A review of the nursing care of enteral feeding tubes in critically ill adults: part I

Teresa A. Williams a,∗, Gavin D. Leslie b,1

a Royal Perth Hospital, PO Box X2213, Perth, WA 6847, Australia
b Centre for Nursing Evidence Based Practice, Education and Research, Royal Perth Hospital, PO Box X2213, Perth, WA 6847, Australia

Accepted 9 August 2004

KEYWORDS
Enteral tube; Feeding; Intensive care

Summary Enteral tubes are frequently used in critically ill patients for feeding and gastric decompression. Many of the nursing guidelines to facilitate the care of patients with enteral tubes have not been based on current research, but on ritual and opinion. Using a computerised literature search and an evidence-based classification system as described by the Joanna Briggs Institute for Evidence Based Nursing and Midwifery (JBI), a comprehensive review was undertaken of enteral tube management.

Several nursing practices related to enteral tube management are described. Evidence to support alternate methods of tube placement assessment other than abdominal X-ray was inconclusive. Enteral feeding should continue if gastric residual volumes are not considered excessive, as feeding is often withheld unnecessarily. Frequency of checking gastric residual volumes is largely opinion based and varies considerably, but prokinetics that aid gastric emptying should be used if absorption of feeds is problematic. Other recommendations include continuous rather than intermittent feeding, semi-recumbent positioning to reduce the risk of airway aspiration and diligent artificial airway cuff management. Contamination of feeds can be minimised by minimal, meticulous handling and the use of closed rather than open systems. Generally, there was little high quality evidence to support practice recommendations leaving significant scope for further research by nurses in the management of patients with enteral tubes.

© 2004 Elsevier Ltd. All rights reserved.

Introduction

Enteral tubes are frequently used in the critically ill patient for gastric decompression, delivery of medications and food substitutes. Although enteral feeding is beneficial, as with most healthcare interventions, there are risks and po-
A review of the nursing care of enteral feeding tubes in critically ill adults

Nursing care of patients with enteral feeding tubes has often been based on ritual and opinion rather than current research (Booker et al., 2000; Edwards and Metheny, 2000; Metheny, 1993). Best practice is based on the highest levels of evidence to facilitate the benefits and minimise the harm associated with any therapy. The systematic and rigorous approach to the analysis and grading of research findings in terms of level of evidence facilitates the development of specific guidelines, standards and recommendations to provide the best possible care for every patient. In part I of this two part paper, the current research findings for the nursing care of critically ill patients with enteral feeding tubes is reviewed. Nursing care of patients to prevent aspiration is described. In part 2 of this paper, nursing management and recommendations for implementing evidence-based protocols for tube and feeding management are discussed.

Data sources and levels of evidence

Several methods were used to identify relevant articles for this review. A computerised literature search of online databases MEDLINE (1966–2003), EMBASE (1966–2003), CINAHL (1982–1996), and the Cochrane Library (1992–2003) was conducted. Searches were restricted to the English language, adults and humans. Relevant abstracts were reviewed and identified articles assessed. The reference lists of all articles were examined for additional papers not previously identified. The evidence base applied in classifying literature was adapted from the recommendations of The Joanna Briggs Institute for Evidence Based Nursing and Midwifery (The Joanna Briggs and Institute, 2002) (Table 1).

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Evidence obtained from a systematic review of all relevant randomized controlled trials</td>
</tr>
<tr>
<td>Level II</td>
<td>Evidence obtained from at least one properly designed randomized controlled trial</td>
</tr>
<tr>
<td>Level III.1</td>
<td>Evidence obtained from well-designed controlled trials, not randomized</td>
</tr>
<tr>
<td>Level III.2</td>
<td>Evidence obtained from comparative studies such as cohort studies, case–control studies preferably from more than one centre or research group</td>
</tr>
<tr>
<td>Level III.3</td>
<td>Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments</td>
</tr>
<tr>
<td>Level IV</td>
<td>Evidence from opinion of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees</td>
</tr>
</tbody>
</table>

