

What evidence exists that describes methods for ongoing verification of nasogastric tube placement in adult inpatients?

This report aims to summarize the best available evidence describing ongoing or bedside methods for ensuring the correct placement of a nasogastric tube in the adult inpatient population, and the frequency of verification.

Key Messages:

- **Nasogastric tubes (NGTs)** are flexible lumen tubes that are passed through the nose to gain access to the stomach and in some cases, the small bowel area. They have various indications for use, but are often placed for administration of medication in patients with difficulty swallowing due to neurological impairments or other conditions, and to deliver enteral nutrition.
- Generally, NGTs are considered to be extremely safe, where insertion and maintenance of the treatment occur without incidence. However, cases of initial misplacement and subsequent migration of the tip of the NGT to the esophagus, lungs and even brain have been documented with deleterious effects to the patient. Therefore, methods to effectively verify the initial and ongoing placement of NGTs are necessary for safe patient care.
- X-ray or radiograph confirmation is the gold standard for verification following the initial placement of the NGT. The evidence around initial verification methods is not discussed in this review.
- In this review, we did not find any study that directly addressed methods for ongoing or bedside verification of NGT placement following initial verification. Practice alerts and standards from nursing or other professional associations, as well as reviews of the literature provided some recommendations for practice, which were somewhat consistent:
 - Regular verification of previously confirmed NGTs was recommended. The frequency described included once per nursing shift, every 4-8 hours and/or before each administration of medication or feed.
 - There was no reported gold standard for ongoing or bedside methods to confirm placement of NGTs in all circumstances and for all patients. The literature suggested using a variety of methods, including:
 - Observation for changes in the external length of the tube
 - Measurement of pH of aspirate (between 1 and 5.5 for gastric placement)
 - Observation of aspirate for color and volume
 - Irrigation and return of warm water
 - Observation of patient symptoms, including respiratory distress
 - X-ray of chest/abdomen as a second line method, or when in doubt.
 - Capnography/Colorimetric capnometry were suggested for mechanically-ventilated patients, but their use is unclear for ongoing verification of NGT placement.
 - One study investigated the use of a gastric lipase test in conjunction with pH testing, but further research is needed.
- Air auscultation and “water bubbling” were not recommended for use in the literature as methods for verification of NGT placement in all circumstances.
- Considerations for practice include the impact on resources, cost and time to verify NGT placement as well as training for staff to be able to administer and interpret verification methods.

Who is this summary for?

This summary was requested by Jasmine Lee Hill, CNS, Surgical Mission at the MUHC.

Information about this summary:

This report covers a broad collection of literature and evidence sources with a search emphasis on systematic reviews.

This summary includes:

Key findings from a broad collection of recently published literature (from 2011-2016) and other evidence sources.

This summary does not include:

Recommendations, additional information, or detailed description of the interventions in the studies.

1. Background:

A nasogastric tube (NGT) is a flexible tube that is inserted through the nose and provides access to the stomach or small bowel [3]. The existence of NGTs can be traced back to the 17th or 18th century where hollow silver or leather tubes were used to deliver enteral feeding [2]. Today, their use is common practice with multiple indications, namely, removal of symptoms associated with ileus or bowel obstruction by stomach decompression, stomach lavage to remove blood clots and to facilitate endoscopy, and administration of medications or enteral feeding for patients with difficulty swallowing or with neurological impairment [4, 5]. NGTs are usually inserted blindly (without the use of fluoroscopic or endoscopic guidance) at the bedside in alert and/or intubated patients. Generally, the insertion and further use of NGTs occurs without complication where the tip of the tube is correctly placed and remains in the stomach or small bowel throughout the course of treatment [6]. However, documented cases of misplaced NGTs in the lungs, esophagus, duodenum or as a rare example, in the brain can cause severe complications including death if not detected prior to medication administration or feeding [7]. NGTs can also migrate out of the stomach at a later stage, with similar complications. The NHS have documented 100 cases, including 21 deaths between 2005-2010 due to misplaced or migrated NGTs that were improperly or not all verified prior to use [6]. This led the National Health Service (NHS) in England to declare feeding into the lung from a misplaced NGT a *Never Event*.

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The use of chest/abdominal X-ray is the gold standard for the initial verification of NGT placement prior to first administration of medication or enteral nutrition in an adult hospitalized patient. This is not the focus of this review. For more information please refer to the 2016 AACN practice alert on verification of feeding tube placement in adults [7].

