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Update on Feeding the Open Abdomen in the Trauma Patient

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Abstract

Purpose of Review Describe how and when nutrition for trauma patients should be provided after damage control laparotomy.

Recent Findings Early enteral nutrition is a requisite component of open abdomen critical care support to achieve optimal outcomes. Providing trophic enteral nutrition is beneficial. Enteral nutrition with an open abdomen complicated by enteroatmospheric fistula is safe and feasible.

Summary Enteral nutrition is initiated with resolution of acidosis, coagulopathy, and hypothermia. Absent intestinal discontinuity, the only absolute contraindication, enteral nutrition is started as soon as possible via any standard route of enteral access. Post-pyloric access should be trialed in patients intolerant to gastric feeds. Parenteral nutrition is considered if an absolute contraindication to enteral nutrition is expected to persist beyond 5–7 days, the patient is intolerant to enteral nutrition, or caloric goal is not achieved with enteral nutrition after 5–7 days. Protein requirements for the OA patient are higher, 2 g/Kg/day.

Keywords Trauma · Nutrition · Enteral nutrition(EN) · Parenteral nutrition(PN) · Open abdomen(OA) · Damage control · Malnutrition · Critical illness

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Introduction

Previous investigations have shown that critically ill trauma patients are at increased risk for complications associated with malnutrition and benefit from provision of early enteral nutrition (EN) [1, 2, 3•, 4]. There is consensus among clinicians that EN is preferable to either parenteral nutrition (PN) or starvation [2, 3•, 4, 5•]. A reproducible association has been drawn between early EN and a reduction in septic complications for patients with major abdominal trauma [1, 6–8]. Feasibility, benefit, and safety of EN with an open abdomen (OA) have been demonstrated [3, 9, 10]. Early EN with an OA is associated with increased fascial closure rates, earlier fascial closure, reduced incidence of infectious complications including pneumonia, reduced incidence of intestinal fistulae, and decreased mortality [3•, 4, 5•, 11, 12]. There have been no adverse outcomes directly attributed to EN with OA, and neither harm nor benefit of EN with an OA has been described for patients with bowel injury, likely due to the heterogeneity of the population studied [5•, 13]. Despite EN being safe and beneficial for the OA patient [3•, 4, 5•, 14], some still hesitate to initiate EN due to fears unsupported by evidence of paralytic ileus, mesenteric ischemia, and bowel wall edema or necrosis [9, 12, 14–16].

The Nutrition Risk with an Open Abdomen

Damage control laparotomy (DCL) improves survival in the settings of abdominal trauma [17], sepsis [18], and abdominal compartment syndrome [19]. Techniques, indications, and management strategies for DCL are well described [17, 19–28]. The OA is a requisite component of damage control and has been described in the literature since the 1980s, yet mitigating its contribution to malnutrition in these patients has only recently been explored.

Those treated with DCL are a cohort of surgical patients that suffer the greatest physiologic derangements in terms of systemic inflammatory response and hypermetabolic state [19]. The associated acute catabolic reaction results in muscle proteolysis, increased urinary nitrogen excretion, and weight loss, compounded by an increased resting energy expenditure and physical loss of fluid, electrolytes, and protein attributed to the large open wound. Immediate protein calorie malnutrition develops [29], with impairment of immune function and subclinical multiple organ dysfunction, which will continue at least until the abdomen is closed [3•, 13, 30, 31•, 32]. Thus, the OA patient's protein, fluid, and electrolyte requirements are greater than those of non-DCL patients.

Complications of the Open Abdomen

Damage control laparotomy is a life-saving maneuver that also carries significant risk of potentially devastating complications. Such complications include increased transfusion requirements, increased ICU utilization and hospital charges, increased infectious complications (including respiratory, bloodstream, wound, and surgical site), fistula formation, complex abdominal wall hernia, and physiologic derangements associated with fluid, electrolyte, and protein losses from exposed viscera [30, 32–35]. There is a direct relationship between the incidence of complications and time to fascial closure, with a significant increase after 8 days [36, 37]. Thus, achieving abdominal closure within a week after the first DCL is a priority [36], and can be accomplished in 75–100% with optimal ICU management *including nutrition support* [3, 4, 19, 32, 34, 38, 39].

