

Review

Preliminary Evidence for a Medical Nutrition Therapy Protocol: Enteral Feedings for Critically Ill Patients

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ABSTRACT

The objective of this study was to evaluate the evidence behind specific but common patient care decisions in support of enteral feedings for patients admitted to intensive care units. Six specific questions were developed and refined to address clinical outcomes specific to clinical practice decisions pertinent to enteral feeding of critically ill patients. The data sources consisted of an intensive literature review from five databases, using standardized search terms. Randomized controlled clinical trials, meta-analyses, consensus statements, reviews, US Food and Drug Administration alerts, and case reports were selected for study. Research reports were abstracted in detail and evaluated for research quality using the criteria developed by the American Dietetic Association. Consensus statements regarding the influence of specific enteral feeding methods on key clinical outcomes (ie, infectious complications, cost, length of hospital stay, and mortality) were developed and graded based on the quality of the available evidence. The data support the use of enteral over parenteral nutrition to reduce infectious

complications and cost, and the initiation of enteral feedings within 24 to 48 hours of injury or admission to an intensive care unit to reduce infectious complications and length of hospital stay in head injury and trauma patients. Postpyloric tube placement is associated with reduced gastric residual volume and reflux, but adequately powered trials are not available to support prevention of aspiration pneumonia. Acceptance of gastric residual volumes of up to 250 mL may increase volume of formula delivered. Proton pump inhibitors are associated with reduced gastric residual volume. Feeding patients in the semirecumbent rather than supine position is associated with reduced aspiration pneumonia and pharyngoesophageal formula reflux. Actual delivery of 14 to 18 kcal/kg/day or 60% to 70% of goal is associated with improved outcomes, whereas greater intake may not be in some populations. Blue food coloring should not be used with enteral feedings due to its limited sensitivity for aspiration and some risk of mortality. Well-designed, adequately powered, randomized controlled clinical trials are needed to evaluate any benefit of tube tip position on aspiration pneumonia or mortality, and of early enteral feedings on mortality.

J Am Diet Assoc. 2006;106:1226-1241.

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0002-8223/06/10608-0007\$32.00/0

doi: 10.1016/j.jada.2006.05.320

Malnutrition is prevalent in intensive care unit (ICU) patients and is associated with increased morbidity and mortality (1). Severe malnutrition is recognized as a major concern in critically ill persons (2). Nutrition support is an important adjunctive therapy with primary goals to prevent malnutrition (3) and to support patients during treatment of an underlying illness. Nutrition support practitioners provide nutritional care plans and case management of enteral feedings for patients admitted to ICUs who are expected to require nutrition support. Many procedures commonly employed in ICU care have limited evidence regarding their safety or effectiveness for patient care. Therefore, development and use of evidence-based practice guidelines that reflect current nutrition therapy recommendations are valuable tools for practitioners (4-6).

The purpose of this project was to examine the evidence basis for common management decisions applied to enteral feedings for critically ill patients with the intent to develop a medical nutrition therapy protocol that health care practitioners may apply in the care of their patients.

MATERIALS AND METHODS

The evidence analysis procedure developed by the Quality Management Team of the American Dietetic Association (7,8) and based on modifications of the process developed by the Institute of Clinical Systems Improvement (9), was applied to the nutritional care of patients admitted to an ICU. A committee of seven nutrition support dietitians with expertise in enteral feedings was assembled and trained in the evidence analysis procedure.

Six specific questions were developed and refined by the committee to address clinical outcomes specific to clinical practice decisions pertinent to enteral feeding of critically ill patients.

1. What is the effect of enteral vs parenteral feeding on infectious complications, cost, length of hospital stay (LOS), and mortality?
2. Does the timing of enteral feeding influence infectious complications, LOS, or mortality?
3. Does the placement of an enteral feeding tube tip in the gastric vs postpyloric position affect gastric residual volume or reflux, aspiration pneumonia, cost, LOS, or mortality?
4. What monitoring criteria should be used for enteral feeding management?
5. Does the amount of enteral formula actually delivered influence infectious complications, cost, LOS, ventilator days, or mortality?
6. Does the use of blue dye aid in the detection of aspiration or influence mortality?

Intensive literature searches with the following databases (Medline, EMBASE, PubMed, Cinahl, and Cochrane) were undertaken using the following search terms: enteral feeding or tube feeding; blue dye; methylene blue; enteral nutrition *and* aspiration pneumonia or pneumonia or ventilator-associated pneumonia; enteral nutrition *and* duodenum or gastric; supine position and pneumonia; enteral feeding *and* infectious complications, mortality, and LOS. Searches were limited to articles published in English, adult patients, ICU location, and 1985 to 2003. Hand searches of panel members' files were also used to locate pertinent research reports. Randomized controlled trials, meta-analyses, reviews, consensus statements, US Food and Drug Administration alerts, and case reports were evaluated. Animal studies were excluded with the exception of the question researching blue dye and enteral feeding. For this question, well-controlled animal studies were allowed as indirect support for human studies of weaker design. Articles whose abstracts suggested relevance to the question at hand were retrieved and abstracted in detail according to the American Dietetic Association evidence analysis process (8). Individual committee members acted as lead reviewer for a question and as such were responsible for abstracting the articles for that particular question. The lead reviewer for each question assigned a quality designator to the article using the comprehensive guidelines provided by the *American Dietetic Association Evidence Analysis Guide* (8). The designators were assigned by a single trained individual for all the studies relating to a particular question. The quality designators were strong (+), neutral (Ø), or poor (−) and reflected the study qual-

ity based on a set of questions designed to evaluate validity and reliability (8). These validity and reliability criteria included relevance of study design to the evidence question, selection of study subjects, clear inclusion/exclusion criteria, comparable study groups, randomization, blinding, study instruments, clear methods and/or processes of data abstraction, appropriate statistical analysis, sample size, limitations addressed, and bias.

