

Carol Rees Parrish, R.D., M.S., Series Editor

Gastric versus Jejunal Feeding: Evidence or Emotion?



Joe Krenitsky

Delivery of enteral feeding into the small bowel has been suggested as a strategy to reduce the risk of aspiration pneumonia and improve the delivery of nutrition. However, randomized studies of gastric versus enteric small bowel feeding have been inconclusive, in part due to the methodological limitations and small number of patients in each study. The conclusions of three different meta-analysis were inconsistent; the efficacy of small bowel feedings to reduce pneumonia incidence or improve delivery of nutrition remains an area of persistent debate. The goal of this article is to critically evaluate the literature available on gastric versus small bowel feedings so that rational and safe feeding protocols can be developed that are based on the best available evidence.

INTRODUCTION

In patients that require nutrition support, enteral nutrition (EN) results in reduced infectious complications, and is more cost effective compared to parenteral nutrition (PN) (1). The knowledge of the benefits of EN has led to increasing acceptance and use of enteral feeding, especially in critically ill patients. However, there remains a substantial reluctance to utilize enteral feedings in some clinical situations due to concerns of feeding intolerance and aspiration risk. It is clear that *some* of these concerns are *perceptions* of feeding intolerance

that have been challenged in recent investigations. For example, research demonstrating successful EN in severe pancreatitis, hypotension with pressors, and immediately after bowel anastomosis, all highlight the feasibility of EN in settings that may have previously been considered a contraindication to EN (2–6).

It is true, however, that many critically ill patients exhibit delayed gastric emptying and have multiple risk factors for aspiration pneumonia (7). The acquisition of nosocomial pneumonia portends a more complicated hospitalization with increased length of stay, hospital costs, and mortality (8). Clinicians have searched for a means to retain the advantage of EN while reducing the risks of feeding intolerance and aspiration. Strategies such as the use of prokinetic medications, elevation of

(continued on page 49)

Joe Krenitsky, M.S., R.D., Nutrition Support Specialist, Digestive Health Center of Excellence, University of Virginia Health System, Charlottesville, VA.

(continued from page 46)

the head-of-bed and placing the feeding tube beyond the pylorus, have all been suggested as possible ways to reduce the risk of aspiration.

Placement of the feeding tube beyond the pylorus may appear to be an obvious choice to reduce aspiration risk, and intuitively, would not appear to have any clinical drawbacks. However, like many other intuitive strategies applied to the critical care setting, controlled trials have yielded unexpected results. There are over 10 controlled trials that have investigated gastric versus small bowel feeding and the risk of aspiration, and no study has demonstrated a significant reduction in pneumonia incidence or mortality with small bowel feedings. Although some studies have suggested that small bowel feeding allows improved feeding tolerance and nutrition provision, other studies have reported no significant difference in feeding tolerance between groups. The individual studies of gastric versus small bowel feeding have **all** been hampered by a small sample size. In an attempt to overcome the limitation of small sample size, at least 3 meta-analyses of these studies have been published (9–11). However, due to limitations in the individual studies and different conclusions of each meta-analysis, there is a lack of consensus among experts regarding the role of post-pyloric feeding in reducing aspiration risk, pneumonia incidence, or improving feeding tolerance and delivery. This qualitative review will discuss the implications of the available research and review the findings of the 3 available meta-analysis in terms of aspiration risk, incidence of pneumonia and feeding tolerance. It will focus on those studies that have randomized patients to gastric versus small bowel feedings that investigated reflux, aspiration, pneumonia, or feeding adequacy. Research designed to investigate gastric versus small bowel feeding in the setting of pancreatitis has been excluded because research into the safety of gastric feedings in pancreatitis is ongoing, inconclusive and the details of that topic would fill an entire article by itself.

CLINICAL TRIALS—STUDY DESIGN

Location of the Feeding Ports

There are at least 10 randomized studies that have investigated gastric versus small bowel feeding (Table 1).

These trials have been conducted in a variety of patient populations including medical, surgical, neurological and trauma ICU patients, as well as non-ICU patients. There are important methodological differences between the studies that make direct comparison difficult. One of the most evident differences between the studies is the position of the tip of the feeding tube. Five studies intended to place the feeding tube into the duodenum (12–16), while 3 studies attempted to place the feeding tube into the jejunum (17–19). Two studies did not state the precise location of the tube (20–21). It is important to note the position of the feeding tubes, both in interpretation of the significance of the study results, as well as in the clinical implementation of feeding protocols. Reflux occurs commonly from the proximal small bowel (15,22) and feedings must be infused beyond the ligament of Treitz to minimize the possibility of reflux (23). Heyland reported that as the feeding tube was placed in a more distal position there were less episodes of gastroesophageal regurgitation (15). However, some reviews and practice guidelines do not differentiate between “post-pyloric” or “small bowel” placement (which could mean proximal duodenum) versus jejunal placement of feeding tubes. In this review, the author will use the terms small bowel or post-pyloric as a *generic* term and for studies that *do not specify location* of the tube beyond the stomach; the term “jejunal” will only be used when studies have specified placement distal to the duodenum. Another important consideration that is not equally controlled for in each study is the possible displacement of feeding tubes during the study. Frequent displacement of post-pyloric feeding tubes has been described in some settings. At least one study reported that 13% of the jejunal group had to be crossed-over to the gastric group due to tube displacement during the study (17). If a small bore nasogastric (NG) or orogastric (OG) tube is used, it is also possible that some of the gastric feeding groups *actually* received small bowel feedings during the study. A number of studies do not report if tube position was reconfirmed during the study period (13,14,17,19,21).

