

# Evaluation of a bedside technique for postpyloric placement of feeding catheters

Adam M Deane, Robert J Fraser, Robert J Young,  
Benita Foreman, Stephanie N O'Conner and  
Marianne J Chapman

Although enteric feeding is the preferred method of delivering nutrients in critical illness,<sup>1,2</sup> about 50% of patients fail to reach caloric targets with nasogastric feeds,<sup>3</sup> with possible adverse effects on clinical outcomes.<sup>4</sup> Unsuccessful nasogastric feeding in critically ill patients has multiple causes, but primarily reflects delayed gastric emptying.<sup>5,6</sup> As small-bowel motility remains relatively preserved,<sup>7,8</sup> direct nutrient delivery into the duodenum may increase caloric intake.<sup>9</sup> Furthermore, postpyloric feeding may decrease the frequency of ventilator-associated pneumonia.<sup>10</sup> Despite these potential advantages, widespread uptake of postpyloric feeding has been limited, in part, because of practical difficulties in placing small-intestinal feeding catheters.<sup>2</sup>

A device that allows real-time localisation of a feeding catheter has recently become available (CORTRAK Enteral Access System, CORPAK MedSystems, Wheeling, Ill, USA). This system uses a modified enteral feeding tube incorporating a removable stylet, receiver plate and display monitor. The copper-coiled stylet generates a low-energy electromagnetic field that is detected by the receiver plate placed on the patient's abdomen. The signal is processed to show the position and direction of the catheter, displayed on a bedside monitor (Figure 1). Our group and others have previously reported on the use of electromagnetically guided devices to place postpyloric feeding catheters in critically ill patients.<sup>11,12</sup>

This study aimed to determine the utility of such a device in mechanically ventilated, critically ill patients, and the speed with which naïve users could learn the technique. None of the participants had experience with the earlier model of the device.<sup>11</sup>

## Methods

Prospective data were collected on all attempts at postpyloric catheter placement using the device in our unit — a tertiary, mixed medical–surgical, adult intensive care unit — between February 2008 and February 2009. Indications for tube placement were classified as clinical (to provide small intestinal feeding because of feed intolerance or for specific clinician preference because of underlying conditions) or as part of research studies on critical illness-related gut dysfunction. Exclusion criteria were oesophageal varices or

## ABSTRACT

**Objectives:** To establish the success rate, time taken and expertise required to place a feeding catheter into the small intestine using a device that permits real-time localisation of the catheter through detection of an electromagnetic field.

**Design:** Prospective observational study.

**Setting:** A tertiary, mixed medical–surgical, adult intensive care unit, between February 2008 and February 2009.

**Participants:** 60 attempts at postpyloric intubation by eight clinicians (consultant and trainee intensivists and a dietitian) in 57 critically ill patients who were undergoing mechanical ventilation and were receiving, or suitable to receive, enteral nutrition.

**Main outcome measures:** Patients were classified into an initial group (10 patients), who had the catheter placed by a single clinician to establish the most effective technique, and a subsequent group (50 patients), who had the catheter placed by any of the eight clinicians. Catheter position was confirmed on abdominal x-ray by an independent radiologist.

**Results:** Postpyloric catheter placement was successful in 56/60 attempts (93%), in 54/57 patients (95%), with a median time to placement of 7.2 min (interquartile range [IQR], 4.3–12.5 min). In the initial group, placement was successful in 7/10 attempts (70%), with a median time to placement of 20.8 min (IQR, 9.5–32.3 min), compared with 49/50 attempts (98%) and a median time of 5.9 min (IQR, 3.9–11.9 min) in the subsequent group ( $P=0.003$ ).

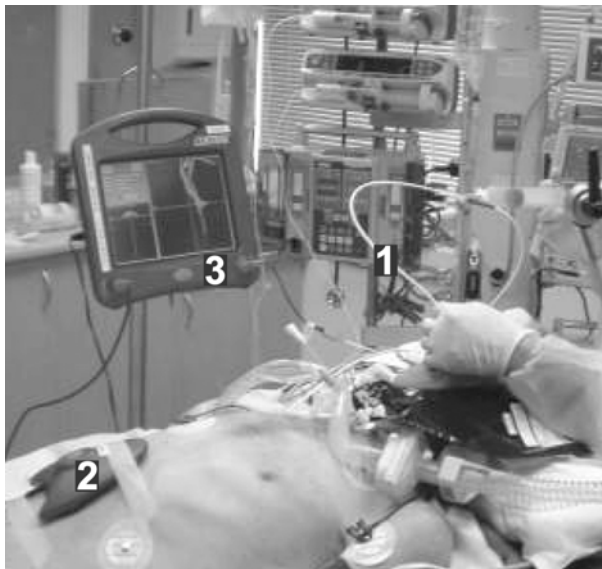
**Conclusions:** An electromagnetically guided device enabled reliable and rapid bedside placement of small-intestinal feeding catheters. Proficiency with the technique was quickly developed and successfully disseminated to a range of clinicians.

