, nasoduodenal, nasojejunal, and nasogastric-jejunal tubes. For long-term placement, (longer than 4 to 6 weeks), percutaneous enterostomy tubes can be placed into the stomach or small bowel using endoscopic, fluoroscopic, laparoscopic, and open laparotomy techniques (see Practice Scenario 12-1).2–8

When long-term access is needed, percutaneous feeding tubes are indicated and the condition of the external abdominal wall, ability to correct coagulopathies (including use of anticoagulant medications), and patient tolerance to anesthesia must be assessed. Percutaneous access devices can be placed with local anesthesia of the abdominal wall and minimal or moderate intravenous (IV) sedation; therefore, these devices may be a better option than those placed under general anesthesia, especially in the patient who may not tolerate general anesthesia. Available expertise in endoscopy and radiology for placement of gastrojejunal and direct jejunal tubes may vary significantly per institution. In some clinical settings, direct jejunal tubes must be placed surgically. Previous surgical scars in the abdominal wall, existing surgical wounds and fistulas, the presence of or future requirements for ostomies, percutaneous or intra-abdominal infusion devices, ascites, and peritoneal dialysis catheters must be assessed as part of the decision-making process.

Practice Scenario 12-1

Question: Is a patient with head and neck cancer a candidate to receive an enteral feeding device? If so, what type of enteral feeding tube should be used?

Scenario: A 72-year-old man was diagnosed with metastatic squamous cell carcinoma of the tongue. He is scheduled to receive a 6-week course of a combination of chemotherapy and radiation therapy followed by reassessment of tumor response. Physical examination reveals a thin man who weighs 80 kg and has lost approximately 11 kg in the past 3 months, which represents a weight loss of 14% of his previous body weight. His electrolytes, complete blood count, liver function tests, and albumin are within normal limits.

Intervention: The patient received a percutaneous gastrostomy tube (G-tube) using the introducer method technique performed by an interventional radiologist.

Answer: This patient could benefit from an enteral feeding tube to address both his existing malnutrition as well as likely further decreases in oral intake related to mucositis, nausea, and vomiting from chemoradiation. As the expected duration of therapy will be more than 6 weeks, the preference would be to place a percutaneous G-tube over a nasoenteric feeding tube. A percutaneous G-tube would also be more convenient for the patient, as bolus feeding is much easier through a larger-bore gastric tube than a smaller-bore nasoenteric tube.

Rationale: During radiation and chemotherapy treatment for head and neck cancer, patients almost always experience dysphagia, odynophagia, and mucositis. In fact, these problems are so prevalent that some clinicians advocate placing “prophylactic” G-tubes before treatment starts.2,3 This type of therapy can help the patient maintain hydration and meet energy and protein goals while dysphagia is severe. One study showed that patients who had a prophylactic G-tube placed before treatment lost 5% less weight than the control group.3 In addition to the timing of gastrostomy placement, controversy also surrounds the type of feeding tube to place in patients with head and neck cancer. Some centers contend that keeping a nasogastric tube (vs percutaneous G-tube) will preserve the muscles of swallowing and allow the patient to independently feed more quickly after therapy is completed.4,5 The general consensus is that patients have less dysphagia and a shorter duration of therapy with the

nasoenteric tube, but they lose less weight with the percutaneous G-tube.6 Clearly, more research is warranted. In this case, a percutaneous G-tube is chosen because of the preexisting malnutrition, the expected development of further nutrition impairment with chemoradiotherapy, and the estimated length of time that a feeding tube will be required. To help minimize the risk of prolonged dysphagia, a patient with head and neck cancer needs to be seen by a speech therapist during the time a nasoenteric tube or percutaneous G-tube tube is used. With either type of tube, the patient can continue to practice swallowing food and liquids as tolerated and do the recommended swallowing exercises.

Using the pull technique for percutaneous G-tube placement may carry a risk for tumor implantation because the G-tube is dragged through the cancer field, potentially seeding the gastrostomy tract with tumor cells.7 To minimize this risk, the "introducer" method can be used by interventional radiologists, surgeons, or endoscopists to place a percutaneous G-tube. In this technique, the stomach is insufflated and anchored to the anterior abdominal wall with T-fasteners. Serial dilators are then used to enlarge the tract, and the G-tube is introduced percutaneously. In this manner, the tube is not pulled through the region with active cancer and risk for tumor seeding is decreased.8

The decision to place an enteral access device for gastric or small bowel feedings is based on gastric motility, gastric aspiration risk, alterations in GI anatomy (eg, postsurgical), and coexisting medical conditions. Gastric feeding is generally reserved for the patients with normal gastric emptying and a low risk of gastric aspiration, although more and more institutions are using gastric feeds as a first-line approach, even in the intensive care setting. Small bowel feedings are preferred in the presence of gastric outlet obstruction, gastroparesis, severely increased risk of aspiration, and pancreatitis. The use of gastrojejunal tube systems, which allow for simultaneous gastric decompression and small bowel feedings, may be indicated for gastric outlet obstruction, severe gastroesophageal reflux, gastroparesis, and early (postoperative) feeding.9,10 The use of small bowel feeding to reduce risk for aspiration pneumonia is controversial, although recent data and meta-analysis suggest this feeding approach may be of benefit (see Practice Scenario 12-2).11–15

Practice Scenario 12-2

Question: What type of long-term tube (stomach or small bowel) should patients receive if they have the preexisting condition of gastroesophageal reflux disease (GERD)? Does the answer change if the patient is in the intensive care unit (ICU)?

Scenario: A 35-year-old man sustained a closed head injury in a car crash. He is expected to have oral dysphagia for many weeks, and the intensivist asks which type of feeding tube would be the best option. Previous history includes long-standing GERD for which the patient was taking an over-the-counter acid-suppression medication.

Intervention: The patient receives a bedside percutaneous gastrostomy tube with a solid internal bolster.