Concurrent Gastric Decompression

An additional aspect that varies in some of the studies was the decision to suction gastric secretions in the

**Table 1
Gastric vs Jejunal Feeding Trials**

<i>Study</i>	<i>Patients</i>	<i>Tube Position</i>	<i>Tube Position Rechecked</i>	<i>Prokinetics</i>	<i>Gastric Suctioning</i>
Montecalvo et al. 1992	38 surgical and medical ICU	Endoscopically placed	Not reported	Not used	No
Strong et al. 1992	33 malnourished hospitalized patients	Second portion duodenum – various methods	Every 3 days	Not reported	No
Kortbeek et al. 1999	80 trauma ICU patients	Fluoro placed duodenum	Not reported	Prokinetics used after 24 hours.	No
Kearns et al. 2000	44 medical ICU	Blind or fluoroscopic placement into duodenum	Not reported	1 dose with tube placement only	No
Esparza et al. 2001	54 mixed ICU patients	Transpyloric – not specified	Continuous monitoring (see paper)	Prokinetics used "as required"	No
Heyland et al. 2001	39 medical/surgical ICU patients	Blind or endoscopically into duodenum	Position reconfirmed only when suspicion of displacement	Prokinetics used "as required"	Yes
Day et al. 2001	25 Neurological ICU	Blind-placement to duodenum	Not reported	Not used	No
Neumann et al. 2002	60 general ICU	Not specified	Not specified	Not used	No
Davies et al 2002	66 Mixed ICU	Endoscopic placed nasojejunal	Every 3 days	Not used	Yes
Montejo et al. 2002	110 mixed ICU patients	Dual-lumen naso G-J	Not specified	Not used	yes

Used with permission from the University of Virginia Health System Nutrition Support Traineeship Syllabus (53)

small bowel feeding group. Three of the studies placed a nasogastric tube to suction or drainage in all patients with small bowel feeding (15,18,19), while the other seven studies did not.

Defining Pneumonia

The method of diagnosing pneumonia also differed between the various studies. Two of the trials used radio-labeled enteral feedings to detect gastroesophageal regurgitation and aspiration (15,20). The

other studies relied on various clinical diagnoses of pneumonia. Clinical diagnosis of pneumonia has been criticized as non-specific in some patient populations (24). Some components of clinical diagnosis rely on subjective interpretation that can be a source of significant bias (especially in those studies that are not double-blind). Only 2 studies reported a double-blind protocol, that is, those involved in the diagnosis of pneumonia could not know the tube position. In contrast to studies that define aspiration via the presence of radio-labeled feeding in the pulmonary tract, clinical diag-

<i>Gastric Residual Cutoff (mL)</i>	<i>Outcomes</i>		
	<i>Pneumonia</i>	<i>Time to reach feed goal</i>	<i>Feeding adequacy</i>
>250 twice in a row	Not significantly different	Not Reported	Significantly greater percentage of goal in jejunal group
Not reported	Not significantly different	Not significantly different	Not significantly different
>250	Not significantly different	Shorter time to reach full feeds in duodenal group.	Not reported
>150	No significantly different	Not reported	Significantly greater percentage of goal in duodenal group
>150	Microaspiration not significantly different	Not reported	Not significantly different
>200	Microaspiration not significantly different (trend only)	Not reported	Not reported
Not reported	Not significantly different	Not reported	Not significantly different
> 200	Not significantly different	Delayed in jejunal group	Not reported
>250 or >2000 in 48 hrs total	Not significantly different	Delay in starting in jejunal group	Not significantly different
> 300	Not significantly different	Not	Not significantly different

nosis of pneumonia does not permit differentiation between aspiration of gastric contents versus aspiration of oral-pharyngeal secretions.

SMALL BOWEL FEEDING AND PNEUMONIA INCIDENCE

No individual randomized study has reported a significant decrease in pneumonia or reduction in mortality with the use of post-pyloric feeding. However, due to the relatively low incidence of pneumonia, none of the

studies enrolled adequate numbers of patients to detect a significant difference in pneumonia. In order to overcome the limitation of small study size, three different meta-analyses have been completed (9–11). Two of the three meta-analysis have concluded that there was no significant outcome advantage with post-pyloric feeding (10,11), but one meta-analysis did report outcome benefits (9). The meta-analysis that reported a reduction in pneumonia incidence has been criticized because it included a study not designed to directly compare gastric and small bowel feeding (11,25). The

study in question was designed to investigate an accelerated feeding advancement (“enhanced enteral nutrition”) which *could*, but did not necessarily, include small bowel feeding (26). Ultimately, **only one-third** of the patients included in the enhanced group *actually received* small bowel feeding. Nevertheless, these patients were all analyzed in the “post-pyloric” feeding group for the “positive” meta-analysis. When the results of this single study were removed, there was no significant outcome advantage to post-pyloric feeding.

