A REVIEW OF CURRENT NURSING PRACTICE AND EVIDENCE-BASED GUIDELINES IN ENTERAL NUTRITION IN THE CRITICALLY ILL PATIENT

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Abstract

Objectives: to provide an overview of evidence-based guidelines regarding some clinical practices related to enteral nutrition along with nursing adherence to these guidelines in the critically ill. Background: evidence-based guidelines for enteral nutrition curtailing the incidence of complications through managing gastric residual volumes, minimizing feeding interruption/under-feeding, confirming tube placement and preventing feeding system contamination. Design: an integrative literature review was employed to include various quantitative methodologies; however, RCTs predominated. Methods: electronic searching of CINAHL, Medline and Cochrane Library databases between 1995- 2011. Of 599 retrieved studies, 87 were included in the review. Results: The studies showed an inadequacy in nursing adherence to enteral nutrition evidence-based. Gastric residual volume should be strictly controlled using prokinetic agents, appropriate head of bed elevation and proper endo-tracheal tube cuff pressure. Feeding interruption should be avoided whenever is possible and an intentional increase to feeding rates/volumes are recommended to avoid under-feeding. X-ray and pH methods of confirming tube placement are more reliable and superior to capnometry and auscultatory methods. Feeding system hanging time should not exceed four consecutive days to prevent infection by endogenous source in addition to delivering formulae at closer body core temperature. Conclusion: evidence-based protocols should be employed effectively and consistently to eradicate discrepancies in nursing practice. Relevance to clinical practice: this paper highlights nursing role in prohibiting the majority of enteral nutrition complications through adhering to evidence-based guidelines.

Keywords: Nursing, Enteral nutrition, Gastric residual volumes, Intensive care, Review

Introduction

Critical care nurses are responsible for delivering prescribed nutrition, fluid and medication safely and effectively (Adam & Batson, 1997; Persenius *et al.*, 2008). They are also responsible for ascertaining enteral nutrition (EN) volume and quality of given formulae (Swanson & Winkelman, 2002; Smith & Watson, 2005; Higgins *et al.*, 2006). Gaps in nursing practice are increased due to the inadequacy of adherence to evidence-based guidelines (Braga *et al.*, 2006; Aari *et al.*, 2008). EN therapy is currently suboptimal, causing serious complications in addition to a failure of administration. Lack of team work, which is resulted from insufficient evidence-based resources, induces discrepancies in practice (Spain *et al.*, 1999; Binnekade, 2004; Martin *et al.*, 2004; Atwal & Caldwell, 2006).

This paper reflects the importance nursing roles toward prohibiting some nutritional complications inherent by enteral nutrition. All these nursing-related issues are essential in term of attaining a successful nutritional care and better feeding outcomes. Thus, the information gained from this paper can be used as guidance for health care professionals to manipulate their practice of some controversial issues surrounding enteral nutrition especially for these issues which are heavily associated with discrepancies in nursing care and poor adherence to evidence-based guidelines.

Background

Some nursing practices can contribute to hypo-caloric, under-feeding (Griffiths, 1997; Marshall & West, 2004; Bongers *et al.*, 2006; Fulbrook *et al.*, 2007). Specific factors such as using improper tube, feeding intolerance and gastric retention are associated with nutritional failure (Binnekade *et al.*, 2005; Petros & Engelmann, 2006). Previous studies suggest that, although using EN protocols, intensive care unit (ICU) patients still receive 50% of the prescribed nutrition, leading to suboptimal nourishment due to the frequent feeding cessation (Grant & Martin, 2000; Jonghe *et al.*, 2001; O'Meara *et al.*, 2008; Persenius *et al.*, 2008). Gastric residual volume (GRV) measurement was introduced as the most influential factor associated with under-feeding. However, some essential nursing interventions such as checking tube placement and maintaining head of bed elevation were much less emphasized (Joiliet *et al.*, 1998; Marshall & West, 2006; Ros *et al.*, 2009).

The discrepancy in nursing practice is heavily associated with nursing capacity to manage complications and their ability to assess feeding outcomes (Sivakumar & Haigh, 2000; Marshall & West, 2004; Ros *et al.*, 2009). For instance, there was no consensus among nurses in defining GRV and its association with aspiration (Splett & Myers, 2001; Fulbrook *et al.*, 2007). Williams and Leslie (2004) asserted that many nursing guidelines and interventions are not primarily based on research, but on ritual and personal opinions. Of all tube feeding complications, pulmonary aspiration demonstrates the most frequently occurring problem in intensive care (Spain *et al.*, 1999; Williams & Leslie, 2004; Persenius *et al.*, 2006; McClave *et al.*, 2009). Nurses and other professions do not always have a sufficient awareness about the significance of using guidelines in controlling GRVs, confirming tube placement and avoiding unnecessary feeding interruption (Briggs, 1996; Kennedy, 1997; Fulbrook *et al.*, 2007; Wentzel Persenius *et al.*, 2009). Table 1 shows the majority of tube feeding complications and their causes, potential effects and treatment strategies.