Answer: This patient can benefit from a tube that most closely mimics the physiological state of the body. He will likely be undergoing extensive rehabilitation with many different therapy sessions. He may also be confused for a period of time, and the fewer tubes and lines that are visible for the patient to grab, the safer he will be. The least-expensive option is to bolus feed, thus eliminating the need for bags, tubing, and a feeding pump. The goal of a tube in the stomach is to work toward 3 or 4 bolus feeds per day, which mimics breakfast, lunch, dinner, and an evening snack.

Rationale: The question often arises as to whether a tube placed in the stomach leads to increased risk for aspiration pneumonia, especially in the setting of GERD, ICU, or dementia. To minimize this risk, many hospital physicians will order a gastrostomy-jejunostomy tube, instead of a gastric tube, to safely feed the patient below the pylorus. Numerous studies have been done comparing the risk for aspiration pneumonia with feeding in the stomach vs small bowel, and the results are conflicting. Guidelines from the American Society for Parenteral and Enteral Nutrition (ASPEN) suggest that gastric residual volumes do not need to be checked in the ICU setting, as they do not correlate with increased risk of aspiration, and the ASPEN guidelines continue to recommend feeding into the stomach as the first-line option.15

Whenever possible, we should feed our patients into the stomach. This route is the most physiologically normal for the body, ensuring appropriate mixing of nutrients with gastric acid. It also allows for flexibility of schedules, is the safest with regards to formula contamination secondary to no formula hang time, allows for blenderized diets, and is the most cost-effective. If the patient does not tolerate gastric feeding or has an aspiration event, the feeding can be diverted to the small intestine.

Enteral Feeding Tube Devices

Physical Characteristics

Patient comfort and tube performance are the key criteria in choosing a brand of feeding tube. Commercially manufactured feeding tubes are usually made of polyurethane or silicone, and each material has specific advantages and disadvantages (Table 12-1). Most nasogastric or nasoenteric tubes are constructed of polyurethane because it allows for a relatively larger inner tube diameter for a given outer diameter size. Most percutaneous tubes are constructed from silicone because of its inherent material longevity and comfort. Rubber tubes, used in Foley catheters and red rubber surgical jejunostomy tubes, are inferior because they degrade rapidly and lack internal (red rubber) or external (Foley catheter) retaining devices. With the new mandate to have ENFit connectors (new connectors engineered to not allow connectivity with connectors for any other clinical use) on all enteral feeding devices by 2017, the use of Foley catheters or red rubber catheters for enteral feeding will no longer be possible.16–18

TABLE 12-1 Comparison of Polyurethane and Silicone Tube Characteristics

	Polyurethane	Silicone
Comfort	Lower	Higher
Stiffness	Higher	Lower
Wall width	Thinner	Thicker
Fungal degradation	More resistant	Less resistant
Common use	Nasoenteric feeding tubes	Percutaneous (abdominal) feeding tubes

Tube Types

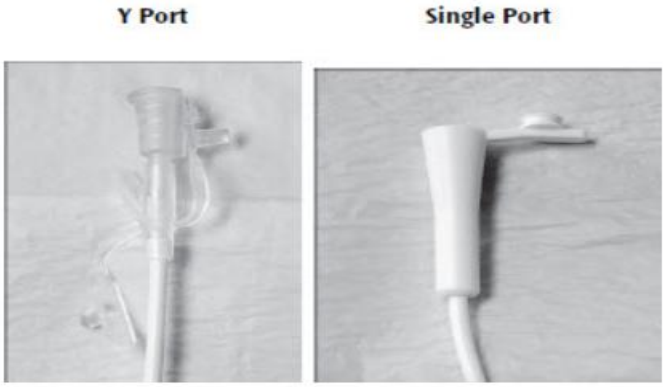
Nasoenteric feeding tubes come in a wide array of diameters and lengths, with an equally wide array of internal stylets, feeding and medication ports, and weighted or unweighted tip configurations (Table 12-2). All feeding tube sizes are reported by the tube's external diameter measurement. However, flow through the tubes and susceptibility to clogging depend on a tube's inner diameter. The inner diameter may vary depending on the specific material used to construct the tube. In general, polyurethane tubes with the same outer diameter as a silicone tube will have a larger internal diameter that may be less likely to clog.

TABLE 12-2 Nasoenteric and Percutaneous Enterostomy Tube Sizes

Tube Type	Size, Fr	Length, cm
Nasogastric	8–16	38–91
Nasoenteric	8–12	91–240
Gastrostomy	12–30	Not applicable
Gastrojejunal	6–14	Not applicable
Jejunal extension through existing gastrostomy	8-12	15–95
Dual-lumen (gastric and jejunal)	16–30	Not applicable
Single-lumen (jejunal only)	12–24	15–58
Low-profile gastrostomy (replacement)	12–24	0.8–6.5
Low-profile gastrojejunostomy	14–22	15–45