or small intestine increase patient tolerance, reduce the risk of aspiration (Treloar and Stechmiller, 1984) and improve delivery of nutrition, but are difficult to aspirate, rupture, knot, block easily, and tend to migrate unnoticed out of position (Marcuard and Stegall, 1990; Powell et al., 1993; Treloar and Stechmiller, 1984). Most patients commence feeding via a gastric tube (Preiser et al., 1999), which is considered safe and efficient (Neumann and DeLegge, 2002), however, patients who develop gastric intolerance whilst being fed via this route may be changed to an intestinal tube (Montejo et al., 2002).

Complications of enteral tubes and feeding

Complications occur with enteral feeding (Cerra et al., 1997) whatever type of tube is used (Table 2). The incidence of complications varies considerably and is largely unknown.

Pulmonary aspiration of oropharyngeal or gastric contents is an important complication reported to occur in 0.8—95% of critically ill patients (Cataldi-Betcher et al., 1983; Winterbauer et al., 1981), although the true incidence is unknown due to lack of definition standardisation (Neumann and DeLegge, 2002) and silent aspiration. What is important is whether the patient develops nosocomial pneumonia as a result of aspiration. Aspiration events are often not accompanied by coughing or other signs of respiratory distress and may not be evident even to skilled clinicians (Arrowsmith, 1993; Elpern, 1997; Metheny et al., 1990). Critically ill patients with enteral tubes are at greater risk for aspiration because of altered sensorium, sedative and narcotic medications, unstable physiological status and physical disruptions of the gastrointestinal tract (Booker et al., 2000). The enteral tube bypasses the protective mechanisms of the oesophagus impinging on the lower oesophageal sphincter increasing the risk of gastro-oesophageal reflux (Cook and Kollef, 1998; Ibanez et al., 1992; Orozco-Levi et al., 1995). Oropharyngeal secretions have been found to be the principal source of aspiration (Valles et al., 1995), however, migration of bacteria along the tube from the stomach to the upper airway may contaminate oral secretions and increase the risk of pneumonia from aspiration (Anonymous, 1996; Ewig et al., 1999; Inglis et al., 1993; Torres et al., 1992), although this process has been disputed (Bonten et al., 1994; de Latorre et al., 1995). Despite frequent suctioning, small volumes of pharyngeal secretions may still be aspirated into the lower respiratory tract increasing the risk of nosocomial pneumonia (Finucane and Bynum, 1996). Risk factors associated with nosocomial pneumonia include organ system failure, method of airway management, age, antibiotic exposure, level of consciousness and positioning of the patient (Kearns et al., 2000).

Intestinal feeding may be used for patients who aspirate frequently or with a higher risk of gastric