Resarch question

The aim of this study is to review the published studies on evidence–based guidelines in relation to managing and controlling GRVs, avoiding under-feeding and malnutrition, confirming tube placement, and avoiding feeding system contamination in EN. This review can provide nurses with the opportunity to improve nursing care and to enhance adherence to the evidence-based recommendations.

Search strategy

Databases and key words

The following electronic databases were searched: CINAHL, MEDLINE via OvidSP and Cochrane Library (1995-2011). Searching was restricted to the English language. Key words used to identify the literature were: EN evidence-based protocols, guidelines, algorithms; nursing role, EN complications.

Inclusion criteria: studies on adult, critically ill patients. The main outcome measures of interest were the role of managing and controlling GRVs, avoiding unnecessary feeding interruption and malnutrition, confirming tube placement, and avoiding feeding system contamination on the incidence of complications. Various methodological approaches were acceptable, and studies published in peer-reviewed Institute for Scientific Information (ISI) Indexed journals were preferred.

Exclusion criteria: studies concerning EN in home care settings, EN in children and geriatric patients were mainly excluded from the review. In addition, studies about EN in animals were also excluded. Fig 1 illustrates the review retrieval process.

Eighty seven of 599 retrieved studies were included in the review. The recommendations of the Joanna Briggs Institute for Evidence Based Nursing and Midwifery were used in classifying literature, showing that each recommended practice was classified into a level of evidence according to the source of research which is taken from (The Joanna Briggs Institute, 2002).

Results

Controlling GRV

Gastric residual volumes must be checked every 4-6 hours for continuous feeding or prior to each intermittent feeding (Padula *et al.*, 2004; Binnekade *et al.*, 2005; Bourgault *et al.*, 2007; Metheny *et al.*, 2008). The nutritional support algorithm created by Woien and Bjork (2006) which stressed on checking GRVs every four hours along with frequent detection for the signs of feeding intolerance enhanced better nutrition and optimal delivered amounts. This algorithm enabled nurses to deliver feeding effectively beside the possibility of regular increment in feeding rate (Woien & Bjork, 2006).

Elpern *et al*. (2004) claimed that no evidence to support the assumption that GRVs absolutely indicate an impaired gastric function or increase in the risk of gastroesophageal reflex leading to pulmonary aspiration (Elpern *et al.*, 2004). Likewise, Metheny *et al*. (2008) found no consistent relationship between aspiration and GRVs as most nurses conceive. However, aspiration occurred more often at higher GRVs. Other factors associated with increased risk of aspiration should be considered such as: low level of consciousness, gastroesophageal reflux, head of the bed elevation, sedation and vomiting (Bourgault *et al.*, 2007; Metheny *et al.*, 2008; Metheny *et al.*, 2010). Similarly, McClave and Snider (2002) support previous premise and suggest stated the following pre-existing factors along with GRVs; trauma, head injury, using of sedation and mental instability. Therefore, the precautionary measures when GRVs < 400-500 ml should be eliminated from our practice as unreliable marker that keep professionals vigilant to maintain GRV at this cut-off/threshold point (McClave & Snider, 2002).