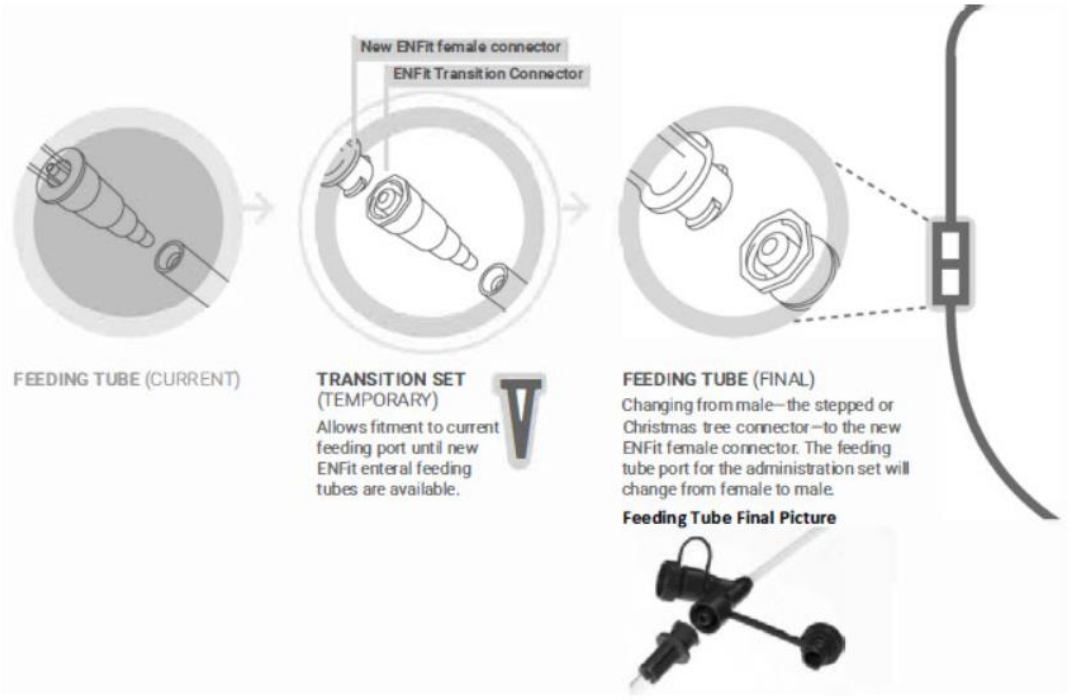
Stylets or guidewires are provided with most nasoenteric feeding tubes to provide tube structure and/or guidance while passing these relatively floppy tubes. They are designed to be shorter than the length of the tube and to have a flexible distal tip to avoid perforation of the GI wall. A water-activated lubricant may be used to coat the tube's internal lumen to allow easier removal of these stylets or guidewires after the tube is in place. Commercially available nasoenteric feeding tubes have either 1 port for feeding or 2 in a "Y" configuration: one for feeding and the other for medication and/or irrigation (Figure 12-1). These ports can accommodate either a feeding set or a syringe, or both. Dual ports allow concomitant feeding and medication administration and/or irrigation. However, to prevent clogging, medications should be administered through the tube only after enteral feedings are held and the feeding tube is flushed with water.

FIGURE 12-1 Nasoenteric Feeding Tube Ports



The US Food and Drug Administration has recognized that serious errors can occur when enteral feeding tubes are inadvertently connected to nonenteral feeding connectors (eg, IV lines, peritoneal catheters, tracheostomy tubes). Such errors have resulted in patient injury and deaths, and they are widely recognized as underreported. The Global Enteral Device Supplier Association is a nonprofit trade association formed to introduce the new international standards for enteral feeding connectors that are designed to increase patient safety and optimal delivery of EN by reducing the risk of tubing misconnections. These ENFit connectors will make it nearly impossible to connect non–enteral feeding catheters to enteral access devices including pumps, connectors, and feeding tubes (Figure 12-2).16,17

FIGURE 12-2 ENFit Connectors for All Feeding Tubes

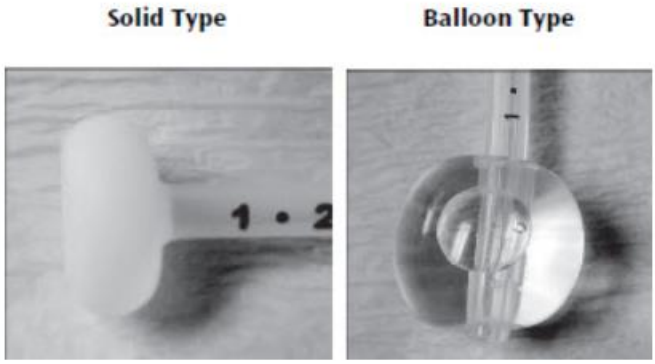


Source: Used with permission from the Global Enteral Device Supplier Association (GEDSA).

Feeding tube tips come in a wide variety of sizes, number of distal feeding delivery holes, and end vs side feeding holes. There are no specific data to favor any particular design. Therefore, the choice is determined by the preference of the individual clinician, institutional availability and mode of placement. Initially, weighted tube tips were thought to facilitate transpyloric passage. However, critical analysis of the literature does not demonstrate a clear advantage with the use of either weighted or unweighted tips.19

Percutaneous enterostomy feeding tubes are also available in a wide array of diameters and lengths (Table 12-2). The internal retention bolsters of percutaneous tubes are constructed of either solid material (silicone or polyurethane) or silicone balloons (Figure 12-3). Solid internal bolsters are more common with initial percutaneous enterostomy tube placement because they have greater longevity. Balloon-type internal bolsters are inserted more commonly with radiologic and surgical tube placement, and they are used as replacement devices in the office setting because of their ease in placement. If placed in the small bowel, the balloon is typically filled to a volume of 3 to 4 mL so it will not obstruct the lumen. These balloons generally only have a lifespan of about 4 to 6 months.20 If possible, use of a nonballoon tube is preferred for direct jejunal tube placement to avoid occluding the narrower jejunal lumen.

FIGURE 12-3 Percutaneous Endoscopic Gastrostomy Tube



An enteral feeding tube is available with a solid internal bolster constrained in a dissolvable capsule that can be placed in the same manner as a balloon tube. This tube may be used for laparoscopic initial gastric or direct jejunal tube placement, as well as for replacement tubes. It combines the longevity of a solid internal bolster with the ease of placement of a balloon-type internal bolster tube.