Using the abstracted worksheets, conclusion statements were then developed by group consensus and assigned conclusion grades I to IV, based on the strength of the evidence (8). A conclusion grade I indicates that the conclusion is supported by good evidence, from studies of strong design for answering the question addressed and the results are both clinically important and consistent with at most minor exceptions. The results are free of any significant doubts about generalizability, bias, and flaws in research design. Studies with negative results have sufficiently large samples to have adequate statistical power. A conclusion grade II indicates that the conclusion is supported by fair evidence from studies of strong design for answering the question addressed, but there is some uncertainty attached to the conclusion because of inconsistencies among the results from the studies or because of minor doubts about generalizability, bias, research design flaws, or adequacy of sample size. Alternatively, the evidence consists solely of results from weaker designs for the question addressed, but the results have been confirmed in separate studies and are consistent with at most minor exceptions. A conclusion grade III indicates that the conclusion is supported by limited evidence from studies of strong design for answering the question, but there is a substantial uncertainty attached to the conclusion because of inconsistencies among the results from different studies or because of serious doubts about generalizability, bias, research design flaws, or adequacy of sample size. In addition, the evidence may consist solely of results from a limited number of studies of weak design for answering the question. A grade IV conclusion statement is supported only by expert opinion but is not substantiated by the results of research studies. When no trials were found to address a question, a statement to that effect was made and no conclusion grade was given.

To prevent multiple reports from the same data biasing the conclusion statement, abstracts from primary research articles were used to formulate the answer and grade the conclusion statements. The reviews and meta-analyses were included as additional support for the conclusion statement, but were not considered in assigning a grade indicator.

RESULTS

Question 1. What is the Effect of Enteral vs Parenteral Feeding on Infectious Complications, Cost, LOS, and Mortality?

Infectious Complications. Enteral feeding is associated with reductions in infectious complications when compared with parenteral feeding (grade I). This conclusion is supported by (Table 1) two randomized controlled trials of strong design in acute pancreatitis (10) and trauma (11) and one of lesser quality in trauma patients (12). Four randomized controlled trials of neutral or lesser design

Table 1. Summary of studies used to answer the clinical question on the effect of enteral nutrition (EN) vs parenteral nutrition (PN) on infectious complications, cost, length of stay, and mortality

Study ^a	Population	IC ^b	Cost	LOS ^c	Mortality
Randomized controlled trial					
Kalfarentzos, 1997 (10)	Acute pancreatitis (N=38) EN=18 PN=20	IC lower with EN vs PN, $P=0.01$	Daily cost savings of £70	— ^d	EN 3/18 vs PN 2/20
Kudsk, 1992 (11)	Trauma EN=51 PN=45	Less septic morbidity with EN vs PN, $P<0.03$	—	No differences in LOS	1/51 EN vs 1/45 PN
Moore, 1989 (12)	Trauma EN=39 PN=36	Reduced IC for pneumonia and abdominal abscesses, $P=0.03$, NS ^e for total IC	—	—	—
Adams, 1986 (13)	Trauma EN=23 PN=23	No differences between EN, PN for IC	\$157 PN vs \$37 for EN. Average cost saving of \$2,383 per patient fed with EN	No differences in LOS	3 PN deaths vs 1 EN death reported
Borzotta, 1994 (14)	Head injury EN=28 PN=21	No differences	Average cost per patient per length of stay: PN \$2,020.23, EN \$1,202.40	No differences in LOS	1 in PN vs 5 in EN group
Cerra, 1988 (15)	Sepsis EN=31 PN=35	No reduction in incidence of multiple organ failure syndrome	Daily cost/patient: \$228 EN vs \$330 PN	—	No differences in mortality
Hadley, 1986 (16)	Head injury EN=21 PN=24	No differences	—	—	3/21 EN vs 2/24 PN
Woodcock, 2001 (17)	Sepsis EN=231 PN=267	No differences	—	—	No difference in mortality in patients randomized to receive EN or PN. Mortality with EN 37.5%, PN 21.9%
Young, 1987 (21)	Head injury EN=28 PN=23	—	—	—	No differences in mortality
Hadfield, 1995 (22)	ICU EN=13 PN=11	—	—	—	Not significantly different for mortality. Two in EN vs 6 in PN, $P=0.08$
Meta-analysis/Review					
Trice, 1997 (20)	Trials=2 EN=118, 51 PN=112, 45	—	PN was 4 to 12.5 times more expensive than EN	—	—

(continued)

Table 1. Summary of studies used to answer the clinical question on the effect of enteral nutrition (EN) vs parenteral nutrition (PN) on infectious complications, cost, length of stay, and mortality (continued)

Study ^a	Population	IC ^b	Cost	LOS ^c	Mortality
Moore, 1992 (19)	EN=118 PN=112	Septic complications 18% with EN vs 35% PN, <i>P</i> =0.01	—	Only penetrating trauma group (subgroup analysis) experienced reduced LOS, <i>P</i> =0.05. No differences overall	No differences in mortality
Heyland, 2003 (18)	ICU ^f patients	Less IC with EN vs PN. RR ^g =0.61, 95% CI ^h : 0.44-0.84, <i>P</i> =0.003	—	—	No difference in mortality. RR=1.08, 95% CI .70-1.65, <i>P</i> =0.7

^aBold indicates studies of strong design.
^bIC=infectious complications.
^cLOS=length of stay.
^dNot evaluated in this trial, meta-analysis, or review.
^eNS=not significant.
^fICU=intensive care unit.
^gRR=relative risk.
^hCI=confidence interval.

quality (13,15-17), with small sample size (n=21 to 35 patients per group) and/or significant design limitations, reported no differences in infectious complication rates due to route of feeding. These studies may suffer from inadequate statistical power or are disadvantaged due to significant baseline differences between enteral and parenteral groups. A trial in head injury of strong design (14) also reports no difference in infectious complications, but has a small number of subjects.

A meta-analysis of strong design (18) and two of lesser quality (19,20) also supported a reduction in infectious complications with enteral feedings. The preponderance of evidence from strong trials was supportive of enteral over parenteral feedings in patients with trauma and head injury, although evidence from other populations was limited.

Cost. Enteral nutrition is associated with reduced cost when compared with parenteral feeding (grade II). Two randomized controlled trials of strong design in acute pancreatitis (10) and head injury (14), and two of lesser design quality in trauma (13), sepsis patients (15), and a meta-analysis with postoperative (20) patients supported the conclusion that enteral feeding is less costly than parenteral feeding, although the difference in cost estimates ranged from 1.4 times (15) to 12.5 times (20) less than that of parenteral nutrition.

LOS. There is insufficient evidence to support a recommendation for enteral vs parenteral feeding based on reducing LOS. Three randomized controlled trials in trauma and head injury patients, two of strong design (11,14), and one of lesser design quality (13) demon-

strated no benefit of enteral feedings on LOS. These trials had small sample sizes and may have been underpowered to answer whether or not a benefit in LOS exists.

A meta-analysis (19) of neutral design quality was unable to find reduced LOS when comparing enteral vs parenteral nutrition in the entire group. When a subgroup of trials with penetrating abdominal trauma was analyzed in this meta-analysis, LOS was reduced in the enterally fed patients.

