Gastric versus Post-pyloric Feeding: Relationship to Tolerance, Pneumonia Risk, and Successful Delivery of Enteral Nutrition

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Current Gastroenterology Reports 2007, **9**:309–316
Current Medicine Group LLC ISSN 1522-8037

Enteral nutrition has been shown to have clinical advantages over parenteral nutrition in critically ill patients. However, delivery of enteral nutrition can be challenging because of intolerance and potential adverse effects. Gastric feeding is more physiologic than post-pyloric feeding, but its use may be limited by intolerance due to gastric dysfunction and by inappropriately low gastric residual volumes. Post-pyloric feeding may help to overcome these disadvantages by making it possible to avoid feeding interruption and potentially reduce the risk of aspiration. Results from studies to date have not shown any advantage of post-pyloric over gastric feeding in regard to outcome. This article focuses on strategies for enteral nutrition delivery in critically ill patients. The selection of site for enteral feeding should be based on risks, patient tolerance, and availability of local expertise. Predetermined feeding protocols may help to optimize the delivery of enteral nutrition. Only sufficient and safe delivery of enteral nutrition will have a positive impact on patient outcome.

Introduction

Nutritional support clearly influences the outcome of critically ill patients. Enteral nutrition (EN) is a preferred route of nutritional support because of its lower rate of complications, preservation of gut function, and lower cost when compared with parenteral nutrition [1,2]. However, successful enteral feeding of critically ill patients can be challenging. Delivery requires enteral access by placement of the feeding tube either in the stomach or beyond the pylorus. Post-pyloric feeding refers to nutrient delivery into the duodenum or more distally into the jejunum. EN must be delivered in a timely fashion to have positive impact on the outcome. Some investigators have questioned the possible benefits of EN because of its inability to reach caloric goal early when compared with parenteral nutrition and because of the complications related to its delivery [3]. EN should be avoided in patients with hemodynamic instability due to risk of small bowel ischemia.

Use of EN is affected by concerns about tracheobronchial aspiration and feeding intolerance based on high gastric residual volumes (GRVs). Controversial issues with regard to EN include the optimal site of nutrient delivery (whether intragastric or post-pyloric), complications involved in its delivery, and the ability of EN to meet caloric goals. This article compares gastric and post-pyloric feeding with regard to risk of aspiration pneumonia and reflux, tolerance, and achievement of caloric goals. Site selection and strategies to improve nutrient delivery in critically ill patients are reviewed.

Gastroesophageal Reflux

A higher rate of gastroesophageal reflux (GER) has been observed in patients receiving enteral feeding. GER is recognized as the initial event leading to aspiration of gastric content. Patients at a higher risk of GER include those with a high volume of gastric content and gastric distention, which lead to relaxation of the lower esophageal sphincter (LES) and more frequent episodes of GER. The presence of a nasoenteric tube can interfere with the function of the upper and lower esophageal sphincters and may predispose a patient to GER and subsequent aspiration. The effect of feeding tube size on the frequency of GER and aspiration is controversial. A higher rate of GER was reported in patients with use of small-bore nasogastric tubes when compared with patients without the tubes (74% vs 35%, $P<0.05$) [4]. The study results suggest that the presence of a nasogastric tube is a risk factor for GER. The same author reported results from a study showing no difference in aspiration of gastric contents in 30 patients on mechanical ventilation with or without small-bore nasogastric tubes, suggesting that small-bore tubes may be safe in preventing ventilator-associated pneumonia [5]. Other studies have shown no difference in the microaspiration rate with the use of various sizes of feeding tubes in adults [6]. In children, the use of smaller tubes has been associated with less GER [7]. Because data are insufficient, replacement of standard large-bore nasogastric tubes with small-bore tubes for prevention of aspiration is not recommended in the intensive care unit (ICU). Despite studies showing fewer reflux episodes after placement of percutaneous endoscopic gastrostomy (PEG) when compared with nasogastric intubation, investigators found no difference in the rate of aspiration pneumonia between these two types of feeding [8]. Advancement of the feeding tube beyond the pylorus theoretically should overcome the risk of GER because the pylorus acts as a protective barrier against reflux of the nutrient contents back into the stomach. However, this is not always the case. Gustke et al. [9] showed significant reduction in GER with placement of the feeding tube beyond the ligament of Treitz, suggesting that this location may provide additional antireflux protection. Later studies revealed no difference in the rate of aspiration pneumonia between gastric and post-pyloric feeding, indicating that other mechanisms were involved in the pathophysiology of aspiration [10]. An increased rate of GER observed with post-pyloric feeding results from the regurgitation of gastric content rather than from the feeding formula. Jejunal feeding may stimulate the production of gastric and pancreatobiliary secretions with secondary increase in gastric output responsible for aspiration [11].