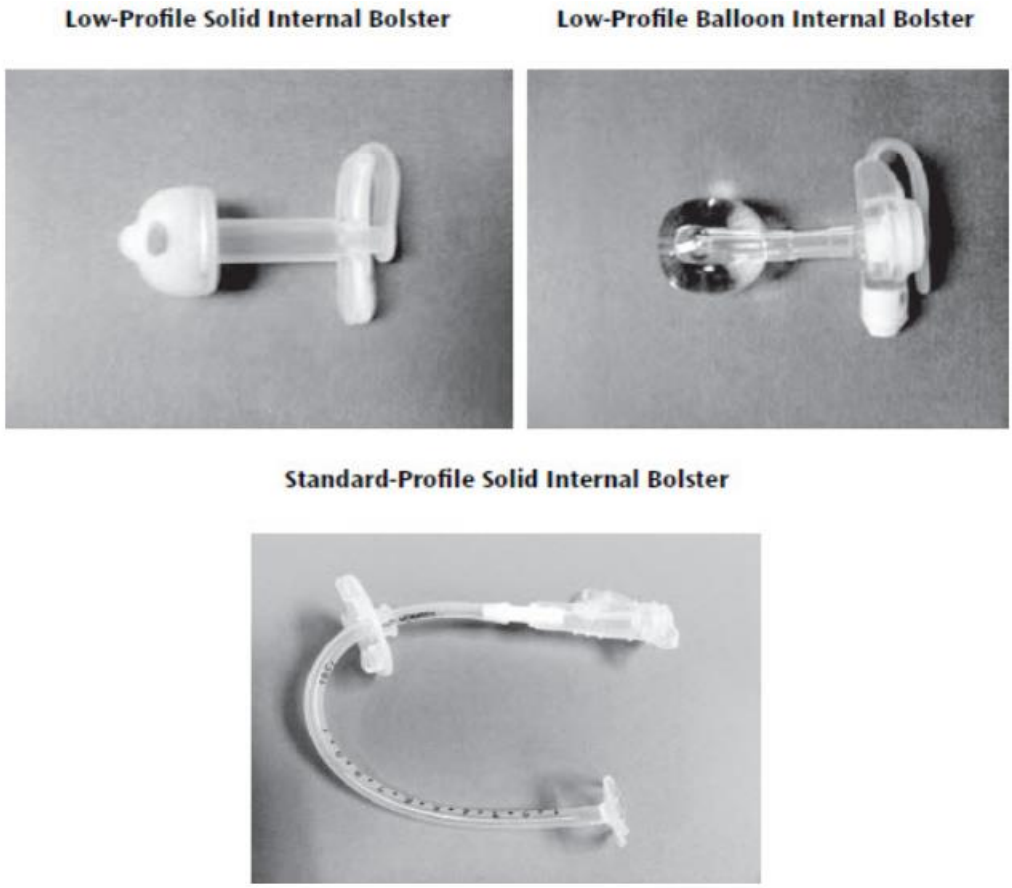
Percutaneous enterostomy feeding tubes may also have multiple ports. Typically, separate ports are included for feeding and medication and/or irrigation. If the internal bolster is of the balloon type, an additional third port is present for balloon inflation or deflation.

Percutaneous gastrojejunal feeding tubes are inserted into the stomach with a smaller-bore extension tube that passes through the pylorus into the jejunum. Some gastrojejunal tubes are specifically

designed with separate gastric and jejunal lumens and have ports that allow for both jejunal feeding and gastric decompression (Figure 12-4). Direct percutaneous jejunostomy tubes are placed directly into the jejunum without passage through the stomach. Low-profile tubes are skin-level devices that are used as initial placement or, more commonly, for replacement devices for gastrostomies, gastrojejunostomies, and jejunostomies (Figure 12-5). They are an excellent option for the patients who are concerned about the cosmetic appearance of a feeding tube. This device can also be more comfortable for patients who are active, sleep in the prone position, or need only intermittent therapy. To attach a feeding connector to the skin-level device, the patient will need adequate manual dexterity or caregiver assistance.

FIGURE 12-4 Percutaneous Endoscopic Gastrojejunostomy

FIGURE 12-5 Replacement Percutaneous Endoscopic Gastrostomy Tubes



Enteral Access Insertion Methods

Nasal Tubes

Nasogastric and nasoenteric feeding tubes are inserted when short-term access is indicated. They can also provide an opportunity to assess tolerance of enteral feedings before placement of a percutaneous enterostomy if longer-term access is required. They may be passed transorally or transnasally, although the nasal approach will be better tolerated in conscious patients. Nasogastric or nasoenteric feeding tube placement is contraindicated if the patient has an obstructing head, neck, and esophageal pathology or injury that prevents safe insertion. Nasogastric or nasoenteric feeding tubes should not be used for feeding until confirmation of proper position is obtained. Plain abdominal or chest radiography is the gold standard for confirmation of placement. However, recent studies suggest that radiographic confirmation may not be required when electromagnetic imaging technology is used for placement by an experienced tube team with demonstrated success.21,22 Other methods, including auscultation, pH set up, and capnography are unreliable and still require radiographic confirmation.23–26

Nasogastric tubes are the easiest feeding tubes to insert. Placement may be performed by a variety of clinicians (physicians, dietitians, nurses) as long as they have been appropriately trained. If possible, larger, stiffer tubes used for gastric decompression should be converted to a smaller-bore feeding tubes (ie, 6 to 12 Fr) for patient comfort and to decrease the risk of associated complications. The most reliable method for measuring the length of the tube necessary for gastric placement is termed NEMU (which stands for “direct distance from nose to earlobe to midumbilicus”), although many clinicians continue to use the NEX (“nose-earlobe-xiphoid”) process.27 Placement of a nasogastric tube requires passage through a patent nare and may be facilitated by concurrent patient swallowing. Aspiration of gastric contents, auscultation of insufflated air over the stomach, and absence of patient coughing or choking suggest, but cannot confirm, correct tube placement. As noted previously, correct position within the GI tract lumen should be confirmed radiographically.

Nasoenteric feeding tubes are placed anywhere distal to the pylorus, whereas nasojejunal tubes are placed distal to the ligament of Treitz. Placing a tube in either of these positions requires more skill than placing a nasogastric tube. Nasoenteric tubes can be placed at the bedside, endoscopically, or fluoroscopically. Bedside placement usually requires experienced personnel with specialized training. An older method that is still practiced in many centers uses the technique described by Zaloga.28 This technique requires the patient to lie on the right side; the feeding tube tip is bent and advanced slowly with a combination of air insufflation, tube rotation, and auscultation. Prokinetics (erythromycin or metoclopramide) are often added to bedside techniques and may increase success rates.29,30 A systemic review by Booth showed that IV erythromycin (in doses of 200 to 500 mg) had the highest success rate.29