Optimal Timing and Route for Nutrition Support

Options regarding nutrition in the critically ill include withholding nutrition, providing EN at a trophic rate, EN at a goal rate, PN only, or combination therapy (EN + PN) [32].

Enteral Nutrition

Enteral nutrition provided within 24–48 h after ICU admission is advocated for all critically ill patients to maintain gut integrity, ameliorate the systemic inflammatory response, reduce morbidity in the form of infectious complications, and convey survival benefit [4, 40••]. Even EN provided at a rate lower than goal ameliorates the immune suppression associated with systemic inflammatory response syndrome [3, 4]. Open abdomen patients are not excluded from the reach of these well-supported guidelines for nutrition in critical illness, but there are some additional considerations in this cohort.

Rationale for Early Enteral Nutrition

The challenge in terms of meeting nutrition requirements for critically ill trauma patients is that they are in a calorie deficit by the time they arrive at the hospital for initial assessment of their injuries, thanks to the pro-inflammatory cascade associated with severe injury [32]. The malnutrition effects of inflammation amass on an exponential scale if the systemic inflammatory response crosses the line from adaptive to maladaptive. By the time nutrition support is being provided for severely injured patients, the deficit is difficult to overcome. Early EN has been described as any proportion of caloric requirement being provided by an enteral route, from immediately after metabolic correction is achieved to immediately after closure of the abdominal wall, or within 24 h to 14 days from injury [1, 2, 3•, 4, 9, 12, 41•]. Early EN with an OA is associated with increased fascial closure rates, earlier fascial closure, reduced incidence of infectious complications including pneumonia, reduced incidence of fistulae, and a decrease in mortality, especially in patients without bowel injuries [3•, 4, 5•, 11, 12]. There have been no reported adverse outcomes from EN with OA [13].

Enteral Nutrition for OA Patients with Bowel Injury

Neither attributable harm nor reproducible benefit of EN with an OA has been described for patients with bowel injuries. Critically ill patients with enteric injury are a subset who deserve individual consideration regarding optimal timing and route for nutrition support. Certainly, a more direct, adequately powered investigation is required to suggest whether the increased morbidity cited in one study [5•] is dependent or independent of EN delivery in the OA population with enteric injury.

Parenteral Nutrition

The open abdomen patient is typically underfed, even by criteria of permissive underfeeding. Frequent and multiple operative interventions and subsequent resuscitations preclude adequate nutrition provision. Therefore, it is not uncommon for the clinician to ask whether or not parenteral nutrition (PN) should be started during the first week of the patient's hospital stay.

Supplementation with early (< 48 h) PN in the critically ill has been avoided by some due to an association of higher cost [42] and increased mortality risk with no clinical benefit compared to patients who undergo delayed initiation of PN (5–7 days) [43, 44]. Others are proponents of early PN, citing studies and systematic reviews that show no difference or reduction in infectious complications and no difference in mortality [45–48]. Unfortunately, no study has focused on patients' status post abdominal surgery. Guidelines support early EN, even in OA patients, as safe and beneficial [49]. Extrapolation from aforementioned studies suggesting no benefit, increased cost, and possible infectious risk upholds the recommendation for delay of PN for approximately 5–7 days. In the scenario of the open abdomen for the first 5–7 days, attempts should be made to optimize provision of early EN, even in low "trophic" (< 30% goal) amounts and between operative interventions [3•, 4, 5•]. Enteral nutrition is better than PN, and if PN is started there are fewer associated complications if it is delayed by about a week. Parenteral nutrition should be considered if EN is contraindicated or is not providing at least 60–70% of the calories and protein needed by the patient at 5–7 days after injury. Even if PN is started, ongoing efforts to optimize the provision and tolerance of EN should continue.

