Intraoperative Feeding Improves Calorie and Protein Delivery in Acute Burn Patients

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Enteral nutrition support is a critical component of modern burn care for severely burned patients. However, tube feeds are frequently withheld during the perioperative period because of aspiration concerns. As a result, patients requiring multiple operative procedures risk accumulating significant protein-calorie deficits. The objective of this study was to describe our American Burn Association–certified burn center's experience implementing an intraoperative feeding protocol in severely burned patients defined as a cutaneous burn ≥20% TBSA. A retrospective review of patients with major thermal injuries (2008–2013). Thirty-three patients with an average of seven operating room trips (range, 2–21 trips) were evaluated. Seventeen patients received intraoperative enteral feeds (protocol group) and 16 patients did not (standard group). Feeding was performed using an enteral feeding tube placed postpylorically and was continued intraoperatively, regardless of operative positioning. There was no statistically significant difference in mortality between the groups (*P* = .62). No intraoperative aspiration or regurgitation events were recorded. The protocol group received significantly more calculated protein and caloric requirements, 98.06 and 98.4%, respectively, compared with 70.6 and 73.2% in the standard group (*P* < .001). Time to goal tube feed infusion rate was achieved on average 3 days sooner in the protocol group compared with the standard group (3.35 vs 6.18 days, *P* = .008). Early initiation and continuation of enteral feeds in severely burned patients led to higher percentages received of prescribed goal protein and caloric needs without increased rates of aspiration, regurgitation, or mortality. (J Burn Care Res 2017;XXX:00–00)

The hypermetabolic and hypercatabolic response to severe burn injury has been characterized in current literature.[1–3] Exogenous calorie delivery to meet the nearly 2-fold increase in basal metabolic rate helps offset the consequences of the catabolic state, improving burn mortality and morbidity.[4] As such, guidelines emphasizing early nutrition support have been established for optimizing nutrition therapy after severe burn injury.[3,5,6]

Current recommendations for severely burned patients endorse quickly initiating enteral feeds often as early as postinjury day 1.[3,7] However, frequent operating room (OR) trips for wound debridement and reconstruction are associated with numerous interruptions of enteral feed delivery. This decrease in nutrition support compounds disease-related nutritional deficits in the acutely burned patient. A recent retrospective study found that fasting for operative procedures significantly reduced the percentage of goal nutrition received by the patient.[4] Previous studies have suggested that feeding can continue during procedures that do not involve airway manipulation.[8]

A Burn Nutrition Support Protocol was developed in recognition of the importance of nutrition support

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in the multimodality therapy of severely burned patients (≥20% TBSA burns). As a part of this protocol, patients with severe burn injuries undergo postpyloric feeding tube placement, confirmed with x-ray, and enteral tube feeding initiated within 24 hours of burn injury.[9] Tube feeds are continued throughout surgery for patients with a secure endotracheal tube or tracheostomy tube and for those who are not undergoing an airway procedure. Of note, tube feeds are continued intraoperatively even for cases that require prone or lateral positioning. This study evaluates the feasibility and safety of providing uninterrupted intraoperative enteral feeds in severely burned patients admitted under this protocol.

METHODS

Study Design

A retrospective chart review of patients admitted to our American Burn Association–verified burn center from January 2008 to December 2013 was performed. The study methods and design were reviewed and approved by the institutional review board. Acutely burned patients with ≥20% TBSA involvement were deemed eligible for inclusion in the study. Patients who received total parenteral nutrition for extended periods of time were excluded.

Before 2010, standard therapy dictated that severely burned patients receiving enteral nutrition support have tube feeds held 8 hours before surgery and restarted 2 hours after surgery. After 2010, the new protocol allowed for the continuation of tube feeds via a postpyloric feeding tube up to and during nonairway surgery, regardless of patient positioning on the OR table.

Variables collected included age, sex, %TBSA burned, and medical comorbidities. Variables collected regarding patient nutrition included percentage intake of recommended daily protein and calories. Variables collected regarding patient recovery included mortality, incidence of culture-positive pneumonia, total intensive care unit (ICU) days, length of stay, need for tracheostomy, and aspiration and regurgitation events during OR procedures. A presumptive diagnosis of aspiration was made if enteric contents or tube feeds were suctioned from the endotracheal tube by flexible suction catheter or bronchoscopy or if visual evidence of regurgitation occurred coincident with an acute change in ventilatory status or oxygenation. Aspiration events or regurgitation events were documented by a board-certified anesthesiologist in charge of the patient in the OR.