Mortality. Insufficient evidence exists to address any influence of enteral vs parenteral feedings on mortality. Four randomized controlled trials of strong (10,11,14,21) and five of lesser (13,15-17,22) design quality reported no difference in mortality due to route of nutrition administration. A power analysis of the number of subjects needed to show a difference in mortality was not found, but the majority of these small trials (<30 patients per arm) are likely to be underpowered. A review of strong design (18) and a meta-analysis of neutral design quality (19) also reported no differences in mortality attributed to enteral vs parenteral feeding.

Question 2: Does Timing of Enteral Feeding in ICU Patients Influence Infectious Complications, LOS, or Mortality?

The committee defined early enteral feeding as initiation of enteral nutrition within 24 to 48 hours after injury or arrival to an ICU. This definition provides for sufficient time to assess initial risk factors (ie, hemodynamic instability, extremely large fluid resuscitation volumes, or

Table 2. Summary of studies used to answer the clinical question on the effect of timing of enteral nutrition (EN) feeding in intensive care unit (ICU) patients on infectious complications, length of stay, and mortality

Study ^a	Population	EEN ^b Definition	Infection	LOS ^c	Mortality
Randomized controlled trial					
Moore, 1986 (23)	Trauma EEN=26 CON ^e =27	12 to 18 h postoperative	Decreased septic morbidity with EEN, $P=0.025$	Average LOS for CON group 28.6 d, EEN group 25.3 d	— ^d
Kudsk, 1996 (24)	Trauma EEN=35 (17 immune-enhanced formula, 18 isonitrogenous formula) CON=19 (unfed)	Within 48 h	Early immune-enhancing diet decreased septic complications vs CON $P=0.03$. ICU days highest in CON subjects	Immune-enhanced EEN decrease LOS vs isonitrogenous EEN or unfed CON, $P=0.03$	—
Taylor, 1999 (25)	Head injury EEN=41 CON=41	Within 24 h of injury	Fewer infections with EEN, $P=0.02$	EEN group median days to discharge 30 vs 46 in CON, $P=0.008$	No significant difference
Grahm, 1989 (26)	Head injury EEN=17 CON=15	Within 36 h of admission	Less infection with EN, $P<0.005$	Decreased LOS with EEN, $P<0.05$	—
Singh, 1998 (27)	Elective surgery EEN=21 CON=22	Within 12 h post operatively	Less septic complication in EEN group vs CON, $P<0.05$	—	18.2% vs 19.1%
Eyer, 1993 (29)	Trauma EEN=19 CON=19	Within 24 h of ICU admission	Total infectious complications increased in EEN, $P<0.05$	Not reported for LOS, no difference for ICU days	No significant difference
Ibrahim, 2002 (30)	Medical ICU EEN=75 CON=75	Total EN needs on the first day of ventilation	EEN associated with greater pneumonia than late-fed group, $P=0.05$	Early fed group has longer LOS vs late fed group, $P=0.043$	20% EEN vs 27% CON, $P=0.334$
Garrel, 1991 (31)	Burn EEN=13 CON=12	Within 48 h of injury	—	LOS shorter for EEN group, $P=0.05$	—
Neumayer, 2001 (32)	Surgical 183 (EN and PN)	PN or EN within 48 h postoperatively	—	Reduced LOS with early and sufficient feeding (>60% of estimated needs)	—
Minard, 2000 (33)	Head trauma EEN=12 CON=15	Initiated <72 hours after trauma	No difference early vs late	No difference early vs late	No significant difference
Kompan, 1999 (35)	Trauma EEN=14 CON=14	Not later than 6 h after admission to ICU	—	No difference	—
Meta-analysis/Review					
Marik, 2001 (28)	ICU patients Trials=15 Patients=753	Within 36 h of admission to hospital or after 36 h of surgery	Lower risk of infection with EEN. RR ^f 0.45, 95% CI ^g : 0.30-0.66, $P=0.0006$. Significant for heterogeneity	Mean LOS reduction, 2.2 days. 95% CI: 0.81-3.63, $P=0.004$. Significant for heterogeneity	RR=0.74 (95% CI=0.37-1.48)

(continued)

Table 2. Summary of studies used to answer the clinical question on the effect of timing of enteral nutrition (EN) feeding in intensive care unit (ICU) patients on infectious complications, length of stay, and mortality (continued)

Study ^a	Population	EEEN ^b Definition	Infection	LOS ^c	Mortality
Yanagawa, 2002 (34)	Trials=7 Patients=284 Elective surgery	Cochrane Review, for EEEN Within 24 h after surgery	—	—	RR=0.67 (95% CI=0.37-1.07) Reported in 9 studies, no significant difference
Lewis, 2001 (36)	Trials=13 Patients=929	Within 24 h after surgery	Lower risk of infection with EEEN. RR=0.72, 95% CI: 0.54-0.98, P=0.001. Trend in reduced mortality with EEEN. RR=0.52, 95% CI: 0.25-1.08, P=0.8	LOS with EEEN reduced by 0.84 days. 95% CI: 0.36- 1.33, P=0.001	—
Heyland, 2003 (18)	ICU patients	Within 24-48 h after admission to ICU	Trend in reduced infection with EEEN. RR, 0.66, 95% CI: 0.36-1.22, P=0.19	No difference	—

^aBold indicates studies of strong design.
^bEEEN=early enteral feeding initiated within 24 to 48 hours after injury or arrival to ICU.
^cLOS=length of stay.
^dNot evaluated in this trial, meta-analysis, or review.
^eCON=control patients, not fed early.
^fRR=relative risk.
^gCI=confidence interval.

bowel distention) for gastrointestinal intolerance in ICU patients. Early enteral feeding should be considered based on the following evidence (Table 2).

Infectious Complications. Early enteral feeding is associated with reduced incidence of infectious complications (grade I). The conclusion statement is supported by two randomized controlled trials of strong design in blunt trauma patients (23,24), two of neutral quality in head injury patients (25,26), and one randomized controlled trial of neutral quality in surgical patients (27). Two studies of neutral design quality (27,30) in trauma and medical ICU patients, respectively, actually reported increased infectious complications with enteral feeding, but had small sample sizes, and an additional potentially confounding variable of bolus rather than continuous tube feeding (30).

Two meta-analysis studies of strong design (18,28) and one of neutral quality in design (36) also demonstrate a reduction in infectious complications when enteral feedings are used compared with parenteral nutrition. The preponderance of data from strong trials supports a reduction in infectious complications with enteral nutrition.

