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FOCUS ON: BURNS CARE

The management of major burns – a surgical perspective

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SUMMARY

In the UK, 1000 patients per year will need resuscitation and inpatient treatment for burns. The mortality has improved significantly over the last 50 years but over three hundred people die each year. A greater understanding of the pathophysiology together with improvements in resuscitation, critical care and surgical techniques have all contributed to survival. For larger burns (greater than 25% total body surface area) there is a profound release of cytokines and chemokines. This results in a marked systemic inflammatory response syndrome, leading to edema, effects on multiple organ systems, a hypermetabolic response and suppression of the immune system. Early surgical care is based around the ABCD philosophy (as guided by Advanced Trauma Life Support and also Emergency Management of Severe Burns). An assessment system based on depth is vital for clinical decision making and prognosis. Many centers now aim for early excision and grafting of burns. Early excision modifies the host responses by removing devitalized tissue that might otherwise invoke deleterious effects, but its removal in itself may also provide a major insult. Several variations in approach are possible to modify the impact of excision and an approach tailored to the individual is appropriate. Covering the excised burn area can be achieved with wide range of materials from allograft to synthetic skin substitutes. Key to successful burn care is a directed multi-disciplinary model for providing appropriate expertise on individual sites, together with the development of burn care networks to facilitate effective delivery of burns services across an entire region.

Thirteen-thousand patients visit Emergency Medicine departments in the United Kingdom annually with a burn injury. One-thousand will require inpatient admission and fluid resuscitation. Despite advances over the last 60 years 300 will die and the majority of these will be elderly.[1]

The burn size lethal to half a specified age group (LD_{50}) has increased from 45% in 1950 to approximately 80% in 1990 for a 21-year-old man.[2] In the pediatric population a 98% total body surface area (TBSA) has a 50% chance of survival. Improvements in initial resuscitation through critical care and the operating theatre have helped achieve this.

Change has been driven by an understanding of the pathological processes involved and a more comprehensive approach to their remedy.[3]

1. The burn wound

Tissue destruction by thermal or chemical injury initiates the pathophysiological processes associated with burn injury. When the volume of tissue destruction involves 25% TBSA the profound release of cytokines and chemokines such as histamine, serotonin, bradykinin, nitric oxide, tumor necrosis factor and interleukins precipitate systemic inflammatory response syndrome (SIRS). A subset of SIRS patients develop multi- organ dysfunction syndrome (MODS) and a few will suffer multi-organ system failure.[4] Why certain patients deteriorate despite high standard care is unknown.

This profound inflammatory response causes edema and fluid sequestration secondary to increased microvascular permeability in both burned and unburned tissue. This affects all organ systems, resulting in myocardial depression, respiratory failure independent of inhalational injury, immunosuppression and renal impairment.

The burned patient exhibits suppression of innate and acquired immune systems. This may be a consequence of the body's own attempts to modulate the hyperinflammatory response potentially exacerbated by initial treatments such as opioid analgesia,[5] repeated blood transfusions and anesthetic agents.[6]

In burn injuries of 40% TBSA or greater there are profound metabolic consequences that are more dramatic and prolonged than in other critically injured patient groups. Increased core temperature, glycogenolysis, lipolysis, proteolysis, oxygen and glucose consumption all characterize the hypermetabolic response and are mediated by hormonal derangements.[7] Holistically this manifests as immunosuppression, poor wound healing and a decrease in lean body mass, with effects that persist long after the burn wounds have healed, impairing rehabilitation.

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"Modern methods of burn treatment have not altered the nature of burn-induced hypermetabolism but have significantly reduced its magnitude."[8] Early excision and wound coverage, nursing in a warm humid environment, preventing sepsis and resisted exercise (exercise against resistance – isometric) have all been shown to moderate the hypermetabolic response.[9] Pharmacological agents such as oxandrolone[10] and propranolol[11] have a role reducing weight loss and energy requirements respectively.

Enteral feeding has not been shown to reduce the hypermetabolic response in human studies but helps to ameliorate the deleterious effects. Early enteral feeding, within hours of injury, has been shown to be safer than parenteral nutrition, maintain gut integrity, reduce mortality and if delivered distal to the ligament of Treitz can be continued intraoperatively.[12]

Our understanding of the burn wound revolves around the three zones of injury proposed by David Jackson in 1953: the zone of hyperemia (peripheral), the zone of stasis (intermediate), and the zone of coagulation (central).[13] This represented a move away from consideration of burn intensity to a system based upon burn depth.

- Tissue involved in the zone of coagulation is unsalvageable despite modern treatment methods.
- Tissue within the zone of stasis has the potential for recovery if further damage can be avoided.[14]
- Tissue within the outer zone of hyperemia is viable and represents the host inflammatory response to injury.

