Research

A prospective study of tracheopulmonary complications associated with the placement of narrow-bore enteral feeding tubes

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Abstract

Background: In order to determine the type and incidence of pulmonary complications associated with the placement of narrow-bore enteral feeding tubes we conducted a prospective, descriptive study in the multidisciplinary intensive care unit (ICU) of a university hospital. All patients that had narrow-bore enteral feeding tubes inserted over a 2-year period (1993-1995) were included. The study required no clinical interventions.
Results: Seven hundred and forty feeding tubes were inserted during the study period. In 14 cases (2%), the feeding tube was inserted into the tracheopulmonary system. Five patients (0.7%) suffered a major complication, including two (0.3%) who died from complications directly related to the feeding tube placement. All patients had altered consciousness and 13 of the 14 had endotracheal tubes in place. Malposition of the feeding tube was not predictable from clinical signs and auscultation, but was detectable by chest roentgenogram.
Conclusions: Inadvertent insertion of enteral feeding tubes into the tracheopulmonary system during placement is associated with significant morbidity and mortality. Clinical signs at the time of insertion are not useful in identifying feeding tubes which are malpositioned. In the ICU patient, a chest roentgenogram is required after all feeding tube insertions prior to the initiation of enteral feeding. In the high-risk patient, alternatives to blind feeding tube insertion should be considered.

Keywords: enteral feeding, feeding tubes, nutrition, pneumothorax

Introduction

Enteral feeding is now generally recognized as the preferred method for providing nutritional support to critically ill patients. When compared to parenteral nutrition, enteral feeding is considered to be both safer and associated with improved outcome [1]. Over the last two decades narrow-bore enteral feeding tubes have gained widespread acceptance as the preferred device for providing enteral nutrition. They were introduced in response to problems associated with the stiffer larger-bore tubes [2,3]. The narrow-bore tubes are softer, made from silastic, and generally provide for greater patient comfort and fewer erosive complications than occur with the larger type. Most tubes of this type have a removable steel stylet, which makes them stiffer and allows for easier passage. A particular advantage of enteral feeding is the avoidance of the risk associated with placement of a central venous catheter [4,5]. However, the use of feeding tubes is not without its own complications. Tracheopulmonary injuries associated with these tubes can be serious, and are attributed to the small size of the tube and the stiffness of the inner stylet [6–9].

We prospectively monitored the placement of narrow-bore enteral feeding tubes in our ICU, in order to evaluate the incidence and type of bronchopulmonary complications.

Methods

This study was performed in an 18-bed multidisciplinary ICU at the Dartmouth-Hitchcock Medical Center, Dartmouth Medical School. For a 2-year period (1993-1995) we prospectively monitored all ICU placements of narrow-bore enteral feeding tubes in order to identify cases of insertion into the tracheopulmonary system. The feeding tube used in all cases was ENtube3 (Rusch, Duluth, Georgia, USA). This study was approved by the Institutional Review Board, which waived the need for informed consent.

Our written policy for placement of narrow-bore enteral feeding tubes requires that after placement a roentgenogram (either a portable chest film or a flat plate of the abdomen) be performed before the initiation of feeding. Prior to obtaining a roentgenogram, proper positioning is verified by auscultation over the epigastrium of air injected through the tube. If the operator is suspicious of malpositioning, then he/she will remove the tube prior to obtaining a film. If a nurse has difficulty placing a tube, then he/she will seek the assistance of a physician (who may be a resident, fellow or attending). This policy is not dependent upon whether or not it is the first placement or replacement of a tube. This personnel performing the procedure, either a physician or an ICU nurse, must be familiar with the possible complications and proper technique.

Results

During the study period, 740 narrow-bore enteral feeding tubes were placed in the ICU. We identified 14 cases (2%) where feeding tubes were inserted into the tracheopulmonary system. The clinical characteristics of these 14 patients are summarized in Table 1.

