6-1-2021

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Received: 6 January 2021 | Revised: 23 March 2021 | Accepted: 4 April 2021

DOI: 10.1002/ncp.10671

SPECIAL REPORT

Development of a Competency Model for Placement and Verification of Nasogastric and Nasoenteric Feeding Tubes for Adult Hospitalized Patients

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Abstract

Nasogastric/nasoenteric (NG/NE) feeding tube placements are associated with adverse events and, without proper training, can lead to devastating and significant patient harm related to misplacement. Safe feeding tube placement practices and verification are critical. There are many procedures and techniques for placement and verification; this paper provides an overview and update of techniques to guide practitioners in making clinical decisions. Regardless of placement technique and verification practices employed, it is essential that training and competency are maintained and documented for all clinicians placing NG/NE feeding tubes. This paper has been approved by the American Society for Parenteral and Enteral Nutrition (ASPEN) Board of Directors.

KEYWORDS
clinical competence, enteral nutrition, feeding tube placements, hospitalized adult, patient safety

INTRODUCTION

For over 400 years, tubes placed within the gastrointestinal (GI) tract have been used to improve patient care. Nasogastric (NG) and nasoenteric (NE) (referring to both nasoduodenal and nasojejunal) tubes are used in hospitals, rehabilitation centers, nursing care facilities, and home settings. As opposed to large-bore tubes, which are designed for gastric decompression, NG and NE small-bore feeding tubes are intended to administer fluids, medications, and nutrition to patients. Decompression and feeding tubes can also be placed orally when nasal insertion is contraindicated, such as with basilar skull fractures. For the purpose of this paper, the discussion of NG/NE tubes also applies to orally placed tubes. These short-term tubes (typically up to 4–6 weeks) are often managed through an interprofessional team approach involving physicians, advanced practice registered nurses (APRNs) (including nurse practitioners and clinical nurse specialists), physician assistants, bedside nurses, dietitians, pharmacists, and, sometimes, speech-language pathologists.

Feeding tubes are intended for use in patients who are unable to swallow for a variety of medical reasons or when a patient presents with energy needs that exceed volitional oral nutrition intake. NE tubes are indicated when gastric emptying is impaired but the small bowel is functional. Although NG and NE tubes are significant adjuncts to patient care with many positive outcomes, these temporary enteral access devices are also associated with complications upon insertion such as malposition and misplacement.

Studies have been published on misplaced NG/NE feeding tubes. A recent article by Metheny et al provided a systematic review on this topic.[1] In a large review of tube insertions, the risk of misplacing an NG tube into the airway may reach 2% or higher when tubes are inserted blindly.[2] NG/NE feeding tubes can be inserted using blind insertion, placement assistive devices, endoscopy, and fluoroscopy. Blind placements infer that the tip of the enteral access device is inserted nasally (or orally) with the intention of placing the tip in either the stomach, duodenum, or jejunum. However, the clinician is unable to visualize the tip during the insertion and placement process; therefore, blind placements pose the greatest risk of malposition.[3,4] It is difficult to pinpoint how often this type of error occurs because there is no central repository for reporting these events. Two large studies of patients with NG tubes (n = 9931 and 740 patients, respectively) had similar results and found that approximately 2% of small-bore NG tubes were inadvertently inserted into the respiratory tract.[3,5] In another study over a 5-year period, 95 incidents were reported to the National Reporting and Learning System and/or the Strategic Executive Information System in which substances were inadvertently administered through the NG or orogastric (OG) tubes into the respiratory tract, resulting in 32 patient deaths.[6] A review of early studies of blind feeding tube placement showed that 1%–2% of small-bore feeding tubes were accidently placed into the lungs and that pulmonary injury occurred in 0.3%–1.2% of patients. These studies suggest that 0.1%–0.5% of all patients who have blindly placed small-bore feeding tubes die as a result of bronchopulmonary injury.[2,6–8] Such findings contradict the common perception that this procedure is relatively risk-free. Institutions and clinicians must promote safe practices to minimize potential patient harm. Over the past few decades, technological advancements have been introduced to facilitate safe placement, yet tube misplacements remain a concern. The purpose of this paper is to develop an interprofessional, multiorganizational competency model to improve placement and verification of short-term feeding tubes in adults.

In 2012, the Board of Directors of the American Society for Parenteral and Enteral Nutrition (ASPEN) approved the formation of an interprofessional and multiorganizational group to address pediatric NG feeding tube placement verification. Thus, the New Opportunities for Verification of Enteral tube Location (NOVEL) project was born. The mission of the group was to promote best practice as it pertains to NG and NE feeding tube placement and verification and to work with industry to develop technology to assist with this process. The NOVEL project started as a pediatric group and now has an adult counterpart with membership representing ASPEN, American Association of Critical-Care Nurses (AACN), Academy of Medical/Surgical Nurses (AMSN), Society of Critical Care Medicine (SCCM), Dietitians in Nutrition Support

Dietetics Practice Group (DNS-DPG) of the Academy of Nutrition and Dietetics, American Association of Nurse Practitioners (AANP), and National Association of Clinical Nurse Specialists (NACNS).

Any recommendations in this paper do not constitute medical or other professional advice and should not be taken as such. To the extent that the information published herein may be used to assist in the care of patients, this is the result of the sole professional judgment of the attending healthcare professional whose judgment is the primary component of quality medical care. The information presented here is not a substitute for the exercise of such judgment by the healthcare professional. Circumstances in clinical settings and patient indications may require actions different from those recommended in this document, and in those cases, the judgment of the treating professional should prevail. This paper was approved by the ASPEN Board of Directors.

