Optimization of the independent double-check process ensures that practitioners think critically while conducting checks as designed. However, independent double-checks can be overused in the healthcare industry, and the improper use of such checks can lead to safety concerns, especially if checks are inconsistent or if clinicians become noncompliant. Standardization of the independent double-check process using checklists can reduce inconsistencies in the process, and a review of the process can help identify reasons for noncompliance or other problems. When coupled with other error reduction strategies, the use of properly implemented double-check processes can prevent errors from reaching patients.[1]

Topics for Future Research

- The effect of EN ordering via CPOE or editable electronic document on EN-related error rates
- Comparison of errors associated with the use of standardized EN order sets vs errors related to the transcription of handwritten orders
- The patient safety impact of pharmacists reviewing the EN order with a patient's medication profile to identify medication interventions
- Documentation of EN errors related to transitions in level of care
- Documentation of errors related to the misconnection of EADs
- The error-related consequences of standardizing the EN order process
- The use of systematic reviews to identify gaps in the EN process

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Section 4. Enteral Access

Background

The selection of the EAD can greatly affect the success of EN. The optimal device and location (gastric vs small bowel) must be determined as placement of any enteral access device entails associated risks. If patients with an EAD are transferred to a facility without complete documentation, the receiving facility, whether acute care, long-term care, or home care agency, will need to confirm the type and placement of that feeding tube prior to initiating EN. The practice recommendations in this section help guide that facility or agency to confirm the EAD type and placement prior to starting feedings and avoid feeding through an EAD that may no longer be at the appropriate distal site.

Complications following EAD placement can include **misplacement**, which is when the tip of the EAD is placed in an anatomical position not intended for the proper administration of EN. EAD **displacement** is when the device tip later migrates or is inadvertently moved to an anatomic position not intended for the proper position of the device. Proper EAD placement and maintenance help prevent aspiration of EN, dumping syndrome, and other adverse outcomes. Although risk of complications cannot be completely eliminated, minimizing placement errors reduces the complication rate and improves patient outcomes.

Question 4.1. What are the critical components to consider when selecting an EAD for a patient?

Practice Recommendations

1. Select an EAD based on patient-specific factors (eg, GI anatomy, GI function, expected duration of EN).
2. Place a short-term nasoenteric or oroenteric EAD in patients who require EN for up to approximately 4–6 weeks in duration.
3. Place a long-term EAD in patients who require EN for longer than 4–6 weeks.

Rationale

The selection of an EAD requires an evaluation of the patient's disease state, GI anatomy (taking into account past surgeries), gastric and intestinal motility and function, and the estimated length of therapy. The healthcare team decides whether to place the distal tip of the EAD in the stomach or in the small bowel. In general, gastric access is appropriate for patients with a functional stomach free of delayed gastric emptying, obstruction, or fistula. Small bowel feedings are most appropriate for patients with gastric outlet obstruction, severe gastroparesis, and in those with known reflux and aspiration of gastric contents. Patients who need simultaneous gastric decompression with small bowel feedings can be best accommodated by a dual-lumen gastrojejunal EAD.

EADs inserted via nasal and oral routes. EADs inserted via the nasal and oral routes are usually intended for short-term use (no more than 4–6 weeks) in the hospitalized patient. However, there may be situations when use of a nasogastric access in the outpatient setting is appropriate. Some patients, particularly pediatric patients in the home, are able to self-place a nasogastric tube as part of their own care.

EADs for long-term access. The decision concerning placement of EADs for long-term EN depends on the estimated length of therapy, the long-term goals, the patient's disposition, and the special needs of the patient and caregivers. The use of gastrostomy tubes (balloon and nonballoon tubes) has become routine practice worldwide and is currently the method of choice for medium-term and long-term enteral feeding.[1] Two studies of adult patients with persistent dysphagia due to neurological disease randomly assigned patients to feedings via NG or PEG tube placement.[2,3] These studies found that the patients with PEG tubes had gained more weight and missed fewer feedings. The patients fed by NG tube received significantly less because of tube difficulties compared with the PEG patients, who had no such difficulties.[2,3] One of the studies allowed patients with an NG tube to cross over to a PEG tube if they had repeated tube difficulties (usually displacement), and, consequently, only 1 of 19 patients had an NG tube in place for 4 weeks.[3] At the end of the study, the last patient with an NG tube opted for a PEG tube, stating that the NG tube was cosmetically unacceptable.