LOS. Early enteral feedings may be associated with reduced LOS (grade II). This conclusion statement is supported by four randomized controlled trials of lesser design quality (26,27,33,34). Two randomized controlled trials of lesser design quality in head injury and trauma patients (35,36) reported no difference in LOS with early enteral feedings. A third clinical trial of neutral quality (32) actually reported increased LOS with the early enteral group vs the delayed group, but a potential confounder is the use of bolus rather than continuous feedings.

The systematic reviews also did not agree. One systematic review of strong design (30) reported the mean reduction in LOS in enterally fed patients in an ICU was 2.2 days. In addition, a meta-analysis of neutral quality in design with elective surgery patients (36) reported a decreased LOS by 0.84 days in early enteral nutrition vs “nil by mouth.” In contrast, a second meta-analysis of strong design (18) reported no difference.

Mortality. A statistically significant difference in mortality due to timing of enteral feeding has not been demonstrated, but study design quality has been limited. A randomized controlled trial of neutral design quality with 150 patients (30) found no difference between early vs late feeding groups for mortality; 20% vs 27% (P=0.334). Similarly, mortality did not differ between early fed and control groups in another small trial of 43 patients (27) of neutral design quality (18.2% vs 19.1%). No power analysis was given to determine if any of these trials achieved adequate sample size to detect a difference in mortality.

A meta-analysis of strong design (34) that included seven trials and 284 subjects reported the relative risk (RR) for death with early nutrition support was 0.67 (95% confidence interval [CI] 0.41 to 1.07) and approaching statistical significance. A limitation of this trial is that both enteral and parenteral feedings were allowed in the inclusion criteria for early feeding. In addition, two meta-analysis (18,28) of strong design and one of neutral quality (36) reported a nonsignificant reduction in RR of mortality due to early feeding.

Because available randomized controlled trials may have been underpowered to show a difference, and the

Table 3. Summary of the studies used to answer the clinical question on the effect of placement of enteral feeding tube tip (gastric vs postpyloric position) on gastric residual volume or gastric reflux, aspiration pneumonia, cost, length of stay, and mortality

Study ^a	Population	Gastric residual volume/reflux	Aspiration	Mortality
Randomized controlled trial				
Heyland, 2001 (37)	ICU ^b ND ^e =18 NG ^f =21	GER ^c =24.9% ND vs 39.8% NG 92% of ND patients with reflux	88% with microaspiration, no difference by tube	— ^d
Davies, 2002 (38)	ICU NJ ^h =34, NG=39	GRV ^g ↓ with NJ; P=0.02	—	—
Minard, 2000 (33)	Trauma ICU ND=12 NG=15	—	No difference	—
Montejo, 2002 (39)	ICU NJ=50 NG=51	GRV ↓ with NJ (40% vs 2%)	No difference pneumonia NG=49%, NJ=2% Power analysis says need 152 patients/group	No difference. No power analysis for mortality
Boivin, 2001 (40)	ICU ND=39 NG=39+ erythromycin	No difference in GRV, NG + erythromycin vs ND	—	—
Esparza, 2001 (42)	ICU ND=27 NG=27	—	No difference aspiration by tube placement. Power analysis says need 54 patients to detect 30% difference	—
Kearns, 2000 (43)	Medical ICU ND=21 NG=23	—	No difference ND=5%, NG=3% Power analysis says 20 patients per group to detect 20% difference	No difference ND=24% NG=26% No power analysis for mortality
Kortbeek, 1999 (44)	Trauma ICU ND=37 NG=43	—	Not different, ND=27% NG=42% Power analysis says 200 patients/group to detect 20% difference	—
Montecalvo, 1992 (45)	ICU JT ⁱ =19 GT=19	—	Pneumonia 10.5% GT ⁱ vs 0% JT	—
Neumann, 2002 (46)	Medical ICU ND=30 NG=30	—	No difference ND=3.3% NG=0% No power analysis	—
Meta-analysis/Review				
Heyland, 2002 (47)	Trials=10 Patients=612	Small bowel feeding ↓ GER	RR ^k =0.79, 95% CI ^l : 0.59- 0.99	RR=0.92, 95% CI 0.72-1.2
Marik, 2003 (48)	Trials=9 Patients=522	—	OR ^m 1.44, 95% CI=0.84- 2.46	—
Heyland, 2003 (18)			Recommend postpyloric tube in patients with high GRV, sedation, supine position. May not be feasible for all patients.	

(continued)

Table 3. Summary of the studies used to answer the clinical question on the effect of placement of enteral feeding tube tip (gastric vs postpyloric position) on gastric residual volume or gastric reflux, aspiration pneumonia, cost, length of stay, and mortality (continued)

Study ^a	Population	Gastric residual volume/reflux	Aspiration	Mortality
McClave, 2002 (41)		—	↓ GER, possibly aspiration	—

^aBold indicates studies of strong design.
^bICU=intensive care unit.
^cGER=gastroesophageal reflux.
^dNot evaluated in this trial, meta-analysis, or review.
^eND=nasoduodenal tube.
^fNG=nasogastric tube.
^gGRV=gastric residual volume.
^hNJ=nasojunal tube.
ⁱGT=gastric tube.
^jJT=jejunal tube.
^kRR=relative risk.
^lCI=confidence interval.
^mOR=odds ratio.

stronger meta-analyses do not agree, the workgroup concluded that further trials are needed to answer the mortality risk vs early enteral feedings question.

Question 3: Does Placement of an Enteral Feeding Tube Tip in the Gastric vs Postpyloric Position Affect Gastric Residual Volume or Gastric Reflux, Aspiration Pneumonia, Cost, LOS, or Mortality?

Gastric Residual Volume/Gastric Reflux. The site of the enteral feeding tube in the postpyloric position is associated with reduced gastric residual volume, a factor that has been associated with reduced reflux of formula (grade I). Small bowel feeding tube placement may not be necessary or feasible for all patients, but may be useful in high-risk patients such as those with supine positioning, sedation, and/or patients with large gastric residual volumes (grade IV). In randomized clinical trials of strong (37) and lesser (38,39) design quality, the use of postpyloric feedings was associated with reduced gastric residual volume and/or gastric reflux, when compared with gastric feeding (Table 3). The North American Summit on Aspiration in the Critically Ill Patient (38) gave expert opinion that small bowel feeding would reduce gastroesophageal reflux and possibly aspiration risk.