Routes for Enteral Administration

Options for EN access in the OA patient include placement of orogastric, nasogastric, nasoduodenal, nasojejunal, gastrostomy, or jejunostomy tubes. In general, due to efficiency and a lack of evidence that it causes harm, it is recommended that naso- or orogastric tube feeding be started early and continued unless the patient develops an absolute contraindication [50•]. In patients who have demonstrated intolerance to gastric EN or are at high risk for aspiration, the level of infusion should be diverted to the distal duodenum or proximal jejunum [40]. The surgeon should take advantage of the intra-abdominal exposure afforded by the open abdomen to place the most appropriate tube. Placing a distal (nasojejunal) tube is much easier to facilitate while the abdomen is open versus closed, and doing so may help avoid an interruption in EN delivery should the patient not tolerate gastric feeds.

Calculating Caloric Requirements: How Much is Enough?

Avoid Underestimating Protein Requirements

The risk of underfeeding when calculating caloric requirements due to increased fluid, electrolyte, and protein losses must be acknowledged when delineating amount and composition of nutrition support [15]. Guidelines from the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Society of Critical Care Medicine(SCCM) include recommendations for 2 g/Kg/day of protein for OA patients. No harm has been noted with more protein provided; however, a plateau effect appears at 2.5 g/Kg/day [32].

Measuring Effectiveness

There remains no direct measurement of a patient's nutrition status, thus some continue to use trends in surrogate markers such as weight, albumin, and prealbumin. Nitrogen balance and its positive trend over time is the nutritional variable most consistently associated with improved patient outcomes during critical illness [31, 51]. This method is less often employed because it is arduous, though it may be a worthy pursuit in the OA cohort. With minor modification to the traditional formula [31•, 51], it can be applicable for the OA patient's unique requirements (Table 1).

Trophic Feeding

Providing low-dose feeding at 10–30 mL/h will help maintain gut integrity [40••]. Early trophic feeding has been associated with outcomes similar to goal rate feeding and with better gastric tolerance [52]. Some EN is better than none.

Enteral Nutrition Intolerance

Monitoring for feeding intolerance and an algorithmic approach to high gastric residual volumes(GRV) are advocated to help prevent complications associated with EN [53, 54••]. GRV > 500 cc should prompt physician assessment for intolerance, but that measure by itself is not a contraindication to continuation of EN (Fig. 1). When the GRV is > 500, post-pyloric feeding should be considered to reduce the risk of aspiration [40••]. A unique opportunity for physical exam related to feeding intolerance presents itself in OA patients. The open cavity provides a window for direct observation of bowel appearance (distended, edematous) and motility.

Nutrition for the Open Abdomen Complicated by Enteroatmospheric Fistula

Enteroatmospheric fistula(EAF) is a complication unique to the OA population. Incidence ranges from 5 to 19% [55]. Safety and feasibility for EN with an EAF and techniques for successful delivery of EN in this situation have been described [55, 56]. Enteral nutrition should be initiated as soon as fistula anatomy is defined and access is achieved [55]. Variables unique to each fistula must be considered

Table 1 Calculating nitrogen balance

CALCULATING NITROGEN BALANCE	
24h UOP collection to measure UUN: 24h AFO collection to measure AFN:	6.25g protein = 1g nitrogen
Traditional nitrogen balance =	nitrogen intake - (UUN +4)
Actual OA nitrogen balance =	nitrogen intake - (UUN + 4 + AFN)
Estimated OA nitrogen balance =	nitrogen intake - (UUN + 4 + 2(AFO in liters))

Methods for direct calculation and estimate of nitrogen balance in the OA cohort of critically ill patients, relative to the traditional calculation. An estimate of 2g of nitrogen is lost per liter of abdominal fluid output. The estimate is based on AFN loss being constant.[31] UOP=urine output, AFO=abdominal fluid output, UUN=urine urea nitrogen, AFN=abdominal fluid nitrogen, OA=open abdomen.