This rapid review will present summaries of the best available evidence that describe methods and the frequency for ongoing verification of NGT placement in the adult inpatient population. A detailed search strategy was developed by an experienced librarian (specific search terms are available upon request). Sources included Medline via Ovid SP (with the Cochrane Library) and CINAHL via EBSCO. Search concepts included Subject Headings and text words. The search date was June 21, 2016, and included articles between 2011-2016. Duplicates and out of scope articles were discarded by the librarian. The EIDM-A also searched the Joanna Briggs Library, UpToDate database and Google, which produce 3 relevant articles. The EIDM-A reviewed all titles and abstracts and included only those that met the research question (24 articles). After reading the full text, 12 articles were retained and included in the review. Articles that described tubes other than NGTs, an exclusive pediatric population, implementation of practices around NGTs, or that described methods for initial verification of NGT placement without mention of ongoing verification practices were discarded. One article was not available via full text, and was therefore not included. The EIDM-A then reviewed the cited references of the included articles, and retrieved 2 additional practice guidelines. The analysis of studies, including appraisal and summary, and the final report were prepared by the EIDM-A and reviewed by the librarian and Chair of the Clinical Practice Review Committee of the MUHC. A total of 14 articles are included here.

Two systematic reviews (including one meta-analysis) on the use of capnography/colorimetric capnometry in mechanically ventilated patients were found. No randomized control trials were found. The studies included in this review are mainly literature reviews, diagnostic studies, case reports, and practice alerts or guidelines for the ongoing verification of NGT placement in adult inpatients. A table of all the articles found and reviewed is available upon request (sonia.castiglione@muhc.mcgill.ca).

Levels of Evidence (adapted from OHRI KTA Evidence Summary document)

Each piece of evidence presented in this summary is assigned a level.

This assignment is based on the evidence being presented and not on the claim made by the authors.

- ☀ **Platinum:** systematic reviews and meta-analysis
- ✳ **Gold:** Randomized controlled trials
- ★ **Silver:** Observational studies (non-randomized trials, case-control, time-series, cohort studies, case series, literature reviews, qualitative studies.)
- ☆ **Bronze:** Expert committee guidelines, reports or opinions, commentary or editorials.
- **Level of evidence** cannot be determined.

2. Summary of Findings:

a. Practice guidelines and practice alerts

● *In 2016, the American Association of Critical Care Nurses issued recommendations for expected practice for initial and ongoing verification of feeding tube placement in adult patients. Ongoing verification for tube location was recommended every 4 hours after feeding had been initiated. They recommended a sequence of methods, provided the clinical scenario. The first option was to observe for a change in the length of the external portion of the feeding tube as determined by any movement of the marked portion of the tube. If there is any doubt, they recommended confirmation of the tube’s location using X-ray, and to mark the exit site after the location is confirmed. Other recommendations included regularly reviewing routine chest and abdominal X-rays for the tube’s location. Additionally, other options for verification included characteristics of the aspirate, that is, checking for changes in volume, measuring pH and observing the appearance of the aspirate if feedings are interrupted for more than an hour. See Table 1 for a summary of recommendations for ongoing verification of placement in adults. [7]*

Table 1 [7]

AACN Practice alert : Recommendations for NG ongoing verification of placement in adult

Following the start of feedings, check tube location at 4 hour intervals (Level of Evidence=B)

| | |
|---|--|
| Length of external portion of feeding tube | Observe for change in length, from marked position |
| | Obtain radiographic confirmation if in doubt |
| | Review routine chest and abdominal radiography reports for tube location |
| Aspirate from feeding tube | Observe changes in volume |
| | Measure pH, if feedings are interrupted for an hour or more |
| | Observe appearance, if feedings are interrupted for an hour or more |

● *A peer-reviewed nursing practice document, published in 2016, described the procedure for NG tube insertion and verification of placement in the adult patient. They recommended against the use of air auscultation and water bubbling methods. They did not recommend any specific method for ongoing verification of NGT but state that “some facilities require the position to be confirmation by pH testing at least once per nursing shift or prior to every medication and feeding.” [3]*

☆ *A 2016 UpToDate report, described the experiences of the authors when verifying the placement of NG or NE tubes in adults. They recommended ongoing checking of the NG tube every 4 to 8 hours by irrigation with water. They described a method that involved injection of 20-30 cc of warm water into the tube and the water immediately suctioned back. If 70% of the water was returned, the authors stated that the tube would most likely be positioned correctly. If there was concern*

about placement, verification using X-ray should be administered. Capnography was mentioned as an alternative to clinical confirmation of NG or NE tube placement in mechanically-ventilated patients. [5]

