Confirming Feeding Tube Placement: Old Habits Die Hard

Multiple publications have addressed the indications for nasogastric or nasoenteric feeding tubes and the importance of initial and ongoing verification or confirmation of their proper placement.\(^1\)-\(^4\) In particular, studies show that feeding tubes are not medically indicated for those unable to swallow because of advanced dementia.\(^1\),\(^2\) For patients with appropriate indications for feeding tubes, studies show that traditional methods of verifying proper placement at the bedside are not reliable. Unfortunately, these methods are still used, despite the availability of more reliable, evidence-based practices to confirm proper feeding tube placement.\(^3\) Of greatest concern, errors have been reported to PA-PSRS even when the gold standard of confirmation, a radiograph (x-ray) of the chest, has been done but misinterpreted by a patient’s physician.

This article will review reports to PA-PSRS indicating problems from misplacement of nasogastric and nasoenteric feeding tubes, review the literature on proper verification of the location of these feeding tubes, and propose algorithms for confirming the location of these tubes, based on the literature review.

Injuries from feeding tube misplacement reported in the clinical literature include aspiration pneumonia, pneumothorax, perforations, empyema, bronchopleural fistula, and even death.\(^4\) Reports submitted to PA-PSRS also reflect complications of feeding tube misplacement, such as the following:

A Keofeed was inserted. A post insertion x-ray revealed that the tube was located in the left lung. The tube was removed prior to feeding being administered, but thereafter the patient developed respiratory distress. A repeat x-ray indicated a left-sided pneumothorax. A chest tube was placed which resolved the pneumothorax.

Traditional Bedside Methods to Verify Feeding Tube Placement

The following three methods have traditionally been used to verify feeding tube placement at the bedside.

**Auscultation**

Auscultation involves instilling air into the feeding tube with a syringe while using a stethoscope placed over the stomach to listen for rushing air. However, this method cannot differentiate between tube placement in the stomach or the lung/bronchial tree.\(^5\),\(^7\) For example, in one study, x-ray confirmation identified 16 instances where nasogastric tubes were not located in the stomach. However, in 15 of those instances, clinicians using the auscultation technique believed that those tubes were in the stomach.\(^8\) Also, the auscultation method cannot determine when a feeding tube’s ports end in the esophagus (a condition that predisposes to aspiration).\(^9\) Misinterpretation of auscultation of air insufflation is known as pseudoconfirmatory gurgling.\(^5\),\(^7\)

**Bubbling**

This method involves observing bubbles when the end of the feeding tube is placed under water; the appearance of bubbles is thought to indicate that the feeding tube is misplaced in the respiratory tract. However, bubbling can also occur when feeding tubes are placed in the gastrointestinal tract.\(^10\) Also, the absence of bubbles does not rule out respiratory placement if the tube’s ports are occluded by the respiratory mucosa.

**Aspirate Appearance**

This method involves assessing the appearance of aspirate from the tube. Ordinarily, small bowel aspirates are golden yellow or greenish brown (intestinal fluid stained with bile); in contrast, gastric aspirates are often grassy green, off-white, or tan.\(^11\) However, respiratory secretions can be white, yellow, straw-colored, or clear.\(^5\) Because both respiratory and gastrointestinal aspirates may be similar in color, they may be easily misinterpreted.

The following is a PA-PSRS report that highlights the use of these less reliable methods of confirming feeding tube placement:

Postoperatively, a nasogastric tube was placed. Two nurses confirmed placement by
Confirming Feeding Tube Placement: Old Habits Die Hard (Continued)

auscultating an air bolus over the epigastric region. Green fluid was aspirated. Thereafter, the patient experienced an acute drop in oxygen saturations. A bronchoscopy revealed that the NG was going through the vocal cords and not in the stomach.

More Reliable Methods to Verify Feeding Tube Placement

Radiographic Confirmation of Nasogastric Tube Placement

The gold standard for nasogastric feeding tube placement is radiographic confirmation with chest x-rays.4-6,12,13

While radiographs are the preferred method of confirmation for small bore feeding tubes, they are not always done when large, rigid nasogastric tubes are inserted.10 However, some sources recommend radiographic confirmation of all blindly inserted tubes for feedings or administration of medications in high-risk patients.9,13 Barriers to radiographic confirmation include the expense of confirmatory x-rays, the effort involved, and radiation exposure to the patient. Moreover, x-rays have been misinterpreted.14

The following PA-PSRS reports indicate misinterpretations by nonradiologists:

Figure 1. Chest Radiograph Representing Properly Placed Nasogastric Feeding Tube with Tip Visible

feeding tube placement is radiographic confirmation with chest and abdominal x-rays.4-6,12,13

A house physician inserted a KoeFeed tube in a geriatric patient. Both the nurse and physician confirmed placement by auscultating inflated air. The physician confirmed placement after reading the x-ray. Tube feedings were begun. The patient was found dead.

