

Misplaced Nasogastric Tube Resulting in Aspiration

April 11, 2024

Singh A, Huang C. Misplaced Nasogastric Tube Resulting in Aspiration. PSNet [internet]. 2024.

<https://psnet.ahrq.gov/web-mm/misplaced-nasogastric-tube-resulting-aspiration>

The Case

An 82-year-old woman presented to the Emergency Department (ED) for evaluation of “altered mental status” after falling down 5 step-stairs at home. She was on apixaban and had a Glasgow Coma Score of 11 (indicating decreased alertness, relative to the normal value of 15) on arrival. She was afebrile, tachycardic (120 beats per minute), with a normal blood pressure (109/51) and excellent oxygen saturation (96%) on room air. Computed tomography (CT) of the head revealed a right thalamic hemorrhage. She received prothrombin complex concentrate to reverse the apixaban. She also received levetiracetam to prevent seizures. She was admitted to the Vascular Neurology service.

Overnight, the patient developed atrial fibrillation with rapid ventricular rate (RVR), which required medications for rate control. The patient failed her swallow evaluation by speech therapy; therefore, a nasogastric (NG) tube was inserted through her right nostril, without difficulty or complications, to administer oral medications. The tube length was 55 cm, and a chest radiograph was obtained to verify placement. The resident physician was asked to review imaging to confirm placement, but this was not done. During nursing shift change, the incoming nurse was told that the NG tube was ready for use. A tablet of metoprolol 25 mg was crushed by the nurse, mixed with water, and administered through the NG tube. A few minutes after administration, the patient was found to be somnolent and hypoxemic, with oxygen saturation around 80%, requiring supplemental oxygen via non-rebreather mask. Chest radiography showed that the NG tube was in the right lung. The NG tube was removed, and the patient’s mental status improved slowly on high flow nasal cannula.

On review of the case, it was confirmed that the patient’s first chest radiograph had not been seen by a provider. No alternate method to verify tube placement had been documented. Additionally, there was no order documenting that the NG tube was safe to be used.

The Commentary

By Anita Singh, MD, and Cecilia Huang, MD

Nasogastric (NG) tube insertion is a commonly performed procedure across all acute and chronic care settings.¹ Indications for nasogastric tube placement include gastric decompression in the setting of ileus or bowel obstruction, medication administration for patients who are either unable to swallow or neurologically impaired, and delivery of enteral nutrition.¹ Contraindications to NG tube placement include basilar skull or facial fracture, due to the risk of intracranial misplacement, and esophageal stricture, due to the risk of esophageal perforation.² The procedure is most often performed by nurses, who may or may not have received bedside training with actual or simulated patients, and may or may not undergo ongoing assessment of their proficiency.

NG Tube-Related Complications

One of the most serious complications of NG tube placement includes improper positioning of the NG tube into the trachea instead of the esophagus, which can lead to catastrophic outcomes, including pneumonia, pulmonary abscess, tracheal perforation, or pneumothorax.³ Prior studies have reported that approximately 2% of small-bore nasogastric tubes were inadvertently inserted into the respiratory tract.^{4,5} In one retrospective study, about 26% of mispositioned nasogastric tubes resulted in complications, including two deaths.⁶ Factors that increase the risk of these complications include altered mental status, impaired swallow/gag reflex, a pre-existing endotracheal tube, and critical illness.^{1,3} Other common complications of nasogastric tubes include discomfort, sinusitis, epistaxis, coiling or knotting.^{2,6} The NG tube can also impair the function of the lower esophageal sphincter, which can lead to increased risks of gastric reflux, esophagitis, esophageal stricture, and aspiration.^{2,7} Chronic placement can lead to nasal alar ulceration or necrosis, chronic gastric irritation leading to gastrointestinal bleeding from gastritis or pressure necrosis.²

Verification Methods

Proper NG tube positioning should be verified before its first use for administering medications or feeding solutions. Various methods have been proposed to distinguish between gastric and pulmonary placement of NG tubes. An x-ray is the most accurate way to verify the placement of NG tubes according to multiple guidelines, including the American College of Gastroenterology, Emergency Nurses Association, and the New South Wales Health Guidelines.⁸ However, recommendations for the first-line method to verify NG tube placement vary across countries. Guidelines from the United States favor radiographic confirmation as the first-line method in adults, whereas guidelines from Europe and Australia favor pH testing, utilizing radiographic testing only when the pH method has failed or when a patient is considered at risk due to respiratory concerns, neurologic impairment, impaired or absent gag reflex, or critical illness.⁸

