Review Article

Nutritional concerns in critically ill burn patients

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ABSTRACT

Nutritional issues in critical care are very important for the better prognosis of patients.These concerns are further heightened if critically ill patients are admitted with co-morbidities and deranged physiology. A similar scenario is encountered when patients with burns are admitted in Intensive Care Units (ICU) for one indication or the other.Their short and long-term prognosis mainly depends on prevention of infection and maintenance of optimal nutritional status.The aim of the current manuscript is to review some of the challenging aspects in critically ill-patients admitted in ICU with history of burns.

Key words: Burns, critically ill-patients, enteral nutrition, intensive care

Introduction

Nutritional supplementation is an integral part of therapeutic management in critically ill patients. The challenges increased manifold if these patients are admitted with co-morbidities, trauma or any other complication. Management of critically ill burn patients is extremely challenging to the attending intensivist. The gross pathophysiological changes, altered fluid dynamics, vulnerability to infections, metabolic derangements, electrolyte disturbances and severity of burns influence largely the nutritional parameters and therapeutic interventions. Ever since the evolution of critical care services, attempts have been continuously made by the researchers to improve and optimize the nutritional status in critically ill-patients. The evolving guidelines and protocols of nutritional therapy in critically sick patients can be extrapolated to burn patients also in Intensive Care Unit (ICU), which has largely been supported by the emergence of evidence-based medicine. The current manuscript is aimed at discussing important issues pertaining to the nutritional supplementation of patients admitted with varying degree of burns to the ICU.

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Search Strategies

The present manuscript is an attempt to highlight the understanding of the nutritional aspects in patient with burns. The measures adopted included extensive scrutiny of literary evidence from internet resources, journals and textbooks of surgery, nutrition, anesthesiology and intensive care. The strategies included exploration of full-text articles and abstracts from various search engines such as PubMed, Medscape, Scopus, Science Direct, Medline, Yahoo, Google Scholar and many others, which included keywords such as enteral nutrition, burns, intensive care, critically ill-patients.

Current Recommendations and Guidelines!

At present, various guidelines set up by European Society for Clinical Nutrition and Metabolism are typically followed in the ICU. ALLIANCE is one of the international organizations, which is working at international as well as at Indian level to set up the nutritional goals. Scope of enteral nutrition has improved with the endoscopic placement of jejunostomy and gastrostomy feeding tubes. Development of various new bio-markers of illness can also be of great help in guiding the nutritional goals. Research

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in the field of pharmaco-genomics has also linked the role of nutrition in gene expression.[1]

Besides aggressive fluid management in burn patients, nutritional supplementation is gaining enhanced clinical significance. Such patients present with numerous clinical challenges which have to be identified at the earliest so as to achieve clinical stability. Management of these patients needs a multidisciplinary approach. The inhalational injury can lead to airway edema, fluid-electrolyte balance, thermoregulatory aspects and risk of infectious complications. Inadequate nutrition in critically ill patients impairs ventilatory drive and weakness of respiratory muscles, thus increasing hospital stay. Nutrition supplies important cell substrates and vital nutrients. Severe form of burn injury is associated with the hypermetabolic state. Various nutrients and many other agents have been found to have their impact on the reversal of the this hypermetabolic state.[2] This hyperdynamic circulatory state is seen if burns are more than 40% of total body surface area (TBSA) and leads to massive protein and lipid breakdown resulting in muscle wasting. Hyperglycemia occurs due to peripheral insulin resistance. Increase in the levels of various hormones such as catecholamines, glucocorticoids, glucagon and dopamine is responsible for this catabolic state.[3] This altered metabolic state starts within days of burn injury and may persist for several years after burns.[4] Morbidity and mortality increases to a significant extent as severe burn injury can affect each and every organ of the body.[5] This increased mortality can be reduced significantly with the use of high protein diet along with early excision and grafting of burn wounds.[6] It has been concluded from previous studies that early and aggressive enteral feeding can improve the outcome by normalizing the intestinal blood flow and by modulating the hypermetabolic response. Enteral nutrition is preferred over parenteral nutrition as the former one reduces bacterial translocation, also maintains the motility of intestine and thus increases the absorption of nutrients.[7] Parenteral nutrition is usually reserved for those patients who cannot tolerate enteral feed or have ileus. Postburn ileus mainly affects stomach and colon and spares small intestine. Thus in burn patients, early enteral feed within 6 h can be started via duodenal or jejunal routes.[8,9]