A Dobhoff tube was placed by a house physician. The x-ray was read and placement confirmed. Tube feedings were initiated. The patient experienced respiratory distress. A review of the x-ray showed that the feeding tube was in the main bronchus.

Confirmation that the feeding tube is properly placed in the stomach or small bowel involves documenting the following on a chest x-ray:

1. The tube follows a straight course down the midline of the chest to a point below the diaphragm.
2. The tip of the tube is below the diaphragm.
Confirming Feeding Tube Placement: Old Habits Die Hard (Continued)

3. The tube is not coiled anywhere in the chest.

4. The tube does not follow the path of a bronchus.\textsuperscript{15}

If the tube is intended to be placed in the small bowel, an abdominal x-ray is needed to determine where the ports are situated. Small bowel feedings are needed when patients cannot tolerate gastric feedings because of significantly delayed gastric emptying, demonstrated chronic aspiration of gastric contents, or a known incompetent lower esophageal sphincter.

In the United Kingdom, the National Patient Safety Agency does not recommend the routine use of x-ray for nasogastric tube placement confirmation, reserving it for patients at high risk for misplacement of the nasogastric tube, such as the critically ill or neonates.\textsuperscript{10}

Endoscopy and Fluoroscopy
Both endoscopy and fluoroscopy accurately verify placement of feeding tubes, but these methods can be cost-prohibitive, time-consuming, and pose additional risks, such as transporting patients to special procedures areas or imaging departments. Because fluoroscopy produces clinically significant radiation exposure, this technique is used for feeding tube placement only as a last resort.\textsuperscript{16}

pH Testing
Another reliable method for ongoing tube placement verification is determining the pH of the fluid aspirated from feeding tubes. Gastric fluid is usually acidic, with a pH less than or equal to 5.5.\textsuperscript{17} Respiratory secretions are almost always alkaline, with a pH greater than or equal to 6. In a large study of 1,284 aspirates from feeding tubes, all samples from the lungs had a pH greater than or equal to 6.\textsuperscript{11} If the pH of the feeding tube aspirate is greater than or equal to 6, the tube may be inadvertently located in the respiratory tract.\textsuperscript{11,17}

However, several conditions can affect the pH of aspirates, resulting in misinterpretation of the placement of a feeding tube.\textsuperscript{3-7} For example, respiratory secretions may be acidic in patients with esophageal rupture, acid reflux, or a pleural infection such as empyema.\textsuperscript{3-6} Feeding tube aspirates are usually alkaline if the tube is in the small bowel or the patient is achlorhydric.\textsuperscript{3,6} Also, gastric pH will rise temporarily when the patient is receiving acid-inhibiting medications (e.g., histamine\textsubscript{2}-antagonist, proton pump inhibitor) or when tube feedings are in progress.\textsuperscript{16}
Confirming Feeding Tube Placement: Old Habits Die Hard (Continued)

In spite of the possibilities for misinterpretation, pH continues to be the most reliable bedside method for ongoing feeding tube placement confirmation, if acidic, and it is endorsed by both the U.K. National Patient Safety Agency and the American Association of Critical Care Nurses. The pH method works best when the patient is not on acid-inhibiting medications and has been fasting for several hours before the aspirate is tested.

Combination of Methods
The American Association of Critical Care Nurses advises that pH testing be augmented by appearance of the aspirate to bring the accuracy closer to the gold standard, radiographic confirmation. The U.K. National Patient Safety Agency prefers pH testing without considering the appearance of the aspirate. Therefore, it cannot eliminate the need for a confirmatory x-ray. Many institutions now regularly use confirmatory x-rays to ensure that a nasogastric tube’s ports end in the stomach instead of the esophagus to minimize risk for aspiration of formula or medications administered via the tube.

- A new technology uses copper wire coiled around a stylet of small-bore feeding tubes. The wire generates an electromagnetic signal from the tip of the stylet. A locator device, placed over the patient’s xiphoid process, produces an image of the feeding tube’s path on a computer screen. Early research indicates that this system accurately indicated placement in 20 of 21 feeding tubes, as verified by x-ray.

