Bronchial nasoenteric tube misplacement: Effective prevention, prompt recognition, and patient safety considerations

Dear Editor,

Despite the ubiquitous nature of nasoenteric nutritional administration, there are no universally reliable and safe methods for the placement of gastric or postpyloric feeding tubes.[1,2] Provision of adequate enteral nutrition is critical to optimization of clinical outcomes for patients who are unable to maintain sufficient oral food intake. Many patients in this category undergo intensive care management and experience acute physiologic stress, with a significant risk of exposure to complications associated with parenteral nutrition for those unable to receive or tolerate enteral intake.[3,4] Despite the high utilization of nasoenteric nutritional administration, the quest continues for more reliable and safer methods for the placement of gastric or postpyloric feeding tubes.

A number of potential complications are associated with nasoenteric tube (NET) misplacement, many of which depend on the location of misplaced catheter, presence or absence of the tube position verification, and whether feeding was initiated through the misplaced device.[2,5,6] This article outlines some of the key considerations pertaining to NET placement, including established methods to minimize the risk of misplacement and other related complications. Radiographic and computed tomography images exemplifying some of the most common occurrences are presented and discussed.

**CLINICAL VIGNETTE**

An elderly patient was recovering in the Intensive Care Unit (ICU) following a laparotomy for blunt abdominal trauma. Due to associated right-sided pulmonary contusions, respiratory failure, and the inability to wean from the ventilator, it was decided that the patient would benefit from the placement of a NET to initiate postpyloric tube feedings. It was estimated that the patient would require approximately 5–7 days of enteral nutrition prior to either extubation or placement of tracheostomy and long-term enteral access (e.g., gastrostomy tube).

On the second postoperative day, following afternoon rounds by the ICU team, a plan was put into effect to place a nasoduodenal tube (NDT) and start the tube
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feedings by early evening that same day. A junior surgery trainee was tasked with performing the placement procedure. The customary method of NDT placement involved advancing the tube to approximately 35–40 cm, followed by a chest X-ray to confirm that the tip of the tube is “past the carina and in the midline” [Figure 1a and b]. After such confirmation, the tube is advanced further [Figures 2a, b and 3a, b], with another confirmatory film performed to verify either gastric or postpyloric placement.

In the hypothetical scenario described in this vignette, the resident was under significant stress, both in terms of the need to multitask and the time pressures inherent to her extremely busy clinical schedule. Due to the above factors, instead of following the confirmatory safety steps outlined in the previous paragraph, she decided to proceed with NET placement that would only include abdominal confirmatory X-ray at the end of the overall process (i.e., the initial chest X-ray and the associated 20–30 min delay would be “circumvented”). In the resident’s limited experience, she frequently omitted this relatively time-consuming step, with no adverse consequences.

After advancing the tube to about 65 cm marker at the nose, the resident encountered an unexpected and unusual amount of resistance. After several attempts at withdrawing and re-advancing the NET, she finally decided to stop any further attempts and obtain an X-ray. With the patient remaining stable from both hemodynamic and respiratory standpoint, the resident was surprised when the chest radiograph demonstrated the tip of the tube well within the right mainstem bronchus [Figure 4]. At this time, the tube was withdrawn completely, and a new NET was placed safely using the established safety protocol.

DISCUSSION

Passage of NET into the tracheobronchial tree (TBT) is a relatively common occurrence.[7] In the alert patient, such an event is usually promptly recognized, and the NET is repositioned. If the misplacement is unrecognized, administration of feeds, liquids, and other materials into the TBT may result in air-space consolidation, pneumonitis, and other potentially severe complications.[8] In intubated patients, misplacement of NETs into the TBT beyond the inflated cuff of a tracheal tube may also compromise mechanical ventilation.[8] Although the softer feeding tubes currently in use may seem safer than the larger, more rigid NETs, lung perforation is possible when these tubes are reinforced by an inner wire stylet.[8] An example of transpulmonary misplacement of NET into the pleural space is shown in Figures 5-7.

Verification of proper NET positioning is required for all patients, but especially for those with depressed mental status, recent stroke, or absent/impaired cough reflex.[2] The detection of air insufflation during abdominal auscultation can be misleading due to potential sound transmission between the pleural space and the upper abdomen. Mistaking aspirated pulmonary fluid for gastric contents may lead to incorrect assumption that the NET is in proper position. Radiographic verification provides more reliable method of ascertaining proper tube position.[1] Other methods of optimizing NET placement include upper endoscopy, ultrasonography, electromagnetic technology, and pH
sensor-assisted placement.\textsuperscript{[10-13]} The presence of such variety of confirmatory and assistive technologies suggests that none of them are universally reliable.

