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Nutrition in the Post-surgical Patient: Myths and Misconceptions

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Abstract
Purpose of Review Despite the large body of evidence supporting adequate early enteral nutrition (EN) in surgical patients, iatrogenic underfeeding is common. Myths and misconceptions persist and patients may receive suboptimal nutritional therapy as a result of outdated or uninformed practices. EN is safe and potentially beneficial in patients requiring vasopressor support. Early feeding proximal to a "fresh" anastomosis is safe.
Recent Findings Routine monitoring of gastric residual volume (GRV) for tube feeding intolerance is no longer recommended, and routine post-pyloric feeding in patients without evidence of impaired gastric emptying does not lower the risk of aspiration. Awaiting the return of flatus before initiating post-operative feeding is not required. Albumin is not an accurate marker of nutritional adequacy in the hospital setting. Permissive underfeeding may not be beneficial for malnourished surgical patients.
Summary This article addresses myths and misconceptions of enteral nutrition in surgical patients.

Keywords Enteral nutrition · Surgery and nutrition · Nutrition therapy · Vasopressors · Post-prandial splanchnic hyperemia · Anastomosis healing

This article is part of the Topical collection on *Nutrition, Metabolism, and Surgery*.

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Introduction

The provision of adequate calories and protein by enteral nutrition (EN), parenteral nutrition (PN), or both, is associated with improvement in clinical outcomes such as infections, complications, duration of mechanical ventilation, hospital length of stay, functional status, and mortality. Rather than mere "support," nutrition *therapy* should be recognized as an integral component of optimal care, of equal importance as adequate infectious source control and complete tumor resection.

Unfortunately, under-nutrition (intentional or unintentional) is very common in surgical patients and may be due to several factors. First, nutritional training in medical school is generally insufficient. A recent survey of US medical schools revealed that only 25% required a dedicated nutrition course and only 27% met the minimum 25 h of nutrition instruction required by the National Academy of Sciences [1]. In the absence of formal education, nutrition practices are often driven by personal preference rather than didactic training or high-quality evidence. Second, nutritional science has advanced significantly and recent studies have challenged many of the traditional dogmas that have guided clinical practice for decades. Lack of continuing education or resistance to change may contribute to outdated practice. The purpose of this review is to examine common myths and misconceptions and to provide updated information regarding nutrition therapy for the surgical patient.

Enteral Nutrition and Vasopressors

EN is commonly withheld from patients receiving vasopressor therapy for fear of causing non-occlusive mesenteric ischemia (NOMI), a very rare (<1%) but highly

morbid complication [2]. However, careful review of the literature reveals that most cases occurred in hemodynamically *stable* patients who had been tolerating tube feeds for over a week before the NOMI occurred [3]. Thus, it is more likely that the vasopressor support was a consequence of NOMI rather than the inciting agent. Animal studies demonstrate that infusion of intraluminal nutrients results in reversal of sepsis-induced mesenteric ischemia and restoration of microvascular blood flow [4, 5]. Human studies confirm improvements in hepato-splanchnic blood flow with low-dose enteral nutrition during vasopressor therapy [6, 7]. Even in cardiac surgery patients with poor cardiac function requiring inotropic support and patients requiring extra-corporeal life support, EN has been shown to be safe [7–9]. Indeed, early EN is associated with better clinical outcomes in the most unstable patients, i.e., those requiring multiple vasopressor support [10••].

While it is not recommended to initiate EN in under-resuscitated patients or in those whose vasopressor requirements are rapidly escalating [11••], for euvolemic patients requiring low-to-moderate doses of vasopressor support, EN is usually safe, well tolerated, and may even improve clinical outcomes [12, 13]. It is generally recommended to start with a low-residue isosmolar formula and monitor closely for signs of hemodynamic and gastrointestinal intolerance [11••, 14•].

Early EN After Gastrointestinal Anastomosis

Gastrointestinal (GI) anastomosis dehiscence and enteric leak are serious post-surgical complications associated with significant morbidity and mortality. The traditional teaching is to "rest" the bowel (nil per os, [NPO]), after GI surgery, especially upper GI surgery, in an attempt to protect the anastomosis from mechanical stress. While this practice may make intuitive sense, withholding intraluminal nutrition may in fact be counterproductive. Animal and human clinical trials have consistently reported that early post-operative proximal EN is safe and may even be beneficial to anastomotic healing.