Recently, devices have been developed to assist with nasoenteric tube placement including a bedside magnet and electromagnetic imaging system. Success rates greater than 90% have been reported when these systems, especially the electromagnetic one, are used.31–33 Nasojejunal placement is most reliably achieved with endoscopic or fluoroscopic techniques, but these methods are costly, require

advanced training, and have particular risks (radiation exposure with regards to radiology and sedation with endoscopy). The reported success rate for bedside nasoenteric tube placement ranges from 56% to 92%, with better than 90% success rates reported for endoscopic and fluoroscopic placement. However, success rates are lower for placement distal to the ligament of Treitz.34

Percutaneous Enterostomy Tubes

Enterostomy tubes are placed when long-term access (longer than 4 to 6 weeks) is required. These tubes may be placed by endoscopic, fluoroscopic, or surgical methods. These methods have similar success rates, although there is less morbidity and cost with endoscopic or fluoroscopic techniques.35–39

Routine preprocedural testing of coagulation parameters and platelets is no longer recommended for patients undergoing enterostomy tube placement, but these tests should be considered if there is concern for abnormal coagulation due to anticoagulant medication, medical history of excessive bleeding, or recent antibiotic use. American Society of Gastrointestinal Endoscopy guidelines consider placement of a percutaneous feeding tube to be a high-bleeding-risk procedure.40 Patients are then stratified into high and low risk for thromboembolic complications. Thienopyridines (eg, clopidigrel) should be held, whenever possible, for 5 to 7 days before PEG placement. If holding the thienopyridine is not possible, some institutions will add epinephrine to the lidocaine for local anesthesia (vasoconstriction), watch out for vessels on the skin and mucosa, and make sure the bolsters are relatively firm (not tight) for 3 to 4 days before loosening them. Aspirin regimens should be continued in patients with high thromboembolic risk.40 Warfarin should be held 5 days before PEG placement and high-risk patients should be bridged with short-acting heparin. The new, direct-acting oral anticoagulants should be held for at least 48 hours before high-risk procedures and restarted up to 48 hours after the procedure.41 Consultation with relevant cardiology, neurology, and anticoagulation services is suggested. Prophylactic antibiotics are administered when enterostomy tubes are placed, as they have been shown to decrease peristomal infection rates when using endoscopic methods for initial placement.42,43

Gastrostomy Tubes

PEG is the most common technique for obtaining long-term enteral access, and it is generally performed under moderate sedation.44 Specific contraindications for endoscopic placement include obstruction of the GI tract proximal to the stomach and the inability to transilluminate the abdominal wall for identification of a safe abdominal access site.45 Additional relative contraindications include ascites, coagulopathy, gastric varices, active head and neck cancers, morbid obesity, and neoplastic, infiltrative, or inflammatory disease of the gastric or abdominal wall.46

The most common method of PEG tube insertion is the Ponsky (pull) technique.47 Air is insufflated into the stomach via an endoscope. The optimal site for PEG tube placement is determined through simultaneous endoscopic transillumination of the abdominal wall and endoscopically visualized finger indentation at the site. A small incision is made at this site, and a needle/trocar is inserted through the abdominal wall and into the stomach. A guidewire is passed through the needle/trocar and grasped with

a snare passed through the endoscope; then, the guidewire, snare, and endoscope are withdrawn through the mouth. A G-tube is affixed to the guidewire and pulled through the esophagus into the stomach and out the abdominal wall. The G-tube is held in place by a solid, mushroom-type internal retention device and an external bumper. Advantages of PEG placement include performance at bedside, lack of radiation, and ability to perform diagnostic and therapeutic endoscopic procedures simultaneously.

Percutaneous G-tubes can also be placed using fluoroscopic guidance. There are 2 general fluoroscopic placement techniques. In the first, a nasogastric tube is placed to insufflate the stomach, a safe window is identified under fluoroscopy, and 1 to 4 T-fasteners are used to perform a gastropexy to secure the stomach wall to the abdominal wall. A needle is used to obtain gastric access, the guidewire is advanced through the needle, and the tract is dilated sequentially until there is a large enough hole for the tube to go through. Lastly, the G-tube is placed through the tract using a peel-away sheath.48,49 The second, less commonly performed fluoroscopic method uses a slightly curved 18-gauge needle or vascular sheath; it is advanced into the stomach and pointed toward the gastroesophageal junction after gastric insufflation. The guidewire is then advanced with or without help of an angiographic catheter into the esophagus and oropharynx and out of the mouth. A G-tube is then threaded over the wire, advanced until it emerges from the abdominal wall, and then pulled into the desired position.37,50 Advantages of fluoroscopic gastrostomy placement include lack of need for conscious sedation in some patients, ability to perform in patients with severe stenosis/trauma of the upper GI tract, and potentially decreased risk of tumor seeding from upper aerodigestive tract cancers (Practice Scenario 12-1). Reported success rates for either fluoroscopic or endoscopic gastrostomies are greater than 95%.51

A G-tube inserted using the laparoscopic or open (laparotomy) method is performed in the operating room using general anesthesia. Surgical placement of feeding tubes is used when patients are undergoing another abdominal operation, when endoscopic and radiologic attempts fail, and/or in the presence of an aerodigestive tract obstruction or facial trauma. Direct laparoscopic gastric tube placement is also done when endoscopic or radiologic placement fails or is not available.

Laparoscopic technique accesses the peritoneal cavity by way of small ports that enter through the abdominal wall.47 A pneumoperitoneum is created through a port inserted just below the umbilicus through which a camera is passed. The stomach is accessed and manipulated through a second port entering in the left lower quadrant and a third port (if required) entering through the right upper quadrant. T-fasteners or laparoscopic sutures are placed to affix the stomach to the abdominal wall. The procedure then proceeds in a manner similar to fluoroscopic gastrostomy, with a hollow needle advanced percutaneously into the stomach lumen followed by wire, dilators, peel-away sheath, and finally the G-tube.52–55

The Stamm technique is the most commonly used surgical placement of an open G-tube.9,45 It requires a small laparotomy in the upper midline of the abdomen. The G-tube is brought into the stomach through a small stab wound in the upper abdominal wall. A small incision is made into the stomach through which the feeding tube enters and around which purse-string sutures are placed to secure the

stomach around the G-tube. The stomach is then sutured to the anterior abdominal wall. This tube may be held in place with an inflated balloon or sutured to the abdominal wall to prevent tube migration.