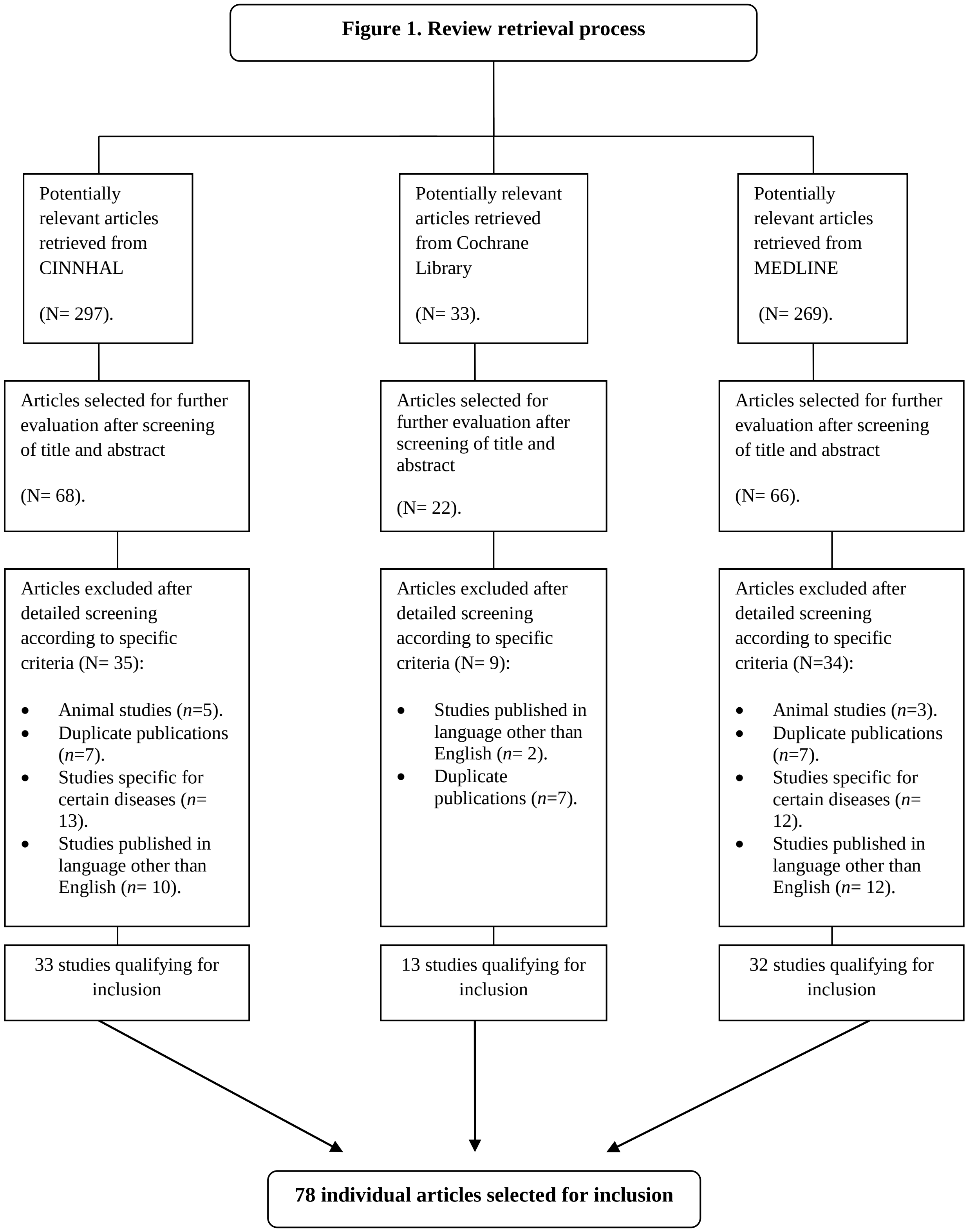

Figure 1. Review retrieval process

Dobson and Scott (2007) established a 'new nurse-led EN algorithm' in critical care. This algorithm comprises solutions for managing GRV concurrently with using prokinetic agents at the same time. The nurse-led feeding algorithm contributes to attain nutritional goals promptly, especially when patients receive the correct type and volume of the prescribed feed. This algorithm advocates using of prokinetic agents as a necessary action when one or more GRVs are above 200 ml (Dobson & Scott, 2007). Similarly, Pinilla *et al*. (2001) created two EN protocols. The first protocol aimed to keep GRVs at 150 ml with optional using of prokinetics. The second protocol aimed to keep GRVs at 250 ml with a mandatory use of prokinetics. This RCT revealed that the incidence of feeding intolerance was significantly less among patients in the second group who were adjusted on GRVs 250ml along with regular use of prokinetic agents (Pinilla *et al.*, 2001).