<table>
<thead>
<tr>
<th>Complication</th>
<th>Study/results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intolerance of feeding (such as high residual gastric volumes, regurgitation, vomiting and diarrhoea)</td>
<td>Adam and Batson (1997): 14% delivery interruption Cataldi-Betcher et al. (1983): 3%; Pinilla et al. (2001): 7% Aronchick et al. (1984): 4 cases in 3 months; Dorsey and Cogordon (1985): 2 cases in 4 months; Harris and Huseby (1989): 5.45; Metheny et al. (1990): 10 cases in 2 years; Valentine and Turner (1985): 0.3%</td>
</tr>
<tr>
<td>Mechanical Block feeding tubes Inadvertant respiratory placement</td>
<td>Marcuard and Stegall (1990); Powell et al. (1993); Treloar and Stechmiller (1984)</td>
</tr>
</tbody>
</table>
### Table 3  Studies assessing intestinal vs. gastric feeding.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Davies et al. (2002)</strong></td>
<td>Randomised, prospective, clinical study of 73 ICU patients</td>
<td>Demonstrated jejunal feeding reduced gastric residual volumes and tended to improve feeding tolerance</td>
</tr>
<tr>
<td><strong>De Jonghe et al. (2001)</strong></td>
<td>Prospective cohort design in 51 consecutive patients who received nutritional support either enterally or intravenously for 2 days</td>
<td>Inadequate delivery of enteral nutrition. Large volumes of enterally fed nutrients wasted because of inadequate timing in stopping and restarting enteral feeding</td>
</tr>
<tr>
<td><strong>Esparza et al. (2001)</strong></td>
<td>Prospective study in 54 critically ill patients</td>
<td>Clinical suspicion of aspiration was insensitive and detected only 60% of isotopically documented aspirations. No difference in aspiration rates between gastrically and transpylorically fed critically ill patients</td>
</tr>
<tr>
<td><strong>Heyland et al. (2001)</strong></td>
<td>Randomised trial with 33 patients</td>
<td>Post pyloric feeding is associated with a significant reduction in gastro-oesophageal regurgitation and a trend toward less microaspiration</td>
</tr>
<tr>
<td><strong>Heyland et al. (2002)</strong></td>
<td>Systematic review evaluated 10 randomised controlled trials</td>
<td>Patients who regurgitated were much more likely to aspirate than those who did not regurgitate. Intestinal feeding more advantageous. Gastro-oesophageal regurgitation was reduced, nutrient delivery increased, target nutrition met in shorter time and ventilator-associated pneumonia reduced with intestinal feeding. Small sample size threatens internal validity. Use of surrogate endpoint (&gt;100 counts/min/g) may not be clinically important</td>
</tr>
<tr>
<td><strong>Kearns et al. (2000)</strong></td>
<td>Prospective, randomised, controlled trial. Medical ICU 44 endotracheally intubated, mechanically ventilated patients</td>
<td>No clear difference in the incidence of ventilator acquired pneumonia in small intestine compared with gastric enteral nutrition. Small intestine feeding received higher calorie and protein intakes</td>
</tr>
<tr>
<td><strong>Kortbeek et al. (1999)</strong></td>
<td>Randomised controlled trial of duodenal vs. gastric feeds of 80 patients</td>
<td>Length of stay and ventilator days were not significantly different. Transpyloric-duodenal feeds significantly reduced the time required to achieve targeted enteric nutrition</td>
</tr>
<tr>
<td><strong>McCclave et al. (1999)</strong></td>
<td>Prospective study 44 medical ICU and coronary care units</td>
<td>Half the patients received their caloric requirements—underordering or frequent and often inappropriate cessation of feeding</td>
</tr>
</tbody>
</table>
motility dysfunction (Kirby et al., 1995). Whether intestinal tubes decrease the rate of aspiration remains controversial (Table 3). Comparing aspiration rates between transpyloric and gastric feeding, some investigators have found no difference in aspiration rates (Esparza et al., 2001; Kearns et al., 2000; Neumann and DeLegge, 2002; Spain et al., 1995; Strong et al., 1992) whilst other investigators have found decreased aspiration rates which did not reach statistical significance (Heyland et al., 2001; Montecalvo et al., 1992). No difference was observed in the rate of nosocomial pneumonia (Kortbeek et al., 1999; Marik and Zaloga, 2003; Montejo et al., 2002) in the ICU length of stay or mortality in patients fed gastrically versus postpylorically (Marik and Zaloga, 2003), although gastrointestinal complications were observed more frequently in patients with gastric tubes (mainly larger residual gastric volumes) (Montejo et al., 2002). Rare complications include mesenteric ischaemia, with abdominal pain, distension, increased nasogastric drainage or intestinal ileus seen with jejunal tubes (Lawlor et al., 1998; Rai et al., 1996; Schunn and Daly, 1995; Smith-Choban and Max, 1988) and small bowel necrosis, which has been associated with a high mortality (Munshi et al., 2000).