Gastrojejunal Tubes

In the situation of impaired gastric motility, pancreatitis, or pancreatic surgery, or any time that enteral feeding into the small bowel with simultaneous stomach decompression is required, a gastrojejunal tube should be placed.56,57 Percutaneous endoscopic gastrojejunostomy may be performed immediately or any time after G-tube placement. Most commonly, a guidewire is placed through the existing gastrostomy, grasped endoscopically, and carried into the jejunum. The endoscope is then withdrawn, leaving the guidewire in place. The jejunal extension tube is threaded over the guidewire into the small bowel.45,58 A more recently described technique uses reclosable clips. The jejunal feeding tube with a suture on its tip is inserted through the PEG or stoma into the stomach lumen. A clip is passed through the working channel of an endoscope and used to grasp the suture and drag the tube into the jejunum as the endoscope is advanced. The suture is then clipped to the jejunal mucosa, securing the feeding tube to the small bowel.59

Fluoroscopic gastrojejunal access is becoming much more common. Initial steps are similar to fluoroscopic gastrostomy placement, as previously described. In addition, to facilitate placement of the gastrojejunostomy, puncture of the stomach is performed in the direction of the pylorus. A guidewire is advanced through the stomach to the ligament of Treitz, and the jejunal extension tube is advanced over the wire into the jejunum.60,61 Fluoroscopic techniques can be used when the patient cannot undergo endoscopy; however, fluoroscopic placement does require transport of the patient to the radiology suite.

Gastrojejunal tubes can be placed during laparotomy or with laparoscopy methods, using any of the previously discussed methods. Using manual and/or endoscopic methods, the jejunal tube is positioned into the small bowel. The gastric component of the tube is left in the stomach. The patient benefits from gastric decompression while receiving enteral feeds into the small bowel, but there is greater risk of the jejunal tube piece migrating back into the stomach on a regular basis.

Jejunostomy Tubes

Direct percutaneous endoscopic jejunostomy is a modification of the pull PEG technique. A pediatric colonoscope or enteroscope is advanced into the small bowel. Transillumination and finger palpation are performed over the jejunum instead of the stomach. A sounding needle and/or trocar is passed through the anterior abdominal wall into the jejunum. An insertion wire is advanced through the trocar and grasped. The procedure is then completed as per the pull-type PEG.61,62

Direct jejunostomy tube placement is performed in a variety of fluoroscopic ways. In general, identification of the target bowel loop is performed by advancing an angiographic catheter into the proximal jejunum and insufflating it with air and contrast,63 or by placing an angioplasty balloon64 or snare loop65 in the desired location to serve as a target. The jejunal loop is accessed with a needle, and

a T-fastener device is then delivered to secure the jejunal loop against the abdominal wall. A guidewire is then advanced through the needle, the tract is dilated, and the jejunostomy tube is placed.

Direct percutaneous jejunostomy using either endoscopic or fluoroscopic guidance is not available in all institutions. It is considerably more difficult technically than percutaneous gastrostomy, even though the methods are similar. Success rates range from 68% to 100% for endoscopic jejunostomy and from 87% to 100% for fluoroscopic jejunostomy.66 Higher rates of successful endoscopic placement have been reported when balloon enteroscopes are used.67,68 Endoscopic jejunostomy tubes are more stable than fluoroscopic tubes because the endoscopic tubes have solid, mushroom-type internal bolsters and larger tube diameters (18 to 20 Fr vs 10 to 14 Fr).

The technique of laparoscopic jejunostomy is similar to laparoscopic gastrostomy. Ports are placed in the left upper quadrant and lower abdominal midline. The jejunum is manipulated to affix it to the abdominal wall with T-fasteners. Then a guidewire is placed into the lumen of the jejunum, and a jejunostomy tube is advanced into the small bowel through a peel-away sheath.47,53 An advantage with this approach is that a larger-diameter tube (18 to 20 Fr) with a solid bolster can be placed. An open jejunostomy is placed using a Witzel technique. In this procedure, a submucosal tunnel is created in the small bowel through which the jejunostomy tube is threaded; this method prevents leakage of small bowel contents onto the abdominal wall.10 Less commonly, a needle-catheter jejunostomy may be placed by laparotomy or laparoscopy.10,69 In this procedure, a needle is threaded into the small bowel. A guidewire is passed into the jejunum. A small jejunostomy catheter (5 to 8 Fr) is passed over this guidewire into the jejunum. The small-bore size of needle-catheter jejunostomies make them prone to occlusion. Because endoscopic and radiologic methods for jejunostomies are complex, surgical jejunostomies are common.

Removal and Replacement of Percutaneous Enterostomy Tubes

Enterostomy tubes can be safely removed or replaced after the stoma tract has matured. Although maturation usually occurs 1 to 2 weeks after initial placement, many clinicians prefer to wait 4 to 6 weeks prior to removal to ensure that the stoma tract is mature. This longer waiting period is especially valid in patients who are on steroids, immunosuppressed, obese, or otherwise suspected of poor wound healing. Removal of G-tubes before stoma tract maturation may result in the stomach or small bowel falling away from the abdominal wall, allowing bowel contents to leak into the peritoneum. If this problem occurs, tube replacement with the assistance of endoscopy, interventional radiology, or even surgery is required.

A standard-profile or low-profile replacement G-tube can be exchanged at the bedside without endoscopy or fluoroscopy. However, gastrojejunostomy and some direct jejunostomy tubes require endoscopy or fluoroscopic guidance for replacement. A percutaneous feeding tube with a solid internal bolster can be removed at the bedside using the traction method. The patient is placed in the supine position with knees bent to relax the abdominal muscles. The exposed gastric tubing is firmly grasped and pulled forcefully. Removal for solid internal bolster devices may be painful, and some clinicians

advocate mild sedation for the procedure. For devices held in place with an inflated balloon, the balloon is deflated and the tube is gently removed; sedation is not required for this procedure.