Crit Care Resusc 2009; 11: 180–183

strictures and previous major gastro-oesophageal surgery (eg, oesophagectomy or gastrectomy).

The study was approved by the local research ethics committee. All patients who required a postpyloric catheter as part of research studies had consent obtained from next

**Figure 1. Components of the electromagnetically guided device for placing small-intestinal feeding catheters**



1 = modified enteral feeding tube incorporating a removable stylet that generates a low-energy electromagnetic field.  
2 = receiver plate on the patient's abdomen.  
3 = monitor that displays the position of the catheter and direction of movement.

of kin. Consent was not required for patients who received a postpyloric feeding catheter for clinical reasons.

Patients were grouped into an initial group (initial 10 attempts at catheter placement) and a subsequent group (all subsequent attempts). Catheters were inserted for the initial group by a single operator (AMD), who had not had previous experience with the device before the study and who developed the placement protocol. Subsequent attempts were performed by either AMD or other consultant intensivist ( $n=3$ ), intensive care trainee ( $n=4$ ) or dietitian ( $n=1$ ), supervised by AMD.

The time required to place the catheter was measured as the time from the start of nasal intubation to completion of catheter insertion.

In the subsequent group, a standardised protocol for catheter placement was adopted. Patients were placed supine, either flat or at a maximum incline of 45 degrees. They were preferably fasting, but catheters were also placed during ongoing gastric feeding, in which case the nasogastric tube was aspirated and clamped beforehand. The catheter was introduced transnasally and advanced until the monitor showed it had reached the gastric fundus. The stomach was then insufflated with air (250 mL), and the catheter was advanced into the antrum. Air insufflation was commenced at a low rate through the feeding channel simultaneously with gradual advancement of the assembly. Total air insuffla-

**Figure 2. Abdominal x-ray to confirm catheter placement**



A radiograph was taken to confirm successful postpyloric placement prior to commencement of feeds. For the study, the radiograph was independently verified by a radiologist (BF).

tion was limited to 500 mL. The nasogastric tube was removed only if it impeded catheter movement. When the display indicated the catheter tip was in the distal antrum, the tip was advanced until the display showed it had crossed to the right side of the abdomen and was moving posteriorly (the proceduralist facing the display screen would see the tip moving to their left and down), indicating successful transpyloric placement. If the display indicated coiling in the stomach, the catheter was retracted to the antrum, and the procedure started again. If placement was difficult, erythromycin (200 mg) was administered to the patient intravenously.

Postpyloric catheter insertion was confirmed by abdominal radiography performed by a radiologist (Figure 2).

Data on times for placement are presented as median (interquartile range [IQR]). Times were also categorised according to clinical indication for small intestinal intubation. Data were compared using the Mann-Whitney U test (SPSS version 16.0, SPSS Inc, Chicago, Ill, USA).

## Results

Over the study period, the device was used on 60 occasions in 57 patients. Three patients had repeated

catheter insertions: in two, the first tube became occluded and was replaced; in the other, an initial unsuccessful placement attempt was followed 2 days later by a successful attempt. Thirty-four patients required a postpyloric feeding catheter for a clinical reason, and 23 for other research study purposes. Nineteen patients received intravenous erythromycin (200 mg), either already prescribed with metoclopramide as prokinetic therapy (14 patients), or as a single agent to assist migration if difficult placement was anticipated or encountered (five patients). Demographic and clinical characteristics of the patients are shown in Table 1.

Overall, postpyloric placement was successful in 56/60 attempts (93%) and in 54/57 patients (95%), with a median time to insertion of 7.2 min (IQR, 4.3–12.5 min).

In the initial group, the success rate was 7/10 (70%), with a median placement time of 20.8 min (IQR, 9.5–32.3 min). In the subsequent group, the success rate was 49/50 (98%), with a median time of 5.9 min (IQR, 3.9–11.9 min) ( $P=0.003$  for between-group comparison). Once the technique was refined, device placement was successful and rapid. In the subsequent group, the median time taken for the first attempt was 8.2 min (IQR, 4.7–12.9 min).

Placement times for the device were similar between patients who required postpyloric feeding for clinical need (8.1 min; IQR, 4–11.5 min) and research study purposes (8.1 min; IQR, 5–12.5 min);  $P$ , not significant).