Aspiration Pneumonia

Enteral feeding is associated with a higher risk of aspiration, which can lead to acute lung injury and nosocomial pneumonia, possibly caused by tracheobronchial aspiration of the gastric content. The reported incidence of aspiration pneumonia varies between 10% and 40% of patients receiving EN in the ICU [12]. Aspiration pneumonia has been associated with a worse outcome, including prolonged ICU stay and increased length of hospitalization. It is the also a leading cause of hospital-acquired mortality, with mortality rates reaching up to 70% in mechanically ventilated patients [13]. However, the true incidence of aspiration pneumonia has been difficult to determine due to vague definitions, unreliable detection, and differences in clinical recognition.

In addition to enteral feeding, other factors that can predispose patients to aspiration include decreased consciousness, neurologic dysfunction, endotracheal intubation, anesthesia, supine position, nasoenteral intubation, gastroparesis, and GER [14]. Determination of the extent to which a single factor contributes to aspiration can be difficult because multiple factors are often involved simultaneously. Interestingly, although aspiration is quite common in critically ill patients receiving enteral feeding, progression to aspiration pneumonia is difficult to predict because of differences in character of the aspirated material and individual host responses. Bronchopulmonary aspiration can result from bacterial colonization in the oropharynx, aspiration of tube feeding, or aspiration of gastric content leading to chemical pneumonitis [15]. Clinically, patients present with fever, cough, wheezing, and rapid respiratory failure. Several bedside methods have been used to facilitate the detection of gastric aspirates in tracheal secretions. These methods include use of blue food coloring and testing for high glucose levels in tracheal or oropharyngeal aspirates [16]. However, both methods lack sensitivity and are unreliable. Blue dye can be harmful, and its use has been associated with deaths [17].

In gastric feeding, enhanced colonization of the stomach by gram-negative bacilli has been observed as a result of buffering gastric acid by enteral feeds. Aspiration of oropharyngeal secretions may be more important in the development of pneumonia than aspiration of the gastric contents. Poor oral hygiene has been found to be a major risk factor for aspiration pneumonia. The oral cavity and teeth become colonized with pathogenic bacteria during prolonged periods of mechanical ventilation [18]. Three prospective trials have monitored the source of bacterial contamination in the upper respiratory tract, stomach, oropharynx, and trachea in ICU patients. In the first study, the oropharynx was the primary site of colonization in 80% of patients, and the stomach was never the primary site of colonization [19]. Pingleton et al. [20] have shown that, in the majority of patients the trachea was secondarily colonized only after the colonization of the stomach or oropharynx. In another study, patients with pneumonia had a significantly higher rate of oropharynx colonization before the onset of pneumonia when compared with patients without pneumonia, whereas no gastric colonization was detected [21]. The results of these studies suggest that aspiration of contaminated secretions from the oropharynx leads to nosocomial pneumonia rather than aspiration of enteral feeds or gastric secretions. Aggressive oral care with chlorhexidine mouthwash has been shown to reduce bacterial colonization of the oropharynx and to decrease the risk of aspiration pneumonia [22]. These results could explain the lack of difference in pneumonia rate between gastric and post-pyloric feeding despite higher risk of reflux with the first method. A recently published meta-analysis reviewed results from four randomized controlled trials involving 1202 patients. This analysis showed that oral decontamination with chlorhexidine did not result in significant reduction in the incidence of nosocomial pneumonia (odds ratio [OR] of 0.42), nor did it alter the mortality rate in mechanically