PLACEMENT TECHNIQUES

There are multiple methods for gaining enteral access. Selection of an appropriate enteral access device is based on the patient's GI anatomy and function, accessibility, disease state, and expected duration of therapy. Short-term enteral access (NG/NE tube) is indicated for patients requiring enteral nutrition (EN) support for up to 4–6 weeks. Hospitalized patients may have a large-bore NG tube (16 French [16Fr] or larger) inserted nasally or orally for gastric decompression. When the patient no longer requires gastric decompression, these tubes are sometimes used for medication administration and enteral feeding. For anticipated EN therapy lasting >5–7 days, a small-bore (≤12Fr), flexible, silicone or polyurethane feeding tube should be used to reduce the risk of complications, such as sinusitis or pressure injuries, and improve patient comfort.[9] Clinicians insert small-bore feeding tubes using various methods, including blind technique, electromagnetic and camera-guided bedside placement, endoscopy, and fluoroscopy. A single error at the time of placement can result in devastating complications. Confirmation of tube tip location is critical before EN initiation. Awareness and knowledge of potential errors will aid in recognizing and avoiding them in practice in order to decrease iatrogenic complications. Real-time recognition of misplacement will further minimize morbidity and even mortality related to enteral feeding tube placement.[10]

Bedside placement of small-bore feeding tubes can be categorized into three major types of techniques: (1) blind placement techniques, (2) direct visualization, and (3) real-time indirect visualization. These techniques offer different safety features to prevent inadvertent pulmonary placement and optimize safe insertion into the GI tract. Within each type, various techniques are used to achieve placement into the small bowel, if that is the desired location, and will be reviewed in the following section.

Blind placement techniques involve tubes inserted without any direct or indirect visualization. The tube is inserted through the nasopharynx or oropharynx and advanced into the upper GI tract. There are many tube advancement techniques suggested to facilitate postpyloric tube placement, if indicated. These include gentle guidance through the pylorus after gastric placement is achieved; addition of prokinetic agents; use of a 10-10-10 technique; air insufflation; corkscrew technique; and use of specialized tubes such as self-propelling or magnetic tubes (Table 1). Direct visualization techniques allow visualization of the GI tract as the tube is being inserted. These techniques include endoscopic or camera-guided methods (Table 2). Real-time tracking or indirect visualization involves the use of procedures that provide guidance during insertion but not direct visualization. These placement techniques include radiologic use of fluoroscopy, ultrasound, or electromagnetic guidance (Table 3). A comprehensive overview of these and other techniques are presented in Tables 1–3 with a review of advantages, disadvantages, placement success, and placement time.

VERIFICATION OF FEEDING TUBE PLACEMENT

Once the feeding tube is placed, verification of the tube tip must be completed. The tube tip location must be verified using an evidence-based approach prior to starting EN. Verification techniques, like placement techniques, have varying degrees of reliability. Reliable techniques include x-ray, pH, capnography, electromagnetic placement device (EMPD), interventional radiology, ultrasound, fluoroscopy, and direct visualization using endoscopy or camera technology. Table 4 includes the major verification techniques and the advantages and disadvantages of each.

Use of radiographs to verify tube placement

The current gold standard to verify NG or NE tube placement is a properly obtained and interpreted radiograph. However, uncertainty regarding the accurate and consistent interpretation and reporting of tube location by both radiologists and nonradiologists raises questions regarding the use of radiography for NG/NE tube location verification as the gold standard.[60–62] Accurate NG/NE tube location by radiographic verification depends on clearness of

TABLE 1 NG/NE tube blind placement techniques

NG/NE tube: Blind placement technique	Advantages	Disadvantages
Overall blind insertion technique[10–17] Information applies to all blind insertion techniques Tubes inserted without any visualization (direct or indirect) and may include special techniques to facilitate postpyloric placement	Expedited placement at bedside RNs or RDNs can be trained to place Decreased cost No additional equipment required for most techniques	Malposition (reported 10% overall complication rate with 1%–4% placement into bronchial tree)[10–15]; patients who have decreased consciousness or gag reflex or are uncooperative during the procedure are at increased risk[12] Generally requires radiographic confirmation prior to feeding initiation; may require repeated radiographic exposure Increased time to migrate FT into SB (reported spontaneous migration occurs in about 35% of placements); intentional manual guidance may facilitate placement; may require prokinetic medications to help migrate FTs into the SB.[16] Lower success rates for postpyloric vs gastric access (described ∼70%–75% but as high as 83%–95% at one site)[12,16,17]
All techniques listed below are blind insertions and include the same advantages and disadvantages plus any additional steps related to specific technique to facilitate postpyloric placement		
10-10-10[18–20] Insert FT to gastric area; give 10 mg metoclopramide; wait 10 min and advance at 10-cm intervals to a depth of 70–80 cm	Reported success rate for postpyloric placement of 86%–90% Can combine with air insufflation	Requires use of metoclopramide, which may be associated with side effects
Prokinetics[21–26] Use of promotility agents such a erythromycin or metoclopramide to help facilitate postpyloric placement	Reported high success rate of postpyloric placement Several studies site 15–25 min to place tube	Potential adverse drug reactions to medications used Can take up to 75 min to migrate past the pylorus May need IV access for medication administration, cost of the medication May require multiple x-rays to verify placement
Air insufflation[27] Insert tube into stomach, instill air 10 ml/kg, no greater than 500 ml	Can be used as an adjunct to other techniques Simple, no additional equipment required 78% reported success rate postpyloric in 2 h	If not postpyloric, try prokinetic agent. May require multiple x-rays to check placement
Corkscrew[28–30] Technique consisting of inserting FT into stomach, removing stylet and bending 30° reinsert stylet, and advancing using a twisting motion	Reported success rate of 92%–95% of postpyloric placement	Requires skilled clinician to place the tube Variable time of placement average 22 min (5–180 min)
Self-advancing nasal jejunal FT[11,31] Tiger 2 (Cook Medical www.cookmedical.com) Specialized tubes with flaps that are propelled through GI tract with peristalsis	Success rate for postpyloric placement 73%–82%	Achieving SB placement can be lengthy (reportedly 2–68 h)[15] Requires patient to have adequate gastric motility (should not use with gastroparesis) Increased risk of mucosal damage[15] Migration failure in 8.9% of cases (tube not in SB at 18 h) May require multiple x-rays to check placement