Systemic disease, chronic illness and advanced age are all risk factors for conversion of the zone of stasis to one of coagulation. Most modern therapeutic regimens and dressings are designed to prevent desiccation, infection, hypoperfusion and edema in order to prevent deterioration of the zone of stasis and therefore minimize the zone of coagulation.

It is important to appreciate that the burn wound is dynamic, capable of progression in terms of depth and extension in size over the initial 48–72 h as the zone of stasis declares itself.

2. Burn assessment

The ability of a burn to heal itself is related to burn wound depth. The deeper the injury the fewer ectodermal appendages survive and the longer the time to healing. Thus partial thickness burns are sub-divided into superficial partial thickness, mid-dermal and deep dermal. The challenge is to identify those wounds that will heal themselves from those that will heal only with scarring and need intervention to speed healing and improve outcome.

Hypertrophic scarring can be predicted based on the time a burn takes to heal. Burns healed between 14 and 21 days have a 33% chance of developing hypertrophic scars whilst those wounds which take longer than 21 days to heal have an approximately 80% chance of developing hypertrophic scars.[15] These scars pose functional and aesthetic problems.

Healing without scarring is an achievable goal in superficial injury, but changes in pigmentation are more difficult to predict. Hypo- and hyperpigmentation are reported post superficial burn injury. Altered melanocyte function and reduced numbers may be indicated.[16,17]

An assessment system based on depth is vital for clinical decision making and prognosis. It also provides a common descriptive currency of burn injury for epidemiological, financial and clinical research.

A variety of methods have been described including clinical examination, thermography, spectroscopy, ultrasound, laser Doppler imaging (LDI), MRI and histological examination.[18]

Clinical examination is the commonest method utilized today, however, it has been shown to be accurate in only 60–80% of cases and most clinicians tend to overestimate depth.[19] Inaccurate initial assessment results in unnecessary operations for some with surgical removal of potentially viable dermis, and delayed treatment for others with the attendant waste of resources.

Laser Doppler imaging (LDI) is performed 48–72 h following the burn, is non-contact and uses laser light to assess microvascular flow. Paucity of flow is equated with depth of burn. Superficial burns have perfusion values greater than normal skin whilst deeper burns have lower blood flow values.[20] It has been shown to accurately predict burn wound depth in 97% of cases.[19] In early aggressive excision treatment regimens LDI may come too late to influence management decisions.

3. Burn care networks

The National Burn Care Review[1] advocated a coordinated network utilizing primary care, accident and emergency, burn facilities, burn units and burn centers with each component managing burn injuries appropriate to its resource mix within an equitable regional context.

From a surgical perspective the correct functioning of this network is imperative. Recognition of the volume of burn care performed in non-specialist centers is essential. This means providing education to referring centers with less experienced staff [21] and improving communication to ensure that patients who would benefit from specialist input are seen promptly.

In the USA and UK this has seen specific referral criteria defined that not only consider anatomical location and TBSA of burned tissue but also etiology, co-morbidities and skill set at the referring facility. Telemedicine has been an invaluable tool in facilitating this[22,23] and may even have a role to play in the follow-up of burn patients. [24]

Burn care represents a truly multi-disciplinary model. The role of the surgeon is as part of that team, neither more or less important than any other team member but perhaps uniquely placed to oversee the team structure and to co-ordinate the burn care network.

"Single clinicians change outlooks for individuals but effective networks can improve outcomes for populations." In the North American burn care systems the burn center director must be a surgeon. This person must direct the acute care of 50 or more acutely burned patients per annum and demonstrate an interest in burn care by completion of an approved fellowship or accumulated experience. They are in increasingly short supply.[25] The composition, training requirements and infrastructure required to declare status as a burn care center are strictly defined as part of a system for dealing with the trauma patient.[26]

There are obvious advantages to this approach beyond the obvious clinical benefit of experience and competence. The collection of burns injuries in one place offers research possibilities to advance burn care.[3] Research must answer questions relating to all aspects of burn care including the small burn not necessarily represented in studies based upon in-patient data.[27] This commitment to data capture is formalized in North America as the National Burn Repository with a minimum data set for all patients[26] and is being established in the UK as the British Isles Burn Injury Database (BIBID).

The familiarity that burn centers have with the management of major skin injury also provides an obvious role to play in the management of necrotizing infections with large volume soft-tissue loss[28], toxic epidermal necrolysis[29] and purpura fulminans.[30]

4. Early surgical care

Early surgical care is based around the ABCD philosophy so familiar to clinicians from advanced trauma life support (ATLS)