A cuffed endotracheal tube was in place in 13 out of these 14 patients. All patients were receiving sedatives at the time of feeding tube placement. The one patient in our series without an endotracheal tube had suffered an anoxic brain injury, and was obtunded. In eight patients the feeding tube entered the right mainstem bronchus, and in six cases it entered the left mainstem bronchus. All initial attempts at feeding tube placement were performed by a critical care nurse. In two cases the nurse encountered difficulty with tube placement and sought the assistance of a resident physician. All tubes were thought to be appropriately placed based on auscultation. However, according to policy, all patients had roentgenograms which demonstrated inappropriate placement. We observed misinterpretations of the film in two cases. In one case the mistake was quickly corrected, however in the second case alimentation was given for approximately 24 h before it was recognized that the feeding tube was actually in the left pleural space. In retrospect, the initial film demonstrated misplacement of the feeding tube in both cases.

Of the 14 patients, five sustained a major complication related to the misplacement of the feeding tube (pneumothorax or homopneumothorax). Two of these patients died of complications directly related to the malpositioning of the feeding tube (one patient died of a tension pneumothorax and the other from sepsis resulting from alimentation into the pleural space). In all, 0.7% of the attempts to place a feeding tube resulted in a major complication and 0.3% of all attempts directly contributed to patient death.

Table 1
Patient characteristics

Sex	Diagnosis	Intubated	First feeding tube	Who placed	Adverse outcome	Therapy
M	Sepsis	Yes	Yes	MD & RN	Pneumothorax	Tube thoracostomy
M	Emergent abdominal aortic aneurysm repair	Yes	Yes	RN	Pneumothorax and hemothorax	Tube thoracostomy
M	Anoxic brain injury	No	Yes	RN	None	None
M	Multitrauma	Yes	Yes	RN	None	None
F	Interstitial pneumonitis	Yes	Yes	RN	None	None
F	Leg ischemia	Yes	No	MD & RN	Tension pneumothorax, death	Tube thoracostomy
M	ARDS	Yes	No	RN	None	None
M	Pneumonia	Yes	Yes	RN	None	None
M	Pneumonia	Yes	No	RN	Pneumothorax	Tube thoracostomy
F	Sepsis	Yes	Yes	RN	None	None
F	Sepsis	Yes	No	RN	None	None
M	Sepsis	Yes	Yes	RN	Fed into left pleural space, death	Tube thoracostomy
M	Sepsis	Yes	Yes	RN	None	None
M	Cystic fibrosis	Yes	Yes	RN	None	None

MD = physician; RN = registered nurse.

Discussion

The development of the enteral tube is attributed to John Hunter in the late 1700s, but it was not until 1976 that Dobbie and Hoffmeister [10] developed a narrow-bore soft polyvinyl chloride tube specifically for enteral feeding. These smaller tubes decreased the risk of ulceration of the nose, pharynx and stomach associated with the larger-bored and more rigid type [11]. However, it was not long after the narrow-bore feeding tube was introduced into clinical practice that complications began to be reported. There have now been over 100 reported cases of tracheopulmonary injuries associated with insertion of these feeding tubes [12].

In our study, narrow-bore enteral feeding tubes were inserted into the tracheopulmonary system in 2% of placement attempts. Overall, feeding tube placement resulted in pneumothorax/hemothorax and/or death in 0.7% and 0.3% of all attempts, respectively. This is consistent with other retrospective reports in the literature (including studies of ICU patients), in which incidence rates of pulmonary complications of 0.2-0.3% of feeding tubes inserted have been noted [6,13,14]. There is also one small series of patients reported with an incidence of misplacement close to our 2% rate [7]. Our mortality (0.3%) is also comparable to other reports [9,12]. On the other hand, a majority (64%) of the misplacements we noted were without complication. This is a much higher percentage than the 15-40% reported by others [9,12]. This may in part reflect the fact that ours was a prospective study which would more likely capture incidental placements not resulting in a major complication. In addition, our policy mandated a chest roentgenogram after placement which would allow identification of all cases.

To place the risks associated with feeding tube placement into perspective, the probability of pneumothorax with central line insertion is in the 1-2% range [4,5]. Therefore, while enteral nutrition avoids the risk of line infection, the risk of a pulmonary complication with feeding tube insertion for enteral nutrition is comparable to that of central line insertion for parenteral nutrition.