Concerns for pediatric patients. In the pediatric literature, commonly accepted criteria for EN intervention depend on the clinical condition of the patient.[4–6] EN support is considered after other aggressive oral interventions have been tried. Pediatric patients who meet the criteria for EN include:

- Children with insufficient oral intake, particularly children older than 1 year who are unable to meet ≥60%–80% of individual requirements for ≥5 days and children younger than 1 year who are unable to meet ≥60%–80% of individual requirements for ≥3 days
- Children who meet the criteria for failure to thrive, wasting, and stunting

EN is also appropriate in a disabled child whose total feeding time is more than 4–6 hours per day. EN can also be an option when diet modification is used as a treatment of a disease (eg, Crohn's disease), food intolerance, and metabolic disorders.[7] Specific indications for feeding tubes in pediatric patients include cystic fibrosis, neurological impairment, oral/head and neck tumors, chronic liver disease, trauma, and extensive burns.[4]

Contraindications to EAD placement. The choice of EAD needs to take into account contraindications to the placement of the device. These can be divided into systemic and mechanical reasons and may be relative or absolute. Systemic contraindications are those where the overall condition of the patient precludes feeding tube placement. Mechanical ones are those where specific local conditions such as hepatomegaly or previous abdominal surgery preclude safe placement of the EAD. In some cases, the condition may be corrected. Absolute contraindications include mechanical obstruction of the GI tract (unless the procedure is indicated solely for decompression), active peritonitis, uncorrectable coagulopathy, or bowel ischemia.[8] Traumatic injuries to the head, face, and neck region as well as recent transphenoidal surgery may preclude a nasally placed EAD. A number of other conditions represent relative contraindications to enteral access, such as recent GI bleeding, hemodynamic instability, ascites, respiratory compromise, and certain anatomic alterations.[8]

Question 4.2. What steps are recommended to confirm placement of a preexisting EAD prior to initiating EN?

Practice Recommendations

1. Develop a policy at the healthcare organizational level to confirm the EAD type and placement prior to EN initiation.
2. Assess the patient and caregiver knowledge about the tube, such as agency or facility where the tube was placed, insertion date, where the patient was transferred from, and what type of tube and previous care and feeding orders were provided to the patient or caregiver.
3. Communicate with staff from the transferring institution, facility, or agency to obtain as much information as possible on the EAD type, tip position, and need for ongoing replacement and documentation.
4. Confirm type of EAD and tube placement via the accepted methods of tube verification (see Section 4, question 4 for methods used in adult patient and question 5 on pediatric patients).

5. Document the confirmation process and findings in the patient's health record.
6. Encourage transferring agencies to communicate the full information about EAD type, insertion date, and placement upon transfer.

Rationale

Adequate and timely transfer of information between care settings during transitions in care is imperative for the safe care of patients.[9] A percutaneously positioned tube in a GI tract that has not fully matured may be displaced prior to or during transfer, particularly if the tube is inadequately secured. If the displacement is not identified, this complication may lead to intraperitoneal administration of EN. Incomplete or incorrect communication of the EN tube type and placement during patient transfer may delay the administration of adequate and appropriate nutrition. Poor communication during transitions of care may also lead to hospital readmissions and emergency department visits that may have been preventable.[10]

The EAD type, placement, and requirements for ongoing replacement need to be communicated in the available medical record and clinical information. Clear descriptions in plain language without ambiguous abbreviations will minimize misinterpretation and error. Ideally, this documentation is provided by the transferring agency to the new facility *prior to* discharge,[10,11] and the enteral prescription and regimen are transferred to the accepting care team via standard electronic information systems that are accessible to all healthcare providers and suppliers associated with the patient.[11] Use of these systems may improve communication; however, they may not be universally available or accessible. If this information must be communicated by telephone, the nutrition support provider at the new facility should repeat it back to ensure that it is received and interpreted correctly. Feeding tube information, such as brand, type, tube tip position, need for ongoing replacement, French size, and length (if applicable), is also verified at this time.[12]

Question 4.3. What steps can be taken to enhance the safety of bedside nasoenteric tube placement?