JEJUNAL FEEDING AND REFLUX/ASPIRATION

Two randomized studies have investigated the effect of small bowel feeding on the incidence of aspiration from enteral formula (15, 20). The use of radio-labeled (technetium 99-sulphur colloid) enteral feeding formula allowed the researchers to differentiate between aspiration of enteral feeding formula and other sources of aspirated material or causes of pneumonia.

Heyland, et al randomized 39 medical and surgical ICU patients to receive either naso/oro gastric feeding versus nasointestinal feeding (15). The authors state that there was no specific attempt to pass the small bowel feeding tube beyond the ligament of Treitz, and all patients with a small bowel tube had continuous gastric suction. All feedings were radio-labeled, and secretions obtained from the oropharynx and endotracheal tubes were analyzed for the presence of the tracer over a 3 day period. The researchers used a detection level of >100 cpm/g from the oropharynx as positive for reflux, and from the trachea, as aspiration. The authors reported that those patients fed into the small bowel with concurrent gastric suction had significantly less reflux of formula than those patients fed into the stomach (24.9% vs 39.8%, $p < .04$). The authors do state that there was a decreased incidence of gastroesophageal reflux in those patients with a feeding tube in a more distal position. Although there was a reduction in gastroesophageal reflux with small bowel feeding, there was no significant difference in aspiration between the gastric and small bowel feeding group. It is worthwhile to note that **one-third** of the patients with feeding into the small bowel *had at least one episode of aspiration of the feeding formula into pulmonary secretions, despite the presence of gastric decompression.*

Esparza, et al utilized similar methodology in a study of 54 critically ill medical ICU patients (20). However, these patients were monitored for up to 8 days (mean – 3.8 days); the researchers used a threshold for technetium 99m detection of 1000 counts/mL/minute. A gamma camera was used to scan pulmonary secretions and lung fields for the presence of technetium, but reflux into the oropharynx was not measured. The researchers were able to continuously monitor the position of the feeding tubes by the use of an electromyograph electrode on the feeding tube (but the authors do not report the position of the tube within the small bowel). Concurrent gastric suction was not used during this study. The investigators reported that there was no significant difference in aspiration incidence between the gastric and small bowel feeding groups. Clinical suspicion of aspiration based on observation of reflux of feeding into the mouth with either the suspected appearance of feeding formula in pulmonary secretions or oxygen desaturation was not an accurate indicator. Only 3 out of 5 (60%) of those with isotope-detected aspiration were identified via clinical determination, and 9 out of 11 (82%) of those who were *clinically* identified as having aspirated, had a scan that was negative for aspiration.

POST-PYLORIC FEEDING AND NUTRITIONAL ADEQUACY

Two studies have reported that the use of small bowel feeding results in improved delivery of enteral feeding to the patient (14, 17). Another study reported that goal feeding was reached sooner in the small bowel group (13). Montecalvo reported that patients receiving jejunal feeding obtained a significantly greater percentage of their feeding goal (61.0 % vs 46.9 %, $p < .05$). The study by Kearns, et al found that the duodenal feeding group received 69 % of estimated needs, while the gastric feeding group received 47 % of estimated needs ($p < .05$) (14). Kortbeek, et al reported that the duodenal fed group received full feeding in 43.8 hours, while the gastric-fed group received full feeding in 34 hours ($p = < .02$) (13).

In contrast, 4 studies reported that there was no significant difference between gastric and small bowel feeding in percentage of nutrition needs provided (12,18,19,20). Furthermore, 2 studies found a signifi-

(continued on page 54)

(continued from page 52)

cant *delay* in feeding with post-pyloric feeding (18,21). Neumann, et al reported that there was a delay in initiation of feeding in the small bowel feeding group and that the gastric group received goal feeding significantly sooner than the small bowel group (28.8 vs 43.0 hrs, $p < .024$) (21). Davis, et al described a significant delay in the start of EN in the jejunal group compared to the gastric group (81 vs 55 hrs respectively, $p < .01$) (18).

Accessing the Small Bowel

Delays in achieving post-pyloric placement of feeding tubes was a primary factor in those studies that reported delays in initiating EN in the small-bowel feeding groups. Facilities that have standardized protocols for tube placement, and experienced personnel involved in enteric tube placement may not experience the same magnitude of delay. One multi-center study reported that those facilities with previous experience with jejunal tubes provided increased EN to the jejunal feeding group (19).

Use of Prokinetics

The use of prokinetic medications during gastric feeding may negate any potential advantage of small bowel feedings in terms of nutrition provision. Those studies reporting that small bowel feeding allowed significantly greater nutrition provision did not allow prokinetics to be used in the gastric feeding group. Several studies have described improved feeding tolerance in critically ill patients that received prokinetics (27), and at least one study has demonstrated that either small bowel placement or prokinetic use increased feeding delivery (28).