● In 2011, an updated patient safety alert was issued by the NHS on the minimum standards for proper NGT placement due to increased cases of harm and death due to misplaced NGTs. Following initial confirmation of NGT placement by pH of aspirate or X-ray, they recommended repeated checks of the tube placement before the administration of each feed, before giving medication, and at least once daily. The method for verification should be pH (where correct positioning is indicated with pH of 1-5.5) as a first-line method, or X-ray confirmed by a radiologist as a second-line method. A minimum of 1-hour delay without any further feeding should be instituted before measuring pH. In cases where patients are continuously fed, have acid-reducing medications, or when medications are frequently given down the NGT, they recommended observation of the external position of the tube, in the absence of physical symptoms. If there is evidence of tube displacement, X ray should be used in these circumstances. [6]

● In 2009, a task force created by the American Society for Parenteral and Enteral Nutrition (ASPEN) published practice recommendations based on research evidence and consensus on the ordering, preparation, delivery and monitoring of enteral nutrition (including NGTs) to promote patient safety in adults and pediatrics. Practice recommendations were graded using the Agency for Healthcare Research and Quality method which identified the strength of the recommendation based on the number, type and quality of studies supporting the practice. Maintenance of NGTs requires that after the feedings have started, there is assurance that the tube remains in the desired location. They did not recommend regular radiographic confirmation of the tube prior to feeding, but discussed other bedside verification methods. At the time of initial radiograph, they recommended marking the exit site of the tube and observing for a change in tube external tube length. If there is significant increase in external tube length, they recommended observing for negative pressure when attempting to withdraw fluid, observing for unexpected changes in residual volumes and measuring the pH of tube aspirates. These tests can indicate movement of the tube to other areas of the GI tracts (small bowel, gastric or esophageal) and into the respiratory area. An X-ray could then be used if there was any doubt. This recommendation was supported by a B grade. The authors were resolute that the auscultatory method is not recommend for verification of NGT placement (Grade A recommendation.) [8]

b. Articles that provide an overview of methods for ongoing verification of NGT placement

★ A 2013 paper critically reviewed relevant guidelines and techniques to safely confirm tube position balanced against the need to provide nutrition quickly. 11 articles were included in the review and were used to describe and critique several methods for verification of NGT, including pH of aspirate, capnography/capnometry, X-ray, endoscopy/fluoroscopy, EM trace and discarded methods (such as auscultation of bubbling, whooshing or vacuum effect.) The authors concluded that “no single method cost-effectively pre-empts lung trauma and confirms gastric position in all conditions.” They recommended the use of first and second line methods based on patient risk (Figure 1). They did not however, specify whether these methods were intended for initial or ongoing verification of placement. [1]

Figure 1 [1]

| Risk | Low | High | Very high |
|-------------|--|---|--------------------------|
| Definition | High level consciousness, spontaneous breathing, no previous tube misplacements. | Unconscious, mechanically ventilated, previous difficulty placing or confirming tube position. | Anatomical abnormalities |
| First line | pH ≤ 5.0 captures 77–90% of gastric placements and pH > 5.0 warns of lung, oesophageal or intestinal placement. To obtain an accurate pH first avoid infusing feed and medicine up to 4 hours, insufflate air to clear the tube ports and aspirate. If there is no aspirate, repeat after adjusting position of tube or patient or, if the patient has a 'safe' swallow, after a drink with a pH ≤ 4.0. Use pH strips validated in the range 2–9, interpreted by a health professional with normal colour vision. Where pH is >5.0 use the air insufflation-vacuum test to screen for intestinal placement prior to re-confirmation and capnography/capnometry to confirm suspected lung placement. If position is still uncertain, move to second line. | Capnography/capnometry at 35 cm can pre-empt lung trauma with pH ≤ 5.0 to confirm gastric position or an EM trace can be used for both. | Endoscopy or fluoroscopy |
| Second line | EM trace or X-ray. X-ray can increase clinical risk from delayed feeding in patients on ICU or who require repeated tube placements, off-ward transport and irradiation. Both methods necessitate interpretation by adequately trained practitioners. | X-ray or EM trace | Endoscopy or fluoroscopy |

★ A review article, published in 2012, discussed the evidence around the maintenance of placement of temporary enteral feeding tubes. A total of 6 articles were retained, that met the inclusion criteria and that were of higher quality. The results suggested that published guidelines do not offer a consistent direction for ongoing verification of feeding tube placement throughout the course of patient care. Bedside methods such as pH testing, visual inspection of aspirate and observation of residual volume could be influenced by multiple factors such as anti-acid medications, continuous feedings and ability to obtain aspirates. The auscultation method had been clearly determined as an ineffective

method for verification of enteral tube placement. The authors suggested that frequent radiologic confirmation “may be necessary to confirm enteral tube placement when bedside detection methods raise questions as to location of tube tip.”