Table 1. Randomized controlled trials of gastric versus post-pyloric feeding

Study	Year	Patients, *n*	Post-pyloric tube position	GRV, *mL**	Use of prokinetics	Pneumonia rate	Mortality rate
Montecalvo et al. [25]	1992	38	Jejunum	>250	No	NS	NS
Strong et al. [52]	1992	33	Duodenum	NR	NR	NS	NR
Kortbeek et al. [28]	1999	80	Duodenum	>250	Yes	NS	NS
Kearns et al. [27]	2000	44	Duodenum	>150	No	NS	NS
Day et al. [47]	2001	25	Duodenum	NR	No	NS	NR
Heyland et al. [15]	2001	33	Duodenum	>200	Yes	NS	NR
Esparza et al. [45]	2001	54	Not specified	>150	Yes	NS	MS
Davies et al. [46]	2002	73	Jejunum	>250	No	NS	NS
Montejo et al. [53]	2002	110	Jejunum	>300	No	NS	NS
Neumann and DeLegge [54]	2002	60	Not specified	>200	No	NS	NR
Boivin and Levy [39]	2001	80	Not specified	NR	Yes	NR	NS

*Cut-off at which gastric feeding was stopped or temporarily discontinued or at which prokinetics were added.
GRV—gastric residual volume; NR—not reported; NS—not statistically different.

ventilated patients (OR of 0.77) [23]. However, the lack of benefit of oral chlorhexidine may have resulted from the small number of studies published. Further studies are needed to clarify a role of oral decontamination. At this point routine oral care, including chlorhexidine, should be implemented for the prevention of aspiration in mechanically ventilated patients.

Other correctable risk factors for aspiration include malpositioned feeding tubes, improper feeding site, large gastric volume, and a supine position. Avoidance of a supine position during tube feeding is important. In a prospective randomized study, increased frequency of gastropulmonary aspiration has been demonstrated, without clinically significant increase in pneumonia rate, in patients receiving nasogastric feeding while in the supine position [24]. The head of the bed should be elevated by 35 to 45 degrees to reduce the incidence of aspiration. However, it is not known how often this position is followed in clinical practice. In certain situations, such as hemodynamic instability, some medical procedures, and transportation for diagnostic tests, head elevation is not feasible for prolonged periods. Prokinetic agents should be considered to enhance gastric emptying and prevent regurgitation in patients who need to be fed while in the supine position. Unrecognized malposition of the feeding tube can contribute to aspiration during enteral feeding. Reasons for displacement of the tubes include incorrect initial placement, upward dislocation of the tube after coughing or retching, or incidental pulling by the patient. Monitoring of tube position during bedside examination is important because migration of the tube tip from the small bowel back to the stomach can lead to unrecognized regurgitation and aspiration. Early identification of high-risk patients and implementation of aspiration precautions can decrease the incidence of aspiration from enteral feeding. In patients with confirmed aspiration, enteral feeding may be continued after appropriate steps are taken to reduce the risk of further aspiration and when supportive pulmonary care is provided.

Controversy About Enteral Feeding

Selection of a feeding method—either intragastric or post-pyloric—can be important in selected patients. The advantages of post-pyloric as opposed to gastric feeding have not been well documented. Does the feeding level have an effect on the incidence of aspiration pneumonia? Randomized controlled trials have provided mixed results in regard to the risk of aspiration pneumonia in both methods of feeding. More than 10 randomized trials have addressed this issue (Table 1). The trials included a heterogeneous patient population but differed significantly in methodology, sample size, tube location, GRVs, use of prokinetic agents, aspiration documentation, and achievement of caloric goals. One of the important issues that could affect the results was the exact position of the feeding tube tip, whether in the duodenum or the jejunum. In a few studies, the location of the tube tip was neither specified nor monitored. Post-pyloric tubes could have been displaced and flipped back into the stomach. Nasogastric tubes may have advanced spontaneously into the duodenum, so that the patient was switched to post-pyloric feeding instead. The rate of GER and aspiration may have been affected by gastric decompression, used in some studies by placement of the additional nasogastric tube or use of double-port tubes.

At least three meta-analyses have compared gastric and post-pyloric feeding with regard to the rate of aspiration pneumonia, mortality, and adequacy of nutrient delivery as the secondary endpoint. Heyland et al. [10] systematically reviewed high-quality randomized controlled studies in critically ill patients [10]. They found no statistical difference in the rate of aspiration pneumonia between gastric and post-pyloric feeding in nine of the studies. In two studies, a trend toward a reduced rate of pneumonia was detected with post-pyloric feeding [25,26]. When the data from the nine studies were combined, the meta-analysis showed a significant reduction in pneumonia with post-pyloric feeding compared with gastric feeding (*P*=0.05). However, this difference was caused by the results of the study by Taylor et al. [26] and disappeared after its exclusion from the analysis (*P*=0.30). The success of nutrient delivery and the achievement of early caloric goals were significantly better in post-pyloric feeds when compared with gastric feeds [25,27,28]. The difference was thought to be related to more interruptions of gastric feeds and to poor feeding advancement from the use of low GRVs. The meta-analysis revealed no difference in mortality or length of hospital stay between the two feeding methods. Post-pyloric feeding was associated with a lower rate of pneumonia and a shorter time in reaching the nutritional target in critically ill patients.