Enteral feeding is often delayed or ceased because of gastrointestinal intolerance (such as high residual gastric volumes, regurgitation, vomiting and diarrhoea) and for stoppage for procedures (Adam and Batson, 1997; Heyland et al., 1995; Heyland et al., 2003). Many critically ill patients have impaired gastric motility, often caused by medications such as opioids or catecholamines, hyperglycaemia, increased intracranial pressure, decreased gastric blood flow or the response to stress and pain (Montejo, 1999; Reignier et al., 2002). Stopping feeds because of the risk of gastrointestinal

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marik and Zaloga (2003)</td>
<td>Systematic review and meta-analysis of nine RCTs. Mixed group of critically ill patients (n = 522), including medical, neurosurgical, and trauma ICU patients</td>
<td>No demonstrated clinical benefit from post-pyloric vs. gastric tube feeding. Incidences of pneumonia, ICU LOS, and mortality were similar between groups</td>
</tr>
<tr>
<td>Montecalvo et al. (1992)</td>
<td>Randomised, prospective study of 38 medical/surgical ICU patients</td>
<td>Clinical nosocomial pneumonia in two (10.5%) patients with gastric tubes, none in the jejunal tube group. Significantly higher proportion of nutrition and lower rate of pneumonia in jejunal tube fed patients</td>
</tr>
<tr>
<td>Montejo et al. (2002)</td>
<td>Prospective, randomised multicentre study. ICUs in 11 teaching hospitals</td>
<td>Gastrointestinal complications less frequent in jejunal tube fed patients. Accepted gastric residual volumes of 300 ml in the intestinal tube group</td>
</tr>
<tr>
<td>Neumann and DeLegge (2002)</td>
<td>Prospective study, 60 patients randomised to receive gastric or small-bowel tube feedings</td>
<td>No increase in aspiration or other adverse outcomes in gastric feeding compared with small-bowel feeding in the ICU. Failed to demonstrate any advantages in nutrition from intestinal tubes</td>
</tr>
<tr>
<td>Spain et al. (1995)</td>
<td>Retrospective study of 74 patients</td>
<td>Failed to demonstrate any advantages in nutrition from intestinal tubes</td>
</tr>
<tr>
<td>Strong et al. (1992)</td>
<td>Retrospective study of 33 patients</td>
<td>Failed to demonstrate any advantages in nutrition from jejunal tubes</td>
</tr>
</tbody>
</table>

Table 3(Continued).
A review of the nursing care of enteral feeding tubes in critically ill adults

Complications may lead to underfeeding or loss of other benefits afforded by early enteral feeding. Placement of intestinal tubes may be difficult and time consuming, due to the technical expertise and equipment that is required which may in turn further delay feeding (Maykel and Bistrian, 2002). Feeding via an intestinal tube has been reported to provide a higher caloric intake than the gastric route (Kearns et al., 2000; Kortbeek et al., 1999; Montecalvo et al., 1992; Montejo et al., 2002), although other investigators report no nutritional advantages (Spain et al., 1995; Strong et al., 1992). Other reasons for not meeting nutritional needs include fasting, procedures, staffing shortages, unavailability of feeds/equipment, low priorities for feeding, variations in feed prescriptions (Adam and Batson, 1997; Briggs, 1996; De Jonghe et al., 2001; Marshall and West, 2004; McClave et al., 1999; Spain et al., 1999) and blockages in feeding tubes (Pinilla et al., 2001). Despite the risks and uncertainty of the best route of administration for enteral feeds, diligent tube maintenance is clearly a nursing responsibility essential to the administration of enteral feeding.

Reducing the risk of aspiration

Residual gastric volumes

Nurses frequently assess gastro-intestinal function by checking gastric residual volumes, listening for bowel sounds and observing for abdominal distension in an attempt to reduce the risk and severity of aspiration (Beattie et al., 1996; Eisenberg, 1994; Jolliet et al., 1998; Kirby et al., 1995). The presence of bowel sounds to confirm gastrointestinal function is questionable (Anonymous, 1994). High residual volumes may indicate delayed gastric emptying, intolerance to enteral feeding and increase the risk of regurgitation and aspiration (McClave et al., 1992; Metheny, 1993). Many conditions decrease gastric motility, including drugs such as opioids, surgery, trauma, shock and respiratory failure (Bosch et al., 1998; Dive et al., 1994; Tarling et al., 1997).

