Bedside Method for Placing Small Bowel Feeding Tubes in Critically Ill Patients*
A Prospective Study

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Enteral delivery of nutrients is important for optimal treatment of critically ill patients. It maintains gut digestive and barrier functions, decreases gut bacterial translocation, decreases the incidence of sepsis, and improves outcome. Gastric emptying is impaired in many critically ill patients and feeding into a gastroparetic stomach leads to large gastric residuals and aspiration. We describe a simple bedside technique for placement of small bowel feeding tubes. Using this technique, we successfully placed 213/231 (92 percent) of feeding tubes in critically ill patients. Three percent were in the first portion of the duodenum, 25 percent in the second portion, 47 percent in the third portion, and 17 percent in the proximal jejunum. The average time for placement of small bowel feeding tubes was $40 \pm 14$ min (mean $\pm$ SD). Abdominal roentgenograms failed to properly locate 13 (6 percent) tubes. The most accurate and cheapest methods for confirming small bowel location of feeding tubes were bile aspiration, pH change from acidic to basic, and blue dye injection.

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It is generally agreed that enteral nutrition is superior to parenteral nutrition.1-3 Enteral feeding of nutrients preserves gut barrier function, enhances gut healing, reduces bacterial translocation, and is associated with reduced rates of sepsis when compared with no nutrition or total parenteral nutrition.1-4 Enteral alimentation is also less expensive than parenteral nutrition. A major drawback to the use of enteral nutrition in critically ill patients is the presence of gastroparesis. However, despite poor gastric emptying, small bowel function usually remains intact. Thus, enteral feeding into the stomach may lead to high gastric residuals (limiting the ability to administer adequate nutrients) or pulmonary aspiration. To avoid these complications, the placement of small bowel feeding tubes is required. In a previous report,5 we found that only 5 percent of weighted small-bore feeding tubes placed into the stomach entered the small bowel spontaneously. Active placement of small bowel feeding tubes can be accomplished with endoscopy, fluoroscopic guidance, or surgically. All these procedures are expensive and involve risks to the patient. This study was performed to prospectively evaluate a bedside technique for placing feeding tubes into the small bowel in critically ill patients. Secondary objectives were to evaluate different methods for assessing tube position in the gut and overall patient tolerance of enteral feeding.

METHODS

Patients

We established a "feeding tube placement" service in our intensive care unit (ICU) in 1987. We report herein the results of 231 consecutive requests for bedside placement of a duodenal feeding tube between November 1987 and October 1990. These requests included patients admitted to the trauma (30 percent), general surgery (15 percent), cardiac surgery (15 percent), neurosurgery (20 percent), and internal medicine (20 percent) services. The majority of patients (95 percent) were intubated at the time of feeding tube placement. Feeding tubes were placed equally well in all groups of patients. There was no effect of age (range, 1 to 80 years), sex, type of surgery, degree of injury, mental status, or drugs administered on our ability to place feeding tubes. Thus, we have grouped all patients together for presentation in this article.

Technique for Tube Placement

The patient is positioned supine with the right side down, if possible. The stomach is emptied with a nasogastric tube (if one is in place). The nasogastric tube is then removed to prevent it from tangling with the feeding tube. The type of feeding tube used is important. Some tubes are too flexible and some do not allow for optimal positioning of the wire stylet during placement (see procedure below). We have tried a large number of different feeding tubes and have found two tubes to work well: Entriix (Biosearch Medical Products, Somerville, NJ) and Corsafe (Corpak Inc, Wheeling, IL). These hygromer-coated self-lubricating tubes have a narrow weighted tip and a metal stylet.

The feeding tube is lubricated prior to use (water activated hygromer). It is then passed nasally or orally into the stomach. Gastric position is confirmed by aspirating gastric contents, checking for acidic pH, aspirating biliary material, auscultating injected air, or direct vision of the tube passing into the esophagus (using a laryngoscope). It is important to make sure that the feeding tube is not in the lung prior to manipulation (to avoid a pneumothorax).

Once gastric location is confirmed, the feeding tube is pulled back to 30 cm and the wire stylet is removed. A 30° bend is placed in the wire stylet 3 cm from the distal tip (about 6.5 cm from the end of the tube). The stylet is rethreaded into the lubricated feeding tube. A 60-ml syringe is attached to the proximal end of the feeding tube to assist in rotation of the tube during passage, aspiration of bowel contents, and injection of air during auscultation. The tube is advanced a few centimeters at a time while slowly rotating the attached syringe. This causes the distal tip to rotate in a circular motion. One is attempting to hook the pyloric outlet that is located slightly proximal to the blind end of the gastric pouch and passes posteriorly. With experience, one can usually feel the tip hit the

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stomach wall and bounce back slightly. As the tip is rotated, one can feel it pass through the pylorus. The feeding tube will pass out through the pylorus or loop back on itself. When the tube loops back, one feels a sudden loss of resistance as the tube is advanced. On the other hand, advancement into the small bowel is accompanied by a continuous low-grade resistance. If the tube loops back, it is pulled back and the procedure is repeated. It is usually necessary to repeat these steps 5 to 20 times (over approximately 10 to 30 min).

