Part 2

Nutrition Support & Burns

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In the first part of this series, I explored the metabolic response to burn injury and how patients may be supported to meet their nutritional requirements, which are significantly increased. In this second part, I will address the composition of the diet for burn-injured patients. I will explore macronutrient considerations and highlight the role of several micronutrients in wound healing and in optimising outcomes for this patient group. Finally, I will look at where further research is needed to guide practice in this area.

Macronutrient considerations

The hypermetabolism that ensues following severe burn injury leads to increased demands for energy which, if not met, lead to significant weight loss.[1] Protein catabolism and inhibited protein synthesis leads to negative nitrogen balance.[2] As a result, one of the major goals of dietetic intervention is to supply sufficient energy and protein to minimise weight loss, support wound healing and maintain organ systems. Whilst the optimal proportions of different macronutrients have not been precisely defined, there are several issues to consider when devising nutritional care plans.

Carbohydrates

Carbohydrates should be the predominant energy source for patients following severe burn injury. It is recommended that carbohydrates should account for 55-60% of energy provision.[3] At the same time, a maximum glucose oxidation rate of 5 mg/kg/min has been proposed.[3] It has been highlighted that the high energy requirements observed in some patients with severe burns may make it necessary to exceed this.[1]

As described in part 1 of this series, burn injury leads to an increased level of circulating catabolic hormones, such as epinephrine and cortisol. This may lead to insulin resistance and medical management of blood glucose levels may be required, including insulin therapy. It is recommended to aim for blood glucose targets of 6-8 mmol/l,[3] whilst avoiding the risk of hypoglycaemia.[1]

Lipids

Lipids are required as a source of essential fatty acids, as an energy source and for the absorption of fat-soluble vitamins. However, data is limited on the optimal proportion of lipid in the diet for burn-injured patients. Effective utilisation of fat as an energy substrate is reduced after severe burns and it has been proposed that wound healing and infection rates may be improved when a reduced supply of lipids is delivered.[4] As a result, guidelines recommend maintaining energy from fat to less than 35% of total energy intake.[3] In practice, keeping fat intake to less than 35% of energy intake may be difficult when devising enteral feeding regimes to meet energy requirements, because of the preparations available.

This may especially be so where there are non-nutritional sources of lipid, such as the sedative propofol.

There is some indication that omega-3 fatty acids are preferential to omega-6 fatty acids because of the anti-inflammatory effects of the former; however, there is presently insufficient evidence for any clinical recommendation.[5]

Protein

Adequate protein is required for wound healing, to minimise the loss of lean mass and to support immune function. The catabolism that follows severe burn injury leads to negative nitrogen balance and patients are subject to ongoing protein losses, including via wound exudate.[2] Protein requirements are estimated to be 1.5-2 g/kg daily following severe burn-injury.[3] This can result in very high protein targets. High protein enteral feeds and/or oral nutritional supplements are typically required, including additional protein modules. Patients should receive dietary counselling on protein-rich food sources once oral diet is resumed. As well as overall protein targets, there has been some investigation into the role of specific amino acids.

The amino acid arginine has been investigated for its potential to positively affect immune function and wound healing. However, there is insufficient evidence for any clinical recommendations to supplement arginine in this patient population.[3] Early studies indicated beneficial outcomes when supplementing severely burn-injured patients with the amino acid glutamine, with benefits reported to include improved wound healing, reduced infection risk and even reduced mortality.[6] More recently, RE-ENERGIZE, a large multi-centre randomised controlled trial published in 2022, did not demonstrate such benefits.[6] This led to a widespread change in practice and glutamine is not now indicated.

Micronutrient considerations

Several micronutrients and trace elements need to be considered within the nutritional management of burn-injured patients. Some have a direct role in wound healing and others appear to positively affect outcomes in other ways, for example, by supporting immune function. Many may act as antioxidants, mitigating the effects of the extensive oxidative stress that is observed after burn injury. To date, the trace elements copper, selenium and zinc, plus vitamins C, D and E have been the subject of much of the available research into micronutrient requirements for burn-injured patients and will therefore be the focus of this section.

