Part 1

Nutrition Support & Burns

Gemma Stewart, Burns and Critical Care Dietitian, University Hospitals Birmingham

Burn injuries can have a profound effect on a person's life, impacting their physical and mental health in a multitude of ways. Caring for individuals after burn injury requires a multidisciplinary team (MDT) approach. Nutritional status plays a pivotal role in clinical, functional and quality of life outcomes, making the dietitian a central member of the MDT. The nutritional care of burn-injured patients can be complex and to optimise nutritional status, the dietitian must work with the MDT and the patient to overcome challenges throughout what is often a long acute admission.

In the first of this two-part series on the nutritional care of burn-injured adults, I describe some of what we know about the physiological effects of burn injuries and how this impacts patients' energy and protein requirements. After discussing the challenges to meet patients' nutritional requirements, I explain the role of nutrition support.

Physiological effects of burn injury

Burn injuries are assessed by their depth and size. The depth may be superficial, superficial partial thickness, deep partial thickness or full thickness. Most injuries are a mixture of depths. The size of the wounds is described as a percentage of the total body surface area (TBSA), and injuries extending over greater than 20% TBSA are considered severe.[1] Depending on the mechanism of injury, in practice, patients with severe burns may present with other complicating injuries such as inhalation injury, fractures or traumatic brain injury. At the outset, many patients with severe injuries will require admission to an intensive care unit for ventilation, fluid resuscitation and to stabilise their condition. The dietitian's involvement with patients who present with severe burns commences on day one of admission and may be required throughout the patient's journey.

Severe burn injury leads to a state of hypermetabolism that is unique in its extent and can continue for up to two years after the initial injury.[2] Although the process is not fully understood, several pathophysiological pathways are implicated in the stress response experienced after burn injury. Systemic inflammation initiates hypermetabolism, leading to greatly increased adenosine triphosphate consumption to support multiple pathways, including protein synthesis and glucose metabolism.[2, 3] This hypermetabolism appears to be driven by an increase in catabolic hormones, including epinephrine, cortisol and glucagon.[4] If left unchecked the resultant catabolism leads to rapid loss of weight, reduced immune function and delayed wound healing.[3]

Effect on energy & protein requirements

The body's stress response after severe burns produces an increase in metabolic rate that is proportionate to the size of injury. It is estimated that patients with injuries covering 40% TBSA experience an increase to their resting energy expenditure of between 40-100%.[2] In response to observed rapid weight loss, it is likely that this effect was historically over-compensated for and burn-injured patients may, in the past, have been overfed.[5] Over time, there has also likely been a genuine reduction in caloric requirements in this patient group, influenced by non-nutritional aspects of care, such as temperature regulated rooms and improvements to surgical techniques that have led to earlier wound closure, as well as the increased use of pharmacological agents, including propranolol.[4]

The gold standard for estimating energy requirements is indirect calorimetry.[5] Whilst the presence of an indirect calorimeter is becoming more commonplace, it remains unfeasible as a method for many dietitians working with burn-injured patients. Predictive equations have not demonstrated to be very accurate in calculating patients' energy requirements.[6] However, European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines recommend the use of the Toronto formula as a validated alternative in the absence of indirect calorimetry.[5] Whilst it would be typical to work with estimated energy requirements of around 30-35 kcals per kg, as in other areas of practice, any calculation should be used as a starting point and adjusted through careful monitoring. The author has known a patient to require upwards of 60 kcals/kg to prevent rapid weight loss. Further, many burn-injured patients begin their journey in intensive care, and it will not be appropriate to commence nutrition at this level in the early acute phase. As in other patient groups in critical care, overfeeding may be harmful, for example, by increasing hyperglycaemia.[7] Additionally, although hypermetabolism can persist for many months, energy requirements eventually reduce, and monitoring may then be required to avoid unwanted weight gain in the long-term.

During hypermetabolism, proteolysis is increased, and catabolic hormones inhibit protein synthesis.[4] Patients with severe burns are subject to increased protein losses via urine, wounds and blood loss. International guidelines, including ESPEN, recommend a protein intake of 1.5-2 g/kg for adults following severe burn injury.[5] It is necessary to ensure sufficient energy intake alongside this, to avoid the use of protein as an energy source.

It has not been demonstrated that high protein intakes in burn patients can reduce the breakdown of protein stores, but rather can increase protein synthesis and reduce the incidence of negative nitrogen balance.[2] Increased protein synthesis should lead to improved wound healing, organ and immune function and it is hoped, therefore, to improved morbidity and mortality.[4] However, whilst the high protein intakes described above are a typical part of dietetic plans, the evidence in support of this is scarce. International guidelines are based on consensus opinion and a recent systematic review concluded that the available evidence is limited due to the low number of clinical trials and their methodological flaws.[4] The authors also cautioned the potential harm in providing very high protein intakes for some patients, citing the risk to kidney function.[4] This should be kept in mind and monitored from intensive care onwards, with reference also to the results of the recent EFFORT trial.[8]

Barriers to meeting estimated nutritional requirements

In practice, meeting the estimated nutritional requirements of severely burn-injured patients can be challenging. This patient group experiences the same environmental, social and systemic barriers to eating as other patients in an acute setting. The choice and timing of meals, the eating environment and the lack of social interaction, can all lead to reduced nutritional intake. However, patients with severe burns are subject to some compounding factors that further reduce their ability to meet their significantly increased nutritional requirements.