(Continues)

TABLE 1 (Continued)

NG/NE tube: Blind placement technique	Advantages	Disadvantages
Magnetically guided[12–14,16,32–35] Specialized tube with magnet tip, use of external magnet to pull tip through the GI tract (may no longer be on the market, has evolved to tube with balloon)	Increase efficiency of postpyloric placement (average reported time of 15 min for placement)[11] Reported success rates of >90% for postpyloric access[12] 76% success rate for SB placement; 84% of placements only required one x-ray[35] Average time to place 12–15 min	Potential for malposition (magnet only used to advance postpyloric) Requires specialized equipment Requires radiographic confirmation Cannot reinsert the stylet for repositioning Tube not MRI compatible; magnet on FT tip requires removal of FT for MRI Magnet *may* temporarily disable a pacemaker Storage of magnet (to avoid unintended magnet adherence) Need to consider cost of equipment and supplies
Balloon[36] Gabriel FT (Syncro Medical www.syncromedical.com) Tube with balloon at tip to assist in propelling tube through GI tract	One tracheal placement recognized during procedure 70% patients placed postpyloric Mean time placement 7.3 min (2–20 min)	Necessitates waiting 12–24 h for migration May require multiple x-rays
Two-step or three-step[37–40] **(combination of other techniques: air instillation, pH, two x-ray), one with spiral tube** Two-step technique: place tube to 30 cm and obtain x-ray to confirm esophageal placement; then continue with insertion through GI tract Three-step (esophageal, gastric, postpyloric): use with 145-cm spiral FT advanced at 5-cm intervals to 100 cm (Flocare Nutricia, the Netherlands); give 20 mg metoclopramide before insertion	Reported success rate of 81%–95.1% Variable time of placement with one study, based on protocol of 10 cm/h would be 4–5 h (median 14–30 min)	Spiral tube: adverse event incidence 26%, but no serious adverse event was observed Mostly metoclopramide-related events, nasal bleeding, vomiting

Abbreviations: FT, feeding tube; GI, gastrointestinal; IV, intravenous; MRI, magnetic resonance imaging; NG/NE, nasogastric/nasoenteric; RDN, registered dietitian nutritionist; RN, registered nurse; SB, small bowel.

Adapted from Brown B, Hoffman SR, Johnson SJ, Nielsen WR, Greenwaldt HJ. Developing and maintaining an RDN-led bedside feeding tube placement program. *Nutr Clin Pract*. 2019;34(6):858-868.[41]

the image, interpretation, and the accuracy and clarity of the radiographic report. All clinicians who are qualified to read x-rays to confirm tube placement should follow these four criteria[70]:

- Does the tube path follow the esophagus and avoid contours of the bronchi?
- Does the tube clearly bisect the carina or the bronchi?
- Does the tube cross the diaphragm at the midline?
- Is the tip clearly visible below the left hemi-diaphragm rather than solely viewing the tip of the tube?

Use of pH

Testing the acidity of fluid aspirated from the stomach to verify NG tube placement has been advocated for decades.[71,72] pH is a negative log measure of hydrogen ions; thus, the lower the number, the more acidic is the fluid. For initial placement verification, a small amount of gastric fluid is withdrawn from the feeding tube. Fluid is tested using pH paper, a pH strip, or other validated product that accurately measures pH by placing a drop of fluid on the product and waiting a set amount of time (based on the manufacturer's recommendations). The color of the product is compared to a chart provided by the manufacturer. Some products report pH in single-digit increments (ie, 1, 2, 3 etc) and others do half increments (ie, 1, 1.5, 2, 2.5, etc). Typically, gastric fluids will register as 1–5.5 on these products unless the individual is receiving an acid-suppressing medication or sometimes unless there is enteral formula in the fluid aspirate. Even patients who receive an acid-suppressing medication may have an acidic