Other Promising Placement Verification Methods
Several investigational studies have identified other methods to verify feeding tube placement:

- Combining bedside pH testing with laboratory testing of either bilirubin concentration or pepsin and trypsin of tube feeding aspirates provides a reasonably reliable method of verifying gastric placement of feeding tubes. However, bedside methods for measuring bilirubin, pepsin, and trypsin are not currently available.

- Capnometry accurately and reliably demonstrated when feeding tubes entered the respiratory tracts of intubated, mechanically ventilated patients. An end-tidal carbon dioxide detector is attached to the proximal end of the feeding tube. In two studies, carbon dioxide was appropriately detected in trachecthetic tubes and not detected in nasogastric tubes of patients in the study. The investigators advocated replacing confirmatory x-rays with capnometry. However, this method cannot determine where the tube’s ports are situated in the gastrointestinal tract (e.g., in the esophagus as opposed to the stomach or small bowel).

<table>
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<tr>
<th>Some Results of Nasal Positioning of a Feeding Tube</th>
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<td>• Local ulceration</td>
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<td>• Epistaxis</td>
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<td>• Sinusitis</td>
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<td>• Otitis media</td>
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Risk Factors for Incorrect Feeding Tube Placement
In general, the patients at greatest risk for misplacement are those with diminished mental status and decreased cough or gag reflexes. Critically ill, obtunded, uncooperative, debilitating patients and those with maxillofacial or craniofacial trauma and craniofacial surgery are at greater risk for feeding tube misplacement.

A University of Pittsburgh retrospective study of 4,190 radiographic reports identified 87 patients with a feeding tube intrabronchial malposition. Thirty-two percent of these patients experienced multiple misplacements. Each occurrence of feeding tube misplacement increased the risk for future misplacement. An endotracheal or tracheal tube cuff does not provide protection from feeding tube misplacement.

The University of Pittsburgh study revealed that two-thirds of the 87 patients with a feeding tube in a bronchus had an endotracheal or tracheal tube. A patient’s apparent tolerance of a procedure cannot be interpreted as an indicator of proper feeding tube placement. For example, consider the following PA-PSRS report:

According to physician orders, a nurse placed an NG tube in an unresponsive patient for tube feedings. Placement was verified with air and residual. A second nurse verified placement. Tube feedings were initiated. The patient did not demonstrate any respiratory problems initially. Thereafter, the patient was noted to be mottled and having...
Confirming Feeding Tube Placement: Old Habits Die Hard (Continued)

respiratory distress. A chest x-ray indicated that the NG tube was positioned in the lower lobe of the left lung. The patient received more than 100 cc of tube feeding. The patient was placed on a ventilator.

Marderstein et al. recommend an initial scout film on critically ill patients when the tube has been advanced 40 cm, so that its midline position can be confirmed beyond the level of the carina, but before an errant tube in the bronchus would begin violating the lung tissue and causing a pneumothorax. If the tube is clearly not in the tracheo-bronchial tree, it is then advanced into the stomach or small bowel, and a second x-ray is done for final confirmation.

Pediatric Considerations
Nursing practices to verify feeding tube placement in adults can be adapted for children. For example, radiographic confirmation of placement and the pH method are effective in both adults and children. When radiographic confirmation is not possible, such as when the patient is at home, the pH method is an acceptable option. Pediatric home care nurses can teach parents how to place feeding tubes and to verify placement before each feeding.

Proposed Strategies for Minimizing the Risk of Nasogastric or Nasoenteric Feeding Tube Misplacement
No method of verifying feeding tube placement is 100% effective. However, algorithms are proposed, based on the literature, to minimize the risk of misplaced nasogastric and nasoenteric feeding tubes (see page 8). Critical points include the following:

- Using feeding tubes for patients with appropriate medical indications. For example, feeding tubes are not medically indicated for patients who are unable to swallow because of advanced dementia.

- Requiring radiographic confirmation of feeding tube placement, if radiography is available, prior to initiating tube feedings, particularly in patients at high risk for tube misplacement.

- Using the pH method to confirm placement when x-rays are not practical, keeping in mind that a pH of 6 or greater has multiple possible reasons:
  - The aspirate may be from the small bowel.
  - The patient may have achlorhydria.
  - The patient may be receiving acid-inhibiting medications.
  - Feedings in the stomach may buffer the pH of gastric secretions.

- Frequently assessing patients with diminished mental status for findings indicative of feeding tube misplacement, such as:
  - unexplained gagging, vomiting, or coughing,
  - signs of respiratory distress, and
  - reduced oxygen saturation.