I say tomatoe, you say tomato...

Another influence on delivery of enteral feedings is the *perception* of feeding tolerance and the need to hold enteral feeding infusion. One group surveyed nurses and found they were significantly more likely to hold EN if the tube was gastrically placed, compared to small bowel placement (17). Education of staff and implementing evidence-based protocols for enteral

nutrition have demonstrated effectiveness in increasing the delivery of nutrition because they address these perceptions and misconceptions regarding enteral feeding (29,30). Protocols that delineate the initiation and advancement of feedings, along with *appropriate* cut-off levels for gastric residuals are equally (if not more) effective in improving the delivery of EN than placing small bowel tubes (29,30,31).

DISCUSSION

Considering that the strategy of post-pyloric feeding is intuitively “obvious,” and the dogma of reduced pneumonia risk with small bowel feedings is so entrenched in the literature, and apparently persuasive, that one has to ask why is there not a more obvious reduction in aspiration and pneumonia incidence in studies of small bowel feeding? The small number of patients enrolled explains the difficulty in showing efficacy in the individual trials, but does not fully explain the failure of meta-analysis to demonstrate any significant outcome advantage (pneumonia or mortality) with small bowel feeding. One possibility is that the majority of studies used a duodenal placed feeding tube. Reflux occurs frequently from duodenal feeding tubes as evidenced by the Heyland and Esparza studies; both demonstrated retrograde migration of technetium-99 from the proximal small bowel. Only three studies specified jejunal placement of the feeding tube (17–19) and only one of the three specified regular and frequent *reconfirmation* of tube position to exclude tube migration back into the duodenum or stomach (18). However, there is no suggestion from these three studies of any outcome advantage of feeding into the jejunum.

One potential reason for the failure of the studies to demonstrate an outcome advantage with post-pyloric feeding may lie with the inhibitory effect of small bowel feeding on gastric motility. The physiologic consequences of jejunal feeding on gastric and duodenal motility is frequently underappreciated. Several groups have demonstrated that jejunal infusion of nutrient solutions may decrease gastric motility and encourage reflux of duodenal contents back into the stomach, and also reflux of gastric contents into the esophagus (22,32,33). Chendrasekhar reported that the 24-hour volume of nasogastric drainage was signifi-

cantly increased in trauma patients after the start of jejunal feedings (301 ml to 587 ml, $p < .01$) (33). Dive monitored gastric pH, and measured the bile content of gastric secretions in a group of critically ill patients before and during small bowel feeding through a dual-lumen nasogastrjejunal feeding tube (22). They reported that gastric pH and bile reflux from the duodenum into the stomach significantly *increased* (1.59 to 2.33, $p < 0.013$) and (392 to 1446 $\mu\text{mol/l}$, $p < .006$) respectively, after jejunal feedings were initiated.

Lien, et al studied the effect of jejunal infusion of enteral feeding compared to saline infusion in patients that had suffered a stroke (32). The investigators placed an esophageal pH probe above the gastroesophageal junction to measure acid reflux during saline and feeding infusion through a PEG with a jejunal extension (PEG-J). The researchers reported that compared to saline infusion, jejunal infusion of feeding formula significantly increased reflux of acid from the stomach into the esophagus. Compared to jejunal saline infusion, patients with a history of reflux increased esophageal acid exposure from 2.7% to 15.3% ($p < .003$) with the initiation of jejunal feeding, and patients without a history of reflux increased esophageal acid exposure from 0% to 5.9% ($p < .01$). Additionally, the number of events of acid reflux, and the time to clear acid from the esophagus, were significantly increased with jejunal feeding compared to the jejunal saline infusion. This seemingly contradictory decrease in gastric motility with small bowel feeding is believed to be caused by the "ileal-brake" mechanism. The ileal brake is a response to long chain fats and peptides in the small bowel that cause a release of chemical mediators such as peptide-YY and glucagon-like peptide-1 that slow gastric motility (34–36). Traditionally, the ileal-brake mechanism was believed to be stimulated with only distal-bowel nutrient infusions, however, several studies have demonstrated provocation of the "ileal" brake mechanism with feeding into the proximal small bowel (34–36).

The practical implications of the delay in gastric emptying caused by small bowel feedings is that patients may be at an *increased risk* of aspiration of endogenous gastric secretions during feeding into the small bowel (compared to fasting). Studies may have failed to show a difference in pneumonia or mortality

because patients traded aspiration of feeding for aspiration of gastric secretions. Post-pyloric feeding has been proposed as a way to decrease the risk of aspiration when patients cannot have the head-of-bed elevated; however, if jejunal feeding results in increased reflux (compared to fasting) it would be ill-advised to permit patients to remain supine during small bowel feeding.

It is worthwhile to note that none of the gastric versus small bowel feeding studies have reported rigorous monitoring of the position of the head of the bed. This is critical because there is good evidence (37–39) that failure to elevate the head-of-bed significantly increases the risk of aspiration pneumonia, even in those patients that are not receiving enteral feeding. Furthermore, recent studies have documented that achieving consistent elevation of the head of the bed often eludes us in a critical care environment (even in the most dedicated of ICU's) (40,41).