Figure 2 [2]

| Assessment method | Advantages | Limitations |
|---|--|---|
| X-ray visualization of tube | Most reliable method currently available ^{19, 20} | Costly, undesirable patient exposure to repeated X-rays, not always practical |
| pH testing of aspirate | Ease of use, reliable, can be used to distinguish between gastric and intestinal tube placement ^{17, 21-23} | Continuous gastric feeding and medications for ulcers and reflux raise gastric pH, possibly falsely indicating that the tube is not in the stomach ²⁴⁻²⁶ |
| Visual assessment of aspirate | Useful in distinguishing between gastric and intestinal tube placement ²⁷ | Color and consistency of aspirate varies, of little value in differentiating between gastric and respiratory placement ²⁸ |
| Visualization of external tube length | Ease of use, may indicate if tube placement has shifted ^{29, 30} | Doesn't indicate location of tube, should never be used as sole means of determining placement ²⁷ |
| Auscultation of air insufflated through the feeding tube for whooshing sounds | None ^{18, 31} | Highly unreliable, whooshing sound can be heard if tube is incorrectly placed in the lung ^{15, 16, 18, 19, 31} |

This may be less favourable in a medical surgical setting, due to the absence of routine chest X-rays. They recommended that nurses regularly review the literature in order to remain up to date in their practice. This review was of low to moderate quality due to the fairly explicit methodology but vague summary and conclusions. [9]

★ A 2012 literature review compared current practice to evidence-based methods for ongoing verification of NGT placement by nurses at the bedside. A scan of 28 New England Hospital policies revealed that 17 continued to promote auscultation methods for assessment of NGT placement. They subsequently reviewed the advantages and disadvantages of methods using supporting evidence (see Figure 2). No single method exists that is “completely reliable, simple and cost-effective” as a means for assessing placement of an NGT. The authors

recommended nursing practice remains up to date with the current evidence. [2]

c. Capnography/colorimetric capnometry in mechanically ventilated patients

☀ A 2015 Joanna Briggs Institute Systematic Review evaluated methods to verify the correct positioning of NGT in mechanically-ventilated adults. Five diagnostic accuracy studies were found that met the inclusion criteria and evaluated capnography and colorimetric capnography to verify NGT placement compared to the gold standard of X-ray confirmation. Only one study, with a very small sample (seven patients) evaluated capnography and therefore no conclusions were made about the accuracy. Colorimetric capnography was tested by four large, well-designed studies, with mechanically-ventilated patients ranging in age from 17-90 yrs. All had NGTs inserted, some via the nose, others through the tracheal tube to test for sensitivity of the method. Colorimetric capnography was able to detect an incorrect placement of the NGT (Sensitivity) 100% of the time, and was able to confirm correct placement in the stomach (with X ray confirmation) 99-100% of the time. The authors concluded that “colorimetric capnography can be used to accurately discriminate between GI tract and airway position of an NGT.” However, this method cannot discriminate the position of the tube within the GI tract, therefore, the authors “cannot conclude anything about verifying the position of NGT if the it is inserted in advance.” For practical application, the device was not manufactured for the NGT and therefore required an adaptor. [10]

☀ A meta-analysis was conducted in 2011 to determine the diagnostic accuracy of the partial pressure of CO₂ monitoring (colorimetric capnometry/capnography) in the specificity and sensitivity of NGT placement in adult patients. Nine articles were retained that met the inclusion/exclusion criteria and were appraised as moderate to high quality. Most of the patients were mechanically-ventilated and the placement was confirmed using radiographic methods. Results of the analysis indicated that the use of colorimetric capnometry/capnography was effective in differentiating between respiratory and GI placement of the NGT in mechanically-ventilated patients. The authors suggested that “colorimetric capnography should be considered for routine practice of confirming NG feeding tube placement.” However, it is noted in this study that these methods did not distinguish between esophageal, gastric and small intestine placement, and require training to administer. As well, the procedure varied between studies and requires further clarification. Other implications for practice included cost which was significantly less, when compared to X-ray (found in three studies reviewed) and time to administer was also significantly less (as per one reviewed study). [11]