Aspiration Pneumonia. Adequately powered trials to test postpyloric vs gastric feeding for effect on aspiration pneumonia are not yet available (no grade). One high-quality trial detected 88% microaspiration in patients, with no difference by tube tip placement (37). A series of small clinical trials of neutral to lesser quality design (33,39,42-44) reported no difference in aspiration pneumonia due to gastric vs postpyloric feeding. Power analysis calculations to detect a 20% difference in aspiration pneumonia when patients are fed gastrically vs in small bowel indicates that 54 (42) to 200 (43) patients per group are needed. Whereas one study of lesser quality design (45) reported a reduction in aspiration pneumonia with postpyloric feeding, the sample size was only 19 patients per group. In addition, that study is more than 10 years old and may reflect a lower acuity ICU care than current practice realities.

In a meta-analysis of strong design in 2002 (47) a reduction in ventilator-associated pneumonia (odds ratio=0.76, 95% CI 0.59 to 0.99) was reported with postpyloric feeding. However, in a re-evaluation of this meta-analysis reported in the Canadian Practice Guidelines (18), where one study was removed due to limitations in the success of the feeding protocol, the RR of pneumonia with postpyloric tube placement was 0.83 and no longer statistically significant (P=0.30). A second meta-analysis of strong design (48) included nine trials but found no difference in incidence of pneumonia due to tube placement. The Canadian Clinical Practice Guidelines (18) suggest postpyloric tube placement for all ICU patients when feasible, and particularly for high-risk patients (ie, those with high gastric residual volume, sedation, or supine positioning). Clearly, a large randomized controlled trial is needed to answer the question of whether or not postpyloric tube placement reduces the incidence of aspiration pneumonia.

LOS, Cost, and Mortality. To date, adequately powered studies have not been located to evaluate differences in mortality, LOS, and cost of nutritional care when comparing gastric vs postpyloric feeding tube position (no grade).

Question 4: What Monitoring Criteria Should Be Used for Enteral Feedings?

Gastric Residual Volumes. Accepting an isolated gastric residual volume of 250 mL, and evaluating the clinical situation with two or more consecutive volumes of 250 mL before stopping/holding the feeding is associated with greater formula delivery (grade III). To date, adequately powered studies have not been conducted to demonstrate a significant relationship between gastric residual volume and aspiration pneumonia (no grade). Available trials are depicted in Table 4. Only one study of neutral design (25) compared a protocol using 200 mL gastric residual volume vs 150 mL to guide holding of enteral feedings, and a second randomized controlled trial (49) of neutral design compared 150 mL vs 250 mL, the latter with mandatory prokinetic agent use. Both trials agreed that using a higher gastric residual volume had benefit in

Table 4. Summary of studies used to support the monitoring of enteral feeding clinical question that addresses gastric residual volumes allowed

Study ^a	Gastric residual volume ^b	Outcomes
Randomized controlled trial		
Taylor, 1999 (25)	150 vs 200 mL	↑ energy intake with 200 mL residual; ↓ infectious complications with 200 mL
Pinilla, 2001 (49)	150 vs 250 mL	↓ high gastric residual volume with 250 mL protocol ↓ intolerance events with 250 mL protocol
Davies, 2002 (38)	250 mL	24-h gastric residual ↓ with jejunal vs gastric feedings
Montejo, 2002 (39)	300 mL	High gastric residual volume ↓ with jejunal vs gastric feeds
Esparza, 2001 (42)	150 mL	No difference in aspiration, but lacks power
Kearns, 2000 (43)	150 mL	No difference in aspiration, but lacks power
Kortbeek, 2000 (44)	250 mL	Pneumonia 42% with gastric, 27% small bowel, but underpowered
Montecalvo, 1992 (45)	250 mL	Nosocomial pneumonia 10.5% with gastric vs 0% with jejunal feedings
Neumann, 2002 (46)	200 mL	No difference in aspiration pneumonia, residual volumes, gastric vs jejunal feeds—underpowered
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McClave, 2002 (41)	All	Gastric residual volume did not correlate with abdominal examination or aspiration by x-ray
Heyland, 2003 (18)	250 mL	If a feeding protocol is used, 250 mL gastric residual volume may optimize formula delivery

^aBold indicates studies of strong design.

^bStudy protocol maximum gastric residual volume(s).

terms of greater formula intake (25) and fewer intolerance events (49). Gastric residual volume over a wide range did not correlate with aspiration events determined radiographically (41). Other randomized controlled trials of weaker design (38,39,41-46) used gastric residual volumes of 150 to 200 mL, but were underpowered to detect significant differences in aspiration pneumonia.

The Canadian Clinical Practice Guidelines (18) support a residual volume of 250 mL for gastric feedings to improve enteral delivery if a feeding protocol is implemented.

Emesis. Whereas adequately designed clinical trials have not defined the volume of emesis that is definitive for holding/stopping the enteral feeding, clinical experience indicates that greater formula intake can be obtained if feeding is stopped or held only when emesis is not associated with medical or nursing procedures and repeatedly large in volume (grade IV).

Promotility Agents. Use of promotility agents (metoclopramide) is associated with reduced gastric residual volume (grade II). In one randomized controlled trial of neutral design (49), prokinetic agents used with gastric feedings increased gastrointestinal transit, feeding tolerance as judged by gastric residual volume, formula delivery, and possibly reduced the risk of aspiration (Table 5). A second randomized controlled trial of neutral design found no difference in pneumonia prevalence, but was likely underpowered (50). A third randomized controlled trial of lesser design quality (40) reported no difference between gastric residual volumes of patients fed gastrically with erythromycin use than those fed with the tube tip in the postpyloric position.

Three consensus statements of strong design (18,41,51) agree that motility agents should be considered to improve formula delivery (18), possibly to reduce risk of

aspiration (41), and to improve feeding tolerance (51). Because erythromycin may affect antibiotic resistance in critically ill patients, metoclopramide may be a better choice in patients where use of the drug is not contraindicated.

Patient Positioning. Feeding patients positioned in a 45° head of bed elevation (compared to supine positioning) during gastric feedings was associated with a decreased incidence of aspiration pneumonia (grade II) and decreased reflux of gastric contents into the pharynx and esophagus (grade I). One well-designed, prospective crossover trial (52) documents both reduced pneumonia incidence and mortality with semirecumbent positioning (Table 6). Both clinically suspected and culture-confirmed pneumonias were reduced by semirecumbent positioning (34% to 8%, $P=0.003$; 23% vs 5%, $P=0.018$) (52). Three other trials of lesser study design quality confirm that gastric residual volume is increased with presence of a nasogastric tube (53), but that semirecumbent positioning protects against gastroesophageal reflux of formula (54,55). When pneumonia occurred within 7 days of gastric feeding, the same organism was cultured from the pulmonary aspirate as that aspirated from the stomach (55), implying the pneumonia was caused by the feeding.