Nutrition plan of the burn patients should include site, type and percentage of burns, age of the patient and any other preexisting medical disorders. These factors are important as patients having burns more than 10% of TBSA along with burns of the face, genitalia, etc., need special care. Children with burns more than 10% of TBSA and patients with inhalational or electrical burns need to be managed very carefully. Preexisting medical disorders can enhance the mortality.[10]

Nutritional Requirements

Energy requirement in the acute phase can be calculated from resting energy expenditures (REE). However, increase is variable over time and mainly takes TBSA into consideration. The concept of hyperalimentation was followed earlier, but REE increase is seen during the 1st week, and it decreases thereafter. It has also been seen that if the feed is given according to 25–30 kcal/kg/day, chances of under feeding are more.[11,12] Overfeeding also increases morbidity. The aim of nutritional support should be to maintain the lean body mass as hypermetabolic state results in catabolism in severe burns. Indirect calorimetry is now considered as the gold standard to calculate energy requirements in burn patients. Measurements are made in the fed state, and the results of the analysis are rounded to the upper 100 value, without exceeding + 10% of the measured value. Carbohydrates form the major source of energy as these provide glucose for metabolic pathways, spare amino acids and also serve as fuel for wound healing but should not be more than 60% of total energy intake and should not be more than 5 mg/kg/min that is, 7 g/kg/day.[13] Fat should not be more than 30–35% of nonprotein calories because the hypermetabolic response in these patients suppresses lipolysis and limit their breakdown to be used as source of energy.[14] Use of low-fat diet is advisable in severe burns. Use of omega-3 fatty acids has been seen to be associated with improved outcome as compared to the use of omega-6 fatty acids as metabolism of the former is associated without invoking any inflammatory response.[15,16] Protein catabolism is also common in burn patients, which can decrease lean body mass and patients get more prone to infections. Burn patients need 1.5–2 g/kg/day of the proteins in feed.[17-19]

Formulas to calculate resting metabolic expenditure (RME) are as follows:[20]

Mathematical formula to estimate RME:

Males = (66.5) + (13.7 × W) + (5 × H) − (6.8 × A).

Females = (655.1) + (9.6 × W) + (1.8 × H) − (4.7 × A).

W: Weight (kg)

H: Height (cm)

A: Age (years)

Above mentioned formula is for healthy, febrile individuals. In patients with burns more than 30%, RME increases by 100%.

Carbohydrates should provide 30–70% of total calories needed. Fats should provide 20–50% and proteins approximately 15–20% of total energy requirement.[21]

Formula to calculate REE is:

REE (Kcal) = −4343+ (10.5 × TBSA burned) + (0.23 × Kcal) + (0.84 × Harris Benedict) + (114 × T°C) − (4.5 × days postburn).

Kcals = calories intake in past 24 h.

Harris Benedict = basal requirement in calories using the Harris Benedict equation with no stress factors or activity factors.

T = body temperature in degrees celsius.

Days postburn = the number of days after the burn injury is sustained using the day itself as day zero.

Role of Glutamine

Glutamine acts as a main energy source for enterocytes and lymphocytes. It is one of the important transport amino acid. It performs various functions asit acts as a source of energy for hepatocytes, maintains integrity, permeability and immune function of small intestine and improves wound healing.[11,12] The dose of glutamine supplementation is around 0.3 g/kg/day.[13]

Role of Visceral Proteins in Critically Ill Patients

Visceral proteins include albumin, transferrin, transthyretin and retinol-binding proteins. These proteins are mostly synthesized in the liver. Inflammation and impaired liver functions result in low blood levels of visceral proteins. Hypoalbuminemia occurs in critically ill patients due to "capillary leak syndrome" with albumin escaping through more permeable capillaries into the interstitium. Distribution of albumin gets affected with an infusion of various fluids used for volume resuscitation of sick patients. Hence, albumin cannot be used for assessment and monitoring of the nutritional status.[21] In one of the studies in the literature, relationship between visceral proteins and clinical outcome has been assessed in 107 burned patients with biweekly measurements from day 12 to day 43 postburn. It has been observed that levels of albumin and transthyretin increase more consistently and rapidly in patients with burns <50% of BSA, whereas further decline was reported for those who died between day 20 and day 43.[22] It has also been observed that transthyretin levels <50 mg/dl or failure to increase of 40 mg/L/week are associated with poor prognosis.[23,24]

It has also been seen in previous several studies that immunonutrition rich in nucleotides and (omega)-3 fish oil decreases the mortality rate along with decrease in recurrence rate of bacteraemia in sick patients in intensive care.[25]