If the routine use of post-pyloric feeding encourages a relaxation of enforcement of proper elevation of the head of the bed, the net result could be an *increase* in aspiration pneumonia. Although it is tempting to suggest that gastric decompression during jejunal feeding might decrease the risk of aspiration of gastric contents, gastric decompression is not completely effective in preventing reflux. Heyland, et al reported that one-third of patients had reflux of the technetium-99 in feeding formula *from the small bowel*, even while receiving gastric decompression (15).

ARE GASTRIC FEEDINGS A PROBLEM?

As outlined above, there are clear limitations to all of the available studies of gastric versus post-pyloric feeding. However, there may be a more obvious reason why it has proven so difficult to demonstrate a clear outcome advantage with post-pyloric feeding. *One must consider the possibility* that the reason there is no apparent outcome benefit of small bowel feeding is that gastric feeding is safe, and aspiration of the feeding formula is not a major contributor to pneumonia in most patients. If standard precautions, such as elevation of the head-of-bed, and confirmation and monitoring of the position of the gastric feeding tube (to

(continued on page 59)

prevent esophageal feeding) are rigorously adhered to, there may be no further risk reduction with post-pyloric feeding in the “average” patient.

FACTORS ASSOCIATED WITH ASPIRATION PNEUMONIA

There are a multitude of factors that contribute to the development of nosocomial or ventilator-associated pneumonia. Observational studies have noted that enteral feedings are associated with pneumonia incidence (42,43); however these *associations* should not be interpreted as a “cause-and-effect” for enteral feeding and pneumonia, as selection bias cannot be avoided in observational studies regardless of the statistical controls that are employed. Certainly, aspiration of the feeding formula should not necessarily be implicated from these observational studies. The need for nutrition support itself may represent a selection into a group with greater pneumonia risk. A review of 4,982 patients found that male gender and increased transfusion requirements were also significantly associated with pneumonia incidence, and reported that parenteral nutrition support actually had a stronger association with pneumonia incidence than that of enteral feeding (43). The finding that parenteral nutrition may pose a greater risk for pneumonia development than enteral feeding is supported by the findings of a randomized study of PN and jejunal feeding that reported increased infectious complications with PN compared to enteral feeding. Surprisingly, the most common infection in the parenteral group was not line infections as might be expected, but was in fact, pneumonia (44).

A number of risk factors have a much more apparent role in the development of pneumonia than the position of the tip of the feeding tube. As stated above, failure to elevate the head-of-bed is a clear risk for pneumonia development even in those patients not receiving enteral feeding (39). The presence of any type of nasal tube, even those that do not access the GI tract such as nasal placement of endotracheal tubes, increase the likelihood of pneumonia, presumably by increasing the risk of maxillary sinusitis (45,46). In addition, appropriate oral care significantly reduces the incidence of ventilator-associated pneumonia (47–48). Considering the relative lack of evidence to support post-pyloric feeding, a much more significant

impact on decreasing pneumonia incidence may be realized by rigorous attention to elevation of the head-of-bed, enacting protocols for orogastric rather than nasogastric feeding, and prioritizing resources to provide adequate oral care rather than spending time manipulating the tip of the feeding tube.

PATIENT SELECTION

Although there is not a clinically apparent benefit to routine placement of all feeding tubes beyond the pylorus, this should not be interpreted to imply that there are not specific patients that may benefit from jejunal feeding. It is necessary to remember that there are no studies that have exclusively randomized patients at exceptionally *high risk* of aspiration or gastric feeding intolerance to gastric versus jejunal feeding. Patients with a history of gastroparesis, esophageal dysmotility or surgical alterations such as esophagectomy or near total gastrectomy are not representative of patients in the randomized studies discussed here. In fact, at least one study has excluded those patients with pre-existing gastroparesis (21), and two excluded patients with previous gastrointestinal surgery (14,19). It is very unlikely that a review board would approve of a study designed to randomize one-half of a high-risk population to gastric feeding. Although post-pyloric feeding does not decrease the risk of pneumonia or mortality in the *average* patient, there is the possibility that particular high-risk patients may benefit (Table 2).

RATIONALE FOR GASTRIC FEEDING

The physiologic purpose of the stomach is to act as a reservoir, and the presence of gastric residuals is a normal and expected occurrence. Critical illness, sedation and analgesia can delay gastric emptying, but the best available evidence is that the vast majority of patients tolerate gastric feeding. Studies of gastric versus post-pyloric feeding have failed to find a significant difference in pneumonia primarily due to the very low frequency of pneumonia reported during each of the studies. One practical interpretation of pneumonia incidence in the accumulated 10 studies in Table 1 is that over 250 patients with critical illness, sedation and analgesia have been randomized to receive intragastric

(continued on page 62)

(continued from page 56)

Table 2
Suggested Indications for Gastric versus Jejunal Feedings

Gastric Access

- Most in-patients
- Cerebrovascular accident
- Majority of ICU patients
- Short gut (to maximize surface area fed)
- Patients with esophageal strictures that would essentially prevent reflux of gastric secretions/food
- Total laryngectomies (cannot aspirate)

Jejunal Access

- Gastroparesis
- Scleroderma
- Severe gastroesophageal reflux disease (GERD)
- Severe pancreatitis unable to resume PO within 5–7 days.
- Distal to a small bowel fistula
- Patients not tolerating gastric feedings (despite prokinetic use)

feedings, with an apparently low incidence of pneumonia (as defined by the investigators).