Practice Recommendations

1. Develop organizational policies to outline who is qualified to place a nasoenteric tube, under what circumstances, and with what supervision or competencies.
2. Assess patients prior to tube placement for potential contraindications, identification of high-risk patients for misplacement, or if bedside placement is medically appropriate.
3. Actively assess patient tolerance *during* tube placement.
4. Educate and assess competencies for all clinicians involved in tube placement.

Rationale

Addressing safety measures designed to enhance the safety of bedside blind insertion of feeding tubes *before and during* tube insertion is critical as this this is where the most serious, potentially life-threatening adverse events occur.[13,14] This is especially needed when considering that numerous disciplines, with varying degrees of training, commonly place these tubes today. The importance of training and competency assessment of all clinicians involved in tube insertion should be clearly delineated.[13–16]

Patient assessment prior to tube insertion is essential to preventing placement-related injury. This could include identification of patients at high risk for pulmonary misplacement; recognizing contraindications to nasal passage of tubes, including recent history of transphenoidal surgery or basilar skull fracture (ethmoid, sphenoid, or occipital bones); evaluation of bleeding risk, including coagulation values and safe limit cutoffs; recent bleeding from esophageal varices; time since banding; and so on. The presence of anatomical factors that can lead to perforation should also be part of the assessment: hiatal hernia or Zenker's diverticulum and previous bariatric surgery. Not all patients are candidates for bedside insertion, and fluoroscopic or endoscopic placement may provide a safer choice for tube placement.[14]

Alternate bedside methods of placement are available and include electromagnetic placement device (EMPD), use of carbon dioxide (CO_2) sensing, and direct visualization using a tube with a camera. These techniques are described below.[13–16] Development of institutional policies and procedures for placement and ongoing competency assessment is crucial. One institution temporarily stopped placement of tubes by untrained personnel until a quality improvement program could be put into place.[14] It is important to document the size and manufacturer/model of the tube once it is placed. The diameter plays an important role in types of formula and medications that can be infused, and internal diameter can change depending on the device material and model.

Question 4.4. What is the best way to confirm accurate EAD placement in ADULT PATIENTS?

Practice Recommendations

1. Obtain radiographic confirmation for any blindly placed short-term EAD to demonstrate that it is properly positioned in the GI tract prior to its initial use for administering feedings and medications in adult patients.
2. When attempting to insert a short-term feeding tube, obtain a tube aspirate for appearance and pH measurement. The appearance and pH are likely dependent on location.

3. Do not rely on the auscultatory method alone to differentiate between gastric and respiratory placement or between gastric and small bowel placement.
4. Mark the exit site of a feeding tube at the time of the initial placement and document either the incremental marking on the tube or the external length of the tube in the medical record.
5. Evaluate whether the incremental marking or external tube length changes, and, if a change is observed, use other bedside tests such as visualization and pH testing of tube aspirate to help determine if the tube has become dislocated. If in doubt, obtain a radiograph to determine tube location.
6. For long-term feeding tubes, document tube type, tip location, and external markings in the medical record and in follow-up examinations.
7. Avoid use of catheters or tubes not intended for use as EADs, such as urinary or GI drainage tubes, which usually are without an external anchoring device. Use of such tubes may lead to enteral misconnection as well as tube inward migration, which can potentially cause obstruction of the gastric pylorus or small bowel.
8. Avoid administration of feedings, fluids, or medications through the EAD until correct position has been confirmed.

Rationale

The patency and placement of an EAD should be confirmed before using it for feeding or medication administration. Proper radiographic imaging is recommended to confirm the position of any blindly placed enteral feeding tube. Healthcare professionals cannot rely on auscultatory methods to differentiate between gastric and bronchopulmonary tube placement because auscultatory methods cannot distinguish tubes improperly placed in the lung or coiled in the esophagus from properly positioned tubes.[17]

Nasal or oral insertion of a short-term EAD is often performed at the bedside. Nasojejunal tubes may be placed blindly or with the assistance of endoscopy, fluoroscopy, electromagnetic, carbon dioxide sensing (capnography), or direct camera visualization devices. Studies have demonstrated that errors in blindly placed NG tubes are not uncommon.[14,18–20] Sorokin and Gottlieb[14] reported a 1.3%–2.4% incidence of misplacement of a tube in 2000 NG tube insertions into adults. Of the misplaced devices, 28% resulted in pulmonary complications, with 2 of these misplacements culminating in death.