Trace elements

The trace elements copper, selenium and zinc are important following burn injury. Copper is an antioxidant and is also a cofactor in enzymes required for collagen synthesis.[7] Deficiency has a negative effect on wound healing and immune function.[1] Selenium is a powerful antioxidant and has a role in immune function.[8] Zinc plays several roles that are beneficial to burn-injured patients. As well as being an antioxidant, zinc is required for collagen and protein synthesis and supports immune function.[7]

Burn-injured patients are subject to significant losses of trace elements, primarily via wound exudate, and serum levels are depleted after burn injury.[1] There are inherent difficulties with obtaining accurate measurements of serum trace elements while patients are in a systemic inflammatory state, which has led some authors and practitioners to question the efficacy of trace element supplementation.[9] The available studies on trace element supplementation following burn injury have involved small sample sizes and used different dosing regimens, different combinations of trace elements or other micronutrients and different delivery methods, with some using intravenous preparations and others enteral. This all adds to the difficulty with interpreting the evidence. However, trace element supplementation has demonstrated beneficial outcomes, including reduced pulmonary infections and improved wound healing and systematic review reported overall benefit in trace element supplementation for burn-injured patients, particularly in relation to reducing incidence of infections.[10] For this reason, although practice is variable, it remains a recommendation of current European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines to supplement copper, selenium and zinc.[3]

Vitamin C

As well as being a powerful antioxidant, vitamin C is required for synthesis and cross-linking of collagen, and therefore has a direct role in wound healing.[1] Further, due to the increased susceptibility to infection that is observed after burn injury, the role of vitamin C in maintaining immune function is also highly relevant.[7] Vitamin C may be depleted after burn injury and could remain so throughout the acute phase of injury.[3] Thus, vitamin C supplementation is routinely administered to burn injury patients, supported by international guidelines.[3] Up to 1 g/day is considered safe and, further, the role of very high dose vitamin C is also under investigation.

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There is some indication that very high dose vitamin C administered during the resuscitation phase after a major burn injury could reduce fluid requirements and oedema.[5] However, this is reported by two small trials and is not yet therefore validated. Further evidence on this potential role for vitamin C is hoped for from a large multi-centre randomised controlled trial which is currently taking place.[5]

Vitamin D

The role of vitamin D in calcium homeostasis and bone health is well established. However, more recently its influence on other systems including immune and cardiovascular have been explored.[7] Vitamin D deficiency is prevalent in the general population in the UK and may be more prevalent in burn-injured and critically ill patients.[11] The risk of vitamin D deficiency in burn-injured patients is influenced by reduced synthesis of vitamin D3 in scar tissue and reduced sunlight exposure.[5] It is hypothesised that vitamin D supplementation could benefit burn-injured patients in several ways, including via immune function or wound healing, and there are some promising indications on clinical outcomes, including reduced fracture risk.[7] However, data is currently limited, particularly in adults. Given the low cost and relatively low risk of vitamin D supplementation, further research is required to investigate whether there is a clinical benefit and to establish dose and timing.[12] ESPEN guidelines recommend supplementation of vitamin D in burn-injured patients, although they acknowledge evidence of benefit is unclear and it is no surprise therefore that practice is variable in this regard.[3]

Vitamin E

Vitamin E is an antioxidant and is depleted post burn injury, although may return to normal after a few weeks.[13] Prolonged depletion has been correlated with increased mortality.[12] Whilst depletion post burn injury is recognised and associated with worse outcomes, the evidence on outcomes following supplementation is not consistent.[7] Much of the available evidence is in vitro or in animal models and so, whilst there are some promising indications that vitamin E supplementation could benefit patients after burn injury, evidence from human studies is lacking.[13] Thus, several authors have called for a large-scale study to address the role of vitamin E in burn injury.

Conclusions

Without appropriate nutrition support, the degree of hypermetabolism, catabolism and oxidative stress witnessed after severe burn injury may lead to rapid weight loss, delayed wound healing, compromised immune function and ultimately death. The dietitian is a crucial member of the multidisciplinary team and must impart expert knowledge and skills when making dietetic plans to optimise patient outcomes.

The increase to resting energy expenditure must be met with a plan to meet energy requirements, whilst also ensuring adequate protein and avoiding the potentially deleterious effects of hyperglycaemia or an oversupply of lipid. Further, it is recognised that several micronutrients are depleted following burn injury and may need to be supplemented to support immune function, aid wound healing and dampen the impact of oxidative stress.

It is apparent that much further work is needed in investigating nutrition support for burn-injured patients. The current paucity of evidence is a limitation to our practice. Further, our ability to draw conclusions from the evidence is often complicated by the differences in dosing, delivery and combinations of nutrients studied. Whilst we await new evidence, we can only continue to refer to the best available evidence. The change in practice towards glutamine supplementation that followed publication of the RE-ENERGIZE trial taught us to remain alert to emerging evidence and to regularly re-appraise the evidence to inform our practice.

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