Bowman *et al*. (2005) established a 'new evidence-based feeding protocol' and 'aspiration reduction algorithm' for enterally fed, mechanically ventilated patients in ICUs. This study showed that, managing GRVs and maintaining an appropriate head of bed (HOB) elevation had significantly reduced the incidence of ventilator-associated pneumonia (VAP) and keeping patients at nutritional goal, in addition to lowering the mortality rate, treatment costs and length of stay (Bowman *et al.*, 2005). Metheny *et al*. (2010) assessed the effectiveness of using 'Aspiration Risk-Reduction Protocol' (ARRP) with enterally fed, mechanically ventilated patients. This protocol consists of three main approaches: a) maintain head of bed elevation at 30° or higher; b) inserting feeding tube into distal small bowel; c) using an algorithm for high gastric residual volumes. The incidence of aspiration was significantly lower in the ARRP group than that in the usual care group (39% vs. 88% respectively). Also, incidence of pneumonia was much lower in the ARRP group than another group (19% vs. 48% respectively) (Metheny *et al.*, 2010). Similarly, Reignier *et al*. (2010) created a protocol consists of increasing feeding rate by 25ml/h every six hours until reach 85ml/h, elevate the head of the bed 35° in prone position and using prophylactic erythromycin (prokinetic agent) when lifting patient to improve gastric empty. The study showed that those patients in intervention were received larger feeding volumes without increase GRVs, vomiting or Ventilator-associated Pneumonia (VAP) (Reignier *et al.*, 2010). Regarding re-delivering gastric residues, a study by Juvé-Udina *et al*. (2009) asserted that reintroducing gastric contents to the patient does not increase the risk of potential complications. On the contrary, it shows a significant effect in maintaining GRVs closer to the physiological level and decreasing the effect of gastric empty delay (GED). However, a frequent elevation of GRVs can result in potential complications and electrolyte imbalance (Ibrahim *et al.,* 2002; Juvé-Udina *et al.*, 2009).

In general, aspiration reduction is a vital issue of EN care. The following techniques, if effectively employed, will guarantee a minimum risk of aspiration: Head of bed elevation should be kept between 30-45°, maintaining endotracheal tube cuff pressure at 20-25 cm H_2O (Sanko, 2004; Bourgault *et al.*, 2007; McClave *et al.*, 2009), using a continuous feeding, prokinetic agents and trans-pyloric feeding route are additional factors associated with decreasing the incidence of aspiration for patients with persistent high gastric residue (Bowman *et al.*, 2005; McClave *et al.*, 2009; Kenny & Goodman, 2010). If aspiration susceptibly occurs, the following techniques are used to detect aspiration: Dye method, which is used by discolouring feeding formulae with blue dye to be easily detected when patients are routinely suctioned (Bourgault *et al.*, 2007). However, recent studies opposed using this technique due to its lack of accuracy in detecting aspiration and a risk for some complications (McClave *et al.*, 2003; Sanko, 2004; McClave *et al.*, 2009). Testing glucose oxidase is another tool used to detect aspiration by checking glucose concentration in the tracheaobronchial secretion. If the glucose level in the content is more than 5mg of glucose per decilitre, it indicates an escaped gastric content into respiratory system (Sanko, 2004; Metheny *et al.*, 2010).

Underfeeding and feeding interruption

Sometimes, unplanned feeding interruption is necessary when there are signs of digestive intolerance or during airway management and diagnostic procedures. This produces another reason for the discrepancies between prescribed and delivered nutrition (Beattie & Anderton, 1998; Jonghe *et al.*, 2001; Petros & Engelmann, 2006). O'Meara et al (2008) evaluated the factors associated with EN interruption in critically ill patients with mechanical ventilation. They found that those patients on mechanical ventilation received approximately 50% of their prescribed caloric resulted from recurrent feeding interruption. Inadequate evidence to support the premise that feeding interruption is considered as a best practice to reducing the incidence of aspiration (Griffiths, 1997; Metheny *et al.*, 2010). During hoaemodynamic instability, EN should be withheld until the patient is fully recovered and should be stopped if GRV exceeds 500ml (Miller *et al.*, 2008). Regardless of the presence or absence of bowel motility, EN should be maintained and unnecessary cessation should be avoided. In case of a high risk of aspiration or feeding intolerance, feeding tube should be placed into small bowel instead of stomach (McClave *et al.*, 2009). The main causes of feeding interruption in the ICUs are gut dysfunction and preparation for procedures (Anderson, 2000). Gut dysfunction should be taken into consideration when reporting high gastric aspirate, abdominal distension and vomiting (Joyce & Deborah, 1996; Higgins *et al.*, 2006). A high gastric aspirate is a reliable indicator to gut dysfunction. However, GRV records are normally decreased after the first few days from starting EN, indicating that patients are being tolerated (Adam & Batson, 1997; Beattie & Anderton, 1998).