Feeding intolerance and increased gastric residuals have been reported more frequently in patients receiving gastric feeding. However, some reports have included residual cutoffs that are well within the normal physiologic range and do not place the patient at increased risk of emesis (14,40). A pragmatic way to utilize the data from the gastric versus jejunal feeding studies is to note that gastric feeding with a residual cut-off of 250 or 300 mL was as safe and effective as post-pyloric feeding (18,19). In addition, the use of prokinetic medication allows gastric feeding with similar effectiveness as post-pyloric feeding in the critically ill population (20). Implementing evidence-based protocols that stipulate a rationale feeding advancement, procedure for checking gastric residuals, as well as a low-threshold for starting prokinetic agents, can improve overall gastric feeding tolerance and delivery of enteral nutrition (28–31,49). In practice, we have found it beneficial to begin with intravenous prokinetics in those patients with minimal gastric emptying, or in those requiring gastric decompression.

Placement of nasogastric (or in intubated patients, orogastric) tubes is easy, and does not require specially

trained personnel. Obtaining post-pyloric access requires additional resources, may delay the introduction of enteral feeding (18,21) and can substantially increase costs if fluoroscopy or endoscopy is used to position the feeding tube. Furthermore, intensive care unit patients that require transport off of the unit for placement of feeding tubes incur risks of aspiration associated just with the “road trip” itself (50). However, jejunal feeding may improve feeding tolerance and decrease PN use in those patients who remain intolerant to gastric feedings (28–31,49,51).

Gastric feeding may provide more effective ulcer prophylaxis than postpyloric feeding (52). Those patients with short-bowel syndrome or other malabsorptive disorders may benefit from intragastric feedings to maximize GI tract length and absorptive capacity, as well as to allow physiologic mixing with pancreatic and biliary secretions. In the clinical setting, when working with patients with malabsorptive disorders that are receiving enteral feeding, it is not uncommon to encounter patients that are unnecessarily receiving post-pyloric feedings. We have encountered patients with short-bowel syndrome that have had dramatic reductions in stool output with improved absorption after switching them from jejunal to gastric feeding. See Table 3 for advantages of gastric feedings.

CONCLUSIONS

There are over 10 randomized studies that have enrolled over 500 total patients into comparisons of gastric versus jejunal feeding. Small bowel feeding may result in decreased gastroesophageal reflux compared to gastric feeding, but there is no significant improvement in nutrition delivery or reduction in pneumonia incidence or mortality in the “average” ICU patient.

The majority of patients tolerate gastric feeding, and evidence-based protocols can improve the delivery and feeding tolerance of enteral nutrition. There is inadequate data to rule out a potential benefit of post-pyloric feeding for patients with a particularly high-risk for gastric feeding, and patients that do not tolerate gastric feedings after the addition of prokinetic medications may benefit from post-pyloric placement of the feeding tube.

(continued on page 64)

(continued from page 62)

Table 3
Reasons to pursue gastric feedings

- Easier to achieve and replace access
- Earlier to initiate feedings
- More options with which to feed patients (syringe bolus, gravity, continuous)
- Stress ulcer prophylaxis
- Utilized full length of GI tract.

Routine placement of post-pyloric feeding access may delay the introduction of EN, and can increase costs of providing nutrition. Strategies for maintaining elevated head-of-bed, transitioning to oral feeding tubes in intubated patients, and proper oral care are effective in reducing pneumonia incidence. Post-pyloric feeding should be reversed for those patients that do not tolerate gastric feeding, and utilize resources for implementing protocols that have demonstrated significant effectiveness to reduce pneumonia incidence. ■