★ A literature review, published in 2011, presented five quantitative studies for discussion on the use of capnography versus pH testing in confirming NGT placement. The studies reviewed ranged in focus from studies investigating effectiveness of either technique in both adult and pediatric populations, to the hospital personnel to accurately perform the tests. The authors concluded that both methods yielded similar results. They commented on the use of pH or capnography in ongoing verification of NGT placement stating, “Capnography is not an option to verifying NGT placement because once there is fluid in the tube it is not possible to obtain accurate readings.” pH testing was deemed as an appropriate verification method for adults, children and infants by the authors. It should be noted that in this paper, the

authors did not provide a clear objective and did not provide any reasoning on the retention of the articles chosen for this review. Therefore, the study is considered as low quality, but was included because it briefly addressed ongoing verification of NGT placement. [12]

d. Methods for NGT verification not previously described

★ In 2016, a diagnostic study investigated whether combining pH testing and gastric lipase testing could improve the accuracy of NGT placement verification. Following the development of a lipase test, 34 adult inpatients on general care wards with NGT placement already verified with X-ray were recruited. A combined pH and human gastric lipase test strip was used to determine the pH level as well as the presence of the enzyme in the aspirate from the tube. They found that the pH from NGT already confirmed in the stomach ranged from 1 to 8.5, and therefore not all were in the reference range of ≤ 5.5 to indicate stomach placement. Additionally, 21 (66%) samples had human gastric lipase present. In 31 stomach samples (97%), had a pH of 5.5 or less and/or human lipase activity, indicating placement in the stomach. The authors concluded that the lipase test in combination with pH testing could reduce reliance on X-ray, especially on patients who are on antacid medications. 22 of the recruited patients (65%) were taking some sort of antacid medication. This test method for ongoing verification had not been compared to samples from tube placement in the esophagus or small bowel versus the stomach. [13]

e. Case studies

★ In 2016, a report described two cases where routine verification methods, X-ray and auscultation of gastric bubbling inaccurately confirmed proper placement of the NG tube in a 17 year-old and a 76-year-old male receiving enteral nutrition. The later died due to complications of NG tube misplacement. The authors conclude that “serious complications can still result when routine verification methods do not detect any abnormalities” and recommend being aware of the limitations inherent to these methods. [14]

★ A case report published in 2016 described the consequences from a misplaced NGT in a 76-year-old woman. Chest radiography was used to confirm misplacement in the lung prior to feeding, but the patient experienced pneumothorax upon NGT removal. The authors concluded, “If the feeding tube is blindly inserted, radiographic confirmation of correct placement is confirmed before administration of medication of feeding.” However, they did not specify whether this was to be done prior to every administration or feeding of if only for initial placement verification. [15]

3. Glossary:

| Method | Definition |
|-------------------------------------|--|
| Air Auscultation | Using a stethoscope to auscultate over the abdomen while insufflating a bolus of 20-30ml of air into the syringe. A “swish” should be heard as air passes into the stomach. [3] |
| Water bubbling method | The end of the NGT is placed in a cup below water level to check if bubbling occurs, which indicates the NGT has been placed in the pulmonary system. [3] |
| Capnography | Device connected to the end of the NGT via an adaptor that measures the relative concentration of CO ₂ in expired air. Has been used to distinguish between NGT placement in the esophagus, bronchus, and stomach. [10] |
| Colorimetric Capnography | Device connected to the end of the NGT via an adaptor that measures the relative concentration of CO ₂ in expired air using a color indicator. When the indicator is purple, CO ₂ is below 4mmHg (gastric placement); when indicator is yellow, CO ₂ is above 15mmHg (airway placement); when between 4 and 15mmHg (inconclusive), the indicator is brown. [10] |
| Visual check of aspirate appearance | Aspirate from the stomach are typically clear and colorless, or pale yellow or green. Aspirate from the small bowel are often brown colored due to bile. [3] |
| Visual check of aspirate volume | A sharp increase in volume of fluid withdrawn from the feeding tube may indicate displacement of the tube from the small bowel into the stomach. Alternatively, inability to withdraw fluid from the feeding tube may signal upward displacement of the tube from the stomach to the esophagus. [7] |
| pH analysis of aspirate | A pH ≤ 4.0 is usually indicative of gastric acid, unless patient is receiving proton pump inhibitor, H ₂ receptor agonist or acid-reducing medications, or is receiving continuous enteral feeding infusion. Others have argued that a pH of ≤ 5.5 indicates stomach placement. [6] |
| Gastric enzyme | Use of strip, to test NGT aspirate for the presence of gastric lipase enzyme activity. This approach is proposed to be combined with pH analysis to strengthen the accuracy. [13] |
| Radiographic verification | A chest/abdomen X-ray can confirm placement only if it shows the full course of the tube and location of all the ports. [3] |

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