To avoid unnecessary feeding cessation during patient positioning, bathing and linen changes, nurses are encouraged to stop feeding at least two hours before any procedure then have to resume and replace the amount which has been left accordingly (Grossman & Bautista, 2001; Bourgault *et al.*, 2007). Heyland *et al.* (2003) showed that most critically ill patients are considered under-fed because of discrepancy between what is prescribed and what is tolerated. Additional amounts of EN over-prescribed had shown not only better nutritional status, but also fewer complications and rapid recovery (Heyland *et al.*, 2003). Likewise, Lichtenberg *et al*. (2010) created further techniques to reduce the effect of unintentional feeding interruption. The protocol aims to accelerate the infusion rate of the prescribed formulae which is normally given over 24 hours to be delivered over 20 hours. The results were that the mean daily delivered volume for the intervention group was 97.3% whilst, 79.7% in the control group ($p<0.001$) (Lichtenberg *et al.*, 2010). This also supports the premise that a regular increase in EN rates is required to compensate patient's undelivered nutrients (Posani, 2000; Heyland *et al.*, 2003 ; Binnekade *et al.*, 2005; Bourgault *et al.*, 2007).

However, nurses should pay attention to the risk of re-feeding syndrome which is characterised by severe fluid and electrolyte shifts that may occur when massive nutritional therapy is commenced, carbohydrate and protein are introduced, to malnourished patients (Crook *et al.*, 2001; Ahmed *et al.*, 2011). Although re-feeding syndrome is less recognised in EN, it is accompanied by serious fluid and electrolyte imbalance such as severe depletion in serum phosphorus, magnesium and potassium along with altered glucose metabolism, vitamins deficiency and fluid-balance abnormalities (Marinella, 2005; Mehanna *et al.*, 2008). The risk of re-feeding syndrome can be reduced as follows: education of hospital staff, identify those patients at risk, start feeding slowly, electrolyte and electrocardiograph monitoring, detecting signs of neurological disturbances such as tremor, seizures and coma due to electrolyte imbalance (Mehanna *et al.*, 2008; Ahmed *et al.*, 2011).

Confirming tube placement

Various methods are used for checking tube placement. Radiographic confirmation of tube placement remains the ‘gold standard’ and it is still reliable and widely accepted technique despite the risk of radiation exposure (Stroud *et al.*, 2003; Williams & Leslie, 2005). The pH method is also used for checking tube placement by analysing the pH of gut aspirate (Sanko, 2004). In a study by Turgay and Khorshid (2010), the results of pH method in detecting tube location were compatible with radiographic method and the auscultatory method showed a lower agreement with radiographic method indicating that the pH method is more reliable in detecting tube position than the auscultatory method (Turgay & Khorshid, 2010). This supports a study by Jacobs *et al.* (1996) which found that using pH-assisted NG tube insertion yields 100% correct placement when verified by x-ray compared with standard NG tube insertions methods (Jacobs *et al.*, 1996). Elpern *et al*. (2007) investigated capnometry (carbon dioxide detectors) and air insufflations for detecting NG tube placement. The study showed that 16% of capnometry tube placements were incorrect when verified by x-ray in addition to 5% of air insufflations indicated to inadvertent tube placement in the lung (Elpern *et al.*, 2004). Miller (2011) reinforces the previous results and found that using carbon dioxide detectors were no more accurate than detecting tube placement by pH testing (Miller, 2011).

Hence, X-ray method and pH testing are the recommended measures for detecting tube placement. Capnometry is useful in case of detecting inadvertent tube placement with urgent adult intubation. However, it is emphasised that other complementary reliable indicators must be used beside this techniques (Burns *et al.*, 2006; Elpern *et al.*, 2007; Miller, 2011). Thereby, the auscultatory method and listening for air exchange at the end of the tube or detect bubbling when the distal end of tube is held under water are excluded techniques from our practice (Stroud *et al.*, 2003; Padula *et al.*, 2004).

Avoiding feeding system contamination

Avoiding EN system contamination is another crucial issue in intensive care. The sources of contamination might be endogenous or exogenous (Pancorbo *et al.*, 2001). Infection can be inhibited by attention to hand hygiene using antimicrobial soup or alcohol-based hand rub and wearing non sterile disposable gloves before preparing and assembling feeding system (Kennedy, 1997; Padula *et al.*, 2004). Mathus-vliegen *et al*. (2006) investigated the relationship between feeding system contamination and the length of feeding system hanging time. The study revealed that the risk of developing pathogenic bacteria (e.g. Enterobacteriaceae and Pseudomonaceae) from an endogenous source is increased after the fourth day of administration by 48% (Mathus-Vliegen *et al.*, 2006). Beattie and Anderton (1998) suggested manufacturers to develop a new feeding system (feeding packs) rather than the traditional glass bottles. This allows disinfecting the feeding system during assembly to avoid any potential or unintentional handling errors. The study found that the risk of developing bacterial contamination has significantly been reduced ($p < 0.05$) when the feeding system is already disinfected (Beattie & Anderton, 1998). The role of formulae temperature contributes in lowering the contamination rate when opened/partially-used quantities of formulae were kept in appropriate refrigeration (McClave *et al.*, 2009). Also, formula administration in temperature different from body core temperature may potentially cause abdominal pain and diarrhoea after administration (Barrett *et al.*, 2009).