TABLE 2 NG/NE tube: Direct visualization placement techniques

NG/NE tube: Direct visualization placement techniques	Advantages	Disadvantages
Camera[42,43] Kangaroo Feeding Tube with IRIS Technology (Cardinal Health, www.cardinalhealth.com)	Images are in real time, allowing for change in tube trajectory when indicated Ability to visualize internal anatomy when that is useful or indicated Able to recognize misplacement; 7/20 (35%) trachea was initially visualized, requiring a second placement attempt Successful use demonstrated in two small studies in $\geq$90%; may be a successful tool for bedside use with dedicated and experienced team use Able to place gastric in 90% of patients 93% agreement between camera image and radiograph Time to placement 5–11 min (range, 2–42)	Limited data at this point Skill required for the camera technology is not in the normal skill set of many who place tubes at the bedside; training, experience, and ongoing usage are required Usefulness is highly dependent on the quality of visualization X-ray verification required Camera at proximal end adds to the tip size, which could make insertion and removal more uncomfortable for the patient and challenging for the clinician Quality of camera image, including in the presence of fluid, might impact the accuracy of anatomical assessment Not useful for NE placements at this time: in one study, only three tubes (7%) able to be placed postpyloric Need to consider cost of equipment and supplies
Endoscopy[15,44–49]	Direct visualization of placement minimizes risk of malposition Provide method for enteral access in populations unable to be served or failed attempts by other methods of placement Success rate 79–96% Time to place 6–28 min Feedings started average of 5.2 h after tube placement	Requires physician or specially trained clinician to place Requires special equipment, anesthetic agent, and increased staff and cost Delay in placement, pending physician availability No major complications (two nose bleeds and three with nausea), bleeding in one patient Another technical challenge includes accidental dislodgement of tube as scope is being withdrawn Frequently requires transportation to a GI suite for placement

Abbreviations: GI, gastrointestinal; NE, nasoenteric; NG, nasogastric.

Adapted from Brown B, Hoffman SR, Johnson SJ, Nielsen WR, Greenwaldt HJ. Developing and maintaining an RDN-led bedside feeding tube placement program. *Nutr Clin Pract*. 2019;34(6):858-868.[41]

pH when tested.[73] This method is not useful to confirm postpyloric tube placement.

Capnography

Capnography is the monitoring of the concentration or partial pressure of carbon dioxide (CO_2) in the respiratory gases and can help clinicians determine when an NG/NE tube has taken an inadvertent course into the trachea during the insertion process. However, CO_2 detection cannot determine whether the depth of insertion into the GI tract is proper; therefore, radiography and/or pH testing should be used to verify that the tip position is appropriate before enteral feeding is initiated or whenever dislodgement is suspected.[65]

The colorimeter device is a CO_2-detecting assessment tool that confirms NG placement in the GI vs respiratory tract and helps avoid inadvertent tracheal placement. This device attached to the distal end of the feeding tube changes color when it is exposed to CO_2, is disposable and designed for single use, and offers advantages in cost and mobility over capnographs.[66] In an accuracy study from Mordiffi et al, results concluded that the use of the colorimeter was only 80% sensitive and 86% specific in determining the location of the NG tube when tested against the x-ray in the adult general ward setting.[67] Therefore, it should likely not be the sole source of tube verification.

TABLE 3 NG/NE tube: Real-time indirect visualization placement techniques

NG/NE tube: Real-time indirect visualization placement techniques	Advantages	Disadvantages
EMPDs[14–16,50,51a] (Cortrak Avanos Medical www.avanosmedicaldevices.com)	Expedited placement at bedside RNs or RDNs can be trained to place Allows operators to visually track feeding tube pathway throughout the insertion process; visualization can help avoid malposition (lung placement) and complications Increased efficiency of SB placement, decreased time to tube placement and feeding Successful postpyloric placement has been described to be 78% and up to 90%–100% (higher success rates linked to experience of practitioners dedicated to placing feeding tubes) Decreased radiation exposure, as it does not require radiographic confirmation (or only one) (FDA approved for placement verification) Stylet can be safely reinserted for repositioning and position checks Demonstration of recognition and avoidance of inadvertent pulmonary placements Time to feeding reduced Average time of placement 6–20 min	May not be as successful in patients with altered gastrointestinal anatomy Requires skilled clinician to place the tube and interpret the screen In January 2018, the FDA issued a corrected report via a Dear Healthcare Provider letter on EN tube misplacements and adverse events, including pneumothoraces, using feeding tube placement systems.[52] Most events related to lack of clinician expertise Need to consider cost of equipment and supplies
EMPD[53] ENvue System (ENvizion Medical, www.envizionmed.com)	Same as above for EMPDs except not approved for verification Able to recognize inadvertent lung placements (two patients in study recognized lung and placement aborted) 34 (60%) with postpyloric placement—not primary objective of study Precise agreement between system and x-ray (96.5%)	Requires skilled clinician to place the tube Not approved for placement verification at this time Need to consider cost of equipment and supplies Consider size, portability, and storage of equipment
Fluoroscopy[11,15,54–56]	Direct visualization of placement minimizes risk of malposition Provide method for enteral access in populations unable to be served or failed attempts by other methods of placement Success rate 84%–97% Median time of placement 17 min	Requires physician (radiologist) or specially trained clinician to place Delay in placement pending radiologist availability Radiation exposure to patient; additional staff and cost May require transport to radiology suite or transport of equipment to bedside; most problematic for patients on mechanical ventilation who may require additional and/or specialized staff for transport Increased costs to the patient associated with physician time and fluoroscopy charges Some reported complications including vomiting, hypotension, apnea, and hypoxia requiring intubation

(Continues)

TABLE 3 (Continued)

NG/NE tube: Real-time indirect visualization placement techniques	Advantages	Disadvantages
Ultrasound[57,58]	Decreased time to feeding, median 5.5 h (2–24) High success rate (90%–93%) without any complication Time to placement average of 22.07 ± 5.78 min	Technical difficulties may exist in obese, patients with gas in bowel loop and so on If prior NG tube, gas appearing in the esophagus may compromise any ultrasonography of the esophageal tube Requires physician (radiologist) or specially trained clinician to operate and interpret ultrasound Difficult to place in some patients with laparotomy, open abdomen, abdominal wall defect, or drainage

Abbreviations: EMPD, electromagnetic placement device; EN, enteral nutrition; FDA, US Food and Drug Administration; NE, nasoenteric; NG, nasogastric; RDN, registered dietitian nutritionist; RN, registered nurse; SB, small bowel.

