

Special Article - Burn Care

Clinical Guide to Nutrition Therapy: One Center's Guide

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Abbreviations

AST: Aspartate Aminotransferase; ALT: Alanine
Aminotransferase; BMI: Body Mass Index; BSA: Body Surface Area;
EN: Enteral Nutrition; RMR: Resting Metabolic Rate; TBSA: Total
Body Surface Area

Introduction

Major burn injury of 20% total body surface area (TBSA) or greater and the associated hypermetabolic and hypercatabolic response pose major challenges for the burn surgeon. These critically ill burn patients undergo major stress and inflammatory responses to the injury. The ensuing responses contribute to an increase in the resting energy expenditure. Support of these responses is the key in decreasing length of stay and providing optimal outcomes. We have found that even those with less than 20% TBSA pose a nutrition risk because many are malnourished on admission. Therefore, it is important to have a methodical approach to nutrition in this high risk population. This is our burn center's approach to nutrition support in the burn patient [1-3].

Clinician Guide to Burn Medical Nutrition
Therapy

Nutrition is a key component of burn injury starting at time of injury through the rehabilitation process. Nutritional management is vital in the support of the immune system and the hypermetabolic response following burn injury. Nutritional risks are related to the patient's baseline state as well as their ability to use nutrients provided. The purpose of this guideline is to provide recommendations for oral diet, enteral and parenteral nutrition support regimens and EN during surgical procedures. Total body surface area burn and depth of burn as well as co-morbid factors are addressed to reduce secondary complications, promote wound healing, minimize lean body mass loss, and reduce hospital length of stay [1-9].

Key aspects of care

- Identifying burn patients who are at nutritional risk on admission.

Abstract

Nutrition plays an important role in supporting the burn patient and the associated hypermetabolic and hypercatabolic response. The consequences of inadequate nutrition include delayed wound healing, loss of lean muscle mass, infections, and poor outcomes. This guideline is one burn center's process to provide a comprehensive methodical approach to provide optimal nutrition for this high-risk population.

Keywords: Burn nutrition; Enteral feeding; Burn injury

- Optimize nutritional care across the continuum to promote wound healing.
- Monitor and treat vitamin and trace element deficiencies and weight loss.
- Optimize glycemic control and metabolic modulation for the burn patient.
- Provide education and discharge plan to patient and family.

Initial assessment [2,3]

- Obtain medical and surgical history.
- Nutrition assessment.
 - Obtain height and weight to calculate body mass index (BMI) and body surface area (BSA).
 - For obesity with BMI >30 kg/m², calculate Adjusted Body Weight where Adjusted Body Weight = [IBW + Actual Weight - IBW] × 0.25 where ideal Body Weight (IBW) is based on BMI of 25 kg/m².
 - Assess home and current medication list.
 - Assess clinical status and plan of care.
- Perform physical exam.

Initial laboratory tests

- Complete Blood Count.
- Chemistry 10 Panel.
- C Reactive Protein.
- Pre-albumin.
- Vitamin D 25-Hydroxy.
- Hemoglobin A1C. Hemoglobin a1C Selenium Copper Ceruloplasmin and Zinc.

Consults

Nutrition consult ordered and completed within 24-72 hours of admission. The dietitian will determine the energy and protein needs as well as the best mode to deliver nutrition. Patients that are intubated will be started on EN support and advanced to 60 ml/h. Goal will be established per registered dietitian when consult is completed.

Initial Estimation of Caloric Needs

- Caloric needs will be assessed using admit weight for patients with BMI ≤ 30 (Class 1 Obesity). If BMI is > 30 kg/m², Adjusted Body Weight will be used. Goal is to minimize weight loss [10-13].
- Caloric needs will be estimated using the following two equations on admission:
 - o Zawacki: Resting Metabolic Rate (RMR (kcal/day) = $1440 \times \text{BSA (m}^2\text{)}$.
 - o Xie: $\text{RMR (kcal/day)} = (1000/\text{BSA [m}^2\text{)}) + (25 \times \text{BSAB [m}^2\text{)})$ [14-16].