Discussion

Nurses are poor at adhering to EN evidence-based guidelines. It was evident that nurses poorly manage and control GRVs, including the frequency of checking gastric residue, using aspiration reduction measures and techniques to detect aspiration. Some nursing practices contribute to under-feeding due to unnecessary feeding cessation and inadequate assessment for feeding intolerance. Tube placement is confirmed using unreliable techniques that should be replaced with the most recommended measures for detecting tube location. Feeding system can be protected from contamination through different measures based on nursing care to keep systems disinfected and valid for feeding delivery. Table 1 sumarises EN complications.

Although the majority of studies stressed the importance of measuring GRV systematically (4-6 hourly), some of these confirmed that abnormal GRV should not be taken as a unique source of aspiration irrespective of other associated issues such as mental status, using sedation and neuromuscular disorders (McClave & Snider, 2002; Elpern *et al.*, 2004; Bourgault *et al.*, 2007; Metheny *et al.*, 2008). In the case of mechanical ventilation, GRV was more emphasized by studies as the risk of aspiration increased with mechanically ventilated patients who have abnormal GRV values. Prokinetic agents appear to be more effective when administered in a constant manner over the duration of feeding to minimize the risk of pulmonary aspiration (Pinilla *et al.*, 2001; Dobson & Scott, 2007; Reignier *et al.*, 2010). However, Head of bed elevation to 30-45°, maintaining endotracheal tube cuff pressure at 20-25 cm H_2O and using the transpyloric feeding routes were techniques approved to reduce the effect of persistent GRV in those at higher risk of aspiration (Sanko, 2004; Bowman *et al.*, 2005; Bourgault *et al.*, 2007; McClave *et al.*, 2009; Kenny & Goodman, 2010).

The episode of gaps between feeding delivery and feeding prescription due to unnecessary feeding cessation has been revealed by some studies. However, most of these studies ignored the assumption that feeding interruption is required when the signs of gut dysfunction, feeding intolerance or risks of aspiration exist (Griffiths, 1997; Miller *et al.*, 2008; O'Meara *et al.*, 2008; Metheny *et al.*, 2010). Regarding the main reasons for stopping feeding in the ICU, which is preparation for procedures, bathing and changing position, nurses should interrupt feeding for two hours in advance before any procedure requires the trendelenburg position (Joyce & Deborah, 1996; Beattie & Anderton, 1998; Anderson, 2000; Higgins *et al.*, 2006). In addition, to curtail the gap in feeding administration, compensatory techniques should be applied. For instance, Woien and Bjork (2006) suggested a regular increase in the rate above what is prescribed. Likewise, Heyland *et al*. (2003) suggest additional amounts of feeding over the prescribed volume, also, Lichtenberg *et al*. (2010)

recommend that the amount to be given over 24 hours, be given over 20 hours, to minimise the risk of underfeeding. However, massive nourishment could lead to the re-feeding syndrome. Nurses should avoid aggressive carbohydrate and protein delivery as it contributes to major electrolyte and fluid imbalance and, eventually, will affect the cardiac and neural functioning. Also, slow starting rate is recommended along with frequent monitoring for the electrolyte, fluid balance and vitamins in the blood (Crook *et al.*, 2001; Marinella, 2005; Mehanna *et al.*, 2008; Ahmed *et al.*, 2011).