Adapted from Brown B, Hoffman SR, Johnson SJ, Nielsen WR, Greenwaldt HJ. Developing and maintaining an RDN-led bedside feeding tube placement program. *Nutr Clin Pract*. 2019;34(6):858-868.[41]

[a]Only selected references included in this citation list.

Camera technology

Another new technological innovation is a single-use, small-bore NG feeding tube with a miniature camera embedded in the distal end to aid in tube placement (Kangaroo Feeding Tube with IRIS Technology, Cardinal Health, www.cardinalhealth.com). This system allows trained clinicians to visually identify anatomical markers during the placement procedure.[42,43] Gastric placement has been shown to be confirmed in >90% of patients.[42,43] Future studies are needed to demonstrate efficacy of small-bowel tube tip placement.

Electromagnetic technology

Ideally, electromagnetic technology allows the user to recognize inadvertent lung malposition as it occurs, and it assists the user to correct the placement immediately, rather than waiting for radiograph confirmation. In research studies focusing on agreement between radiographs and clinician interpretation of EMPD tracing, EMPD has been shown to provide 97%–100% accuracy.[74–76] A study of 1692 feeding tube placements demonstrated that utilizing EMPD avoided 68 lung placements by recognizing proximal pulmonary deviation.[13] This study demonstrates that team management of NE tube placement using EMPD optimizes patient safety, standardizes practice, decreases cost, and is a safe alternative to radiograph. An additional recent single-center study compared NE tube tip position using EMPD technology with radiology reports in the electronic health record. Findings from this study suggest that EMPD images provide substantial agreement with x-ray confirmation and almost perfect agreement when the tip of the tube is within the small bowel.[77]

Ultrasound

Another technology for determining feeding tube tip location includes the use of ultrasound. A few studies have demonstrated accuracy with this technique.[57,58,78] However, a systematic Cochrane Review from 2017 identified 10 studies (545 participants and 560 tube insertions) that met inclusion criteria. Ultrasound did not have sufficient accuracy as a single test to confirm gastric tube placement. Yet, in settings where x-ray is not readily available, ultrasound may be useful to detect misplaced gastric tubes.[79] Larger studies are needed to determine the possibility of adverse events when ultrasound is used to confirm.

Emerging technologies

Many of these above-mentioned placement and verification techniques have been used for years. There are some emerging technologies that are just being developed or are improving existing techniques and will be briefly outlined below. Balloon-guided placement is a newer technique using a specialized tube with a balloon at the tip.

TABLE 4 Feeding tube verification techniques

Method	Notes	Advantages	Disadvantages
X-ray (radiographic confirmation)[59–62]	Generally considered the gold standard to verify NGT placement is a properly obtained and interpreted radiograph. X-ray should include lower chest and upper abdomen	Accurate NGT location by radiographic verification depends on clearness of the image, interpretation, and the accuracy and clarity of the radiographic report. The report should contain information on the path of the NGT and the exact location of the tube tip that indicates its readiness for use	Uncertainty regarding the accurate and consistent interpretation and reporting of NGT location by both radiologists and nonradiologists raises questions regarding the use of radiography for NGT location verification as the gold standard Waiting for x-ray to verify placement may delay feeding and decrease total calories
pH[63,64]	Feeding may need to be held for up to 30 min, and small amount of gastric fluid is withdrawn from feeding tube; fluid is tested using pH paper and color is compared to manufacturer's chart. The pH of gastric contents ranges from 1.5 to 5	Inexpensive Quick completion time pH may be effective even if patient is on acid-suppressing medications First method of confirmation recommended by NHS of the UK and by AACN and confirmed by x-ray	Individual performing test cannot be color-blind Cannot be used to confirm postpyloric placement Most procedures require periodic quality control testing and annual competency to fulfill point-of-care testing requirements Can be false negative if the tube is in the lung and patient aspirated gastric fluid If feeding needs to be held to check pH, it may decrease total caloric delivery
Capnography[65–67]	Colorimetric CO_2 detector is used during placement; misplaced tubes reveal characteristic exhaled CO_2 waveform or color change	Used to determine if feeding tube enters trachea during placement	Cannot determine proper depth of insertion into GI tract; still requires x-ray or pH testing for placement confirmation
Camera[42,43]	Single-use, small-bore feeding tube embedded with camera	Timely identification of potential malposition in "real time" Anatomical markers can be identified during placement Correct gastric placement in ≥90% of patients	Limited data available Not FDA approved for verification of tube tip May require longer time for clinicians to become proficient Identification of the tube position beyond gastric positioning may be difficult for non–endoscopy-trained clinicians
EMPD[68]Only Cortrak (Avanos) is FDA approved for verification	Feeding tube with specialized transmitting stylet; receiver placed on patient's lower chest/abdomen; clinician views tube pathway on monitor during placement	Timely identification of potential malposition in "real time," instead of waiting for x-ray 97%–100% accuracy compared with x-ray; cost savings if x-ray is not required Cortrak is FDA approved for verification of tube tip but may need to consider a second method of confirmation if indicated[51]	Can still have a misplacement; requires trained, skilled clinicians Recent retrospective review found only one adverse event of pneumothorax[65]Requires patient alignment and receiver safely secured to patient for accuracy, assuming no alteration in GI anatomy Requires skilled clinician for verification