References

1. Braunschweig CL, Levy P, Sheean PM, et al. Enteral compared with parenteral nutrition: a meta-analysis. *Am J Clin Nutr*, 2001;74(4):534-542.
2. Marik PE, Zaloga GP. Meta-analysis of parenteral nutrition versus enteral nutrition in patients with acute pancreatitis. *BMJ*, 2004;328(7453):1407-1412.
3. Revelly JP, Tappy L, Berger MM, et al. Early metabolic and splanchnic responses to enteral nutrition in postoperative cardiac surgery patients with circulatory compromise. *Intensive Care Med*, 2001;27(3):540-547.
4. McClave SA, Chang WK. Feeding the hypotensive patient: does enteral feeding precipitate or protect against ischemic bowel? *Nutr Clin Pract*, 2003;18(4):279-284.
5. Rokyta R Jr, Matejovic M, Krouzicky A, et al. Post-pyloric enteral nutrition in septic patients: effects on hepato-splanchnic hemodynamics and energy status. *Intensive Care Med*, 2004;30(4):714-717.
6. Lewis SJ, Egger M, Sylvester PA, et al. Early enteral feeding versus "nil by mouth" after gastrointestinal surgery: systematic review and meta-analysis of controlled trials. *BMJ*, 2001; 323(7316):773-776.
7. Corke C. Gastric emptying in the critically ill patient. *Crit Care Resusc*, 1999;1(1):39-44.
8. Chastre J, Fagon JY. Ventilator-associated pneumonia. *Am J Respir Crit Care Med*, 2002;165(7):867-903.
9. Heyland DK, Dhaliwal R, Drover JW, et al. Canadian Critical Care Clinical Practice Guidelines Committee. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients. *J Parenter Enteral Nutr*, 2003;27(5): 355-373.
10. Marik PE, Zaloga GP. Gastric versus post-pyloric feeding: a systematic review. *Crit Care*, 2003;7(3):R46-R51.
11. Ho KM, Dobb GJ, Webb SA. A comparison of early gastric and post-pyloric feeding in critically ill patients: a meta-analysis. *Intensive Care Med*, 2006;32(5):639-649.
12. Strong RM, Condon SC, Solinger MR, et al. Equal aspiration rates from postpylorus and intragastric-placed small-bore nasogastric feeding tubes: a randomized, prospective study. *J Parenter Enteral Nutr*, 1992;16(1):59-63.
13. Kortbeek JB, Haigh PI, Doig C. Duodenal versus gastric feeding in ventilated blunt trauma patients: a randomized controlled trial. *J Trauma*, 1999;46(6):992-996.
14. Kearns PJ, Chin D, Mueller L, et al. The incidence of ventilator-associated pneumonia and success in nutrient delivery with gastric versus small intestinal feeding: a randomized clinical trial. *Crit Care Med*, 2000;28(6):1742-1746.
15. 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(8):1495-1501.
16. Day L, Stotts NA, Frankfurt A, et al. Gastric versus duodenal feeding in patients with neurological disease: a pilot study. *J Neurosci Nurs*, 2001;33(3):148-149, 155-159.
17. Montecalvo MA, Steger KA, Farber HW, et al. Nutritional outcome and pneumonia in critical care patients randomized to gastric versus jejunal tube feedings. The Critical Care Research Team. *Crit Care Med*, 1992;20(10):1377-1387.
18. Davies AR, Froome PR, French CJ, et al. Randomized comparison of nasojejunal and nasogastric feeding in critically ill patients. *Crit Care Med*, 2002;30(3):586-590.
19. Montejo JC, Grau T, Acosta J, et al. Nutritional and Metabolic Working Group of the Spanish Society of Intensive Care Medicine and Coronary Units. Multicenter, prospective, randomized, single-blind study comparing the efficacy and gastrointestinal complications of early jejunal feeding with early gastric feeding in critically ill patients. *Crit Care Med*, 2002;30(4): 796-800.
20. Esparza J, Boivin MA, Hartshorne MF, et al. Equal aspiration rates in gastrically and transpylorically fed critically ill patients. *Intensive Care Med*, 2001;27(4):660-664.
21. Neumann DA, DeLegge MH. Gastric versus small-bowel tube feeding in the intensive care unit: a prospective comparison of efficacy. *Crit Care Med*, 2002;30(7):1436-1438.
22. Dive A, Michel I, Galanti L, et al. Gastric acidity and duodenogastric reflux during nasojejunal tube feeding in mechanically ventilated patients. *Intensive Care Med*, 1999; 25(6):574-580.
23. Virchenko SB, Sayenko VF, Kucherenko TL, et al. The duodenojejunal junction and Treitz ligament in the regulation of duodenal emptying. *Scand J Gastroenterol*, 1993; 28(9):753-759.
24. Croce MA, Swanson JM, Magnotti LJ, et al. The futility of the clinical pulmonary infection score in trauma patients. *J Trauma*, 2006;60(3):523-527.
25. Jabbar A, McClave SA. Pre-pyloric versus post-pyloric feeding. *Clin Nutr*, 2005;24(5): 719-726.
26. Taylor SJ, Fettes SB, Jewkes C, Nelson RJ. Prospective, randomized, controlled trial to determine the effect of early enhanced enteral nutrition on clinical outcome in mechanically ventilated patients suffering head injury. *Crit Care Med*, 1999;27(11):2525-2531.
27. Booth CM, Heyland DK, Paterson WG. Gastrointestinal promotility drugs in the critical care setting: a systematic review of the evidence. *Crit Care Med*, 2002;30(7):1429-1435.
28. Heyland DK, Dhaliwal R, Day A, et al. Validation of the Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients: results of a prospective observational study. *Crit Care Med*, 2004;32(11): 2260-2266.