Confirming tube placement using unreliable techniques such as air bubbling, auscultatory and carbon dioxide methods might yield inaccurate indication of the tube location (Burns *et al.*, 2006; Elpern *et al.*, 2007; Miller, 2011). Although the study by Turgay and Khorshid (2010) did not examine the effect of different kinds of anti-acids and proton pump inhibitors (PPIs) on the pH, it was found to be consistent with other studies that affirmed the superiority of X-ray and pH techniques in detecting tube placement over the above techniques (Jacobs *et al.*, 1996; Stroud *et al.*, 2003; Elia *et al.*, 2004; Padula *et al.*, 2004). Finally, to eradicate the sources of feeding system contamination, using antiseptic techniques while handling, preparing and assembling feeding system is required. In addition, using closed-packed feeding systems, appropriate storing temperature and shorter hanging times (preferred to be changed daily) are also essential to prevent any growth from endogenous or exogenous sources (Pancorbo *et al.*, 2001; Mathus-Vliegen *et al.*, 2006; Barrett *et al.*, 2009; McClave *et al.*, 2009).

Table 1: Complications of EN, Causes, Potential Outcomes and Preventive Strategies and Level of Evidence.

Category	Examples	Possible causes	Potential outcomes	Prevention strategies and level of evidence	References
Mechanical	Tube dislodgment. Tube misplacement. Tube occlusion.	Inappropriate feeding tube. Inadequate tube irrigation. Formula viscosity Insufficient drugs crash.	Pulmonary complications. Failure of administration.	Choosing suitable feeding tube pore (I), frequent irrigation using sterile water (II), checking tube placement each shift (IV), pH method to check place (III).	(MarIan & Allen, 1998; Marik & Zaloga, 2001; Pancorbo *et al.*, 2001; Stroud *et al.*, 2003).
Gastrointestinal	Diarrhoea Gastrointestinal intolerance. Constipation Gastric distension Gastric bloating Vomiting Delay gastric empty	Formula osmolarity (hypertonic), fat content, low fibre feeds. Improper feeds temperature. Malabsorption Lactose intolerance Low serum albumin (hypoalbominemia). Bacterial contamination. Medication (e.g. antibiotic-associated diarrhoea). Excessive formulation, Infusion rate	Failure of administration. Electrolyte imbalance. Under-feeding	Fiber-enrich formula (III), Using Prokinetics for feeding intolerance(I), managing feeding rate(I), using aseptic technique (III), withhold feeding if GRVs exceed 500ml (II), reintroducing gastric content less than 500ml (I), detect signs of feeding intolerance (III), using suitable feeding temperature(II).	(Adam & Batson, 1997; Beattie & Anderton, 1998; Pancorbo *et al.*, 2001; Elia *et al.*, 2004; Elpern *et al.*, 2004; Petros & Engelmann, 2006; Bourgault *et al.*, 2007).
Metabolic	Electrolyte imbalance Hyperglycaemia Hypoglycaemia Over hydration Dehydration	Fluid excess Fluid depletion Inadequate free fluid Excessive renal lose Interrupt feeding for patient receiving insulin. Unnecessary feeding cessation.	Metabolic abnormalities. Poor glycaemia control. Electrolyte imbalance Under-feeding CNS deterioration	Accurate nutritional assessment, avoid unnecessary feeding cessation (I), controlling blood glucose level (110-115 mg/dl) (III), additional feeding amount than prescribed (II).	(Eschleman, 1991; MarIan & Allen, 1998; Pancorbo *et al.*, 2001; Stroud *et al.*, 2003; Barrett *et al.*, 2009).