The most important advantage of non-radiographic methods, such as pH testing, is their timeliness; awaiting x-ray for confirmation may take several hours to complete and review. However, there is no consensus on the pH cutoff for distinguishing between gastric and pulmonary aspirates, with typical gastric values less than 4.0-5.5.⁸ The mean pH levels of the lung have been described at 7 or higher,^{1,8} but infected pleural or respiratory secretion can yield more acidic pH.⁸ Additionally, the widespread use of gastric acid inhibiting medications can raise the gastric pH, which may make it more difficult to distinguish between gastric and pulmonary aspirates.⁸ One study proposed using pH and bilirubin testing together as a more predictive test to confirm gastric placement of NG tubes,⁹ since the mean bilirubin level in the lung is 0.08 mg/dl versus 1.28 mg/dl in the stomach.¹ However, this approach requires a test strip that can read

bilirubin levels, which may not be readily available in many settings.⁹ Other potential challenges in pH testing include measurement error and difficulty obtaining an aspirate from the NG tube.⁸

Other non-radiographic verification methods described in the literature include carbon dioxide detection and auscultation. However, these methods have not been shown to be reliable in distinguishing between gastric and pulmonary placements of NG tubes,⁸ although capnography and colorimetric capnometry appear promising in mechanically ventilated patients.¹⁰

Approaches to Improving Patient Safety

Insertion Methods and Simulation Training

A review of 44 misplaced small-bore feeding tubes reported to the Pennsylvania Patient Safety Authority in 2011-2013 suggested that switching equipment and inconsistent staff training may represent contributing factors.¹¹ Standardized, simulation-based training and competency-based qualification of staff who insert NG tubes may be helpful,^{12,13} although evidence from controlled trials is lacking. Assessment of feeding tube position after it has been inserted to approximately 30 to 35 cm allows repositioning of misplaced tubes and can potentially prevent pulmonary injury, at the cost of greater radiation exposure and staff time.

Closed Loop Communication and Use of Electronic Medical Orders to Reduce Errors

Pulmonary mispositioning of NG tubes is perhaps one of the most serious complications of NG tube placement because of the potential for severe adverse events.⁴ In fact, in England, the National Health Service considers the administration of food, medications, or fluid into the respiratory tract or pleural space via NG tube a “never event,” or an event that is completely preventable by safety guidelines and barriers that are readily available to be implemented by healthcare professionals.^{8,14} Clear, accurate, and effective communication is crucial to patient safety, and handoff periods are particularly vulnerable to deficiencies in relaying proper information.¹⁵ As such, “closed loop communication (CLC),” developed in the aviation field, provides a standardized system to communicate and reduce the risk of inappropriate information transfer. Mirroring military radio transmission models, CLC is a three-step process by which the transmitter communicates a message to a receiver, the receiver accepts the message with verbal confirmation and seeks clarification if needed, and the original transmitter verifies that the message has been correctly received and interpreted, thereby closing the loop.¹⁵

The lack of clear communication at multiple interdisciplinary levels stands out as a major deficiency in this case. This is evidenced in the breakdown of closed loop communication between the physician and the nurse, and between nurses at change of shift. While the initial nurse proactively requested the primary provider to confirm NG tube placement on x-ray, there was no clear follow-up on this request. The loop was never closed. Although verbal communication is important, a physician order or clearly labeled note indicating that the enteric tube was safe to use would have been helpful to electronically communicate and document appropriate NG tube placement. Depending on the culture and practices in the hospital, nursing staff should expect either a brief physician note confirming correct placement of the tube or a standardized order clearing the tube for immediate use (similar to what is typically done for central venous catheters). While both verbal and written forms of communication are crucial in decreasing the risk of an adverse event, either one alone could have prevented the adverse event in this specific case.