Calculation of protein needs

TBSA $< 20\%$ 1.5-2 g protein/kg.

TBSA $> 20\%$ 2-2.5 g protein/kg.

Protein goal should be titrated based on wound status, medications, renal and liver function.

Glutamine: Enteral glutamine supplementation is started on patients with $> 30\%$ TBSA. Glutasolve powder should be added to the nutrition regimen to provide 0.3 -0.5g/kg/d based on IBW. Glutamine supplementation is discontinued if patient develop multisystem organ failure or encephalopathy [17-19].

Fluids

Fluid needs are estimated and administered based on fluid and electrolyte status. Free water deficit is estimated and replaced as indicated with hypernatremia. Fluid needs in general are not area based on 1ml/Kcal or 35ml/kg. Additional fluids are added based on insensible losses as indicated.

Ongoing monitoring

- Daily weights during dressing change.
- Calorie counts.
- Bowel regimen.
- Weekly estimated wound healing including remaining percent open wound and donor site wound size. Goal tube feed rate to be adjusted based on total wound size.
- Weekly CRP and pre-albumin.
- Weekly indirect calorimetry (metabolic study) on mechanically ventilated patients with $\text{FiO}_2 < 0.6$ and PEEP < 12 . (See Appendix 1 for criteria). Goal tube feed rate to be adjusted based on results.
- Weekly percentage of goal volume tube feed intake achieved.

- Monitoring as indicated for specific pharmacologic interventions (i.e., oxandrolone and propranolol).
- Weekly assessment and monitoring by registered dietitian [3, 6].

Nutrition support

It is important to maintain gut integrity; therefore, the oral and enteral route are the preferred routes. The use of the gut will minimize the release of gut derived mediators that can activate the inflammatory response. Parental nutrition (PN), while having a role in the care of burn patients, should be used after other options have failed [2,3,6,20].

Oral diet

In previously healthy adults, burns covering 10% to 15% of the body surface rarely show significant increases in the metabolic rate and thus most patients will not need additional nutrition support. Patients with $< 20\%$ TBSA without pre-existing malnutrition should receive a regular diet. Patients will be monitored weekly for intake, nutrition labs and wound healing. Oral supplements will be initiated if needed to meet nutritional needs.

Enteral nutrition support

The enteral route is preferred overall in hospitalized patients because it decreases atrophy in the intestine, maintains gut weight and has been shown to decrease the incidence of hospital infections [21]. The post pyloric route is the preferred route in the critically ill patient because of the advantages over gastric feedings. The risk for aspiration in patients with artificial airways is minimized thereby reducing the risk for pneumonia. It has been demonstrated that using the post pyloric route in burn patients who may have delayed gastric emptying will allow for more consistent delivery of the goal nutrition rate [22-24] Post pyloric feeding tubes should be placed in patients that meet the following criteria. Once feeding tube placement is verified, it should be bridled. Bowel function is monitored daily. Constipation may occur from immobility or from the use of opioid pain medications. All patients are started on a bowel regimen including docusate 100 mg bid and Senna 8.6 mg daily. Motility agents such as metoclopramide and erythromycin may be beneficial for patients to avoid feeding intolerance [23,24]. Doses are adjusted and other agents are added as indicated. Tolerance to enteral feeding is monitored daily. Intolerance can manifest itself as physical symptoms such as abdominal distention, nausea, vomiting, bloating, and bleeding from the GI tract, metabolic derangements including electrolyte disturbances and hyperglycemia and/or absorption of nutrients or diarrhea [2,21].

- $> 20\%$ TBSA second and third degree burns.
- $\geq 10\%$ TBSA second and third degree burns and > 65 years of age.
- Severe inhalation injury requiring mechanical ventilation and/or other major injuries/trauma.
- BMI < 18.5 kg/m² and/or unintentional weight loss of $> 5\%$ in 1 month or 7.5% in 3 months with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting.

- Inadequate nutritional intake for >1 week prior to admission or oral intake <50% for more than 5 days in hospitalized patients.
- BMI >30 kg/m² with >10% third degree burn.