Infectious	Pneumonia Diarrhoea Lung aspiration	Positioning (supine). Low level of consciousness. Gastroesophageal reflex (regurgitation). Vomiting, head trauma, bacterial transmission, persistent high GRVs.	Sepsis Delay wound healing. Impaired immunological defence. SIRS/ delay recovery Alter hemodynamic status.	Air way management (I), HOB elevation (30°-45°) (II), regular GRVs check-4 hourly (IV), avoid acid suppression (II), oral hygiene (III), keep ETT cuff pressure at 20-25 cm H_2O (III), using intestinal feeding (I), using prokinetics agents (I).	(McClave *et al.*, 2003; Heyland *et al.*, 2003 ; Williams & Leslie, 2005; Metheny *et al.*, 2008; McClave *et al.*, 2009; Metheny *et al.*, 2010).
Other:	Gastrointestinal ischemia	Increasing gap between mucosal Pco2 and arterial Pco2	Mucosal atrophy Gut dysfunction Poor tissue perfusion	Avoid excessive carbohydrate (III)	(Shikora *et al.*, 1996; Lunn *et al.*, 1998; Jeejeebhoy, 2002).
	Feeding system contamination.	Improper preparation, handling, storage, and administration. Prolonged system hanging time. Bacterial contamination (endogenous, exogenous).	Diarrhoea Vomiting Feeding intolerance Fever sepsis	Decrease length of hanging time (II), using non-sterile technique (II), hand wash (II), using feeding pack (Closed Pack) (III), formulae refrigerating (II), flushing tube after each use (III).	(Beattie & Anderton, 1998; Sanko, 2004; Mathus-Vliegen *et al.*, 2006; Barrett *et al.*, 2009).
	Tube complications	Insertion complications Post insertion trauma	Nasal damage, bleeding. Discomfort, erosion, abscess, sinusitis. Bleeding; intestinal, colonic perforation. Bronchial administration. Oesophagitis, aspiration. Tube dislodgment.	Using guidwire feeding tube (I), avoid larger tube, flushing tube before and after feeds (III), avoid supine position and use semi-recumbent (II), use gravity for administration (II).	(Eschleman, 1991; Spain *et al.*, 1999; Stroud *et al.*, 2003; Barrett *et al.*, 2009; McClave *et al.*, 2009).
	Re-feeding syndrome	Aggressive carbohydrate and protein administration to malnourished patients	Electrolyte depletion (i.e. ph, mg & k), vitamin deficiency, fluid-balance disturbances.	Slow feeding start (II), monitoring fluid and electrolyte balance (III), staff education (III), and detecting neural disturbances signs (II).	(Crook *et al.*, 2001; Marinella, 2005; Mehanna *et al.*, 2008; Ahmed *et al.*, 2011).
	Anxiety	Abdominal bloating Nasal irritation Undesirable taste Impaired self esteem	Refusing feed Uncooperative patient Emotional problems Fear from death	Patient education (III), Considering ethical issues (IV). Family support (IV). Taking patient choice (IV).	(Madigan *et al.*, 2002; Elia *et al.*, 2004; McMahon *et al.*, 2005; Persenius *et al.*, 2009)

Strengths and limitations

Through reviewing studies published over a wide period, this study examines the progress in developing nursing practice in general, and the methods for managing the most controversial issue in EN in particular. The development in evidence-based protocols allows professions to identify the gaps in their practice. Thus, the power of such protocols is heavily dependent on the integration of relevant literature that contributes to implementing evidence in practice. However, although studies were limited to the adult patients in critical care areas, the range of inclusion criteria means the inclusion of different methodological perspectives might generate inconsistent levels of evidence. Therefore, this integrative review would be more powerful if more restrictions were applied on the included studies, specific the inclusion of only experimental studies to provide more consistent results.

Conclusion

EN promotes patients' recovery, reduces the length of stay, and enhances patients' immunity. EN should be applied committing with evidence-based practice. Many clinical guidelines and protocols were established to facilitate using EN safely and to minimise disparities in nursing practice. A considerable number of evidence-based protocols were established to manage some practical issues associated with EN and its complication in the critically ill. Feeding intolerance should be detected and avoid relying solely on GRVs to assess patient's digestive status. Other pre-existing factors contribute to unusual gastric retention such as head injury and using sedation. GRV should be measured at least 4-6 hourly with more frequency in abnormal GRVs records. Various measures should be undertaken to lower the risk of aspiration when exceeded GRV exists. Using prokinetic agents is one of these measures that should be used concurrently with feeding. Elevating head of bed 30-45° and maintaining endotracheal cuff pressure at 20-25 cm H_2O are another recommended practices for enterally fed, mechanically ventilated patients.

The problem of under-feeding is notably evident. Unnecessary feeding interruption should be avoided whenever it is possible and the undelivered amount should be compensated accordingly. The regular increase in feeding rates/amount is a recently innovated practice to reduce the gaps between prescribed and delivered nutrition. Feeding interruption should be anticipated by nurses to place the patient in an appropriate position and calculate feeding deficits accordingly. Gut dysfunction and preparing for procedures are the most influential factor triggering feeding interruption. Therefore, interpreting GRVs accurately is substantial to detecting feeding intolerance and minimising feeding cessation.

Re-feeding syndrome is uncommon; however, it can be avoided through attention to feeding rate, electrolyte and fluid monitoring.

X-ray is still considered 'gold-standard' for detecting feeding tube placement. pH method is also approved as a reliable indicator to tube location. Capnometry is recommended in urgent situations and should be accompanied with one of the former accurate techniques. Air insufflations, detecting bubbling and any auscultatory methods are eliminated from practice. Nurses should consider less feeding system hanging time which prohibits the occurrence of infections from endogenous sources. In addition, providing feeding with expedient temperature and deliberate disinfecting feeding equipments prior using are practices contribute to lower the incidences of infectious episodes.

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