The measuring of gastric residual volume by aspiration with a syringe is a popular approach, although this has not been validated (Chapman et al., 2000). Using a mobile gamma camera, scintigraphy, is noninvasive, well tolerated, and may not interfere with nursing care (Horowitz and Dent, 1991), however, its use in ICU is impractical (Chapman et al., 2000). Methods that may be used in the future include continuous monitoring of oesophageal tone, electrogastrograms and tonometry (Alston, 2001).

Wide variation exists in the literature as to what constitutes an excessive gastric residual volume. The value that is considered to be acceptable or excessive (Table 4) has not been established by controlled trials and is often based on opinion (McClave et al., 1992; Metheny, 1993; Pinilla et al., 2001). Measuring residual gastric volumes is an imprecise method of determining gastric emptying and upper digestive functioning (Alston, 2001; Chapman et al., 2000), with the volume of salivary and gastric secretions often not taken into account. In addition, gastric residual volume and the presence of bowel sounds may not correlate with gastric emptying (Goldhill et al., 1997). Having high residual gastric volumes does not always imply gastric status (Joolite et al., 1999) suggesting the rationale for using gastric residual volumes is flawed (Burd and Lentz, 2001; McClave and Snider, 2002). The current practice of stopping enteral feeding if gastric residual volumes are less than 400–500ml is not physiologically or clinically appropriate (Lin and Van Citters, 1997). Decreasing the designated threshold of gastric residual volume at which feeds should be withheld does not decrease the risk of aspiration (Luke et al., 2002; McClave and Snider, 2002; Pinilla et al., 2001; Powell et al., 1993). Despite few randomised controlled trials being conducted regarding the management of gastric residual volumes (Booker et al., 2000), current research supports continuation of feeding if possible (Davies et al., 2002; Jolliet et al., 1998; McClave and Snider, 2002; Mentec et al., 2001). Elevated residual volumes should alert clinicians to potential problems, but a single high gastric residual volume should not result in automatic cessation of feeding. Feeding should continue whilst the patient is closely monitored (McClave et al., 1992). Cessation of enteral feeding due to high residual volumes is a frequent avoidable action contributing to inadequate caloric intake (Spain et al., 1999). It has been recommended that only patients demonstrating overt regurgitation, vomiting or aspiration should have their feeds abruptly ceased (McClave and Snider, 2002). If gastric aspirates exceed 500ml, then it has been recommended that feeds should be withheld and the patient reassessed (McClave et al., 2002). Gastric aspirates of 500ml or less should be returned. If the aspirate is 200–500ml, careful bedside assessment using a decision algorithm to manage enteral nutrition delivery is recommended (McClave et al., 2002). Feeding should continue whilst reducing the rate of feeding and administering prokinetics considered (Mentec et al., 2001). Further studies are needed to determine the amount of gastric residual volume that is excessive.
Table 4 Studies investigating gastric residual volumes.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohen et al. (2000) assessed the effect of continuing enteral nutrition in patients with an elevated gastric residual volume but normal gastric emptying by the paracetamol absorption test</td>
<td>Prospective study of 32 critically ill patients</td>
<td>25% of patients with high gastric residual volumes (greater than 150 ml or more than twice the hourly nutritional administration rate) had normal paracetamol absorption tests for gastric emptying. Accepted gastric residual volumes of 250 ml or more than the amount delivered since the previous gastric aspiration before ceasing feeding. Complications were rare and they had a much higher rate of tolerated enteral nutrition when compared to other studies.</td>
</tr>
<tr>