The most difficult part of the procedure is learning how to locate the position of the distal tip of the feeding tube. Bedside localization is accomplished by a variety of techniques: air injection with auscultation, aspiration of bile, and measurement of aspirated pH. Air injected into the stomach is heard in the left upper quadrant. As the feeding tube enters the pyloric region, air injection sounds are heard in the midline and radiate to the left upper quadrant. Once the tube passes through the pylorus and into the duodenum, air injection sounds are heard over the right upper quadrant and do not radiate to the left upper quadrant. As the tube is advanced into the distal duodenum, air injection sounds are again heard in the left upper quadrant and left flank region. Air injected into the stomach produces deeper and more resonant sounds compared with higher-pitched sounds when it is injected into the small bowel. Following injection, air can usually be aspirated from the stomach, but little can be aspirated from the small bowel. Provided the patient is not having significant biliary reflux into the stomach, the aspiration of bile during passage suggests a postpyloric location. We also test the pH of aspirated fluid using pH paper. Gastric fluid is usually acidic (even in patients receiving H₂-blockers, the pH is usually 4 to 5). Fluid from the duodenum has a pH greater than 7 to 8.

When the tube is felt to be in the small bowel, we place a nasogastric tube into the stomach. This tube is used to monitor gastric emptying (by residuals), monitor for small bowel reflux into the stomach, and keep the gastric volume low so as to avoid esophageal reflux and pulmonary aspiration. Following confirmation of nasogastric tube position, we inject 5 to 10 ml of blue food coloring through the small bowel feeding tube. Failure of the dye to appear in the nasogastric tube is confirmatory of a small bowel location.

Following bedside feeding tube placement, we obtained an abdominal roentgenogram on all patients (Fig 1). In addition, blue food coloring was put into the enteral formulas and administered through the feeding tubes. We monitored gastric fluid for appearance of the dye.

**RESULTS**

We attempted 231 bedside small bowel feeding tube placements and were successful in 213 (92 percent). Seven (3 percent) were placed into the first portion of the duodenum, 57 (25 percent) into the second portion of the duodenum, 109 (47 percent) into the third portion of the duodenum, and 40 (17 percent) into the proximal jejunum (Table 1). The average time to place the feeding tubes was 40 ± 14 min (mean ± SD). We failed to enter the small bowel in 18 attempts (8 percent). These tubes were subsequently placed with endoscopy.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. (%)</th>
</tr>
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<tbody>
<tr>
<td>Total tubes attempted</td>
<td>231 (100)</td>
</tr>
<tr>
<td>Failed placements</td>
<td>18 (8)</td>
</tr>
<tr>
<td>Successful placements</td>
<td>213 (92)</td>
</tr>
<tr>
<td>First portion of duodenum</td>
<td>7 (3)</td>
</tr>
<tr>
<td>Second portion of duodenum</td>
<td>57 (25)</td>
</tr>
<tr>
<td>Third portion of duodenum</td>
<td>109 (47)</td>
</tr>
<tr>
<td>Proximal jejunum</td>
<td>40 (17)</td>
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There was a discrepancy between bedside localization of the feeding tubes and radiologic localization in 13 (6 percent) placements. Tubes were reported to be in the stomach by abdominal roentgenogram when bedside localization indicated postpyloric position. Proper small bowel position was present when blue dye injected through the feeding tube did not return through the nasogastric tube (n = 10) or radiocontrast dye revealed the tube to be located in the small bowel (n = 3). Postpyloric location was subsequently confirmed when enteral feeding solution did not appear in gastric aspirations. Feeding tubes improperly localized by roentgenogram consisted of one tube in the first portion of the duodenum, four tubes in the second portion, six tubes in the third portion, and two tubes in the proximal jejunum.

All 18 tube placements that failed to pass into the duodenum produced blue gastric aspirates when blue dye (food coloring) was injected through the feeding tube. Seven additional placements produced some blue discoloration in gastric aspirates. These patients also had biliary reflux and it was believed that blue dye from the duodenum was refluxing into the stomach. Proper small bowel localization in these cases was accomplished by pH and roentgenogram. Thus, failure to obtain blue dye in gastric aspirates indicated small bowel placement.

Change in pH from acidic to alkaline was indicative (100 percent predictive power) of small bowel placement. Some patients (n = 4) had alkaline gastric pH due to antacids or large duodenal reflux. In these patients, pH change was not useful for localization.