Three consensus statements of strong design (18,41,56) concur that semirecumbent positioning should be used to reduce risk of aspiration pneumonia.

Question 5. Does the Amount of Enteral Formula Actually Delivered Influence Infectious Complications, Cost, LOS, Ventilator Days, or Mortality?

Actual Formula Delivery. Actual delivery of enteral formula of approximately 14 to 18 kcal/kg/day or 60% to 70% of enteral feeding goal, in the first week of ICU admission, is associated with shortened LOS and time on ventilator, and with

Table 5. Summary of studies used to support the monitoring of enteral feeding clinical question that addresses use of prokinetic agent

Study ^a	Population	Outcomes
Randomized controlled trial		
Boivin, 2001 (40)	ICU ^b ND ^d =39 NG ^e +erythromycin=39	No difference GRV ^c >150 mL in gastric feeds + erythromycin than in postpyloric feeds. No power analysis
Pinilla, 2001 (49)	ICU NG=36 NG+prokinetic=44	Enteral feeding intolerance ↓ by use of GRV 250 mL and prokinetic agent
Yavagal, 2000 (50)	ICU+NG feeds Metoclopramide=131 Placebo=174	16.8% of metoclopramide and 13.8% of placebo had pneumonia
Meta-analysis/Review		
Heyland, 2003 (18)		Motility agents should be considered as a strategy to improve delivery of enteral nutrition
McClave, 2002 (41)		Prokinetic agents may ↓ risk of aspiration
Booth, 2002 (51)		Metoclopramide safest prokinetic agent; ↑ gastrointestinal transit and feeding tolerance
^a Bold indicates studies of strong design. ^b ICU=intensive care unit. ^c GRV=gastric residual volume. ^d ND=nasoduodenum. ^e NG=nasogastric.		

Table 6. Summary of studies used to support the monitoring of enteral feeding clinical question that addresses the use of semirecumbent positioning

Study ^a	Population	Outcomes
Randomized controlled trial		
Drakulovic 1999 (52)	Medical or respiratory ICU ^b Supine=47 Semirecumbent=39	Pneumonia ↓ 34% to 8%, $P=0.003$. Enteral feeds ↑ risk of pneumonia 5.7x; Supine position ↑ risk 6.8x. ICU mortality ↓ supine=28%, semirecumbent=18%, $P=0.02$.
Ibanez, 1992 (53)	ICU with NGT ^c =50; Supine=24 Semirecumbent=26 Without NGT=20; Supine=12 Semirecumbent=8	GER Supine=81% Semirecumbent=67% $P=0.26$ GER with NGT 74% vs 35% without, $P<0.002$
Orozco-Levi, 1995 (54)	ICU Randomized crossover, 15 patients Supine vs semirecumbent	GER is common, semirecumbent position ↓ ($P<0.05$) but does not eliminate
Torres, 1992 (55)	Respiratory ICU Randomized crossover, 19 patients Supine vs semirecumbent	Supine position and length of time supine are risk factors for aspiration of gastric contents. GER ↓ with semirecumbent position ($P<0.05$), with 30 vs 300 min ($P=0.05$). Pneumonia (3/19 cases) developed within 7 d of study had same organisms as aspirated from stomach
Meta-analysis/Review		
Heyland, 2003 (18)		45° elevation of head of bed should be considered as a strategy to minimize the risks of enteral nutrition
McClave, 2002 (41)		Keep head of bed 30°-45° to ↓ aspiration risk
Collard, 2003 (56)		Use semirecumbent position for all eligible patients
^a Bold indicates studies of strong design. ^b ICU=intensive care unit. ^c NGT=nasogastric tube.		

Table 7. Summary of studies used to answer the clinical question on the influence of the amount of enteral formula delivered on infectious complications, cost, length of stay, ventilator days, and mortality

Study ^a	Patient population	Finding
Kudsk, 1996 (24)	Trauma EEN ^d =51, CON ^e =45	18 kcal/kg/d, trend ↓ LOS, ^b ↓ time of ventilator ^c
Atkinson, 1999 (57)	ICU ^f N=390	720 mL (14 kcal/kg/d), no difference in mortality, no difference in LOS ^{cg}
Krishnan, 2003 (58)	Medical ICU N=187	9-18 kcal/kg/d, ↓ time on ventilator
Taylor, 1999 (25)	Head injury EEN=41, CON=41	59% energy goal, ↓ INF ^h , ↓ LOS
Neumayer, 2001 (32) Bower, 1995 (59)	Surgical N=183, TPN and EN ICU N=296	>60% energy goal, ↓ LOS, ↓ cost 820 mL/d (14 kcal/kg), no difference LOS, INF ^g
Dickerson, 2002 (60)	Obese, ICU N=40	13-18 kcal/kg/d, ↓ LOS, ↓ INF

^aStudies of strong design quality are bold.
^bLOS=length of hospital stay.
^cInsufficient number of subjects for statistical power.
^dEEN=early enteral feedings.
^eCON=control.
^fICU=intensive care unit.
^gIntervention vs control.
^hINF=infectious complications.

reduced infectious complications, particularly when initiated within 48 hours of injury or admission (grade II). Initial evidence suggests that achieving greater than 70% of goal in medical ICU and obese surgical patients may have outcomes that are more detrimental when compared with those who received 60% to 70% of enteral feeding goal (grade III).

Infectious Complications, LOS, Ventilator Days. Actual attainment of full goal nutrient delivery by enteral feedings in the first week of ICU admission is unusual (Table 7). From three studies of strong design (24,57,58) and four of lesser quality (25,32,59,60), threshold intake of approximately 14 to 18 kcal/kg/d or 60% to 70% of goal is associated with reduced LOS (24,25,32,60), reduced time on the ventilator (24,58), and reduced infections (25,60). Most feedings were initiated within 48 hours of injury or ICU admission (24,30,32,59).