Use of Notification Systems for Critical Results

Another weak link in the communication chain in this case involved the primary provider and radiology. The American College of Radiology's practice parameters (formerly guidelines) include contacting ordering clinicians "expeditiously" to convey critical radiology results, such as "pneumothorax, pneumoperitoneum, or a significantly misplaced line or tube".¹⁶ Nevertheless, it can often be difficult for radiologists to find the appropriate provider to inform.¹⁷ The Alert Notification of Critical Results (ANCR) provides one model to facilitate notification of critical imaging test results via automated transmission of information to the appropriate receiving physician.¹⁸ ANCR was designed to interact with multiple clinical applications including the picture archiving and communication system (PACS), the hospital paging system, and the electronic health record (EHR). Half of providers surveyed in one study agreed that the use of ANCR reduced medical errors and improved the quality of patient care.¹⁸ In this case, if the resident physician had been alerted earlier to the mispositioned NG tube by radiology, they may have informed nursing to stop using the tube, and written orders to remove or replace it.

In this case, due to the physician's failure to review the chest radiograph and insufficient communication between the provider and initial nurse, inaccurate information was conveyed to the oncoming shift nurse, resulting in inappropriate administration of medication through a mispositioned NG tube. There is evidence that communication and handoff failures are a root cause of two-thirds of sentinel events in hospitals.¹⁹ One approach to improving handoffs between medical professionals involves using a standardized tool, such as the I-PASS system, which led to a 23% relative reduction in overall medical-error rate and a 30% relative reduction in preventable adverse events, when studied among resident physicians at 9 different hospitals.²⁰ I-PASS is a handoff program that trains medical professionals to synthesize and exchange patient information concisely, including illness severity (I), patient summary (P), action list (A), situational awareness and contingency plans (S), and synthesis by receiver (S).²¹ In this case, implementing a standardized handoff tool may have helped resurface action items (such as confirming NG placement with the resident provider) at the time of information exchange to the incoming nurse.

Incorporating Alternative Techniques to Verify Placement

One final option to improve patient safety includes incorporating a low-cost, nursing-driven alternative technique to ensure proper NG tube placement before the first use of a newly placed tube. For example, newly placed peripheral intravenous (IV) lines are flushed with saline and drawn back to ensure blood return to confirm proper placement prior to use. Similarly, nurses could measure NG tube aspirate pH for newly placed NG tubes as an additional checkpoint to assess for correct enteric placement. Although this is not currently standard practice in the US, a low aspirate pH value (e.g., <5.5) could serve as another confirmatory measure and additional barrier to erroneously using improperly placed NG tubes.

Conclusion

In this case, the inappropriate use of a misplaced NG tube resulted in the patient's acute decompensation and hypoxemic respiratory failure. Administration of food, fluid, or medications through an improperly placed NG tube is considered a "never event," or an event that should not occur due to clear guidelines and readily available techniques for healthcare professionals to utilize to prevent its occurrence. The gold standard to confirm NG placement in the United States is by radiography. However, a variety of verification

methods have also been described to confirm NG tube placement that can be done at bedside, including evaluation of the aspirate pH and bilirubin. These techniques may be considered in settings where x-ray confirmation of NG tube placement is not readily available. Bedside evaluation of the NG tube aspirate characteristics may be considered as a low-cost secondary confirmatory measure for appropriate placement of the NG tube prior to the administration of feedings, fluid, or medications. The major deficiency in this case involved the lack of clear communication between multiple interdisciplinary teams. Tools to improve timely and accurate exchange of information include closed loop communication (CLC), the I-PASS system as a handoff template, an automated method to convey critical radiologic results (such as ANCR), and the utilization of a standard and expected EHR order to document appropriate placement prior to safe use of an NG tube.

Take-Home Points

- Proper placement of an NG tube should always be confirmed prior to administration of feedings, fluids, or medications.
- The gold standard for confirmation of NG tube placement in adults in the United States is by radiography
- Evaluation of NG tube aspirate characteristics such as pH and bilirubin are methods that may be considered to confirm NG tube placement at bedside; however, a variety of factors may impact the pH of pulmonary or gastric aspirate.
- Clear communication between members of interdisciplinary teams is essential in reducing the risk for errors. Tools that may be utilized include closed loop communication, I-PASS handoff template, automated methods to deliver critical results, and standardized documentation indicating an NG tube is safe to use.

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This project was funded under contract number 75Q80119C00004 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The authors are solely responsible for this report's contents, findings, and conclusions, which do not necessarily represent the views of AHRQ. Readers should not interpret any statement in this report as an official position of AHRQ or of the U.S. Department of Health and Human Services. None of the authors has any affiliation or financial involvement that conflicts with the material presented in this report. [View AHRQ Disclaimers](#)