Confirmation that the newly inserted EAD is correctly positioned is mandatory before feedings or medications are administered. A variety of bedside tests to determine tube placement are used with varying degrees of accuracy. Usually bedside detection methods serve as precursors to radiographic confirmation, as they may serve to decrease the number of radiographs needed to a single one.[8] For a blindly inserted EAD, the gold standard for confirming correct placement is a properly obtained and interpreted radiograph that visualizes the entire course of the tube.[14,21–23]

Confirmation is usually provided through imaging, which can add significant cost and time to EAD placement. Recent adjuncts have been developed, including the use of carbon dioxide or pH sensors to confirm intubation of the stomach rather than the pulmonary tree.[24] Sensitivity and specificity of those 2 methods have been reported in one trial as high as 86% and 99%, respectively.[25] Newer technology provides the clinician with multiple options in confirming tube location prior to the initiation of enteral feeding. A multicenter study compared the use of an electromagnetic placement device (EMPD) for placement and tube tip confirmation to standard x-ray. Of the 194 patients in this study, only 1 had data showing discrepancies between the original EMPD verification and the final abdominal radiograph interpretation, providing a 99.5% agreement.[26] Other recent studies and a literature review demonstrated similar conclusions,[27,28] while 2 more recent papers point out the potential risk of eliminating x-ray confirmation with inexperienced operators.[29,30]

A more recent innovation is a disposable feeding tube with an integrated real-time imaging system to visually aid in the placement of small-bore feeding tubes. This technology method features a 3-mm camera integrated within a small-bore feeding tube to allow clinicians to identify anatomical markers during the placement of a tube.[31]

Although observing for respiratory symptoms is warranted during EAD insertion, malpositioning may occur without any apparent symptoms.[32,33] The appearance and pH of aspirates from a feeding tube may provide clues to an EAD location but has not been shown to be reliable as a single marker for tube tip location. Fluid withdrawn from a tube that has perforated into the pleural space typically has a pale yellow serous appearance and a pH of 7 or higher, whereas fasting gastric fluid typically is clear and colorless or grassy green or brown with a pH of 5 or less.[34–38] Several studies demonstrating the use of pH testing indicate a pH of ≤5.5 from tube aspirate is adequate to check the position of the tube in the stomach.

The auscultatory method of tube tip confirmation is unreliable.[17,39] Multiple case reports clearly indicate that clinicians cannot differentiate between respiratory and gastric placement by the auscultatory method.[32,40,41] Several studies have indicated that capnography can be helpful in determining when a tube has taken the wrong course into the trachea during the insertion process.[42,43] However, it is important to point out that this method cannot distinguish between EAD placement in the esophagus and the stomach. Thus, even though capnography may indicate nonbronchotracheal placement of a newly inserted tube, a radiograph is still required to ensure proper placement in the stomach.

A tube is malpositioned if it is located in the stomach of a patient receiving small bowel feedings. One study found that experienced nurses could not distinguish between gastric and

small bowel placement by the auscultatory method.[44] A higher level of accurate placement has been reported when clinicians observe the appearance and pH of the feeding tube aspirate.[45] Small bowel aspirates are typically bile stained, while fasting gastric fluid is typically clear and colorless or green or brown.[35] Gastric fluid usually has a lower pH than that of small bowel secretions. For example, Griffith et al found that most gastric pH readings were ≤5, with or without the use of gastric acid suppression therapy.[37] It should be noted that when gastric pH is ≥6, the pH method is of no benefit in predicting tube location in the GI tract (or in ruling out tracheopulmonary placement).

