

may likely be even higher in burn or multitrauma patients (see sections M and P).

[Quality of Evidence: Very Low]

Rationale: Recent studies in critical illness suggest that provision of protein is more closely linked to positive outcomes than provision of total energy (specifically, delivery of the other macronutrients of fat and carbohydrate). Also, the dose of protein required by critically ill patients appears to be higher than previously thought. A prospective observational study in mechanically ventilated patients demonstrated that achievement of both protein (1.3 g/kg protein provided) and energy targets was associated with a 50% decrease in 28-day mortality, whereas no decrease in mortality was noted when energy targets alone were met (0.8 g/kg protein provided).⁹¹ In another prospective observational study in a mixed MICU/SICU, a stepwise decrease in 28-day mortality was demonstrated with increased protein provision (group 1: 0.79 g/kg, 27% mortality; group 2: 1.06 g/kg, 24% mortality; group 3: 1.46 g/kg, 16% mortality).⁹² Two small RCTs, however, showed no difference in mortality when a higher protein dose was provided.^{93,94} Unfortunately, determination of protein requirements in the critical care setting remains difficult, with most clinicians using simplistic weight-based equations (1.2–2.0 g/kg/d). Use of nitrogen balance or NPC:N (70:1–100:1) is of limited value in the ICU.⁹⁵

D. Monitoring Tolerance and Adequacy of EN

Question: How should tolerance of EN be monitored in the adult critically ill population?

D1. Based on expert consensus, we suggest that patients should be monitored daily for tolerance of EN. We suggest that inappropriate cessation of EN should be avoided. We suggest that ordering a feeding status of nil per os (NPO) for the patient surrounding the time of diagnostic tests or procedures should be minimized to limit propagation of ileus and to prevent inadequate nutrient delivery.

Rationale: Tolerance may be determined by physical examination, passage of flatus and stool, radiologic evaluations, and absence of patient complaints such as pain or abdominal distention. GI intolerance is usually defined by vomiting, abdominal distention, complaints of discomfort, high NG output, high GRV, diarrhea, reduced passage of flatus and stool, or abnormal abdominal radiographs. Metheny et al reported that more than 97% of nurses surveyed assessed intolerance solely by measuring GRVs (the most frequently cited threshold levels for interrupting EN listed as 200 mL and 250 mL).⁹⁶

Less than half of patients ever reach their target goal energy intake during their ICU stay. A number of factors impede the delivery of EN in the critical care setting.^{97–99} Healthcare providers who prescribe EN tend to underorder energy, prescribing only 60%–80% of energy requirements. Patients typically receive approximately 80% of what is ordered. This combination of underordering and inadequate delivery results in patients receiving on average only 50% of target goal energy from one day to the next. Cessation of EN occurs in >85% of patients for an average of 8%–20% of the infusion time (the reasons for which are avoidable in 23% of planned procedures and 65% of all occasions).^{97,99} While patient intolerance accounts for a third of cessation time, only half of this represents true intolerance. Remaining NPO after midnight for diagnostic tests and procedures affects 25%–33% of ICU patients and accounts for up to 25% of cessation time. Technical issues involving the enteral access device, such as maintaining patency or repositioning/replacing the tube, can account for up to 25% of cessation time. In one study, patients randomized to continue EN during frequent surgical procedures (burn wound debridement under general anesthesia) had significantly fewer infections than those patients for whom EN was stopped for each procedure.¹⁰⁰ Ileus may be propagated by repeated and prolonged periods for which patients are NPO.¹⁰¹

Question: Should GRVs be used as a marker for aspiration to monitor ICU patients receiving EN?

D2a. We suggest that GRVs not be used as part of routine care to monitor ICU patients receiving EN.

D2b. We suggest that, for those ICUs where GRVs are still utilized, holding EN for GRVs <500 mL in the absence of other signs of intolerance (see section D1) should be avoided.

[Quality of Evidence: Low]

Rationale: GRVs do not correlate with incidences of pneumonia.^{102,103} regurgitation, or aspiration.¹⁰⁴ Although a study showed that cumulative GRV >250 mL over 24 hours correlated with gastric emptying using scintigraphy studies and (13) C-octanoate breath tests,¹⁰⁵ 3 other trials using the paracetamol (acetaminophen) test showed poor correlation of GRVs done every 4 hours to gastric emptying.^{106–108} In a trial using a highly sensitive and specific marker for aspiration, GRVs (over a range of 150–400 mL) were shown to be a poor monitor for aspiration, with a very low sensitivity of 1.5%–4.1%, a positive predictive value of 18.2%–25%, and a negative predictive value of 77.1%–77.4%.¹⁰⁹ Results from 4 RCTs indicate that raising the cutoff value for GRVs (leading to automatic cessation of EN) from a lower number of 50–150 mL to a higher number of 250–500 mL does not increase the incidence of regurgitation, aspiration, or pneumonia.^{80,102,103,109} Decreasing the cutoff value for