If the tube is exchanged with a low-profile device, the length of the existing stoma tract is measured before choosing and placing the correctly sized replacement device. The replacement device is then lubricated and advanced through the stoma tract into place. Replacement feeding tubes are held in place with an inflated internal balloon or a solid silicone internal retention bolster (Figure 12-5). When using a balloon replacement tube, follow the manufacturer's recommendations regarding balloon volume. Generally, 5 to 20 mL of sterile water should be used for gastric tubes and 3 to 4 mL sterile water for small bowel tubes. Correct tube position can be checked after replacement by aspiration of gastric contents or auscultation of insufflated air. However, these methods are not completely reliable. If there is any concern for misplacement, the tube position should be assessed with fluoroscopic or endoscopic imaging (Practice Scenario 12-3).70

Practice Scenario 12-3

Question: What is the complication in a patient with percutaneous gastrostomy tube (G-tube) who develops abdominal pain after tube exchange?

Scenario: The patient is a 24-year-old woman with a history of severe gastric and small bowel dysmotility. She has a 24-Fr gastric balloon decompression tube that was initially placed several years ago and is regularly changed by the patient at home. She most recently uneventfully changed her gastric tube the day before she presented to the emergency department with severe abdominal pain. The patient awoke in the middle of the night with gastric leakage and intense pain around her feeding tube. She was unable to aspirate any gastric fluid from the feeding tube or move the tube within the tract. Her skin was very reddened and ulcerated from the leakage of gastric fluid.

Intervention: The patient had a radiologic evaluation of her feeding tube, and the tip was located within the gastric wall with leakage of the Gastrografin dye into the subcutaneous tissue. No peritoneal leakage was noted. The percutaneous G-tube was removed and a new G-tube placed through the same tract. Proper position was confirmed by instillation of contrast through the tube with filling of the stomach with contrast noted.

Answer: Dislodgement of her abdominal feeding tube occurred after replacement. Healthcare providers should have an extremely low threshold for confirming tube position if there is any concern for tube malposition after replacement.

Rationale: If a patient develops abdominal pain after percutaneous feeding tube replacement, the concern is that the tube was potentially placed within the stoma tract instead of correctly into the gastric lumen or perforated into the peritoneal space. This problem most often occurs when there has been difficulty with tube replacement, but it can also occur when replacement is reported to go smoothly. When a malpositioned tube is suspected, the tube position should be evaluated

fluoroscopically or endoscopically. Treatment depends on how severe the problem is and if there has been contamination of enteral feeds into the peritoneal cavity. If significant peritoneal contamination has not occurred, the malpositioned tube can be removed and another tube placed using the same tract. If there is no further leakage into the peritoneal cavity, the tube is safe to use. If more significant disruption of the tract occurs and a new tube cannot be placed at the existing site, the patient can be supported through a nasoenteric feeding tube while the stoma tract closes and any infection is treated.70 If significant leakage has occurred and abdominal sepsis develops, the patient is supported with intravenous fluids and antibiotics, and a surgical consultation is obtained. Necrotizing fasciitis has been reported in severe cases of untreated, uncontrolled infection. This condition is a surgical emergency with high morbidity and mortality. Emergency consultation for wide surgical debridement is indicated.

Postinsertion Care

Oral Hygiene and Skin Care

Regardless of the tube type or insertion technique, all patients require appropriate oral hygiene. It is often important for preventing aspiration pneumonia in ventilator-dependent patients or those with a depressed level of consciousness.

Patients with nasal tubes benefit from skin care to the nasal area to address prolonged exposure to tape and adhesive products. Repositioning the nasal tube and avoiding pressure to the nares is important to prevent pressure necrosis.

Patients and caregivers may use mild soap and water to cleanse the stoma site for percutaneous tubes. The area should be rinsed and dried thoroughly.

Routine use of antibiotic ointments or hydrogen peroxide at the tube site is not recommended. Dressings can be applied if there is drainage from the stoma site; however, they should not be placed with excessive tension, which can promote infection and buried bumper syndrome.

Prevention of Clogging

All feeding tubes are prone to clogging. Usual causes include suboptimal flushing, not flushing prior to and after each medication administration, accumulation of pill fragments, frequent checking of residuals, and administration of high-protein or high-fiber formulas.45,58 Compliance with intermittent flushing protocols is essential to prevent clogging. Water should be used as the flush fluid of choice. Two reports have demonstrated superiority of prophylactic use of pancreatic enzymes to prevent tube occlusion compared with standard water flushes.71,72

Medications in liquid form may contain higher amounts of sorbitol/sugar, have a higher osmolality and/or a higher viscosity, and may be costlier than tablet forms. Giving a crushed and diluted medication could therefore be preferable; however, crushed pills can be more likely to clog a small-bore tube than

medication in a liquid form. Clearly, each patient should be evaluated individually, and in conjunction with a pharmacist, to determine the best way to deliver a medication to a tube feeding patient. Whether a medication is in pill or liquid form, each medication should be given separately with a water flush before and after each medication administration.30 See Chapter 18 for further discussion of enteral administration of drugs.

Enteral Access Device Complications

Nasal Tubes

Complications of nasogastric and nasoenteric feeding tubes can be divided into those occurring during the insertion procedure or those occurring in the postprocedure period. The overall rate for procedure-related complications—including epistaxis, aspiration, and circulatory or respiratory compromise—is approximately 10%. The most-dreaded procedural complication is initial misplacement of the nasoenteric tube into the bronchopulmonary tree. This complication occurs in 2% to 4% of nasoenteric tube placements. Notably, it is unsuspected in 80% of occurrences, and it results in pneumothorax in up to 50% of cases.23,73–75 Radiography is the gold standard for ensuring correct placement and should be performed before the feeding tube is used. Published data demonstrate that adopting radiographic confirmation protocols decreases inadvertent use of incorrectly placed feeding tubes.24 As stated previously, use of a bedside electromagnetic imaging system by experienced clinicians may obviate the need for radiographic confirmation.21,22

Postprocedural complications include inadvertent tube dislodgement, tube malfunction, sinusitis, tube occlusion, tube feeding aspiration, and intestinal ischemia. Dislodgement occurs in 25% to 41% of cases.76–78 The use of a nasal bridle decreases tube dislodgment rates dramatically.79 Gunn and colleagues reported that the incidence of accidental dislodgement decreased from 36% to 10% when a magnet-based system was used to place the nasal bridle.80 Malfunction of the tube, including breaking, cracking, or kinking of the tube, occurs 11% to 20% of the time.77,78

When accurately diagnosed by sinus needle puncture and aspiration, sinusitis occurs about 12% of the time.81 This problem is believed secondary to obstruction of physiological sinus drainage by the nasoenteric tube.