The major risk factors for tracheopulmonary placement of feeding tubes include endotracheal intubation or tracheostomy, and altered mental status [8,12]. Consistent with this, all our patients were sedated or obtunded and only one did not have an endotracheal tube in place. The experience of the individual placing the feeding tube does not seem to be a major factor [12] (all of our initial placements were attempted by experienced critical care nurses), nor does the ease of insertion indicate proper placement. In fact, a vast majority of the cases reported by us and others were asymptomatic at the time of diagnosis [12].

In most cases, the diagnosis is made within hours of feeding tube insertion [9]. In our series, over 90% were diagnosed within 1 h, reflecting the requirement for chest roentgenogram. Delay in diagnosis, particularly if it is associated with initiation of feeding, greatly increases the risk of morbidity and mortality [8].

We found that clinical indicators of proper tube placement (such as auscultation over the stomach of air injected into the tube) were unreliable. Air could be auscultated in all patients who were subsequently determined to have undergone tracheopulmonary tube placement. Review of the literature confirms our experience with auscultation for verification of tube placement in the stomach [6,8,9,12]. Similarly, aspiration of gastric contents for confirmation can also be misleading [8]. We require a chest roentgenogram prior to the initiation of feeding. However, the interpretation of a radiograph in critically ill patients can be difficult. As in previous studies, we observed errors in interpretation which resulted in significant morbidity [6,14]. One of our patient deaths was directly attributable to the initiation of feeding after a tube was misinterpreted as being in proper position on the chest roentgenogram.

How can these complications be prevented? To decrease the inherent risks, it is advisable to have only trained operators perform this procedure. There have been several strategies suggested to avoid inadvertent tracheopulmonary placement of enteral feeding tubes. These have included fluoroscopy, laryngoscopy and endoscopy-guided insertion [9,12,14]. All of these techniques would increase cost and time for insertion and require the availability of specialist assistance. Insertion of the enteral feeding tube without the stylet is difficult.

Roubenoff and Ravich [12] have suggested a two-step technique for the placement of feeding tubes in high-risk patients. This technique initially requires the placement of the tube in the esophagus to the level of the xiphoid and confirming the position with a chest roentgenogram. If the position is acceptable (midline), the tube is then advanced into the stomach and the position again confirmed by a second chest roentgenogram. If the tube is seen to be in the stomach, the stylet is removed and feeding is initiated. These authors maintain that this procedure is successful in avoiding the tracheopulmonary placement of enteral feeding tubes and, in spite of the requirement for two chest roentgenograms, is cost-effective.

Care should be exercised in injecting air through a feeding tube until proper placement is verified. If a feeding tube is placed directly into the pulmonary parenchyma and then air is injected in order to verify the tube's position, it is theoretically possible to induce a local airway disruption and a pneumothorax. This possibility has not yet been evaluated,

however the injection of air is unreliable in confirming proper tube placement, therefore other approaches might be attempted - such as measuring the pH of aspirated fluid.

Small-bore feeding tubes were introduced to decrease mechanical complications associated with stiffer, large-bore tubes, such as ulceration and bleeding from the nose, pharynx, larynx, esophagus and stomach. In addition, small-bore tubes may be passed into the duodenum, thus obviating the problem of a functional gastric outlet obstruction, which is common in critically ill patients. However, a randomized comparative study may be warranted to analyze whether or not the risk of insertion of small-bore soft tubes is outweighed by a decrease in mechanical complications associated with large-bore tubes.

Our study confirms the risk of inadvertent tracheopulmonary insertion of enteral feeding tubes and the significant morbidity and mortality which can be associated with its occurrence. This is particularly the case in the critical care population, who are at increased risk from this complication. Since clinical assessment of appropriate feeding tube placement can be unreliable, a chest roentgenogram, as a minimum, should be obtained prior to the initiation of feeding. However, the high morbidity and mortality associated with this complication suggests that alternatives to blind insertion of enteral feeding tubes should be considered in the high-risk population.

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