- After initiation of tube feedings, regularly assessing the external length of tubing extending from the insertion site to detect changes. This method requires that the tube’s exit site be marked with ink at the time of initial radiographic confirmation of correct placement. A large increase in external tube length may indicate the tube has been pulled out partially and is no longer in the desired site.

Complications Related to Feeding Tubes

- Cardiac arrhythmias
- Hypoxemia (in dysphagic stroke patients)
- Perforation
- Esophageal ulceration
- Inflammation
- Pleural effusion
- Empyema
- Fistula formation
- Nutrient pneumonitis
- Aspiration pneumonia
- Pneumothorax
- Tracheal, bronchial, or esophageal placement
- Lung abscess
- Intracranial penetration
- Submucosal passage
- Pneumomediastinum
- Hydrothorax
- Isocalothorax (enteral feed hydrothorax)
Several other strategies, including the following, may also help the efforts to minimize the risk of misplacements:

- Developing and revising policies and procedures to provide guidance, standardization, and consistency regarding feeding tube indications, placement, and steps to verify placement.

- Ensuring that healthcare providers have proven competencies:
  - For feeding tube insertion
  - For verification of proper placement
  - For accurate interpretation of confirmatory radiographics

- Implementing a specialized team of nurses, such as an enteral access team, to help ensure competent feeding tube placement, consistent practices, and reduced complications.

- Requiring that attending radiologists or credentialed non-radiologists read x-rays to confirm feeding tube placement before initiating feedings.

- Considering implementation of any newer, promising placement verification method if studies confirm efficacy.

Self-Assessment Questions
The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

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1. A reliable indicator of correct nasogastric tube placement in the patient is hearing air being insufflated on auscultation of the abdomen over the stomach.
   A. True
   B. False

2. The pH of nasogastric tube aspirates can be affected by:
   A. Oxygen saturation and blood glucose
   B. Tube feedings and medications
   C. Diarrhea and obstipation
   D. None of the above

3. Risk factors for feeding tube misplacement include:
   A. Renal and liver failure
   B. Pneumonia and gastritis
   C. Maxillofacial or craniofacial trauma and obtunded patients
   D. Active cough and gag reflexes

4. Effective risk reduction strategies include:
   A. Combining auscultation with radiographic confirmation
   B. Combining bubbling with inserting feeding tubes in patients unable to swallow because of advanced dementia
   C. Combining auscultation, bubbling, and aspirate appearance
   D. Combining pH testing with aspirate appearance and radiographic confirmation

5. Feeding tube placement in the stomach is confirmed if the chest x-ray indicates:
   A. The tip of the tube is below the level of the diaphragm
   B. The tube is coiled in the chest, but remains in the midline
   C. The tube does not follow the path of a bronchus
   D. The tube follows a straight course down the midline of the chest with the tip below the level of the diaphragm

Conclusion
Because “it’s always been done this way” is not a good reason for healthcare workers to continue using less reliable methods to confirm feeding tube placement. Implementing evidence-based methods will promote a safer environment of patient care.
Confirming Feeding Tube Placement: Old Habits Die Hard (Continued)

Notes
# Suggested Algorithms for Minimizing the Risk of Nasogastric or Nasoenteric Feeding Tube Misplacement

## I. Verifying the initial insertion of a nasogastric or nasoenteric feeding tube.

A. Is a nasogastric or nasoenteric feeding tube indicated?\(^1,2\) (If not, no tube is inserted.)

B. Should the tube end in the stomach or small bowel? (See text for some indications for small bowel feedings.)
   - For the initial insertion of a nasogastric feeding tube, go to algorithm II.
   - For the ongoing confirmation of the placement of a nasogastric feeding tube, go to algorithm III.
   - For the initial insertion of a nasoenteric feeding tube, go to algorithm IV.
   - For the ongoing confirmation of the placement of a nasoenteric feeding tube, go to algorithm V.