After feedings have been started, it is necessary to check that the tube remains in the desired location (either the stomach or small bowel). Securing tube with a bridle may be helpful for preventing accidental dislocation (see below for more detail on securement). Unfortunately, a small bowel tube may dislocate upward into the stomach or a gastric tube may migrate downward into the small bowel; a worse scenario is when a tube's tip dislocates upward into the esophagus.[46] Obviously, an x-ray cannot be obtained several times a day to confirm tube location; thus, clinicians rely on a variety of bedside methods for this purpose. Use of the above-mentioned bedside placement technology (electromagnetic, direct visualization, pH measurement, or CO_2 sensing) can help clinicians to verify tube tip position. A sharp increase in gastric residual volume may indicate displacement of a small bowel tube into the stomach.[47,48] For long-term EADs, incorrect feeding technique and complications in tube replacement and removal can result from failure to recognize the type of tube inserted (gastric vs small bowel), the insertion technique, and the location of the distal catheter tip. Follow-up of a long-term percutaneous EAD is indicated to ensure that the enteral retention device is properly approximated to the abdominal wall, there is no tube migration, and excessive tension to the exterior portion of the tube is avoided, as well as to assess the condition of the surrounding skin.

Question 4.5. What is the best way to confirm accurate EAD placement and evaluate risk versus benefit of radiation exposure especially in PEDIATRIC/NEONATAL patients?

Practice Recommendations

1. Use accurate measurement of enteral tube insertion length, gastric pH testing, and visual observation of gastric aspirate as acceptable nonradiologic methods for assessing tube placement when radiographic verification is not available.
2. Obtain an abdominal radiograph when other nonradiographic methods for validation of tube location are not confirmatory.
3. Avoid using auscultation alone as verification for nasogastric feeding tube placement.

Rationale

Although placement of a nasogastric tube is a common procedure, it is not without risk of significant harm or death. Great care must be taken when placing tubes and confirming their correct placement. In 2012, the Child Health Patient Safety Organization issued a safety alert to recommend immediate discontinuation of the auscultation method for the assessment and verification of NG tube placement.[49] A study cited in the alert reported that 1.3%–2.4% of NG tubes in more than 2000 insertions were located outside the GI tract. Moreover, more than 20% of the misplaced NG tubes led to pulmonary complications.[14,49] This alert acknowledges an abdominal radiograph as the current gold standard when other nonradiographic methods for validation of tube location are not confirmatory.

When abdominal radiography is not readily available or advisable, the Child Health Patient Safety Organization safety alert identifies accurate measurement of EAD insertion length, gastric pH testing, and visual observation of gastric aspirate are acceptable nonradiologic methods for assessing tube placement listed in the alert.[49] In addition, the alert specifies children who are considered at high risk for misplaced or dislodged gastric enteral tubes: neonates, children with neurological impairment, children in an obtunded neurological state, and children who are encephalopathic, have a decreased gag reflex, or are sedated or critically ill. For these children, the alert recommends abdominal radiography as the best practice for verifying location of a gastric enteral tube.[49]

In addition to the above-mentioned alert, the American Association of Critical-Care Nurses issued a practice alert[50] and the American Society for Parenteral and Enteral Nutrition (ASPEN) published practice recommendations[51] to address the risks and potential complications associated with misplaced NG tubes.[50,51] Placement of a gastric EAD potentially poses risks to patient safety, and device dislodgement poses similar risks.

In a retrospective study of children, Ellett et al[52] demonstrated by radiographic documentation a prevalence of 21% for misplaced or dislodged NG, orogastric, and transpyloric tubes. In a follow-up prospective study, Ellett and Beckstrand[53] used abdominal radiography to evaluate device placement and reported a prevalence between 22% and 44% in NG tube placement error in children in their institution, a rate that exceeds the range found in adult studies. Although alternative methods exist, abdominal radiographic imaging is the "gold standard" for verifying NG tube placement.[18,51,54–56] However, even with radiographs, there may be variation in the interpretation of device location. This variation is due to a lack of consensus on identification of specific anatomical landmarks used to verify the NG tube position within the gastric lumen.[56] In addition, the lack of a relevant clinical history explaining the need for a radiograph along with omission of a specific request for device and device tip location in the radiology requisition can