In animal experiments, early proximal EN after GI surgery significantly increases the anastomotic collagen synthesis and anastomosis bursting pressure, compared with isocaloric early PN [15, 16•, 17]. Interestingly, Tadano et al. demonstrated that even intraluminal saline (i.e., a mechanical load with no caloric value) resulted in improvements in anastomotic strength when compared to PN only. Thus, it may be hypothesized that simply allowing the flow of normal gastrointestinal secretions may benefit a fresh anastomosis when compared to routine nasogastric suction. Recently, a randomized trial enrolling patients undergoing major rectal surgery demonstrated significantly lower rates of post-operative ileus in patients receiving EN within 8 h after operation compared to early PN [18].

Human clinical trials have consistently reported the benefits of early EN initiation after GI surgery. Rates of wound infections, intra-abdominal abscess, anastomotic dehiscence, pneumonia, ICU stay, hospital stay, post-operative cost, and mortality are lower and there is no evidence of harm [19–21••].

Gastric Residual Volume Monitoring

Monitoring gastric residual volume (GRV) for evidence of feeding intolerance is a common practice in the intensive care unit (ICU). It seems reasonable to assume that high GRVs reflect increased risk for regurgitation, aspiration, and pneumonia. However, this chain of causation has not been definitely proven in clinical practice. Furthermore, there is no standardization of GRV measurement technique, threshold, patient position, frequency, etc. [22]. GRV monitoring may not be effective in preventing aspiration events because the majority of these cases in the ICU are unrecognized and result from oropharyngeal secretions (rather than gastric regurgitation) [23].

Multiple investigations have demonstrated that monitoring GRV is not associated with improved clinical outcomes in mechanical ventilated patients receiving early EN and that the practice can negatively affect the adequacy of calories and proteins, thus contributing to iatrogenic malnutrition [24, 25]. The 2016 Society of Critical Care Medicine (SCCM) and American Society of Parenteral and Enteral Nutrition (A.S.P.E.N.) guidelines do *not* recommend routine monitoring of GRV to monitor ICU patients receiving EN [11••].

Post-pyloric Feeding

To prevent aspiration pneumonia, clinicians may attempt to feed directly into the duodenum or jejunum. It is generally accepted that post-pyloric feeding results in lower measured GRV and lower rates of gastric regurgitation [26, 27]. However, using technetium-labeled tube feeds, Heyland et al. have demonstrated that gastroesophageal regurgitation still occurs in 25% of patients with post-pyloric feeding tubes [27]. Additionally, there is evidence that the source of most aspiration pneumonia is oropharyngeal secretions, *not* gastric regurgitation [28]. Thus, decreasing gastric reflux episodes may not influence clinically important outcomes such as pneumonia rates and ventilator days. At least 15 randomized controlled trials have been

performed, with some studies reporting lower rates of pneumonia in those receiving post-pyloric feeding [29, 30] and others reporting no difference [31–33]. Several meta-analyses have been performed and results have been contradictory [34–36].

Achieving timely post-pyloric placement may be challenging. Blind bedside insertion beyond the pylorus is often unsuccessful [37, 38] and endoscopic or fluoroscopic techniques present logistical and cost challenges precluding routine utilization. The benefits of lower regurgitation must be weighed against the economic costs, the delay in EN initiation, and the need to travel outside the ICU or perform an invasive procedure [39]. Additionally, small-caliber post-pyloric feeding tubes are also more prone to clogging. Routine post-pyloric feeding in patients without evidence of impaired gastric emptying does not improve the risk of aspiration or lower the mortality rate, but does increase the incidence of feeding tube difficulties [32].

Post-operative Flatus or Bowel Sounds

Although the practice is waning, it is still commonly observed that some surgeons prefer to delay oral or enteral feeding until after the patient has passed flatus or has normoactive bowel sounds. This reluctance is rooted in the belief that return of full bowel function is heralded by flatus and that earlier feeding may be dangerous to the patient. While this rationale sounds reasonable at face value, both animal studies and clinical trials have demonstrated the opposite. Indeed, the practice of auscultation for bowel sounds after surgery is without any basis in empirical evidence [40]. Several randomized trials have indicated no therapeutic benefit in waiting for bowel sounds or flatus to provide enteral nutrition after GI surgery, and multiple meta-analyses have consistently reported that early enteral nutrition within 24 h of GI surgery is safe and possibly results in superior clinical outcomes compared to the traditional practice of withholding oral intake until the passage of flatus or normoactive bowel sounds [20, 21••, 41]. In one of the largest recent studies, Lassen et al. randomized 453 patients undergoing major open upper GI surgery (hepatic, pancreatic, esophageal, gastric, biliary, etc.) to routine NPO, jejunal tube feeding, or normal food ad lib starting on post-operative day 1 [42]. In the normal food group, resumption of bowel function was significantly improved, as was the rate of major complications and hospital length of stay.