<td>Davies et al. (2002) compared nasojejunal to nasogastric feeding in critically ill patients</td>
<td>Prospective study</td>
<td></td>
</tr>
<tr>
<td>Goldhill et al. (1997) investigated the absorption of cisapride, and its effect on gastric emptying and the usefulness of clinical signs of gastric emptying</td>
<td>RCT involving 27 patients</td>
<td>Rate of feeding should be decreased if gastric residual volumes were greater than 300 ml. High residual gastric volume did not always imply gastric stasis. Metoclopramide effective prokinetic agent. Practice of stopping enteral feeding if gastric residual volumes were less than 400–500 ml not physiologically or clinically appropriate.</td>
</tr>
<tr>
<td>Jolliet et al. (1998) assessed a simple approach to optimise enteral nutrition modalities with practical application.</td>
<td>Literature review by the working group on nutrition and metabolism of the European Society for Intensive Care Medicine</td>
<td></td>
</tr>
<tr>
<td>Jooste et al. (1999) assessed the effect of metoclopramide on gastric motility in critically ill patients</td>
<td>Prospective, controlled, single-blind cross-over trial in 10 patients</td>
<td></td>
</tr>
<tr>
<td>Lin and Van Citters (1997) tested the hypothesis that gastric residual volume increases with slower gastric emptying and faster formula delivery but reaches a plateau volume</td>
<td>Computer simulation modelling</td>
<td></td>
</tr>
<tr>
<td>McClave et al. (1992) investigated the gastric residual volume that indicates intolerance or inadequate gastric emptying</td>
<td>Assessed 20 healthy normal volunteers, 8 stable patients with gastrostomy tubes and 10 critically ill patients prospectively for 8 h while receiving enteral nutrition</td>
<td>Wide range of residual volumes (even up to 400 ml) were seen with no obvious intolerance such as regurgitation. Residual volumes were higher with higher feeding rates. Should be wary when residual volumes exceed 200 ml. Small sample size and narrow sampling time frame (6 h following fasting for 2 h) threaten the internal validity of this study. Rate of feeding may not be appropriate for patients who have been fasting.</td>
</tr>
<tr>
<td>McClave and Snider (2002) summarised results from studies that evaluated the practice, interpretation, and impact on patient outcome from use of gastric residual volume</td>
<td>Systematic review</td>
<td>Use of gastric residual volumes as a marker of impending clinical deterioration is limited by the fact that the timing of increases in GRV is unpredictable and high GRVs do not correlate independently to adverse outcome. Practice of GRV may in fact impede delivery of ETF by promoting inappropriate cessation and reducing potential infusion time.</td>
</tr>
</tbody>
</table>
Enhancing gastric motility by the use of prokinetic agents, with differing pharmacological properties, have been supported by randomised trials (Boivin and Levy, 2001; Booth et al., 2002; Chapman et al., 2000; Heyland et al., 1996; Jooste et al., 1999; MacLaren et al., 2000; Spapen et al., 1995; Yavagal et al., 2000). Metoclopramide is a selective dopamine-2 receptor antagonist that enhances cholinergic induced peristaltic contractility of the upper gastrointestinal tract (MacLaren et al., 2000). Cisapride acts by selectively enhancing cholinergic motor activity throughout the gastrointestinal tract (MacLaren et al., 2000). Eythromycin enhances motilin release from the duodenal enterochromaffin cells (MacLaren et al., 2000). A systematic review of promotility drugs concluded that prokinetics are effective in promoting gastric emptying in ICU patients (Booth et al., 2002; MacLaren et al., 2000). Introducing prokinetic agents early has been suggested when the pre feeding residual volume exceeds 20 ml or during feeding if residual volumes exceed 100 ml (Mentec et al., 2001). Mandatory use of prokinetics reduces the incidence of enteral feeding intolerance (Pinilla et al., 2001). There are concerns regarding their safety and lack of effect on clinical outcomes such as survival (Booth et al., 2002).