The pain of burn injuries is extreme and, as the author has witnessed, this can severely impact upon appetite. Further, pain management requires the use of regular high-dose opiate analgesics which can reduce patients' alertness, may cause nausea or vomiting and frequently results in constipation, further reducing appetite.[5] Wound management may require multiple trips to theatre under sedation for changes of dressings and surgical procedures, including skin grafts. This can result in several periods of nil by mouth status within a week, thereby reducing the time available for nutritional intake.

> "Increased protein synthesis should lead to improved wound healing, organ and immune function and it is hoped, therefore, to improved morbidity and mortality.[4]"

Depending on the location of the wounds and the size of dressings, a patient's functional ability to eat and drink may be compromised, for example in the case of hand wounds. The circumstances and consequences of burn injuries, in many cases, will be traumatic and the psychological impact may affect appetite. Finally, it is the author's observation that many patients present with challenging social or psychological backgrounds, including substance abuse or significant mental health history. For some patients, this means that their pre-injury nutritional status is already compromised. The dietitian must assess and consider these factors when devising nutritional care plans.

How to meet nutritional requirements

Each patient must be assessed individually. However, in practice, patients with burn injuries covering up to 20% TBSA may be able to meet their nutritional requirements with the support of dietary advice and oral nutritional supplements. A diet plan including high energy and high protein foods will be required and it is likely that oral nutritional supplements will be prescribed. For patients with injuries covering greater than 20% TBSA it is anticipated that enteral feeding will be required. The timing, route and formula will need to be considered.

Following severe burn injuries, the gastrointestinal tract can be affected, with consequences including gut oedema and ileus.[3] Enteral nutrition is preferred over parenteral nutrition wherever possible.[5] Early enteral nutrition is encouraged and feeding commenced within six hours of injury can lead to benefits, including attenuating the stress response and preserving the mucosa of the gastrointestinal tract.[7] There are also indications that early enteral feeding may support improved wound healing.[2] The duration of enteral feeding will vary depending on the patient's progress, as well as the surgical aims and therapeutic goals agreed with the MDT. As a patient's rehabilitation progresses, it may be appropriate to consider overnight feeding to avoid interference with therapy.

Both nasogastric and nasojejunal tubes may be used in patients with burn injury. The dietitian should discuss the most appropriate route of feeding with the surgical team. If a nasogastric tube is placed, the anaesthetist may require the feed to be paused prior to and during procedures, to reduce the risk of aspiration. Where nasojejunal tubes are used it is usually possible to continue feeding throughout surgical procedures.[2] For this reason, in patients with injuries greater than 30% TBSA, or where wound management is otherwise likely to involve multiple procedures under sedation, a nasojejunal tube should be considered. If a nasogastric tube is placed, feeding regimes may need to take account of any planned breaks, for example, by feeding over a reduced number of hours, or using volume-based feeding.

The composition of macronutrients within the diet will be explored in further detail in the second part of this series. However, for most patients, the choice of enteral formula will be dictated by their high energy and protein requirements. A whole protein, energy- and protein-dense formula is likely to be used. A non-protein calorie to nitrogen ratio of 100:1 has been recommended for patients with severe burns.[2]

Conclusion

The degree and duration of the metabolic response to burn injury is unlike any other disease or trauma. This state of hypermetabolism, the symptoms of the injury and aspects of treatment all impact upon patients' nutritional requirements and their ability to successfully meet them. Nutrition is vital to optimise outcomes and the dietitian must work together with the patient and the MDT to decide upon the most appropriate plans to meet nutritional goals.

In the next part of this series, I will consider more closely the composition of nutrition delivered, when I explore macronutrient and micronutrient considerations following burn injury.

References: **1.** Porter C, *et al.* (2016). The metabolic stress response to burn trauma: current understanding and therapies. Lancet.; 388(10052): 1417-1426. **2.** Clark A, *et al.* (2017). Nutrition and metabolism in burn patients. Burns Trauma.; 5: 11. **3.** Rousseau A-F, Pantet O, Heyland D. (2023). Nutrition after severe burn injury. Curr Opin Clin Nutr Metab Care.; 26(2): 99-104. **4.** Hampton V, *et al.* (2021). Evaluation of high protein intake to improve clinical outcome and nutritional status for patients with burns: a systematic review. Burns.; 47(8): 1714-1729. **5.** Rousseau A-F, *et al.* (2013). ESPEN endorsed recommendations: nutritional therapy in major burns. Clin Nutr.; 32(4): 497-502. **6.** Wang Y, *et al.* (2024). Estimates of resting energy expenditure using predictive equations in adults with severe burns: A systematic review and meta-analysis. J Parenter Enteral Nutr.; 48(3): 267-274. **7.** Houschyar M, *et al.* (2020). Burns: modified metabolism and the nuances of nutrition therapy. J Wound Care.; 29(3): 184-191. **8.** Heyland D, *et al.* (2023). The effect of higher protein dosing in critically ill patients with high nutritional risk (EFFORT Protein): an international, multicentre, pragmatic, registry-based randomised trial. The Lancet.; 401 (10376): 568-576.