## Discussion

This study confirms earlier reports that electromagnetic guidance allows rapid postpyloric positioning of feeding catheters.<sup>11,12</sup> The success rate and placement times compared favourably with our previously published pilot data (success rate, 7/8; median time, 12.6 min).<sup>11</sup> Using a similar device, Gray and colleagues reported a success rate of 63/81 (mean placement time, 40 min) in unselected critically ill patients who required enteral nutrition.<sup>12</sup> As our study included only critically ill patients undergoing mechanical ventilation, with most having a clinical need for postpyloric feeding, it demonstrates that electromagnetically guided postpyloric tube placement is effective in feed-intolerant critically ill patients. Once a reliable approach to use of the device was established (in the initial group), 49/50 subsequent attempts were successful, and placement was rapid and accurate. Furthermore, minimal training was required for successive clinicians.

Four attempts at placing a postpyloric tube were initially unsuccessful. One patient was morbidly obese and had dressings covering major burns to the thorax and abdomen, which prevented optimal positioning of the receiver. In the subsequent five patients with major burns, the receiver unit was placed in a sterile covering, which allowed successful catheter insertion in all. Another patient with an unsuccessful placement attempt was pacemaker-dependent, and current from the temporary in-situ transvenous pacing wires interfered with detection of the electromagnetic field. These examples suggest more experience is required to define conditions that require a modified technique, or are unsuitable, for catheter placement.

A number of techniques to place postpyloric feeding tubes in the critically ill have been reported. The limitations of fluoroscopically and endoscopically guided techniques are well recognised,<sup>2</sup> particularly the delays associated with limited access to specialised equipment and staff. In contrast, the electromagnetic device is available for immediate use by ICU staff at the bedside to enable early commencement of nutrition. The technique is also suitable for use in patients with contraindications to endoscopy, such as intracranial hypertension and cervical spine injury. A number of other devices suitable for bedside use have been described previously. Compared with the electromagnetically guided device, a self-migratory device was slower to place and had a lower success rate (63/128 attempts by Day 3).<sup>13</sup> Significant adverse events have also been reported.<sup>14</sup> A device using magnets is reported to be successful at assisting postpyloric placement<sup>15</sup> (success rate, 89%), but time to placement was longer (mean, 15 min) than we found for the device in our study.

Other techniques<sup>16-19</sup> have been described but none has been widely adopted, in part because they require specific

**Table 1. Demographic and clinical characteristics of the 57 study patients**

Characteristic	No.*
Age (years), mean (range)	55 (39–66)
Sex	44 M, 13 F
APACHE II score on admission, mean (range)	20 (16–24)
Day of ICU admission, mean (range)	6 (3–8)
Receiving invasive mechanical ventilation	57 (100%)
Indication for postpyloric catheter	
Clinically required	34 (60%)
Study purposes	23 (40%)
Diagnosis	
Sepsis	18 (32%)
Trauma	13 (23%)
Pancreatitis	6 (11%)
Burns	6 (11%)
Neurosurgical	6 (11%)
Other diagnoses	8 (14%)

\*Unless otherwise indicated.

expertise. Our study is the first to establish that the technique of postpyloric catheter insertion under electromagnetic guidance is easily taught to clinicians of varying clinical experience and skills. Once the technique was mastered by the first operator, it was taught to subsequent operators, resulting in similar rapid and accurate placement, suggesting that high-level manual dexterity is not necessary for its successful use.

The primary limitation of this study is that it is descriptive rather than comparative. Given the results, a comparative study is warranted, although it is important to be mindful that there is no accepted "gold standard" technique for placing small-intestinal feeding catheters. Another limitation is the small patient numbers, which were insufficient to provide data on the potential effect of improved nutrient delivery on outcomes. However, the objective of our study was to establish the utility of a method to insert postpyloric tubes; a large trial to compare the effectiveness of postpyloric and gastric feeding (using a self-migratory catheter) is currently underway.<sup>20</sup> The results of this trial will provide important information on the impact of the route of enteral nutrition on outcomes, which in turn may provide additional impetus for direct small-intestinal nutrition. The limitation of a prospective observational study in a single centre should also be recognised. Our ICU has a special interest in nutrition in the critically ill. We attempted to improve the generalisability of our results by including a range of operators, but acknowledge the results may not be reproducible across all ICUs.

In conclusion, this electromagnetically guided device allowed rapid introduction of postpyloric feeding catheters. The speed and ease of placement, together with the limited training needed to develop proficiency in a diverse group of clinicians, suggests the technique is worthy of larger-scale clinical trials.