Nutrition Support Protocol

After 2010, all patients with ≥20% TBSA burns were nourished according to the Nutrition Support Protocol guidelines. These patients all underwent nasogastric feeding tube placement within 24 hours of admission and Osmolite 1.5 (Abbott Laboratories, Columbus, OH) was started at a rate of 30 ml/hr once enteral tube placement was confirmed. Tube feeds were advanced by 20 ml/hr every 4 hours until the goal tube feed rate was reached. The goal rate was determined by a dedicated Nutrition Support Certified Dietitian from the Metabolic Support Service. In the case that 4-hour gastric residuals were greater than 200 ml, the gastric contents were emptied by suction and tube feeds continued at the previous rate. In addition, enteral feeds were administered to these patients during operative procedures according to the following criteria: 1) the patient had a secure airway with an endotracheal tube or tracheostomy tube and 2) radiographic confirmation of duodenal position of feeding tube within 24 hours of the procedure. If these criteria were not met, the patient was made NPO 8 hours before the procedure and tube feeds were restarted within 2 hours at the previously tolerated rate.

Statistical Analysis

Data were collected retrospectively and compiled using Microsoft Excel 2010 (Microsoft Corp., Redmond, WA) and analyzed using Stata Statistical Software: Release 14 (StataCorp., College Station, TX). Data that were considered normally distributed are reported as the mean ± SD and percentage. Categorical variables were analyzed using the χ^2 test (or Fisher's exact test, when appropriate). A P value of $<.05$ was considered statistically significant.

RESULTS

Demographics

During the 5-year study period, 33 patients with ≥20% TBSA burns qualified for inclusion. The standard group is defined as all patients treated before 2010, whereas the protocol group includes patients treated under the guidelines of the Nutrition Support Protocol after its introduction in 2010. We identified 16 patients in the standard group and 17 patients in the protocol group who met the criteria for inclusion (Table 1). The two groups were comparable in baseline demographics (Table 2A). Table 2B outlines the admission characteristics. All patients in the protocol group received intraoperative tube feeding in all nontracheostomy surgeries, while no patients in

Table 1. Mechanism of injury

	Standard	Protocol
Total patients	16	17
Scald	0 (0)	1 (6)
Flame	9 (56)	10 (59)
Gas/flammable liquid	3 (19)	1 (6)
Flash burn	2 (13)	2 (12)
Explosion	2 (13)	2 (12)
MVA	0 (0)	1 (6)

MVA, motor vehicle accident.
Data expressed as n (%).

the standard group received intraoperative tube feeding. It was rare for enrolled patients to require TPN during this study. TPN was only used in patients with paralytic ileus or major gastrointestinal bleeding.

Nutrition Delivery

Patients in the protocol group displayed a trend toward faster goal tube feeds and attained a greater percentage of target calories ($P < .001$). Patients in the protocol group also attained a higher percentage of protein compared with the standard group ($P < .001$). The total tube feed days in both groups were equivalent. There were no intraoperative aspiration events or regurgitation events in either group. These findings are depicted in Table 3.

Clinical Outcomes

The differences between the two groups for pneumonia, bacteremia, and wound infection were statistically insignificant (Table 4). There were four (25.0%) mortalities in the standard group compared with three (17.6%) in the protocol group. The mean ventilator days for the standard group were 44.5 ± 44.0 days (range, 6–161 days) compared with 32.6 ± 25.5 days (range, 5–90 days) for protocol group ($P = .35$). The ratio of ICU days/%TBSA in the standard group was 1.18 and 1.73 in protocol group ($P = .81$). Oxandrolone, an anabolic steroid, was given to 5 (31%) patients in the standard group and 13 (76%) in the protocol group ($P = .01$).

Table 2A. Demographics

	Standard (n = 16)	Protocol (n = 17)	*P*
Age (years)	49.8 ± 16.7	41.6 ± 19.7	.210
Range of age (years)	25–78	18–84	
Sex, male (%)	13 (81)	12 (71)	.688
TBSA (%)	45.7 ± 18.9	42.6 ± 17.1	.634
Range of TBSA (%)	20–78	25–75	

Data expressed as mean ± SD or n (%).

Table 2B. Admission characteristics

	Standard (n = 16)	Protocol (n = 17)	*P*
Trips to the OR	7.3 ± 5.7	7.7 ± 4.0	.766
Range of trips to the OR	2–21	2–16	
Hospital days	57.9 ± 43.5	52.6 ± 23.4	.664
Range of hospital days	6–161	25–103	
ICU days	48.5 ± 42.2	45 ± 23.2	.772
Range of ICU days	6–161	18–100	
Ventilator days	44.5 ± 44	32.6 ± 25.5	.345
Range of ventilator days	6–161	5–90	
Ratio of ICU days/%TBSA	1.18	1.73	.810

ICU, intensive care unit; *OR*, operating room.
Data expressed as mean ± SD.