We successfully fed all patients who received the small bowel feeding tubes using enteral nutrition. No patient developed small bowel ileus requiring discontinuation of the enteral feedings. Twenty percent of patients developed diarrhea (greater than 250 ml of stool per day) following initiation of enteral feedings. Diarrhea was transient and resolved in most patients within two to three days of feeding initiation. We placed blue food coloring into the enteral feeding formulas and no patient had evidence for aspiration (assessed by blue dye aspiration). None of our patients developed vomiting.

**DISCUSSION**

We describe a method for placing feeding tubes into the small bowel at the bedside. A similar technique was first described by Thurlow in patients in the surgery ward. This technique is simple but requires some training and experience. Once mastered, however, it is highly effective (92 percent). We have taught this technique to our house officers. Most are achieving placement of 70 to 80 percent.

This bedside technique is very safe. We have monitored oxygenation using pulse oximeters in most patients. The technique causes little change in oxygen saturation. We have also placed small bowel feeding tubes in 30 patients with intracranial hypertension. By placing the tubes slowly and gently, intracranial pressure remained at baseline levels. We also placed tubes using this method in a variety of hemodynamically unstable patients, many receiving inotropic agents and vasopressor drugs. The procedure can be performed with little if any cardiovascular deterioration. These effects contrast with those produced during endoscopy or fluoroscopy. In addition, this procedure is less expensive than either endoscopy or fluoroscopy.

Active placement of feeding tubes into the small bowel is essential for early feeding of critically ill patients. We have previously reported that only 5 percent of feeding tubes pass spontaneously into the small bowel in critically ill patients. Reported that only one third of feeding tubes passed spontaneously through the pylorus over 24 h in general ward and ICU patients. Silk et al reported a spontaneous passage rate of 0 to 4 percent in hospitalized patients (including ICU). Frager and colleagues reported a 15 percent success rate for blind passage of feeding tubes into the small bowel in ICU patients. Fluoroscopy was successful in 95 percent of patients. In addition, metoclopramide had little effect on the rate of feeding tube passage in hospitalized patients. Kittenger et al, in a prospective randomized controlled study, found that parenteral metoclopramide did not improve the frequency of transpyloric intubation with feeding tubes in nondiabetic patients. However, it did improve the frequency of passage in diabetic patients (64 percent vs 20 percent).

We have substantiated the utility of using pH and dye injection for localization of small bowel feeding tubes. Although these results seem obvious, this is the first study to demonstrate their high predictive values. In this study, pH change and dye injection were more accurate than roentgenograms for determining feeding tube location. Since these tests are cheaper than roentgenograms, we advocate their routine clinical use.

This study demonstrates that early enteral nutrition is possible in most critically ill patients when feeding tubes are placed into the small intestine. We did not design the study to evaluate gastric vs duodenal feedings. In a previous report, however, we found that many critically ill patients had gastroparesis and developed large gastric residuals when fed into the stomach. The prevalence of aspiration is reported to vary from 1 to 44 percent among patients who receive enteral nutrition. Few studies have compared the rates of pneumonia or aspiration in patients receiving gastric vs small bowel feedings. Zaloga found that 30 percent of trauma patients fed gastrically had evidence...
of aspiration (by tracheal glucose measurement) while 0 percent of trauma patients fed into the small bowel had evidence of aspiration. Jacobs et al\(^1\) reported a 54 percent incidence of pneumonia in ventilated patients receiving continuous gastric feeding. There was no control group in this study for comparison. The authors believed that neutralization of gastric acid by the feedings contributed to the pneumonia (by producing bacterial overgrowth). Olivares et al\(^3\) reported a 24 percent incidence of pneumonia in patients with gastric feeding tubes vs a 5 percent incidence in those without gastric feeding tubes. Winterbauer and colleagues\(^4\) reported a 38 percent incidence of aspiration during gastric feeding. There was no control group in this study. Metheny et al\(^5\) reported a 5.7 percent incidence of pulmonary aspiration directly related to feeding tubes in hospitalized patients. Aspiration was fivefold greater in patients receiving gastric compared with small bowel feedings.

Continuous enteral feeding has been shown to be effective prophylaxis against stress ulceration.\(^6,7\) Most of this prophylactic effect is believed to result from acid neutralization by feedings in the stomach. One may wonder whether feeding into the small intestine (bypassing the stomach) predisposes to gastric bleeding. Our standard approach is to administer sucralfate into the stomach using a concomitant nasogastric tube. In this manner, we maintain the antibacterial gastric barrier. None of our patients developed new gastric bleeding after entry into the study.

We conclude that bedside placement of small bowel feeding tubes, using the technique described in this article, is successful in the majority of critically ill patients. The best techniques for localizing the feeding tubes in the small bowel are pH change, appearance of bile, and dye injection. These methods are cheaper and more accurate than abdominal roentgenograms. In addition, most critically ill patients can be successfully fed when enteral nutrition is administered into the small bowel.

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