### Author details

Adam M Deane, PhD Candidate,<sup>1</sup> and Intensivist<sup>2</sup>

Robert J Fraser, Professor,<sup>3</sup> and Director<sup>4</sup>

Robert J Young, Associate Professor,<sup>1</sup> and Director<sup>2</sup>

Benita Foreman, Registrar<sup>5</sup>

Stephanie N O'Conner, Clinical Service Coordinator Research<sup>2</sup>

Marianne J Chapman, Associate Professor,<sup>1</sup> and Director of Research<sup>2</sup>

1 Discipline of Anaesthesia and Intensive Care, University of Adelaide, Adelaide, SA.

2 Intensive Care Unit, Royal Adelaide Hospital, Adelaide, SA.

3 Discipline of Medicine, University of Adelaide, Adelaide, SA.

4 Investigations and Procedures Unit, Repatriation General Hospital, Adelaide, SA.

5 Department of Radiology, Royal Adelaide Hospital, Adelaide, SA.

Correspondence: Adam.deane@adelaide.edu.au

### References

- Heyland DK, Dhaliwal R, Drover JW, et al. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients. *JPEN J Parenter Enteral Nutr* 2003; 27: 355-73.
- Deane A, Chapman MJ, Fraser RJ, et al. Mechanisms underlying feed intolerance in the critically ill: implications for treatment. *World J Gastroenterol* 2007; 13: 3909-17.
- De Beaux I, Chapman M, Fraser R, et al. Enteral nutrition in the critically ill: a prospective survey in an Australian intensive care unit. *Anaesth Intensive Care* 2001; 29: 619-22.
- Stapleton RD, Jones N, Heyland DK. Feeding critically ill patients: what is the optimal amount of energy? *Crit Care Med* 2007; 35: S535-40.
- Chapman M, Fraser R, Vozzo R, et al. Antro-pyloro-duodenal motor responses to gastric and duodenal nutrient in critically ill patients. *Gut* 2005; 54: 1384-90.
- Deane A, Fraser R, Chapman M. Prokinetic drugs for feed intolerance in critical illness: current and potential future therapies. *Crit Care Resusc* 2009; 11: 132-43.
- Dive A, Miesse C, Jamart J, et al. Duodenal motor response to continuous enteral feeding is impaired in mechanically ventilated critically ill patients. *Clin Nutr* 1994; 13: 302-6.
- Chapman MJ, Fraser RJ, Bryant LK, et al. Gastric emptying and the organization of antro-duodenal pressures in the critically ill. *Neurogastroenterol Motil* 2008; 20: 27-35.
- Davies AR, Froome PR, French CJ, et al. Randomized comparison of nasojejunal and nasogastric feeding in critically ill patients. *Crit Care Med* 2002; 30: 586-90.
- Heyland DK, Drover JW, MacDonald S, et al. Effect of postpyloric feeding on gastroesophageal regurgitation and pulmonary microaspiration: results of a randomized controlled trial. *Crit Care Med* 2001; 29: 1495-501.
- Young RJ, Chapman MJ, Fraser R, et al. A novel technique for postpyloric feeding tube placement in critically ill patients: a pilot study. *Anaesth Intensive Care* 2005; 33: 229-34.
- Gray R, Tynan C, Reed L, et al. Bedside electromagnetic-guided feeding tube placement: an improvement over traditional placement technique? *Nutr Clin Pract* 2007; 22: 436-44.
- Berger MM, Bollmann MD, Revelly JP, et al. Progression rate of self-propelled feeding tubes in critically ill patients. *Intensive Care Med* 2002; 28: 1768-74.
- Taylor SJ, Pullyblank A, Manara A. Nasointestinal intubation with tiger tubes: a case series indicates risk of mucosal damage. *J Hum Nutr Diet* 2006; 19: 147-51.
- Gabriel SA, Ackermann RJ. Placement of nasoenteral feeding tubes using external magnetic guidance. *JPEN J Parenter Enteral Nutr* 2004; 28: 119-22.
- Thurlow PM. Bedside enteral feeding tube placement into duodenum and jejunum. *JPEN J Parenter Enteral Nutr* 1986; 10: 104-5.
- Lord LM, Weiser-Maimone A, Pulhamus M, Sax HC. Comparison of weighted vs unweighted enteral feeding tubes for efficacy of transpyloric intubation. *JPEN J Parenter Enteral Nutr* 1993; 17: 271-3.
- Slagt C, Innes R, Bihari D, et al. A novel method for insertion of post-pyloric feeding tubes at the bedside without endoscopic or fluoroscopic assistance: a prospective study. *Intensive Care Med* 2004; 30: 103-7.
- Lee AJ, Eve R, Bennett MJ. Evaluation of a technique for blind placement of post-pyloric feeding tubes in intensive care: application in patients with gastric ileus. *Intensive Care Med* 2006; 32: 553-6.
- Davies AR. Australian New Zealand Clinical Trials Registry (ANZCTR number 12605000149662). 2009. Available at: [http://www.anzctr.org.au/trial\\_view.aspx?ID=170](http://www.anzctr.org.au/trial_view.aspx?ID=170) (accessed Apr 2009). □