The frequency of checking gastric residual volumes varies from 2 to 24 hourly (Arrowsmith, 1993; Bowers, 1996; Cataldi-Betcher et al., 1983; Goodwin, 1996), and is opinion based. Aspiration regimes include 4 hourly on the first day of feeding and then 8 hourly (Fellows et al., 2000); 3 to 4 hourly when feeding was commenced then checking daily once full volume and tolerance is established (Goodwin, 1996; Jolliet et al., 1998; Kleibeuker and Boersma-van Ek, 1991); and 4 to 12 hourly (Edwards and Metheny, 2000; Metheny, 1993; Payne-James, 1992). The risk of aspiration during continuous nasogastric tube feeding has been reported as greatest during the first few hours of administration (Kleibeuker and Boersma-van Ek, 1991). It may be necessary to monitor residuals more closely during the early phase of feeding, and then less frequently once feeding is established. In patients with established feeding and where volume of aspirate is not a problem, consideration may be given to less frequent aspirations (Fellows et al., 2000). Although there are no established guidelines indicating how often enteral tubes should be aspirated, most institutions follow some type of protocol although compliance issues have been identified (Breach and Sandanha, 1988; Sands, 1991).

Discarding gastric aspirate may result in loss of gastric fluid and electrolytes (Cataldi-Betcher et al., 1983) but reduces the potential for contami-
Table 5  Studies investigating return of gastric aspirates.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booker et al. (2000)</td>
<td>Randomised controlled trial, 35 patients but only 18 sets of useable data obtained</td>
<td>No significant differences between the discard group or return group. Both groups had substantial numbers of complications, including feeding delays due to high gastric residual volumes (7 in the discard group and 8 in the return group). Although electrolyte levels did not differ significantly between the 2 groups, potassium levels tended to be lower in the discard group. Small sample size, many data being collected retrospectively and the effect of fluid intake and output not being measured that may have influenced electrolyte status threatened internal validity.</td>
</tr>
<tr>
<td>McClave and Snider (2002)</td>
<td>Systematic review</td>
<td>Recommended that aspirates be returned</td>
</tr>
</tbody>
</table>

nation during the aspiration process and clogging of enteral tubes when aspirate is returned. A RCT found no significant differences in outcomes between the discard group or return group (Booker et al., 2000), although potassium levels tended to be lower in the discard group (Table 5). Small sample size, many data being collected retrospectively and the effect of fluid intake and output that may have influenced electrolyte status not being measured, threatened study internal validity.

Patient positioning during enteral feeding

Continuous feeding increases the risk of aspiration as the oesophageal sphincter remains open, therefore, nursing the patient at a minimum of 30–45° elevation has been recommended to reduce this risk (Table 6) (Arrowsmith, 1993; Bowers, 1996; Drakulovic et al., 1999; Elpern, 1997; Ibanez et al., 1992; Kirby et al., 1995; Kollef, 1993; Orozco-Levi et al., 1995; Potts et al., 1993; The Joanna Briggs and Institute, 2002; Torres et al., 1992; Treloar and Stechmiller, 1984). Some investigators believe that elevating the head of the bed does not prevent aspiration (Elpern et al., 1987), however, the semi-recumbent position may reduce the risk. Because the head up position is difficult to achieve at all times, aspiration may occur during those times when a patient has to lie flat (Metheny, 1993).

Management of artificial airways

Patients with artificial airways are at risk of aspiration. Decreased elevation of the larynx, obstruction by the cuff of the artificial airway, decreased sensation of the larynx, reduced reflexes due to chronic airway diversion and uncoordinated laryngeal closure due to chronic upper airway bypass have been noted with the use of artificial airways (Goodwin, 1996). Tracheostomy tube cuffs do not prevent aspiration, even when properly inflated (Elpern et al., 1987; Koeman et al., 2001). Whilst trial based evidence is lacking, a cuff pressure maintained at 20–25 cmH₂O and regular oropharyngeal suctioning to the back of the mouth in intubated patients has been well supported by expert opinion to minimise the risk of aspiration (Elpern, 1997).

Mouth care

The risk for aspiration pneumonia is decreased by up to 60% in patients receiving aggressive oral hygiene/decontamination (Koeman et al., 2001; Terpenning et al., 2001; Yoneyama et al., 2002). Pa-
A review of the nursing care of enteral feeding tubes in critically ill adults

Table 6  Studies evaluating patient position in patients receiving enteral nutrition.