Tracheopulmonary complications (TPCs) occur in approximately 2\% of NET insertions, with TPC-associated mortality of about 0.5\%.\textsuperscript{[14]} Pneumothoraces account for approximately 60\% of TPCs, with up to half requiring tube thoracostomy.\textsuperscript{[14]} The stylet-stiffened fine bore tubes may be able to “squeeze” past low-pressure cuffs, and the presence of cuffs may actually increase the risk of pulmonary entry by interfering with glottic closure and the swallowing mechanism. In one study of nearly 4,200 patients, approximately 2\% of placements were complicated by intrabronchial malposition and 0.2\% experienced an NET-related pneumothorax.\textsuperscript{[6]}

Figure 5: Malpositioned feeding tube in the left pleural space. In this case, when resistance was met during the insertion process, forceful advancement of the tube resulted in penetration into the pleural cavity, leading to pneumothorax. No feeds were administered and the tube was promptly withdrawn, with subsequent placement of left-sided tube thoracostomy and an otherwise uneventful clinical recovery. Of note, a postpyloric feeding tube was inserted using fluoroscopic guidance the following day.

Figure 4: Nasoenteric tube misplaced into the right mainstem bronchus. The patient remained asymptomatic as the nasoenteric tube was removed, reinserted, and properly guided into the postpyloric position on subsequent attempts.
Intrapulmonary complications (including intrapleural placement seen in Figures 5-7 and pneumothorax seen in Figure 6) may increase in the presence of endotracheal intubation, tracheostomy, previous misplacement, lung transplantation, and altered mental status (including pharmacologic sedation). Prevention of iatrogenic pleuropulmonary complications requires a high index of suspicion, use of methods like capnometry to detect tracheal entry, or use of endoscopy-aided techniques. Established clinical criteria for appropriate NET positioning are not applicable in situations where the patient is unable to reliably interact with the practitioner. Insufflation of air with concurrent upper abdominal auscultation may not be sufficient to prove gastric placement because smaller tubes do not always allow sufficient passage of air. As previously mentioned, air bubbling in the pleura, lung, or esophagus may be transmitted below the diaphragm. Aspiration of fluid should not be interpreted as appropriate gastric or postpyloric placement because the aspirate may originate from the pleural space or from bronchial secretions. While radiographic imaging performed around the time of NET placement is strongly recommended, misinterpretation may occur in nearly 30% of cases. It is important to remember that fine-bore NETs may be associated with a unique set of complications, including increased risk for tracheal misplacement, blockage of tube by enteral feeds or crushed medications, and NET displacement during retching or regurgitation. Moreover, hospitalized patients who require NET placement are typically critically ill and have other coexisting risk factors and medical conditions predisposing them to NET-related complications outlined previously in this communication. Intrabronchial, intrapulmonary feeding can result in severe pneumonia, asphyxiation, pneumothorax, and potentially death.

The incidence of NET placement-related incidents may be reduced by creating specialized placement teams and fostering a culture of safety. At our institution, the process of NET placement is interrupted at ~ 35–40 cm (e.g., subcarinal esophagus, see Figure 2), where the NET is secured, and an anterior–posterior radiograph is taken. Further advancement is only performed after confirmation of esophageal placement (e.g., the tip of the NET is past carina and remains in the midline). After final positioning, another confirmatory anteroposterior radiograph of the chest and upper abdomen is performed.

**PULMONARY ASPIRATION**

Pulmonary aspiration related to NETs can be divided into two broad categories: Aspiration of inert fluids (e.g., tube feeds) and aspiration of acidified gastric contents. The two aspiration subtypes share some common risk factors. As the NET passes through the esophagus, it may interfere with the lower esophageal sphincter, resulting in a propensity for gastroesophageal reflux and aspiration. Specific contributory factors include the change in gastroesophageal angle, decreased level of consciousness causing impaired lower esophageal sphincter function, suppressed cough/gag reflexes due to continuous sedation, and delayed gastric emptying. Moreover, mechanical ventilation and sustained supine positioning also increase the probability of aspiration. Finally, luminal NET migration may occur with repeated bouts of coughing and/or vomiting and the presence of coexistent conditions such as hiatal hernia, neurologic dysfunction, or gastroparesis. From a patient safety perspective, administration of tube feeds into the TBT through a malpositioned NET should be considered a “never event”, due to the fact that bypassing established placement verification procedures is not justifiable under any reasonable circumstances.

**CONCLUSIONS**

The authors provided an overview of risk factors associated with NET misplacement and the various complications that may ensue as a result. Prevention of tube misplacement, coupled with clinical vigilance and early detection of malpositioning through imaging, constitutes the best approach to safe NET insertion. Although adjunctive technologies may improve NET placement efficacy and safety, such approaches do not provide universal guarantees. Knowledge of risk factors associated with NET malpositioning, combined with an awareness of diagnostic and verification techniques, should be viewed as required knowledge for practitioners who place and utilize nasoenteric feeding tubes. Due to the level of patient harm associated with initiating tube feeds through a misplaced NET, such occurrences could reasonably be classified as “never events”.

**Figure 7:** Reconstructed computed tomography images of the case presented in Figures 5 and 6. The tracheal and mainstem bronchus passage of the feeding tube is demonstrated in greater detail.
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