In the second meta-analysis, Marik and Zaloga [29] evaluated the effects of feeding level on the incidence of aspiration pneumonia, caloric intake, length of ICU stay, and mortality in nine clinical trials. They found a trend toward higher incidence of pneumonia in gastric feeding, but the difference was not statistically significant (*P*=0.19). Mortality, length of ICU stay, and attainment of caloric goals were similar using the two feeding methods.

The most recent meta-analysis, performed by Ho et al. [30], evaluated 11 randomized controlled studies with regard to benefits and adverse effects of early post-pyloric feeding compared with gastric feeding in critically ill patients without impaired gastric emptying. The rates of aspiration pneumonia and mortality were not significantly different in patients receiving gastric as opposed to post-pyloric feeding, including rates in patients with or without concurrent gastric decompression. The gastric feeding group had a much lower rate of feeding tube placement difficulties or blockage (0% vs 9.6%). Significant clinical benefits for early post-pyloric feeding, as opposed to gastric feeding, in critically ill adults, were lacking.

In summary, except for the first meta-analysis, no statistical difference in aspiration risk was found between gastric and post-pyloric feeding. However, the first meta-analysis included a study of suboptimal quality, and after this study was excluded, the outcome was similar to the results of previous meta-analyses. Clinicians must find a balance between the potential complications from early enteral feeding and its expected benefit.

Feeding Tolerance: GRV

Many critically ill patients have difficulty tolerating feeding into the stomach because of nausea and abdominal distention. GRVs are used in clinical practice as the primary determinant of intolerance in patients receiving nasogastric feeding. GRVs are measured by aspiration of gastric content from a nasogastric tube. The accuracy of GRVs is often limited due to lack of a standard for measurement. GRVs consist of enteral formula along with swallowed saliva and gastric secretions. GRV values cited in the literature range from 100 to 450 mL. Traditionally, GRVs greater than 150 mL indicate that EN should be ceased, because higher GRVs are associated with higher risk of regurgitation and aspiration [31]. Physical findings (abdominal distention, increased tympany, and decreased bowel sounds) do not correlate well with GRVs [32]. GRVs are often a limiting step in EN delivery. Newer data suggest that higher GRV values should be used for detection of intolerance [33•]. Higher GRVs are expected with initiation of feeding, higher rate of infusion, and bolus feeding rather than continuous feeding. Monitoring of GRVs allows early detection of feeding intolerance and early intervention to combat intolerance, such as treatment with prokinetic agents or conversion from gastric to post-pyloric feeding. Therefore, vigilance is needed even with low GRVs in asymptomatic patients with suspected gastric dysmotility and in those who are uncommunicative. Isolated high GRVs should be rechecked instead of automatically discontinuing the tube feeds. A trend in GRVs may be more clinically significant than a single GRV value. Clinical judgment is important, and any evidence of overt regurgitation or aspiration should lead to immediate cessation of feeding and reevaluation. Successful delivery of EN is highly dependent on the appropriate threshold selection for GRVs. Discontinuation of feeding because of GRVs is recognized as one of the correctable factors responsible for feeding cessation and delay in nutrition delivery. Acceptance of GRVs up to 250 mL may allow a higher volume of EN delivery. Tube feeding should not be discontinued unless GRVs are greater than 400 to 500 mL in patients who are doing well clinically. Promotility agents can help to reduce GRVs and to prevent reflux of gastric contents. Aggressive feeding protocols have been shown to provide a significantly greater percentage of goal calories and improved outcome. GRVs obtained by aspiration from a nasogastric tube do not allow differentiation of the components of the stomach, such as gastric secretion and feeds. A recent study has confirmed the feasibility of refractometry and Brix value measurement of gastric juice for bedside monitoring of gastric tolerance, providing valuable complementary information to GRVs [34••]. This method appears to be simple, reproducible, and inexpensive.