DISCUSSION

The purpose of this pilot study was to examine if intraoperative feeding continuously throughout operative procedures in severe burn patients is safe and efficacious. The hypermetabolic response in burn injury patients has been well documented.[11] This overwhelming physiologic response leads to increased energy expenditure and a decreased lean body mass and fat stores that all lead to catabolism.[11,12] Thus, appropriate nutrition supplementation is crucial to minimizing catabolism and preserving lean body mass.[12]

Studies have shown that malnutrition is linked to poor outcomes in the critically ill, such as increased overall mortality, increased wound infections, and longer hospital stay.[13] Poor wound healing and decreased cytokine function are additional deleterious sequelae of malnutrition.[14] Enteral nutrition specifically has been shown to decrease mucosal atrophy and preserve gastric function.[15,16] Our study demonstrated a significantly greater percentage of caloric and protein needs achieved in the continuously fed protocol group compared with those in the standard group.

Table 3. Nutrition delivery

	Standard (n = 16)	Protocol (n = 17)	*P*
Goal calories (kcal/d)	3176.0 ± 370.6	2954.0 ± 596.3	.213
Calories achieved (%)	73.2 ± 18.4	97.5 ± 13.8	.001
Goal protein (gm/d)	150.75 ± 18.6	140.12 ± 30.2	.158
Protein achieved (%)	70.6 ± 19.8	98.1 ± 18.1	.001
Start tube feed days	2.0 ± 1.4	1.1 ± 1.0	.045
Range of start tube feed days	1–6	1–4	
Goal tube feed time	6.18 ± 3.9	3.4 ± 1.2	.008
Range of goal tube feed time	2–16	2–6	

Data expressed as mean ± SD or percentage.

Table 4. Complications

	Standard (n = 16)	Protocol (n = 17)	*P*
Pneumonia (%)	14(88)	16(94)	0.601
Bacteremia (%)	7(44)	8(47)	1.000
Wound infection (%)	12(75)	10(59)	0.465
Mortality (%)	4(25)	3(18)	0.688

Data expressed as mean ± SD.

Other studies have demonstrated that perioperative aspiration of gastric contents has an associated morbidity of up to 70%, and they have advocated patient fasting before intubation.[17] However, our study demonstrates similar rates of pneumonia and no aspiration events or regurgitation events in the protocol group, as long as patients were receiving postpyloric feeds and there was no airway manipulation. Furthermore, many studies suggest that burn surgeons exclude or discontinue feeds for OR cases in which patients are in the lateral decubitus or prone position. Yet others have documented that patients with significant burns can still receive intraoperative enteral nutrition.[18,19] The present pilot study supports this assertion and suggests that burn patients can receive enteral nutrition intraoperatively, regardless of surgical position and without an increased risk of aspiration events, regurgitation events, or pneumonia.

It has been shown that enteral nutrition in burn patients lowers infection rates and length of stay and increases survival when compared with delayed enteral nutrition.[20] In this study, burn patients who were in the continuously fed protocol group reached their goal caloric needs in half the number of days as compared with the standard group (3.4 vs 6.2 days). The total percentage of goal caloric and protein needs achieved during the hospital stay was also higher in patients that were fed intraoperatively as compared with patients who were in the standard group. Additionally, the total hospital days, ICU days, and ventilator days, on average, also decreased in the protocol group (58 to 53 days, 49 to 45 days, 45 to 33 days, respectively). Importantly, there were no differences in morbidity and mortality, suggesting that early and continuous feeding can be used safely in this patient population.

Although we observed no aspiration or regurgitation events in the protocol group, a larger study cohort is needed to confirm findings. Based on the small cohort size of our protocol group, the rate of aspiration regurgitation events is expected to be between 0.0 and 17.6%.[21] In addition, our study was retrospective in nature, and the standard and protocol groups were from two different study periods. Although not statistically significant, tube feeding was started a day earlier for patients in the protocol group, and time to goal tube feeding was on average 3 days earlier compared with the standard group. These differences partly contributed to higher percentage of calories achieved in the protocol group. These data cannot account for the changes in clinical practice during these different study times; however, the burn care staff remained the same, including the surgeons, dedicated anesthesiologist, and dietician.

Despite these limitations, the present study effectively demonstrates that burn patients can be fed throughout surgery and receive more of their goal nutrition. Burn patients are a unique patient population with a high metabolic requirement. Efforts have been made to increase nutrition intake, and guidelines have been made to improve the management of burn patients. Interruptions in the delivery of enteral nutrition are a significant cause of caloric deficits in critically ill patients. The implementation of new clinical feeding protocols could help increase the amount of nutrition received in a patient population that is in critical need of improved nutrition.

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