Another time-honored surgical practice, routine nasogastric tube (NGT) decompression after abdominal surgery, has not been shown to benefit patients. A systematic review of 28 randomized trials (over 4000 patients) concluded that routine post-operative NGT decompression led to later return of bowel function with a similar incidence of anastomotic leak [43].

Albumin–Nutrition Myth

Serum albumin and prealbumin are widely considered as nutritional biomarkers and many experienced clinicians continue to use them to guide nutritional therapy. Multiple reports in the surgical literature have described poor outcomes in patients with lower preoperative albumin levels [44–47]. This connection between albumin and nutrition was first reported several decades ago in patients with kwashiorkor's disease and marasmus [48]. However, it is now recognized that albumin and prealbumin are negative acute phase reactants, meaning that expression and synthesis decrease in the setting of inflammation (acute, subacute, and chronic) *regardless* of the nutritional state [49, 50]. In addition to inflammation, albumin synthesis is affected by other factors, including liver disease, aging, and even recumbent position [51, 52]. While albumin level remains an independent predictor of post-operative outcomes, it is not reflective of nutritional status in the hospital setting and is no longer recommended for routine monitoring [11••].

Permissive Underfeeding—Controversies Related to Recent Publications

Recently, several large randomized trials comparing "full" feeding to permissive underfeeding have been published. Before accepting these results and applying their conclusions to clinical practice, it is important to understand the nuances and limitations of the studies.

The EDEN trial was a multicenter trial enrolling 1000 critically ill patients with acute lung injury, randomizing subjects to either trophic feeds (10–20 kcal/h) or "full" EN (25–30 kcal/kg/day of non-protein calories and 1.2–1.6 g/kg/day of protein) in a 1:1 ratio. There were no significant differences in ventilator-free days (primary outcome), rate of infections, or 60-day mortality between groups [53••]. It is important to note that patients in the EDEN trial were young (mean age 52 y) and were not generally considered malnourished (mean BMI 30). Previous investigators have suggested that aggressive feeding does not benefit patients with BMI ranging between 25 and 35 [54]. Additionally, the "full-feeding" group received an average of only 1300 kcal/day, meaning that half of the subjects in that group received less than 80% of nutritional needs. Heyland et al. have demonstrated that the optimal amount of calories is likely >80% [55].

The PERMIT multicenter trial randomized 894 critically ill patients to either permissive underfeeding (40–60% of

calculated caloric requirements) or standard enteral feeding (70–100%) [56]. This trial reported no significant differences in ventilator-free days and mortality at 90 days (primary outcome). However, it is important to note that, like the EDEN trial, the patients were relatively young (mean age 50) and well-nourished (mean BMI 30). Additionally, the standard enteral feeding group only received an average of 1299 daily calories, which is far short of the calculated average 1842 daily caloric needs. Finally, both groups received an average of 57–59 g of protein per day, which is less than 1.0 g/kg/d. The EDEN trial similarly provided both groups with <1.0 g/kg/d protein. The importance of adequate protein provision is becoming more apparent and some believe that protein is more important than calories in critically ill patients [57, 58]. Current guidelines recommend *at least* 1.2 g/kg/d, and doses of >2.0 g/kg/d may even be considered in select patients [11••].

Taken together, the EDEN and PERMIT trials suggest that in relatively young ICU patients without malnutrition, delivering 70–80% of caloric needs (and <1.0 g protein/kg/d) does not result in superior outcomes compared to trophic or permissive underfeeding. These results cannot be extrapolated to malnourished patients and the benefits of early goal feeding (approximately 100% caloric needs) have not yet been defined [59].

Conclusion

In conclusion, formal nutrition education in medical practice is often inadequate. Despite high-quality evidence and formal guidelines from multiple professional societies, practice is often driven by bias and tradition. Although well-intentioned and seemingly rationale at face value, myths and misconceptions may inadvertently lead to worse patient outcomes via iatrogenic malnutrition. If carefully administered and properly monitored, early enteral nutrition is safe and beneficial in many conditions previously believed to be relative contraindicated, including vasopressor support, proximal to an anastomosis, and prior to return of flatus. Routine gastric residual volume monitoring is not evidence-based, poorly standardized, and may be counterproductive. Albumin levels are confounded by inflammation and do not accurately represent nutritional adequacy in the hospital setting. Permissive underfeeding should only be considered in patients without evidence of malnutrition, though adequate protein supplementation should be strongly considered. Ongoing re-examination of traditional practices is required to ensure that patients receive the highest quality care.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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