Role of Prokinetic Agents in Improving Feeding Tolerance

Delayed gastric emptying occurs frequently in ICU patients and increases the time needed to achieve nutritional goals. Drugs stimulating gastric motility, including metoclopramide (10 mg four times daily intravenously or enterally), erythromycin, (100–200 mg daily

Table 2. Indications for gastric and post-pyloric feeding

Gastric	Post-pyloric
Majority of patients	Gastroparesis
Trauma	Severe gastroesophageal reflux
Stroke	Scleroderma
Short bowel	Severe pancreatitis
Total laryngectomy	Intolerance of gastric feeding (after failure of prokinetics)

intravenously), and cisapride (off the market) have been used successfully in the treatment of feeding intolerance in critically ill patients [35,36]. Prokinetic agents reduce GRVs, improve tolerance of enteral feeding, and enhance early nutritional intake [37]. Naloxone, a selective blocker of intestinal opioid receptors, has been used successfully in patients receiving opioid analgesia. Enteral administration of naloxone (8 mg every 6–8 hours) has been associated with reduced GRVs and decreased pneumonia rate [38]. Gastric feeding with erythromycin was equally effective in achieving nutritional goals among critically ill patients when gastric intolerance was detected early [39].

Type of Feeding: Continuous versus Bolus

Choice of continuous versus bolus feeding may be important in achieving caloric goals and reducing the risk of aspiration. Increased volume and a higher rate of feeds can increase the intragastric pressure and probability of GER. Continuous feeding has been shown to reduce the risk of aspiration, compared with bolus feeding, because it causes less gastric distention and less GER [40]. Continuous feeding has been associated with fewer interruptions of nutrient delivery and improved gastric tolerance, including lower rates of diarrhea, regurgitation, and vomiting and more efficient glucose metabolism. Intermittent feeding allows a lower gastric pH, minimizing bacterial colonization of gastric content and reducing the risk of aspiration pneumonia when compared with continuous feeding [41]. However, the benefit of intermittent feeding in reducing pneumonia in tube-fed patients has been controversial [19]. Bolus feeding should be reserved for patients with an intact gag reflex and a normal level of consciousness.

Caloric goal and delivery site

The goals for EN are to maximize the delivery of feeding while minimizing its associated risks. Early achievement of the caloric target is critical for positive outcomes. Inadequate EN delivery has been well documented in ICU patients. In a prospective study assessing consistence of caloric intake in critically ill patients, the average intake was only 50.6% of the targets [42]. Suboptimal nutrient delivery and underfeeding can result in worse outcome. Nasogastric feeding may be safe in a selected group of patients [43,44]. Bypassing the stomach through post-pyloric provision of EN has the theoretical benefit of reducing the frequency of GER and aspiration and improving nutrient delivery. In some institutions, feeding beyond the ligament of Treitz has become standard in the ICU. The selection of site for nutrient delivery may be an important consideration for enteral feeding (Table 2).

Gastric feeding

Advantages

Direct feeding to the stomach is more physiologic than post-pyloric infusion of nutrients. Placement of a nasogastric feeding tube is simple and less time-consuming than the placement of a nasoenteral feeding tube and may thus allow earlier initiation of feeding. The stomach can tolerate higher volumes of feeds and higher osmotic loads than the small bowel, reducing diarrhea and cramping resulting from longer retention of formula in the stomach. In gastric feeding, standard formulas rather than more expensive semi- or elemental formulas can be used. In addition, EN can be provided as cyclic rather than continuous feeding into the stomach. Bolus feeding mimics the natural pattern of eating. Another theoretical benefit of gastric feeding is greater neutralization of the gastric acid, thus providing additional protection from stress ulcers.

Disadvantages

The main concern is the potentially higher risk of pneumonia from aspiration of the formula from the stomach when compared with risk in post-pyloric feeding. The effect of intragastric infusion on the rate of regurgitation and microaspiration has been evaluated in two prospective randomized studies using radioisotope-labeled formula. In the first study, radioactivity was measured after a sample was taken from the oropharynx and trachea hourly for 6 hours daily in ventilated ICU patients [15]. Patients who received feeding into the stomach had more episodes of GER (7.5% vs 3.9%, P=0.22) and a trend toward more microaspiration (39.8% vs 24.9%, P=0.04) than those fed beyond the pylorus. In the second trial, pulmonary secretions or lungs in 54 mechanically ventilated patients were scanned daily to detect aspiration after radio-labeled feeds, and tube position was monitored daily by continuous electromyography [45]. The authors found no statistical difference in the aspiration rate between gastric and post-pyloric feeding (7% vs 13%, P>0.05). Interestingly, clinical suspicion of aspiration was found to be insensitive and correlated only with 60% of isotopically documented aspirations.