29. Bowman A, Greiner JE, Doerschug KC, et al. Implementation of an evidence-based feeding protocol and aspiration risk reduction algorithm. *Crit Care Nurs Q*, 2005;28(4): 324-333.
30. Barr J, Hecht M, Flavin KE, et al. Outcomes in critically ill patients before and after the implementation of an evidence-based nutritional management protocol. *Chest*, 2004; 125(4):1446-1457.
31. Pinilla JC, Samphire J, Arnold C, et al. Comparison of gastrointestinal tolerance to two enteral feeding protocols in critically ill patients: a prospective, randomized controlled trial. *J Parenter Enteral Nutr*, 2001;25(2):81-86.
32. Lien HC, Chang CS, Yeh HZ, et al. The effect of jejunal meal feeding on gastroesophageal reflux. *Scand J Gastroenterol*, 2001;36(4):343-346.
33. Chendrasekhar A. Jejunal feeding in the absence of reflux increases nasogastric output in critically ill trauma patients. *Am Surg*, 1996;62(11):887-888.
34. Lin HC, Zhao XT, Wang L. Jejunal brake: inhibition of intestinal transit by fat in the proximal small intestine. *Dig Dis Sci*, 1996;41(2):326-329.
35. Van Citters GW, Lin HC. The ileal brake: a fifteen-year progress report. *Curr Gastroenterol Rep*, 1999;1(5):404-409.
36. Dobson CL, Davis SS, Chauhan S, et al. Does the site of intestinal delivery of oleic acid alter the ileal brake response? *Int J Pharm*, 2000;195(1-2):63-70.
37. Torres A, Serra-Batlles J, Ros E, et al. Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: the effect of body position. *Ann Intern Med*, 1992;116(7):540-543.
38. Metheny NA, Chang YH, Ye JS, et al. Pepsin as a marker for pulmonary aspiration. *Am J Crit Care*, 2002;11(2):150-154.
39. Drakulovic MB, Torres A, Bauer TT, et al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet*, 1999;354(9193):1851-1858.
40. Metheny NA, Clouse RE, Chang YH, et al. Tracheobronchial aspiration of gastric contents in critically ill tube-fed patients: frequency, outcomes, and risk factors. *Crit Care Med*, 2006; 34(4):1007-1015.
41. van Nieuwenhoven CA, Vandenbroucke-Grauls C, van Tiel FH, et al. Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: a randomized study. *Crit Care Med*, 2006;34(2):396-402.
42. Bullock TK, Waltrip TJ, Price SA, et al. A retrospective study of nosocomial pneumonia in postoperative patients shows a higher mortality rate in patients receiving nasogastric tube feeding. *Am Surg*, 2004;70(9):822-826.
43. Shorr AF, Duh MS, Kelly KM, Kollef MH. CRIT Study Group. Red blood cell transfusion and ventilator-associated pneumonia: A potential link? *Crit Care Med*, 2004; 32(3):666-674.
44. Kudsk KA, Croce MA, Fabian TC, et al. Enteral versus parenteral feeding. Effects on septic morbidity after blunt and penetrating abdominal trauma. *Ann Surg*, 1992;215(5): 503-511.
45. Holzapfel L, Chevret S, Madinier G, et al. Influence of long-term oro- or nasotracheal intubation on nosocomial maxillary sinusitis and pneumonia: results of a prospective, randomized, clinical trial. *Crit Care Med*, 1993;21(8):1132-1138.
46. Holzapfel L, Chastang C, Demingon G, et al. A randomized study assessing the systematic search for maxillary sinusitis in nasotracheally mechanically ventilated patients. Influence of nosocomial maxillary sinusitis on the occurrence of ventilator-associated pneumonia. *Am J Respir Crit Care Med*, 1999;159(3):695-701.
47. Mori H, Hirasawa H, Oda S, et al. Oral care reduces incidence of ventilator-associated pneumonia in ICU populations. *Intensive Care Med*, 2006;32(2):230-236.
48. Koeman M, van der Ven AJ, Hak E, et al. Oral Decontamination with Chlorhexidine Reduces the Incidence of Ventilator-associated Pneumonia. *Am J Respir Crit Care Med*, 2006;173(12): 1348-1355.
49. Marr AB, McQuiggan MM, Kozar R, et al. Gastric feeding as an extension of an established enteral nutrition protocol. *Nutr Clin Pract*, 2004;19(5):504-510.
50. Kollef MH, Von Harz B, Prentice D, et al. Patient transport from intensive care increases the risk of developing ventilator-associated pneumonia. *Chest*, 1997;112(3):765-773.
51. Dodek P, Keenan S, Cook D, Heyland et al. Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med*, 2004;141(4):305- 313.
52. Valentine RJ, Turner WW Jr, Borman KR, et al. Does nasoenteral feeding afford adequate gastroduodenal stress prophylaxis? *Crit Care Med*, 1986;14(7):599-601.
53. Parrish CR, Krenitsky J, McCray S. University of Virginia Health System Nutrition Support Traineeship Syllabus. Available through the University of Virginia Health System Nutrition Services in January 2003.

PRACTICAL GASTROENTEROLOGY

R E P R I N T S

Practical Gastroenterology reprints
are valuable, authoritative, and informative.

Special rates are available for
quantities of 100 or more.

For further details on rates
or to place an order:

Practical Gastroenterology

Shugar Publishing

99B Main Street

Westhampton Beach, NY 11978

Phone: 631-288-4404

Fax: 631-288-4435

www.practicalgastro.com