## II. Confirmation of the initial insertion of a nasogastric feeding tube.

A. Is radiography available for x-ray confirmation?
   - If Yes:
     1. Confirm (and document) that the nasogastric tube follows a straight course down the midline of the chest to a point below the diaphragm, that the tip of the tube is below the diaphragm, that the tube is not coiled anywhere in the chest, and that the tube does not follow the path of a bronchus.\(^15\)
        - If the tip of the tube is below the lower edge of the x-ray, get an abdominal flat plate.
        - If confirmed, begin tube feedings when appropriate and observe for findings indicative of feeding tube misplacement\(^17\) (see text).
        - If the gastric pH is greater than or equal to 6 and the patient has reason for the pH to be temporarily elevated (medications or food), wait for the effect to wear off, if possible, and recheck the gastric pH.
        - Otherwise, if the gastric pH is greater than or equal to 6, arrange for x-ray confirmation before feeding.
   - If No:
     1. Check (and document) the gastric pH.
        - If the gastric pH is less than or equal to 5.5, begin tube feedings when appropriate and observe for findings indicative of feeding tube misplacement\(^17\) (see text).
        - If the gastric pH is greater than or equal to 6 and the patient has reason for the pH to be temporarily elevated (medications or food), wait for the effect to wear off, if possible, and recheck the gastric pH.
        - Otherwise, if the gastric pH is greater than or equal to 6, arrange for x-ray confirmation before feeding or administering medication via the nasogastric tube.

## III. Ongoing confirmation of the placement of a nasogastric feeding tube.

A. For intermittent tube feedings or nasogastric administration of medications:
   - Before each tube feeding or nasogastric administration of medication, check (and document) the gastric pH.
     1. If the gastric pH is less than or equal to 5.5, continue the tube feedings or administration of medications and observe for findings indicative of feeding tube misplacement\(^17\) (see text).
     2. If the gastric pH is greater than or equal to 6 and the patient has reason for the pH to be temporarily elevated (other medications or residual tube feedings), wait for the effect to wear off, if possible, and recheck the gastric pH.
     3. If the gastric pH is greater than or equal to 6 and the patient is known to have a pH persistently in that range, continue the tube feedings or administration of medications and observe for clinical findings indicative of feeding tube misplacement\(^17\) (see text).
     4. Otherwise, if the gastric pH is greater than or equal to 6, arrange for x-ray confirmation before feeding or administering medication via the nasogastric tube.

B. For continuous tube feedings:
   - At least once daily, if possible, and whenever clinical findings of feeding tube misplacement are observed, stop feedings until the stomach
is empty, check for residual tube feedings, and check (and document) the gastric pH.

- If the gastric pH is greater than or equal to 6 and the patient has reason for the pH to be temporarily elevated (other medications or residual tube feedings), wait for the effect to wear off, if possible, and recheck the gastric pH.

- If the gastric pH is greater than or equal to 6 and the patient is known to have a pH persistently in that range, continue the tube feedings and observe for clinical findings indicative of feeding tube misplacement\(^\text{17}\) (see text).

- Otherwise, if the gastric pH is greater than or equal to 6, arrange for x-ray confirmation before continuing feedings.

IV. Confirmation of the initial insertion of a nasoenteric feeding tube.

(It is assumed that a nasoenteric feeding tube would only be inserted under direct endoscopic visualization, which would need no further initial verification, or with the capability for x-ray confirmation.)

- Confirm (and document) — using both a chest x-ray and an abdominal flat plate — that the nasoenteric tube follows a straight course down the midline of the chest to a point below the diaphragm, that the tip of the tube is below the diaphragm, but not in the stomach, that the tube is not coiled anywhere in the chest, and that the tube does not follow the path of a bronchus.\(^\text{15}\)

  - If confirmed, begin tube feedings when appropriate and observe for findings indicative of feeding tube misplacement\(^\text{17}\) (see text).

  - If not confirmed, reposition and repeat the confirmation process.

V. Ongoing confirmation of the placement of a nasoenteric feeding tube.

(\(\text{It is assumed that feedings are continuous.}\))

- Whenever clinical findings of feeding tube misplacement are observed (see text), stop feedings until the upper small bowel is empty, check for residual tube feedings, and confirm (and document) — using an abdominal flat plate — that the tip of the nasoenteric tube is below the diaphragm, but not in the stomach.

  - If confirmed, resume tube feedings and observe for findings indicative of feeding tube misplacement\(^\text{17}\) (see text).

  - If not confirmed, reposition and repeat the confirmation process.

- In patients at high risk for misplacement of nasoenteric feeding tubes (see text), at least once daily, if possible, stop feedings until the upper small bowel is empty, then check tube feeding residuals and the pH of the aspirate.

  - If the pH of the aspirate is greater than or equal to 6, continue the tube feedings and observe for findings indicative of feeding tube misplacement\(^\text{17}\) (see text).

  - If the pH of the aspirate is less than or equal to 5.5, confirm (and document) — using an abdominal flat plate — that the tip of the nasoenteric tube is below the diaphragm, but not in the stomach.

    - If confirmed, resume tube feedings and observe for findings indicative of feeding tube misplacement\(^\text{17}\) (see text).

    - If not confirmed, reposition and repeat the confirmation process.

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