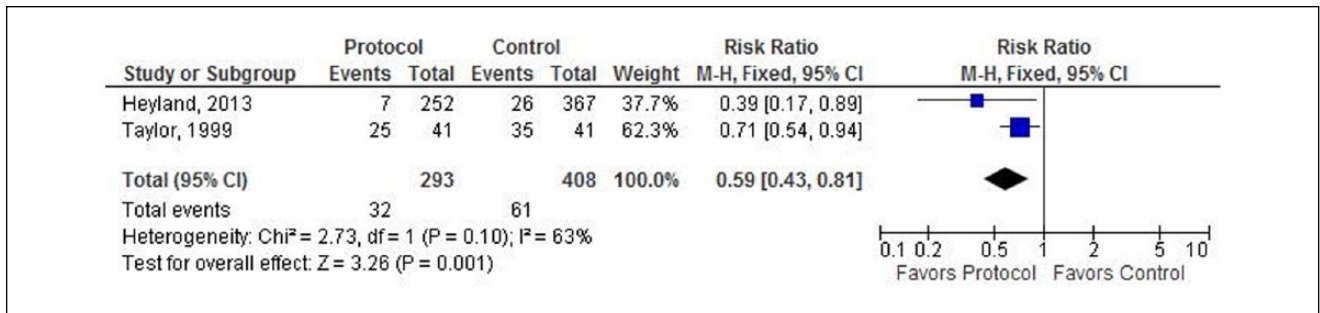


Figure 6. Feeding protocol vs control, infections.

GRVs does not protect the patient from these complications. Use of GRVs leads to increased enteral access device clogging, inappropriate cessation of EN, consumption of nursing time, and allocation of healthcare resources and may adversely affect outcome through reduced volume of EN delivered.¹¹⁰

Three studies have shown that eliminating the practice of using GRVs improves delivery of EN without jeopardizing patient safety.^{110–112} All 3 trials—2 RCTs^{110,112} and 1 prospective before/after implementation trial¹¹¹—showed no significant difference between groups with regard to pneumonia. Two of the trials showed significantly greater EN delivery, by either increased volume of EN infused¹¹¹ or greater reduction in energy deficit.¹¹² One trial showed significantly more vomiting but significantly better overall GI tolerance when GRVs were eliminated,¹¹² while a second trial showed no difference in vomiting between groups.¹¹¹

If the practice of GRVs is eliminated, a number of alternative strategies may be used to monitor critically ill patients receiving EN: careful daily physical examinations, review of abdominal radiologic films, and evaluation of clinical risk factors for aspiration. EN protocols should be initiated, and efforts to proactively reduce risk of aspiration pneumonia should be made (see sections D3 and D4). For those ICUs reluctant to stop using GRVs, care should be taken in their interpretation. GRVs in the range of 200–500 mL should raise concern and lead to the implementation of measures to reduce risk of aspiration, but automatic cessation of EN should not occur for GRVs <500 mL in the absence of other signs of intolerance.^{80,102–104,109}

Question: Should EN feeding protocols be used in the adult ICU setting?

D3a. We recommend that enteral feeding protocols be designed and implemented to increase the overall percentage of goal calories provided.

[Quality of Evidence: Moderate to High]

D3b. Based on expert consensus, we suggest that use of a volume-based feeding protocol or a top-down multistrategy protocol be considered.

Rationale: Use of ICU- or nurse-driven protocols that define goal EN infusion rate, designate more rapid start-ups, and provide specific orders for handling GRVs, frequency of flushes, and conditions or problems under which EN may be adjusted or stopped has been shown to be successful in increasing the overall percentage of goal energy provided.^{80,113–117} In addition, volume-based feeding protocols in which 24-hour or daily volumes are targeted instead of hourly rates have been shown to increase volume of nutrition delivered.¹¹⁶ These protocols empower nurses to increase feeding rates to make up for volume lost while EN is held. Top-down protocols use multiple different strategies simultaneously at the time of initiation of EN to enhance tolerance and increase delivery of EN, removing individual strategies as tolerance improves over the first few days of infusion. Top-down multistrategy protocols typically use volume-based feeding in conjunction with prokinetic agents and postpyloric tube placement initially (among other strategies), with prokinetic agents stopped in patients who demonstrate lack of need.¹¹⁶

By aggregating the data from 2 studies that met our inclusion criteria (Figure 6), use of nurse-driven EN protocols to increase EN delivery positively impacted patient outcome by reducing the incidence of nosocomial infections as compared with controls where no protocol was used (RR = 0.59; 95% CI, 0.43–0.81; P = .001).^{80,116}

Question: How can risk of aspiration be assessed in critically ill adults patients receiving EN, and what measures may be taken to reduce the likelihood of aspiration pneumonia?

D4. Based on expert consensus, we suggest that patients receiving EN should be assessed for risk of aspiration and that steps to reduce risk of aspiration and aspiration pneumonia should be proactively employed.

Rationale: Aspiration is one of the most feared complications of EN. Patients at increased risk for aspiration may be identified by a number of factors, including inability to protect the