<table>
<thead>
<tr>
<th>Study</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drakulovic et al. (1999)</td>
<td>The frequency of suspected and microbiologically confirmed pneumonia was significantly less in patients randomised to the semi-recumbent position</td>
</tr>
<tr>
<td>Elpern et al. (1987)</td>
<td>The upright position was used 80% of the time in 31 intubated patients and an aspiration rate of 27% was observed</td>
</tr>
<tr>
<td>Ibanez et al. (1992)</td>
<td>Randomised controlled trials demonstrated greater gastro-oesophageal reflux in patients with orotracheal intubation and naso gastric tube. Semirecumbency does not prevent GER, but there is less incidence than in the supine position</td>
</tr>
<tr>
<td>Kellef (1993)</td>
<td>Three times increased risk of nosocomial pneumonia during the first 24h of mechanical ventilation in cohort of patients nursed supine</td>
</tr>
<tr>
<td>Orozco-Levi et al. (1995)</td>
<td>Prospective, randomised crossover design studies observed that the supine body position had a higher rate of pulmonary aspiration but clinically significant aspiration was not observed. Higher radioactive counts of technetium sulphur colloid, instilled into the stomach, in endobronchial secretions in patients nursed supine</td>
</tr>
<tr>
<td>Potts et al. (1993)</td>
<td>Patients with clinically significant aspiration were fed supine 98% of the time, patients who did not aspirate being fed supine only 21% of the time</td>
</tr>
<tr>
<td>Torres et al. (1992)</td>
<td>Prospective, randomised crossover design studies observed that the supine body position had a higher rate of pulmonary aspiration but clinically significant aspiration was not observed. Higher radioactive counts of technetium sulphur colloid, instilled into the stomach, in endobronchial secretions in patients nursed supine</td>
</tr>
<tr>
<td>Treloar and Stechmiller (1984)</td>
<td>Zero incidence of aspiration when the head of the bed was elevated by 30–45°</td>
</tr>
</tbody>
</table>

Patients should receive regular mouth care (McClave et al., 2002) but antiseptic solutions should be used in preference to antimicrobials to decrease the possibility of antimicrobial resistance (DeRiso et al., 1996).

Continuous versus intermittent feeding

Continuous feeding delivered via a peristaltic pump is considered to reduce the risk of aspiration because of the assured constant delivery volume and smaller volumes in the stomach at any one time (Ciocon et al., 1992; Kocan and Hickisch, 1986; Steevens et al., 2002). Intermittent feeding supposedly allows pH to restore itself between boluses of food thus minimising gastric colonisation. However, critically ill patients have higher than normal pH (Metheny et al., 1997). Studies evaluating intermittent feeding have design and methodological flaws. Although no significant differences have been found between continuous and intermittent feeding

Table 7  Continuous vs. intermittent feeding.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKinlay et al. (2001)</td>
<td>Randomised study of 34 neurological ICU patients</td>
<td>No differences in bowel activity, evidence of aspiration or meeting caloric targets were found</td>
</tr>
<tr>
<td>McKinlay et al. (1995)</td>
<td>Randomised study of 18 trauma patients</td>
<td>Continuous feeding facilitated nutrient delivery with less gastrointestinal complications</td>
</tr>
<tr>
<td>Spliker et al. (1996)</td>
<td>13 patients converted from continuous to intermittent feeding</td>
<td>No significant differences were found between the 2 groups</td>
</tr>
</tbody>
</table>
with less gastrointestinal complications (McKinlay 2002) on the basis it facilitates nutrient delivery recommended (McClave et al., 2002; Metheny et al., 1995).


Koerner L, Keshaviah P, Gaddis J, Prosek M. Early enteral nutrition on intestinal permeability and the develop-


A review of the nursing care of enteral feeding tubes in critically ill adults