Two studies documented less positive outcomes when patients were fed energy >70% of goal. In a prospective trial of strong design (58), medical ICU patients who received the highest tertile of energy intake had reduced likelihood of being discharged alive (RR 0.82, 95% CI 0.7 to 0.94) or breathing spontaneously at discharge from the ICU (RR 0.69, 95% CI 0.52 to 0.94) (58) when compared with patients who received the least amount of nutrition. These findings were strongest in patients with a Simplified Acute Physiology Score >50, a high acuity marker, where the tertile with >66% energy goal intake had 0.47 odds ratio (95% CI 0.28 to 0.75) of discharge alive. In a retrospective medical record review of weaker design (60), patients with obesity who actually received enteral energy intake at <18 kcal/kg adjusted body weight had a shorter ICU LOS (18.6 vs 28.5 days, $P<0.03$) and fewer

antibiotic days (16.6 vs 27.4 days, $P<0.03$) than those who received greater energy delivery. Because both of these studies may be influenced by undocumented confounding clinical variables, such as inadequate glycemic control or “hidden” energy supply (eg, 5% dextrose solutions or lipid-based sedatives), caution must be used in their interpretation.

Cost or Mortality. Adequately powered clinical trials have not been reported to determine the influence of nutrient intake on cost of medical care or mortality (no grade).

Question 6. Does Use of Blue Food Coloring Aid in the Detection of Aspiration or Influence Mortality?

The work group members recommended that blue dye should be abandoned in enteral feedings in ICUs because the risk of using blue dye inappropriately or routinely in high-risk patients outweighs any perceived benefit (grade III), based on the following evidence:

Aspiration. Blue dye (FD&C Blue No. 1 and methylene blue) is not sensitive in detecting aspiration (grade III), based on nonconflicting evidence from one nonrandomized trial of lesser quality design with concurrent controls (61), one sensitivity and specificity study of strong design (62), two reviews of lesser quality design (63,64), a consensus statement (41), a US Food and Drug Administration public health advisory (65), and five case reports (66-70). A review of 13 articles (63) summarized the potential problems with use of the blue dye method to detect aspiration in patients receiving tube-feeding as low sensitivity, unknown long-term effects of food dye, no safe dose established, risk of patient discoloration, false-positive tests for blood in stool and gastric

fluid, difficulty reading pH paper when testing for gastric acidity, false-positive readings on glucose oxidase strips, formula contamination due to colonization of dye in bottles, allergic reactions, and blocking of electron transport chain by methylene blue. There is fair evidence (63-65,69) that use of blue dye is not sensitive for the detection of aspiration, often yielding false-negative results (69). In addition, in an animal model, coloration of enteral feedings produced only 46.3% sensitivity in detecting multiple forced aspirations (62). Although the extent to which this animal study can be extrapolated to human beings is unknown, the clinical significance of potential false-negative reports in detection of aspiration may be important.

Mortality. There may be increased mortality risk when the dye is administered in an excessive dose or to patients with increased gut permeability (grade III). Nonconflicting evidence from case reports (66,69,70) and one review of lesser quality design (63) indicates that use of blue food coloring in enteral formulas may contribute to increased mortality. A case report (70) described the manifestations of methylene blue toxicity from enteral feedings in two infants, both of whom died, whereas the second case report (66) reported skin hyperpigmentation in an adult patient with multiple organ failure, who died from systemic inflammatory response on day 18 after cardiac surgery.

DISCUSSION

The evidence examination presented in this article is important in several regards. First, it summarizes a series of basic decisions that should be considered before initiating enteral feedings in ICU patients. Although some of these concepts are not entirely new (enteral over parenteral, early vs later enteral feedings), the limited support by scientific evidence for some commonly followed procedures (eg, postpyloric tube positioning) is clarified. On the other hand, the maneuver of feeding in the semirecumbent position has a strong base of evidence that is not commonly known. The body of data in support of discontinuing the use of blue dye in enteral formulas has been growing, but is not strong because it is based on studies of limited quality but is nonetheless compelling because of the risk of mortality. The new concept of outcomes associated with volume of formula delivered is novel and deserves further research exploration.

Data supporting the benefits of enteral over parenteral feedings to reduce infectious complications and cost and early enteral feedings to reduce infectious complications and LOS are fairly consistent in head injury and trauma patients. It must be noted that there is the potential for the highest acuity patients, who will always have the greatest complications and mortality, to be included in the small number of patients who do not tolerate enteral feedings and must be fed by the parenteral route. This acuity factor, which may not be detected with sensitivity by typical acuity scores, may provide a confounder to skew the outcomes against enteral feeding, particularly in small studies. Data are also limited from medical or respiratory ICU populations.

The argument about whether or not feedings should be given in the stomach or postpylorically has been vigorously debated over many years, but the available trials

are inadequately powered to answer if aspiration pneumonia is reduced by the method. The clear reduction in gastric residual volume might be taken to imply an associated reduction in aspiration risk, but all trials to date have had too few patients to detect a difference in aspiration. Large randomized controlled trials, perhaps 200 patients per treatment arm, are needed to clarify any benefit of postpyloric feeding. Because it is much less arduous and costly to attain gastric than postpyloric tube positioning, these trials have the potential to influence both the quality and cost of medical care, and should be undertaken.

The strongest available clinical data for the prevention of aspiration pneumonia and pharyngeal formula reflux support semirecumbent over supine positioning. Whereas the use of semirecumbent positioning is an inexpensive care maneuver, it may actually be contraindicated in some patients with severe head or spinal cord injury or in those with hemodynamic instability. Thus, other methods of assuring gastric emptying, such as postpyloric tube position or promotility agents, may be considered when these patients must be enterally fed.

In critical care, unavoidable conditions arise that impede delivery of enteral formula, resulting in actual patient intake of less than estimated energy and nutrient goals.

The addition of blue dye to enteral feedings became standard practice during the past 10 years, though available data verify limited sensitivity of the method to detect aspiration pneumonia. Although the use of this method should be discontinued due to the accumulating case reports documenting negative outcomes, including mortality, clinicians may ponder how best to prevent reflux of formula by a patient. Taken as a whole, our evidence analysis suggests that monitoring patients for excess gastric residual volumes (>250 mL repeatedly), possible use of promotility agents if residuals are large, and semirecumbent positioning should be employed. In those situations where semirecumbent positioning is not feasible or gastric residual volumes are very large, postpyloric tube positioning might also be employed.