Post-pyloric feeding

Advantages

Post-pyloric feeding should be considered in patients with gastric intolerance, those at high risk for aspiration and severe GER, or following gastric surgery. Patients with impaired gastric motility from analgesia and sepsis may benefit from post-pyloric feeding if treatment with prokinetic agents is not successful. Less interruption in nutrient delivery can be expected if GRVs do not need to be measured. Therefore, post-pyloric feeding allows earlier achievement of caloric goals when compared with gastric feeding [27,46]. In critically ill neurologic patients, neither feeding method allowed achievement of the mean recommended caloric intake during a 10-day study [47]. Another group of patients who clearly benefit from jejunal feeding are those with severe acute pancreatitis [48]. For those patients, jejunal feeding beyond the ligament of Treitz has become standard care.

Disadvantages

One of the main problems is the access issue for post-pyloric feeding. In critically ill patients, spontaneous transpyloric passage of nasoenteric feeding tubes is often unsuccessful because of gastric dysmotility [49]. Prokinetic agents (metoclopramide, 10 mg, given once) can improve spontaneous transpyloric tube advancement. The bedside placement of a nasoenteric tube can be frustrating. Success rates for bedside placement have been reported to be between 20% and 90%, depending on the available expertise [50]. The bedside placement of a nasogastric tube is time-consuming and requires radiographic confirmation of tube placement. Newer techniques have been developed to speed post-pyloric tube placement [51•]. Radiologic and endoscopic placement of nasoenteric tubes has been successful in more than 90% of cases, allowing immediate initiation of feeding [46,49]. However, these techniques require expertise that is not available in every institution. Fluoroscopic tube placement requires patient transportation outside the ICU, which may be a limiting factor, especially if the patient is unstable. Endoscopic placement of the nasoenteric tube can be time-consuming and is frequently delayed if a gastroenterologist is not available. Nasoenteric tubes require more maintenance because of the smaller size of the feeding channel. They clog more often, and their use has been associated with a higher rate of intestinal ulceration and perforation. Tube displacement can occur, with the tube flipping back to the stomach. Technical delays in initial tube placement and feeding may have a negative impact on outcome.

Conclusions

EN is the first choice of nutrient delivery for critically ill patients. Early delivery of enteral feeding is important to assure a positive outcome. Frequent interruptions of feeding due to concerns about intolerance can limit the benefits of EN. Appropriate bedside evaluation and implementation of feeding protocols can improve nutrient delivery by making feeding practices more consistent. Determining clear criteria for shifting from gastric to post-pyloric feeds helps to achieve the caloric target sooner. Post-pyloric tube placement is associated with reduced GRVs and GER, but adequately powered trials have not shown that post-pyloric feeding prevents aspiration pneumonia. Identification of patients at risk for aspiration is important. Candidates for post-pyloric feeding include patients treated with sedatives and opioids (due to supine position) and those with high GRVs, gastroparesis, or severe acid reflux. Suboptimal delivery of EN, delays in tube placement, automatic cessation of feeding due to inappropriately preset low GRVs, and slow feed advancement may have an unfavorable impact on outcome. Routine use of post-pyloric feeding is feasible when radiologic and endoscopic techniques are available for quick tube placement. In contrast, if post-pyloric tube placement is typically delayed, protocols promoting gastric feeds should be used instead. Modifications in gastric feeding, such as conversion from bolus to continuous feeding, standard use of prokinetics, close monitoring of feeding, oral antiseptics, elevation of the head of the bed, and limited use of opioids, can improve the safety of EN delivery. Other strategies to prevent aspiration should be available in the institution, such as advancing the feeding tube into the jejunum and using gastric decompression tubes. Meta-analyses have shown no statistical difference in the outcomes between intragastric and post-pyloric feeding. A positive trend has been observed with respect to earlier achievement of the nutritional target with post-pyloric feeding. Finally, large randomized controlled trials are needed to evaluate the effect of feeding level on aspiration pneumonia and mortality.

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