(Continues)

TABLE 4 (Continued)

Method	Notes	Advantages	Disadvantages
Ultrasound[69]	Clinician performs ultrasound examination of right or left neck (to identify esophagus), epigastrium, gastric fundus, and antrum	May be used to detect misplaced gastric tube if x-ray is not available	Limited data available Not FDA approved for verification of tube tip Requires a skilled clinician to perform

Abbreviations: AACN, American Association of Critical-Care Nurses; CO_2, carbon dioxide; EMPD, electromagnetic placement device; FDA, US Food and Drug Administration; GI, gastrointestinal; NGT, nasogastric tube; NHS, National Health Service.

This tube is inserted blindly, but insertion is stopped at 30 cm, the balloon is inflated, and assessment of any oxygen desaturation indicates bronchial placement. If no desaturation is observed, the balloon is deflated and the tube advanced into the stomach. The balloon is then inflated in the stomach in order to passively assist with postpyloric migration. An x-ray is then obtained 12–24 h post placement to determine location.[36] In an initial study of 50 patients with this tube, 70% of the tubes were placed in the small bowel with a mean placement time of 7.3 (range, 2–20) min. One inadvertent tracheal placement was prevented using this technique.[36]

Emerging technologies for determining feeding tube tip location include new pH devices. RightSpot pH indicator (RightBio Metrics, www.rightbiometrics.com) is an in vitro diagnostic pH test to confirm gastric placement of the tube tip. Another innovation is the NGPOD system (NGPod Global Limited, www.ngpodglobal.com). This system removes the need to aspirate gastric contents from the patient and provides a YES/NO result for indicating placement of an NG tube.

A recently introduced device useful in tube placement confirmation is DoubleCHEK (Enteral Access Technologies, Ltd, www.enteralaccesstech.com). This device combines pH and CO_2 detection for placement confirmation. This technology can be used for NG and NE placement, in both adult and pediatric patients. As this is a very new technology, there are currently no clinical trials on this device, but it offers promising prospects for placement confirmation.

Tube securement

Once the tube has been placed, appropriate securement is imperative to prevent tube dislodgement. Various securement techniques exist to secure the tube, including use of tape, transparent dressings, and commercial securement devices. A variety of tube securement techniques are outlined in Table 5.

PRACTITIONERS PLACING BEDSIDE FEEDING TUBES

NG tube placement can be achieved relatively quickly and safely, but for those patients requiring small-bowel feeding, NE tube placement with assistive technology has become the preferred method for many to achieve enteral access while attempting to minimize patient risk. Compared with gastric placement, NE tube placement requires more clinician time and skill. Depending on licensure and institutional privileges, a variety of clinicians including, but not limited to, nurses, dietitians, APRNs, physician assistants, and physicians may be placing NG or NE tubes. Regardless of discipline or education, clinician competency is essential for independent placement of enteral tubes and should range from proficient to expert level.

Staffing models

To improve safety and efficiency when placing NG and NE feeding tubes at the bedside, healthcare facilities have employed various staffing models such as designating specific individuals or developing formal or informal placement teams, or as a function of an existing nutrition support team or service. Typically, these clinicians use assistive technology to place the majority of tubes into the postpyloric position, when indicated. Healthcare facilities should first assess the total number of orders and the timing of orders for tube placement and then perform a cost-benefit ratio analysis in order to determine the most appropriate model for their specific needs. Policies and staffing capacity must align with these needs. It may not be difficult to place a tube during the day, Monday through Friday, but consideration must be given to how tubes are placed on evenings, nights, weekends, and holidays. Some institutions have addressed this challenge by developing a staffing matrix that specifies what individual clinician or team member is responsible for completing orders for feeding tube placement at different times of the day.[41] Other

TABLE 5 Feeding tube securement techniques

Method	Procedure	Considerations
Tape, nasal tube	Tape placed on the top of the nose; remainder of tape split lengthwise and wrapped around the tube	Disadvantages may include skin breakdown[80] or 20%–40% rate of tube dislodgement[81] Steps should be in place to prevent skin breakdown, such as use of skin adhesive agents with oily or moist skin, and to avoid pressure on surrounding tissue with frequent monitoring and adjustment as indicated
Transparent dressing	Dressing used to adhere tube to the cheek or neck	Tube is less visually distracting Works well for small, soft tubes; including dressing close to naris adds to security and may reduce "pistoning" or movement of the tube at the naris May be at increased risk for skin breakdown
Nasal securement methodology Two commercial devices available: Corgrip (Avanos Medical; www.avanosmedicaldevices.com) AMT bridle (Applied Medical Technology; www.appliedmedical.net) Noncommercial technique[85]	Lubricated probes are inserted into each nare; probes connect via magnet and filament is looped over the vomer bone, creating a bridle; filaments exiting both nares are secured with a clip and simple knot	Useful if limited skin surface for securing tube (eg, burn, trauma) Prevents dislodgement of tube; reduces need for tube replacement (cost savings and avoidance of interrupted feeding, patient discomfort, and repeated x-ray)[81] Need to ensure bridle clip does not place pressure on nares resulting in pressure injury[82–84] It could also result in internal injury if the tube gets caught or pulled on if allowed to hang from the nose Can be cost-effective as compared with tape, owing to less tube displacement with the bridle[85] Securing the neck lends extra stabilization Devices associated with reported complications such as nasal bleeding[86–89]