Other Important Nutritional Aspects in Burn Patients

Burn patients need sedation and analgesia very frequently, so these are at increased risk of constipation. Thus, their diet should be rich in fibers. Early enteral feed via gastric route is preferred in these patients as it is associated with attenuation of the stress response, stress-induced ulcers and increased production of immunoglobulins. Few factors can prevent early start of enteral feeding as in the initial phase of resuscitation, larger amounts of crystalloids used, can lead to edema of the intestine and paralytic ileus. Enhanced capillary leak in the early phase of burns increases the fluid requirement.[26]

Micronutrient supplementation reduces the mortality and morbidity in critically ill patients as their deficiency results in lowered host defenses and impaired production of antioxidants. Also, the intravenous route is best for their supplementation. Duration, dose and timing of giving these micronutrients are the important considerations for improving their utility.[27] Thus the addition of copper, zinc, selenium, Vitamin B1, C, D, E to feed is of great helpful. Copper, zinc and selenium are lost in larger amounts in burn patients in the exudate. Their supplementation decreases fat breakdown, improved wound healing, and thus shorter hospital stay. Thiamine replacement improves lactate and pyruvate metabolism. Vitamin C and E supplementation enhance wound healing. Their dose should be 1.5–3 times higher than recommended daily intake. Loss of Vitamin D is also needed to prevent bone loss. Increased oxidative stress in burn patients is associated with enhanced depletion of micronutrients. Several other measures like warm ambient temperature (28–30° centigrade), nonselective beta blockers (propranolol) and oxandrolone are also important measures, which prevent hypermetabolism and hyper catabolism in burn patients.[13] Beta blockers, by reducing heart rate by 20% attenuate stress hormone release. Propranolol can be started at

the end of the 1st week of burns.[28,29] Oxandrolone in a dose of 10 mg/12 h decrease mortality and thus hospital stay in burn patients.[30,31] There is no role of arginine supplementation according to the recent review.[32] Ornithine alpha-ketoglutarate is precursor and thus an alternative to glutamine, it's use during acute phase after burns improves nitrogen balance.[33]

Glucose Control in Burn Patients

Target glucose levels between 5 and 8 mmol/L has been seen to be associated with several clinical benefits such as better graft uptake, lesser infectious complications and ultimately decreased mortality. 100–150 mg/dl is a standard target, which is otherwise maintained in other critical patients in ICU.[34,35] Exenatide, a new incretin, which inhibits glucagon secretion can decrease external insulin requirement in pediatric burn patients.[36]

Adequate pain control and physiotherapy are also essential in early rehabilitation of these patients.[13]

Enteral Versus Parenteral Nutrition

The enteral nutrition maintains the integrity of intestine by maintaining tight junctions between intraepithelial cells, enhance intestinal blood flow and induce the release of cholecystokinin, gastric, bombesin and bile salts. It also maintains villous height and support IgA producing immunocytes. Within hours of major insult, intestinal permeability changes due to loss of functional integrity thus increasing the risk and severity of infectious complications.[37,38]

Indications of enteral nutrition:[39,40]

Major reason for preference of enteral nutrition over parenteral nutrition is decrease in morbidity with the use of enteral nutrition due to reduction in the incidence of central venous line-related infections, pneumonia and abdominal abscess in trauma patients.[41] In several studies, benefits in the form of a decrease in hospital stay, cost of nutrition and regain of the cognitive function in head injury patients has been seen with enteral nutrition.[42,43] Five of the various six meta-analysis done in the literature has shown no difference in the mortality between enteral and parenteral form of nutritional therapies.[42,44-47] In a study done by Simpson and Doig, despite the higher incidence of infectious complications with use of parenteral nutrition, significantly lower mortality has been seen as compared to enteral nutrition.[48]

Enteral feeding should be started early within first 24–48 h after admission, once fluid resuscitation is complete and patient is hemodynamically stable. Feed should be advanced towards desired target within next 48–72 h. In a study by Marik and Zaloga, a significant reduction in infectious morbidity and hospital stay has been seen with early enteral nutrition when compared to delayed start.[49] If patients are on high dose of inotropes or vasopressors and need excessive volumes of fluids for resuscitation, due to chances of sub-clinical ischemia or reperfusion injury to the gut, enteral nutrition should be withheld.[50]