Enteral formula

- Blend of arginine, omega-3 fatty acids and nucleotides. [25].
- Start at 20 ml/hr. and advance by 10 ml/hr. every 4 hours to 60 ml/hr.
- Goal rate to be calculated by the registered dietitian.
- If post pyloric enteral access is delayed more than 10 hours post burn in hemodynamically stable patient, EN may be started via naso/orogastric tube (NG/OG) and changed over to feeding tube once post pyloric access is established [26,27].

Enteral Nutrition and Vasopressor Therapy

- Patients who are hemodynamically unstable with increasing vasopressor requirements or requiring additional vasoactive agents to maintain a mean arterial pressure >60 should remain NPO [15-17].
- Once vasopressor requirements are decreased and patient is hemodynamically stable, gastric or post pyloric feedings may be initiated.
- Fiber-containing and high-fat EN formulas should be avoided in these patients to minimize motility complaints and intolerance [28-30].

Volume-based feeding and monitoring of ent intake

Enteral nutrition order will be placed with the hourly goal rate and total volume to be infused over the course of 24 hours. At the end of every 4 hour period the nurse will assess the tube feed intake, tolerance and will titrate the tube feed rate to achieve the 24 hour goal intake in patients who have been tolerating EN well. Maximum infusion rate will be 150 ml/hr. Change in rate should be clearly documented in the medical record. The registered dietitian will evaluate nutritional goal, actual intake, wound status, EN tolerance and nutritional status. The tube feeding regimen will be adjusted as indicated [31-33].

Please follow the steps below to titrate EN to maximize nutritional intake.

1. Check EN intake every four hours and clear the pump.
2. Subtract the intake from the 24 hour volume prescribed to determine the volume to be fed for the rest of the 24 hour period.
3. Follow a volume-based feeding schedule and titrate the infusion rate to goal as patient tolerates.
4. Reassess the volume infused every 4 hours and repeat the above steps. Keep the maximum infusion rate as 150 ml/h.

5. Please see algorithm below on advancement and troubleshooting for EN [9,20,30,34-41].

Enteral and oral diet

Enteral nutrition will be cycled to nocturnal feedings to meet 75% of goal overnight on postoperative day 5 after the final grafting procedure and/or per team recommendations. EN will be discontinued once patient is meeting 60 -70% of nutritional needs with oral diet and all wounds are healing per physician assessment.

Refeeding syndrome

Patients will be screened and followed closely if identified to be at risk for refeeding syndrome. Refeeding syndrome is a life threatening condition that is characterized by fluid and electrolyte shifts in malnourished patients undergoing refeeding of oral, enteral or parenteral nutrition. In patients with any suspicion of pre-burn malnutrition (or alcoholism), 100 mg/d of thiamine should be supplemented with initiation of nutrition support for 3-5 days. General guidelines for caloric intake are to provide 10 kcal/kg/d for 3 days and advance slowly to goal in next several days. Aggressive repletion of electrolytes should be maintained during this time period, and advancement should be based on electrolyte status [42-44].

Parenteral nutrition

Indications for PN are as follows:

1. PN will be initiated in patients who have failed post pyloric EN trial per algorithm outlined in Appendix 2.
2. EN is contraindicated due to paralytic ileus, short bowel syndrome, mesenteric ischemia, small bowel obstruction, high output fistula.

PN will be ordered, infused and managed per our institution's adult nutrition support services and parenteral nutrition policy and procedure [45,46].

Pharmacology management

Injury also results in increased need for levels of vitamins A,C,D and E along with trace elements such as iron, copper, selenium and zinc. Supplementation should be considered in order to protect against oxidative stress, promote wound healing, optimize immune function, and decrease infectious complications.

Vitamin D levels are measured on all burn patients on admission. Vitamin D supplementation should be added based on 25 OH vitamin D level: <25 ng/mL: 50,000 IU once a week x 8 weeks, with a follow up measurement once this course is completed. Ongoing supplementation will be based on the repeated measurements drawn every 4 weeks as needed while hospitalized.