facilities have developed policies and procedures for placing feeding tubes during the day while having the bedside RN place an OG or NG tube if enteral access is needed on evening or night shifts.[14] Placing an NG tube instead of an NE tube on "off" shifts may not be ideal, but each facility must weigh the risks vs the benefits of this practice based on the training and availability of their staff.

Individuals placing feeding tubes

Healthcare facilities may choose to designate individual clinicians to place NE tubes. By placing NE tubes more frequently, clinicians likely become more proficient at this skill and are able to practice at the expert level. Often, these clinicians are designated as a "super user." A "super user" can be defined as a core team member who is trained, independent, and a validated operator of a feeding tube placement device.[90] This model may work better for smaller healthcare facilities with lower numbers of feeding tube placement orders or for training medical staff. It is important to determine if adequate staffing is available to place NE tubes during all necessary placement times.

Feeding tube placement teams

For larger healthcare facilities with higher demand for NE tube placement, developing placement teams may be a more efficient model. Similar to an intravenous catheter placement team, tube teams are intended to improve patient safety using highly trained clinicians that are proficient in completing this procedure in a timely manner. One model of a multidisciplinary tube team involves collaboration between dietitians and nurses. In one study, the dietitian/nurse small-bowel feeding tube placement team, using an EMPD, successfully placed 86.4% of ordered feeding tubes (n = 74), with 64% (n = 41) at or beyond the ligament of Treitz, suggesting this is a cost-effective alternative to fluoroscopy placement of NE tubes.[91] A second study including a dietitian/nurse placement team using an EMPD (n = 101) demonstrated cost savings through reduced x-ray use (P = .001) and 66% lower time to initiate EN (P = .0032), compared with the blind 10-10-10 protocol.[50]

Koopman et al evaluated their hospital outcomes before and after the creation of a dedicated "tube team." Feeding tube placement using EMPD by a dedicated team eliminated airway tube placement, pneumothorax, and all mortality.[14] Similarly, team management of small-bowel feeding tube placement by trauma intensive care unit nurses using the EMPD system was found to optimize patient safety, standardize practice, and decrease hospital cost.[13]

Training and competency

With the development of tube placement best practices and an increase in the knowledge of adverse events and tube placement error prevention strategies, the next logical step is to develop a model for standardized competencies around feeding tube placement that all institutions may use.[92] Such a model for tube placement and verification competencies promotes consistency between institutions and offers a template for a variety of nutrition professionals to identify a minimum standard level of knowledge and skills for this procedure. Regardless of the type of technology employed or whether a formal team is in place, a standardized model for tube placement and verification could be applied in a multidisciplinary fashion and be used to educate and assist physician training (medical students, residents, and fellows), dietitians, nurses, APRNs, physician assistants, and nutrition support pharmacists, as appropriate. A secondary gain from this competency model might be more standardized placement and verification patterns, which could help educate providers, improve patient care and safety, and decrease procedure-associated adverse events.[92]

Each institution must establish a comprehensive training program and method for evaluating staff competency in placing NG and NE feeding tubes. Clinicians must review and understand their facility's placement policy. Training programs often include didactic courses, required reading or viewing of educational materials, review of a skills checklist, direct observation of NG or NE placement by a trained clinician, and possibly simulation training.[93] Simulation as an educational method emulates the dynamics of a clinical environment and prepares the learner for clinical decision making.[94,95] The emphasis on simulation is often the application and integration of knowledge, skills, and clinical judgment. "Train the trainer" is also an approach that can be utilized whereby the trainer becomes a "super user."[96] In turn, feeding tube placement "super users" may facilitate the training of new clinicians through a program including didactic education, hands-on simulation training, instruction in interpreting radiographic images, and bedside coaching.

The "ASPEN Safe Practices for Enteral Nutrition Therapy" document,[97] Question 4.3, recommends improving the safety of bedside NG/NE tube placement with the following steps:

- Develop organizational policies that identify qualified and competent staff to place NG/NE tubes.
- Assess patients prior to tube placement for potential contraindications, identification of high-risk patients for misplacement, or if bedside placement is medically appropriate.
- Actively assess patient tolerance during tube placement.
- Educate and assess competencies for all clinicians involved in tube placement.

In addition, the ASPEN "Standards for Nutrition Support: Adult Hospitalized Patients," standard 12.1.3, specifies "appropriate access devices shall be placed by a physician, nurse, or trained healthcare professional who is competent to place the specific access device."[98] Discipline-specific standards of practice and professional performance published by ASPEN address feeding tube placement.[99–101]

Assessment of competency is common in healthcare and is used to evaluate performance of a specific skill, such as bedside feeding tube placement. Competency standards are variable but typically include the ability to perform a skill safely, ethically, proficiently, and efficiently. Several healthcare facilities have published their competency rubrics, many of which are based on guidelines provided by manufacturers of assistive technology for feeding tube placement.[41] The DNS-DPG of the Academy of Nutrition and Dietetics has created a competency rubric included in *Small Bowel Feeding Tube Insertion by Registered Dietitian Nutritionists: A Toolkit for Success*.[102] Nursing references such as *Elsevier Performance Manager–Clinical Skills* and the *AACN Procedure Manual* also include detailed skills checklists for small-bore feeding tube insertion, care, and removal that facilities may use to assess staff competency.[103,104] In addition, if a healthcare facility adopts a new feeding tube placement technology, the manufacturer will provide some degree of in-person training, remote clinician support, didactic education materials, and competency tools.