As bowel sounds are indicative of contractile movements and it is not necessary that these indicate integrity of bowel mucosa, absorptive capacity and barrier function. Main reasons for intestinal dysfunction in critically ill patients are mucosal barrier dysfunction, mucosal atrophy, reduced gut-associated lymphoid tissue and dysmotilty.[50,51] Hence in critical patients, neither the presence or absence of bowel sounds and passage of stools is mandatory for initiating enteral feed.[51] And also if sick patients show intolerance to gastric feeding, are at high risk of aspiration and have high residual volume, can be started on small bowel feed. There is also an evidence that if early enteral nutrition has not been started within 7 days, parenteral nutrition can be started.[50] As permeability if intestine increases during 1st week of severe burns, there is need to provide > 50–65% of the desired target. During first 7–10 days, parenteral nutrition supplementation has not been found out to be helpful. Braunschweig et al. and Sandström et al. have also concluded from their study that after first 7–10 days, requirement for proteins and energy are increased in order to prevent complications due to poor nutritional status. Thus, if we are unable to meet the energy requirement of the sick patient by 100% of the target level needed, parenteral nutrition can be supplemented.[43,51] Studies in the literature have also shown that those patients who receive larger volume of enteral nutrition, encounter less complications and thus less associated morbidity than patients receiving lower feed amount.[43,53] There are various indications of enteral nutrition as listed in Table 1.

Obese patients are at higher risk of infections, deep vein thrombosis, insulin resistance, etc., So protein supplementation in a dose of 2–2.5 g/kg of ideal body weight/day and 60–70% of caloric requirement enhance neutral nitrogen balance and promote wound healing.[52] To prevent problems associated with ileus and inadequate nutrient delivery, time for fasting before or after any procedure should be kept minimum possible.[50]

Various tests are needed in patients receiving total parenteral nutrition in the form of total blood count, B12 and folate levels, serum magnesium, phosphate, calcium,

glucose, liver function tests, serum albumin, prealbumin, C-reactive protein zinc and copper levels. Investigations to be done in patients on total parenteral nutrition have been mentioned in Table 2, as written below.

Frequency of tests can be reduced once the patient is stable. Complete attention should be given to peripheral lines for signs of thrombophlebitis and centrally sited lines for signs of infection or inflammatory changes.[54]

Dietary Modifications in Special Situations

Endocrine disorders

It has also been studied in the literature that normal functioning of many endocrine organs like thyroid, pancreas etc., is also linked to the nutritional status. Thus nutritional imbalance can hamper their normal functioning. Various endocrine disorders such as obesity, thyroid disorders and diabetes have been linked with dietary modifications. Increased prevalence of endocrine disorders have been seen with over nutrition. Dietary patterns actually programme the different mechanisms associated with these disorders. As in case of diabetes mellitus, presence of transcription factor TCF7L2 has been linked, which can be regulated by fat and glucose rich diet. All the dietary components affect endocrine system of body.[55]

Table 1: Indications of enteral nutrition

Reduced level of consciousness
Impaired swallowing
Critical care patients
Acute pancreatitis
Esophageal obstruction and dysmotilty
Impaired gastric emptying
Gastric outlet obstruction
Hepatic failure
Inadequate oral intake
Moderate intestinal failure
Maintenance of gut integrity
Modulate stress response and systemic immune response
Attenuate disease severity
To provide immune-modulating agents
Means for stress ulcer prophylaxis

Table 2: list of investigations to be done in patients recieving total parenteral nutrition

Blood glucose monitoring every 4-6th hourly
Full blood count and serum magnesium and phosphate levels if high risk of re-feeding syndrome needs to be done daily
Liver function tests, lipid profile, calcium, albumin, prealbumin, transferrin, CRP should be done once or twice weekly
Zinc, iron, selenium and copper levels should be monitored every 2-4 weekly
Manganese and 25-OH Vitamin D levels should be taken 3-6 monthly

CRP: C-reactive protein

Chronic kidney disease

Dietary modifications both improve symptomatology as well as progression of kidney diseases. Many factors like type and severity of renal disease, nutritional status, dry weight, dietary intake, co-morbid diseases, physical activity, biochemical markers and also the adjusted body weight help in calculation of energy requirement of these patients.[56]

Challenging Aspects

Present challenges and possible measures which can be taken in developing countries may include but are not limited to:

- Limited availability of indirect calorimetry in ICU
- Scarcity of availability of bio-markers of illness, which can improve in molecular basis of the different pathological conditions
- Extensive search is needed in field of tight glycemic control, pharmaco-nutrition and immune-nutrition
- Need to carry out randomized control trials and studies to make guidelines
- Lesser funds are available for health services.

Our own guidelines and recommendations should be made according to the Indian scenario after extensive research and studies. These guidelines need to be followed strictly in ICU as per the institutional resources. Training programmes should be conducted for training of the staff.

Limitations

Limitations of current review article may include but are not limited to lesser number of randomized controlled trials, paucity of universal guidelines, different beliefs and cultural practices in our country, different food fads, socio-religious factors etc., which can have either direct or indirect effect on the nutritional aspects in burn patients.

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