>25 ng/mL: 2000 IU daily [47-52].

TBSA <20% and > 10% TBSA:

Therapeutic multivitamin with minerals daily.

Ascorbic acid 500 mg twice daily

Zinc sulfate 220 mg once daily

Vitamin A 20,000 IU once daily for 3 doses

TBSA >20%, intubated patients:

Consider 14-21 days of IV supplementation of:

Copper	4 mg
Selenium	500 µg
Zinc	30 mg
Vitamin B1	100 mg
Ascorbic acid	1000 mg
Vitamin E	1,500 IU BID x 7 days [1,4,5,30,36]

Levels of copper, selenium and zinc are measured weekly [13,34,36,53,54].

Adjunct Therapies**Oxandrolone**

- Oxandrolone is used in severe burn injury (>20%) to stimulate protein synthesis and anabolism. Oxandrolone has the additive effects of attenuating the inflammatory response in burn injury and increasing collagen synthesis.
- After screening for contraindications for use start on hospital day 5 at 10mg po or per tube every 12 hours.
- Stop when resolution of the stress response, no active infection, or open wound is <10% TBSA.
- Associated with hepatotoxicity - monitor weekly AST and ALT hold if AST or ALT >100.
- Rechallenging patients who experience hepatotoxicity can be considered once AST/ALT normalize [54-58].

Propranolol

- Propranolol has been used in patients with burn injury to counteract the detrimental effects of ongoing adrenergic stimulation. Propranolol has been demonstrated to improve cardiac workload and wound healing in adult patients with severe burn injury (TBSA >20%).
- Start after resuscitation at 10 mg every 6 hours and titrated up based on heart rate reduction [20,36,54].

Special populations

Elderly: In elderly patients, nutrition support should be considered early in admission since these patients usually will not be able to sustain adequate intake throughout the course of treatment and rehabilitation.

Pregnancy: In order to meet the increased needs during pregnancy, an additional 300 kcal/d especially during the second and third trimester is recommended. Other recommendations that will support the increased needs of pregnancy based on pregravid weight status are as follows:

Pregravid weight within desirable range: 30 kcal/kg.

>120% of desirable weight: 24 kcal/kg.

<90% desirable weight: 36 – 40 kcal/kg.

When patient have superimposed burn injury on pregnancy, the

Table 1: Recommended Weight Gain Based on Gestation Status.

Gestation status	Recommended weight gain in pounds
Singular gestation	
Underweight (BMI <19)	28-40
Normal weight (BMI 19.8-26)	25-35
Overweight (BMI 26-29)	15-25
Twin gestation	
	44

nutritional needs are best assessed by indirect calorimetry. If patient is not appropriate for indirect calorimetry, any of the above two methods can be used based on the extent of injury and nutritional status of the patient. Prenatal vitamin will be used in place of therapeutic multivitamin. Other vitamin mineral supplementations that are routinely given for burn patients will be held and used only on an as needed basis for a very short interval due to potential for toxicity, especially vitamin A and zinc. Normal levels for triglycerides is >230 mg/dL. During the latter stages of pregnancy the concentration of serum albumin and prealbumin decrease and this should be taken in to consideration when assessing nutritional status of patients decrease. Normal values for iron studies are slightly decreased. Maternal weight gain will be monitored as per the guideline below based on pregravid weight status [2] (Table 1).

Surgical management**Enteral nutrition during operative procedures:**

Multiple studies have demonstrated safety and efficacy of continuing EN during surgery. Continuing EN via post pyloric feeding tube will reduce calorie and protein deficit, promote wound healing, and reduce post-operative complications. Patients will be continued on EN @ 50 ml/h during the course of surgery. Enteral nutrition will be continued if the following conditions are met:

1. Feeding tube position has been radiographically verified and patient has been tolerating feeding well.
2. Patients are intubated or tracheotomized [59-62].

Conclusion

A systematic multidisciplinary approach to nutrition will provide the best outcomes for the burn patient.

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