In an observational pilot study, Bourgault et al identified previously trained RNs ($n = 20$) who, through self-report, estimated that they needed to complete a mean of eight tube placements with an EMPD before they felt confident performing this procedure.[90] Interpretation of the insertion tracing was the most commonly observed operator error reported, and the RNs in this cohort self-reported needing to complete a mean of 10 placements before "confidence" was established. These authors suggested that at least three observations (an arbitrary number used by the

Case # ____________________________

Clinician ____________________________

Verified by (preceptor) ____________________________

Date	Competency/Critical Behaviors	Competency met	Review needed	Evaluator's initials
	Verify order for tube placement			
	Review patient health history for any contraindications to tube placement			
	Obtain verbal informed consent if applicable			
	Gather appropriate supplies			
	Perform hand hygiene			
	Introduce self to patient, explain procedure, and offer comfort measures as indicated			
	Confirm patient identity according to policy			
	Place patient in the appropriate position			
	Place tube according to policy and technique for facility			
	Secure tube with tape, transparent dressing, or a commercial fixation device			
	Educate patient and family as appropriate			
	Document tube placement according to policy			
	Verify proper tube placement prior to use, per policy			

FIGURE 1 American Society for Parenteral and Enteral Nutrition (ASPEN) Bedside Feeding Tube Placement Competency Tool

study site and others) should be performed to assess initial competency; however, that number may need to be individualized.

ASPEN MODEL FOR BEDSIDE FEEDING TUBE PLACEMENT COMPETENCIES

Based on the recommendations from this author workgroup, the following competencies should be met for the institution to sign off on the feeding tube placement competency:

1. Every clinician should complete a facility- or organization-developed program for initial competency, with content including the following:

- NG or NE tube indications and contraindications.
- Institution-specific policies and procedures.
- Observation of NG and NE tube placement.
- If using assistive placement technology, review manufacturer's recommendations.

2. The program should assess prior knowledge and effective learning using tools such as a pretest and posttest or interactive question-and-answer session.
3. The clinician should place a minimum of eight feeding tubes, using the specified placement technique for the initial competency evaluation under the supervision of an experienced preceptor. These cases should reflect the spectrum of medical and nutrition conditions, body weights, and age ranges cared for by the institution.
4. During evaluation of competency, the preceptor should use the Bedside Feeding Tube Placement Competency Tool (Figure 1).
5. For annual (preferred) or periodic competency reevaluation, completion of institutional-set required number of ongoing continuing education hours and review of a minimum of three patients should be performed using the Bedside Feeding Tube Competency Tool (Figure 1).

The model of standards for competency described in this paper will require time and resources for implementation at the organizational level. Each institution should incorporate this model in a way that is practical within its resources and capacity. Initial, annual, and/or ongoing competency evaluation is required to ensure that clinicians placing NG and NE tubes adhere to policies and procedures, understand the technique, and have developed critical thinking skills for evaluating patient safety or other clinical concerns. It is also imperative that clinicians placing NG/NE tubes perform this procedure frequently enough to maintain their skill set. For example, healthcare facilities may require clinicians to place a certain number of feeding tubes over a 6- to 12-month time period to maintain their institutional privileges, in addition to meeting the requirements of the competency tool for tube placement.[41]

DISCUSSION

Placement and verification of NG/NE feeding tubes require a comprehensive approach to safety that applies to all clinicians and incorporates evidence-based practices into interprofessional care strategies that foster patient safety. Institutions committed to patient safety should review this model and introduce these practices based upon an understanding of their patient population, personnel, and internal processes. Assistive placement technology is recommended because it adds a layer of safety but is not infallible. Careful attention to best practices and standardized processes, regardless of technological availability, is essential to deliver quality care. All clinicians placing NG/NE tubes need appropriate training and competency testing for best patient outcomes. This is just a model and it should be applied to each institution as appropriate, but a standardized approach to tube placement is crucial.

CONCLUSION

The placement and verification of feeding tubes should be developed as a clinical standard of care. Learning the techniques of placing feeding tubes may not be difficult but, without proper training and measures of competency, can lead to devastating and significant patient harm. Collaborative efforts between various disciplines and departments are needed for success. Institutions need to consider available personnel, the methodology and equipment to be used based on research and evidence, maintenance of ongoing training and competency, and cost to provide the safest, most efficient practice of the placement of feeding tubes for adult hospitalized patients.

CONFLICT OF INTEREST

Beth Lyman is a consultant for Avanos and NeoMed. All other authors have nothing to disclose.

FUNDING INFORMATION

None declared.

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How to cite this article: Powers J, Brown B, Lyman B, et al. Development of a competency model for placement and verification of nasogastric and nasoenteric feeding tubes for adult hospitalized patients. *Nutr. Clin. Pract*. 2021;36:517–533. https://doi.org/10.1002/ncp.10671