Tube occlusion is a frequent problem (20% to 45%) and often requires tube replacement.78,82,83 Risk factors for tube occlusion include increasing tube length, decreasing tube caliber, inadequate water flushing, frequent medication delivery, and use of the tube to measure residual volumes.83 When feeding tubes become clogged, simple flushing with water can relieve the obstruction in one-third of patients.84 If this method fails, the installation of pancreatic enzymes can reopen an additional 50% of the occluded tubes.84,85 Mechanical dislodgement may also be achieved using a cytology brush, an endoscopic retrograde cholangiopancreatography catheter, or a commercial corkscrew device.86 Finally, replacing the nasal feeding tube is the last resort.

Rarely, the provision of EN to a hypotensive, critically ill patient may be associated with intestinal ischemia, which is usually evidenced by increasing GI intolerance (increased tube output, abdominal

pain and distension, ileus). This complication is best avoided by cessation of enteral feeding pending further evaluation in hypotensive patients. These patients typically require increasing doses of vasopressor agents with progressive GI intolerance.34,87

Enterostomy Tubes

Complications of percutaneous enterostomy tubes can be divided into procedural and postprocedural events. Incidence of procedure-related complications (eg, intraprocedural aspiration, hemorrhage, perforation of the GI lumen, and prolonged ileus) is 1.5% to 4%, and procedure-related mortality is rare, occurring in 0% to 2% of cases.70 Risk factors for aspiration include the supine position, advanced age, need for sedation, and neurologic impairment.88 Pneumoperitoneum as a result of the percutaneous procedure is common and in the absence of peritoneal signs is of no clinical consequence.89 Infusion of water-soluble contrast with fluoroscopic or computed tomography imaging is the test of choice if peritonitis is suspected. The procedural and long-term mortality rate directly related to PEG placement is very low despite the up to 50% annual mortality in patients receiving G-tubes.88 This very high rate of mortality is a function of the significant comorbidities of the patients rather than the procedure or the feeding tube itself.

The overall postprocedure complication rate for enterostomy tubes ranges from 4.8% to 10.8%.72 Minor postprocedural complications are 2 to 3 times more common than major ones (Table 12-3). Peristomal infection is the most common complication of gastrostomy placement.44,90 Most of these infections are mild. In rare cases, necrotizing fasciitis with high morbidity and mortality can develop. Prophylactic antibiotics before tube placement, early recognition of wound infections, treatment with antibiotics, local wound care, and debridement, if necessary, are the keys to successful management.44,46,91

TABLE 12-3 Major and Minor Complications of Enterostomy Tube Placement

Complication	Reported Frequency, %
Major complications	
Aspiration	0.3–1.0
Hemorrhage	0–2.5
Peritonitis/necrotizing fasciitis	0.5–1.3
Death[a]	0–2.1
Minor complications	
Peristomal infection	5.4–30
Peristomal leakage	1–2
Buried bumper syndrome	0.3–2.4
Inadvertent removal	1.6–4.4
Fistulous tracts	0.3–6.7

[a]Data are for percutaneous endoscopic gastrostomy placement.

Leakage around the gastrostomy site is a common and underrecognized problem in nutrition support.92 Risk factors include infection, excessive cleansing with irritant solutions (eg, hydrogen peroxide,

povidone-iodine), and excessive tension and side torsion on the external portion of the feeding tube. Prompt treatment of infection, good ostomy skin care, loosening of the outer bumper, and stabilizing the G-tube to prevent tension torsion on the tube will address these issues.86

Buried bumper syndrome results from growth of the gastric mucosa over the internal bumper (see Practice Scenario 12-3). Risk factors include excessive tension between the internal and external bumpers, poor wound healing, and significant weight gain.93–95 Treatment is based on maintaining the stoma tract while restoring the internal bumper entirely within the stomach lumen.96,97

As noted previously, accidental G-tube removal should be addressed urgently. If a standard tube is not promptly available, a suitably sized Foley or red rubber catheter can be used to keep the tract open until a standard replacement tube can be placed. In patients prone to pulling tubes, the use of an abdominal binder, placing mittens on the patient's hands, cutting down the external tube length to 6 to 8 cm, or switching to a low-profile device can reduce the risk of future removal.70

Gastrojejunal and Jejunal Tubes

Complications of gastrojejunal tubes and jejunal tubes are similar to those described previously for G-tubes. Gastrojejunal feeding tubes are also complicated by frequent (up to 70%) malfunction, migration, and/or occlusion of the smaller jejunal extension tube.98,99 Additional complications of direct jejunostomy tubes include jejunal volvulus and/or small bowel perforation.100 Although more distal feeding with jejunal tubes is often recommended by expert opinion, there is no clear evidence that it markedly decreases a patient's aspiration risk. ASPEN guidelines recommend feeding into the stomach as a first choice. However, as stated previously, recent data and meta-analysis suggest that jejunal feeding may be associated with decreased risk of aspiration pneumonia.11–14 Clearly, this issue needs more quality research before a definitive recommendation can be suggested.

Conclusion

Enteral feeding remains the feeding route of choice in the presence of a functional GI tract. Success depends on using the best insertion method available to place the appropriate access device in the appropriate location of the GI tract. Proper care and maintenance of enteral access devices are critical to successful EN therapy. Clinicians should also focus on the prevention and early recognition and management of device-related complications.