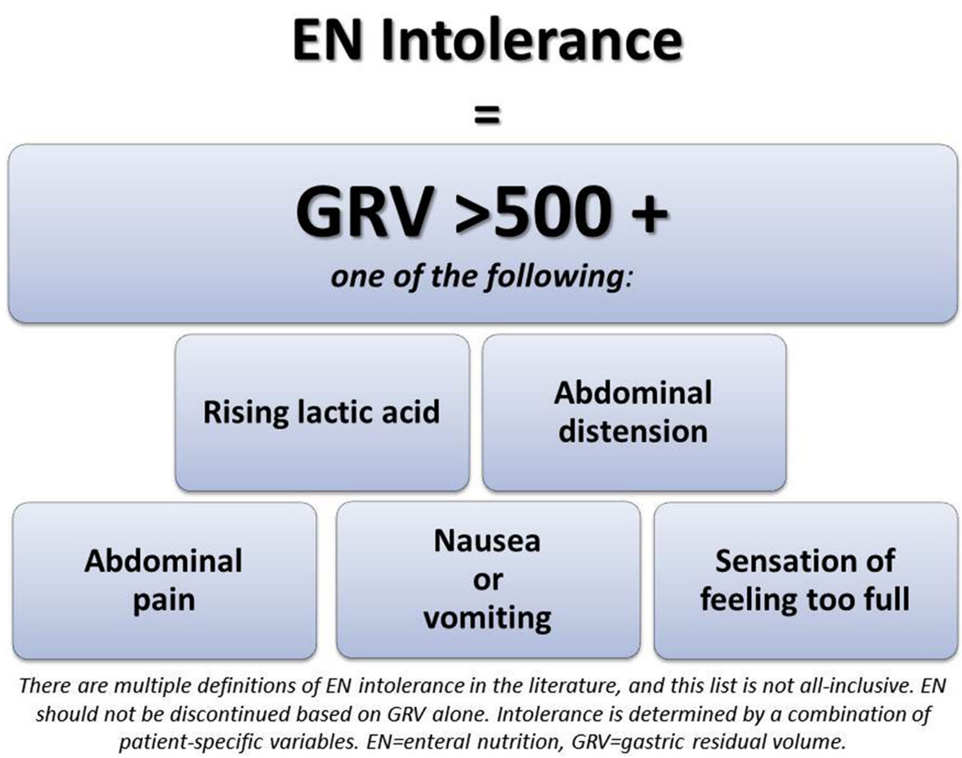

Fig. 1 Determinants of enteral nutrition intolerance

when choosing a nutrition delivery route and site for enteral access. These include the anatomic location, size, output volume, and length of residual segments. For EAF patients to achieve goal caloric intake, they often need combination PN and EN. Parenteral nutrition should be initiated after a trial of EN. If a subtotal volume of EN is tolerated, nutrition goals can be achieved by adjusting proportions of macronutrients administered by each route as the patient's tolerance changes. If the fistula output is high, anatomy is not favorable for intestinal absorption ($<$ 75 cm small intestine), or the patient is unable to tolerate any EN, early PN is indicated. Intolerance or malabsorption are not absolute contraindications to trophic EN, as a majority of EAF patients can eventually be weaned off of PN [56]. Patients with EAF should be allowed to take oral nutrition as long as fistula effluent can be managed.

Conclusions

Published guidelines for nutrition in the critically ill patient are directly applicable to the subset who undergo damage control laparotomy. Open abdomen patients are at greater risk for malnutrition due to direct protein losses through the abdominal wound. It is reasonable to expect early enteral nutrition will prevent complications and improve outcomes for the trauma patient with an open abdomen. Inherent to the open abdomen patient population are a plethora of confounding variables, thus the majority of current analyses are underpowered to draw conclusions about specific subsets.

The open abdomen patient is no longer a rarity in the intensive care unit. The strategy for managing these patients should be to resuscitate then provide early EN. Interruptions of EN are frequent, and the patient may not immediately tolerate feeds at goal. However, provision of trophic EN is beneficial early in the patient's course. Establishing enteral access is easier with the abdomen open. Although no direct measurement of nutrition exists, there is evidence to support these patients' higher risk of malnutrition and need for 2 g/Kg of protein per day. Parenteral nutrition should be delayed until approximately 1 week, and daily efforts to provide EN should continue.

Compliance with Ethical Guidelines

Conflicts of interest Katie Love Bower and Bryan R. Collier declare that they have no conflict 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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- •• Of major importance

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