In critical care, unavoidable conditions arise that impede delivery of enteral formula, resulting in actual patient intake of less than estimated energy and nutrient goals. Clearly, underfeeding is the norm during the first weeks in the ICU due to discrepancies between what is prescribed and actually delivered successfully to the patient. Therefore, determining a minimum threshold of enteral intake becomes essential to assess the relationship between enteral formula delivery and associated clinical outcomes. By our analysis, delivery of enteral formula between 14 and 18 kcal/kg/day is associated with improved patient outcomes. Because the majority of the studies that met this threshold began enteral feeding within 48 hours of ICU admission, timing of formula initiation may be an important factor to meet an ade-

Clinical Questions with Graded Conclusion Statements

1. What is the effect of enteral vs parenteral feeding on infectious complications, cost, length of hospital stay (LOS), and mortality?
 - Enteral feeding is associated with reductions in infectious complications when compared to parenteral feeding (grade I).
 - Enteral nutrition is associated with reduced cost when compared to parenteral feeding (grade II).
 - There is insufficient evidence to support a recommendation for enteral vs parenteral feeding based on reducing LOS (no grade).
 - Insufficient evidence exists to address any impact of enteral vs parenteral feedings on mortality (no grade).
2. Does the timing of enteral feeding influence infectious complications, LOS, or mortality?
 - Early enteral feeding is associated with reduced incidence of infectious complications (grade I).
 - Early enteral feedings may be associated with reduced LOS stay (grade II).
 - A statistically significant difference in mortality due to timing of enteral feeding has not been demonstrated (no grade).
3. Does the placement of the enteral feeding tube tip in the gastric vs postpyloric position affect gastric residual volume or gastric reflux, aspiration pneumonia, cost, LOS, or mortality?
 - The site of the enteral feeding tube in the postpyloric position is associated with reduced gastric residual volume, a factor that has been associated with reduced reflux of formula (grade I).
 - Small bowel feeding tube placement may not be necessary or feasible for all patients, but may be useful in high risk patients such as those with supine positioning, sedation, and/or patients with large gastric residual volumes (grade IV).
 - Adequately powered trials to test postpyloric vs gastric feeding for effect on aspiration pneumonia are not yet available (no grade).
 - To date, adequately powered studies have not been located to evaluate differences in mortality, LOS, and cost of nutritional care when comparing gastric vs postpyloric feeding tube position (no grade).
4. What monitoring criteria should be used for enteral feedings?
 - Accepting an isolated gastric residual volume of 250 mL, and evaluating the clinical situation with two or more consecutive volumes of 250 mL before stopping/holding the feeding is associated with greater formula delivery (grade III).
 - Although adequately designed clinical trials have not defined the volume of emesis that is definitive for holding/stopping the enteral feeding, clinical experience indicates that greater formula intake can be obtained if feeding is stopped or held only when emesis is not associated with medical or nursing procedures and repeatedly large in volume (grade IV).
 - Use of promotility agents (metoclopramide) is associated with reduced gastric residual volume (grade II).
 - Feeding patients positioned in a 45° head of bed elevation (compared with supine positioning) during gastric feedings was associated with a decreased incidence of aspiration pneumonia (grade II) and decreased reflux of gastric contents into the pharynx and esophagus (grade I).
5. Does the amount of enteral formula actually delivered influence infectious complications, cost, LOS, ventilator days, or mortality?
 - Actual delivery of enteral formula of approximately 14 to 18 kcal/kg/day or 60% to 70% of enteral feeding goal, in the first week of intensive care unit admission, is associated with shortened LOS and time on ventilator, and with reduced infectious complications, particularly when initiated within 48 h of injury or admission (grade II).
 - Initial evidence suggests that achieving greater than 70% of goal intake may have less positive outcomes for medical intensive care unit and surgical patients with obesity when compared to individuals who received less enteral nutrition (grade III).
 - Adequately powered clinical trials have not been reported to determine the influence of nutrient intake on cost of medical care or mortality (no grade).
6. Does the use of blue food coloring aid in the detection of aspiration or affect mortality?
 - The work group members recommended that blue dye should be abandoned in enteral feedings in the intensive care unit, because the risk of using blue dye inappropriately or routinely in high-risk patients outweighs any perceived benefit (grade III).
 - Blue dye (FD&C Blue #1 and methylene blue) is not sensitive in detecting aspiration (grade III).
 - There may be increased mortality risk when the dye is administered in an excessive dose or to patients with increased gut permeability (grade III).

Figure. Summary of six specific questions developed and refined to address clinical outcomes specific to clinical practice decisions pertinent to enteral feeding of critically ill patients and graded conclusions based on intensive literature review from five databases (**Medline, EMBASE, PubMed, Cinahl, and Cochrane**), using standardized search terms.

quate cumulative intake. These admittedly limited data suggest that a minimum threshold of enteral formula must be delivered to see benefit of feeding.

The issue of possible negative outcomes associated with greater nutrient delivery deserves further examination in large, prospective randomized controlled trials. Hidden issues, such as inadequate glucose control or additional energy supply by lipid-based sedatives, can only be eliminated by a well-controlled prospective trial. Are these findings particular to a specific subpopulation (eg, those with obesity, insulin resistance, or extremely high acuity)

rather than the general population? Does the specific nutrient content of the formula used play a role? Answers to these key questions may yield impressive quality of care benefits in the future.

Further consideration of the nutritional assessment and monitoring phases of ICU enteral feeding management, immune-enhancing formula outcomes, and evidence specific to patients with obesity are planned to support a complete medical nutrition therapy protocol. Clearly, this process of evidence evaluation is a key tool to the development of best practice guidelines.

CONCLUSIONS

The clinical questions with conclusion statements for enteral feeding of critically ill persons are summarized in the Figure. The use of an enteral feeding protocol for critically ill patients by health care professionals in ICUs should include the following elements: use of the enteral route in preference over parenteral in patients with trauma and head injury when gastrointestinal function permits, initiation of enteral feedings within the first 48 hours after injury or admission, semirecumbent positioning when clinically feasible, and the avoidance of blue dye. Although postpyloric feeding tube placement may not be feasible for all patients, attaining this location may aid in management of gastric residual volumes and prokinetic agents may also be effective. Actual attainment of full goal feedings in the first week of ICU care is unusual, but attainment of 60% to 70% of goal or 14 to 18 kcal/kg/day is associated with improved outcomes. Initial data suggest that greater intake levels may not yield better outcomes in high-acuity medical patients or patients with obesity. These findings summarize the work group recommendations for enteral feeding of critically ill patients and are not intended to be extrapolated to non-critically ill patients without further research.

This manuscript is a summary of the first phase of the evidence analysis process and updated evidence analysis guidelines will be available in September at www.adaevidencelibrary.com.

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