Burn Care: An overview of current approaches to its optimal delivery

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Abstract

Severe burns are one of the most devastating forms of trauma. There is widespread recognition that well-resourced specialist burn centres deliver the optimal care for these patients. Within such facilities, modern burn care has become a carefully orchestrated and goal-directed exercise in resuscitation, infection control, critical care, surgical wound care, pain relief, nutrition, as well as psychosocial and physical rehabilitation. These interventions have been effectively augmented by advances such as skin substitutes, the pharmacological amelioration of the hypermetabolic response, and laser therapy. This paper overviews current and future management principles to obtain satisfactory results in the surgical subspeciality area of burn care.

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Background

Burn injuries remain one of the most prominent causes of traumatic morbidity and mortality internationally. More than 11 million burn injuries are sustained requiring medical attention annually, resulting in more than 265 000 deaths.[1] The vast majority of these injuries occur in low- and middle-income countries, where the challenge to supply adequate burn care is thwarted by either grossly inadequate resources or administrative oversight, and frequently both. For those who survive major burn injury, recovery is often characterised by considerable aesthetic, functional and psychosocial challenges. This paper overviews selected considerations when managing the patient with an extensive burn injury.[2]

The burn centre approach

As much as in any other sector of health care, the presence of an adequate infrastructure, a dedicated interdisciplinary environment and an intact family support structure, plays a significant role in returning these individuals to functional, well adapted and fulfilling lives. As such, there is widespread recognition that patients who meet certain criteria are best managed in a burn centre. At its best, this is a self-contained interdisciplinary environment with dedicated, isolated beds, sub-specialist plastic and general surgeons, supported by an interdisciplinary team whose primary function it is to look after such patients. These individuals include nurses with wound care and intensive care training and experience, as well as dedicated dietitians, social workers, physical and occupational therapists, as well as an array of consultants from the full spectrum of medical specialities.

The American Burn Association has established a verification system to assess and advise burn centres in areas where they may be deficient, as well as to encourage hospital, regional and national authorities to support burn centres to meet these challenges. There is a growing appreciation for the value of quality improvement initiatives originating within the burn centre too, which places value on processes like mortality and morbidity meetings, routine comprehensive patient and outcome data collection and reporting, as well as research and audit.

Assessment and acute management

Fluid resuscitation with Ringers Lactate, based on the Parkland Formula (4 X TBSA Burn X mass of patient = volume over 24 hours, with half given over the first eight hours), remains the mainstay of initial management, and fluid volumes are then carefully titrated to endpoints including urine output, lactate, base deficit, and haemodynamic variables.[3,4] Meticulous attention to detail, changes in clinical condition, and regular hourly assessment are necessary to undertake this effectively. Five percent albumin may be introduced from as early as eight hours after the burn injury, once capillary integrity has been restored, as it is believed to remain intravascular for a longer period than crystalloids. Although its use might be considered intuitive, the role of colloid solutions such as plasma and albumin to reduce fluid resuscitation volumes remains controversial. What is well-recognised, however, is the deleterious effect excessive fluid administration has in the development of 'fluid creep', a condition of interstitial fluid overload which can lead to abdominal, orbital, and extremity fascial compartment syndromes, pulmonary oedema, and mortality.[5,6]

Various methods have been utilised to assess and document the extent of the burn (upon which the fluid resuscitation is based), including the rule of nine's, the patient's palm method, the Lund and Browder chart, as well as three-dimensional computer models. All have their weaknesses, especially considering the various proportions and body-mass indexes of patients with burn injuries; significant differences in assessment are observed even between experienced burn surgeons.

Acute burn surgery

Burn surgeons aim to obtain wound healing within three weeks, ostensibly to limit the development of scar hypertrophy and contracture and to reduce infection risk. As such, early tangential excision and autografting remains the surgical priority for deep partial and full thickness burn injuries, but the timing is sometimes dictated by the patient's general condition, the availability of operating time, and the anatomical areas involved. Burn centres ideally have ready access to deceased donor allograft skin, which offers considerable value to the burn surgeon. The three main indications include its use as a temporary biological cover for excised burns in the extensive burn, as a test of the wound bed in the context of infection, and in the staged management of sheet grafting of important functional and aesthetic areas like hands and faces.[7] Permanent skin substitutes like Integra (Integra Lifesciences, Plainsboro, US) are believed to add value to reduce the negative sequelae of thin widely meshed (3:1) autograft in cases where repeat harvesting of these areas is inevitable in extensive burns.[8] Biobrane (Smith & Nephew, London, UK) is a useful (more rapidly applied) alternative to allograft in the excised burn, or as the definitive biological dressing for superficial partial thickness burns or exfoliative skin conditions.[9,10] Meek micrografting, a method to widely cut and spread autograft into islands placed on a pre-folded gauze, is arguably the most elegant current method of widely meshing autograft from limited available donor sites to optimise coverage for the very extensive burn.[11] Strategies to prevent hypothermia have recently been recognised to contribute to improvements in outcomes by reducing a host of associated infectious and non-infectious sequelae.[12,13]

Patients with burn injury frequently require transfusions, and the recent TRIBE study has confirmed that the optimal haemoglobin target for blood transfusion is between 7 and 8 g/dl. Higher targets are likely just more expensive, predispose patients to greater risks of infection and transfusion-related complications, without any demonstrable benefit.[14] A variety of intraoperative strategies are available to reduce blood loss and the need for transfusion, including the injection of tumescent solutions containing adrenaline in both donor and recipient sites, the use of tourniquets for extremity surgeries, as well as topical applications of agents like tranexamic acid and adrenaline.[15]

Critical care of the patient with burns

Patients with burn injuries are particularly susceptible to nosocomial infections, including ventilator-associated pneumonia,[16] wound infection, and sepsis associated with indwelling lines, catheters and tubes necessary for their critical care. Infection prevention and control protocols, patient isolation, efficient surgery, optimal antimicrobial dressing use and reduced duration of invasive devices, all contribute to limiting morbidity from infections, which remain the leading cause of death from thermal injury. Antibiotics are initiated empirically for systemic infection according to known resistance patterns, as well as the timing and location of infections, and adjusted subsequently based on cultures.

Multiple neural pathways contribute to pain and anxiety and so most patients benefit from a multipronged analgesic strategy which incorporates agents such as gabapentin in addition to standard simple and opiate analgesics.[17] The ability to offer conscious or deep sedation when performing dressing changes for extensive areas with protocols including benzodiazepines, ketamine, propofol and opiates, is a major advantage of a well equipped burn intensive care setting, and likely reduces the incidence of anxiety and pain syndromes.

Major burn injuries are characterised by an extraordinary multisystem hypermetabolic and hyper-inflammatory response and much of the impetus for modern care research is focused on agents that might ameliorate these effects. Propranolol, which is believed to significantly reduce insulin resistance and improve peripheral lean mass, is one such agent, and multi-centre trials are currently underway to evaluate its real benefit in adult patients.[18-20] The resting energy expenditure associated with the major burn is substantially higher than baseline, necessitating considerable nutritional requirements, both caloric and in terms of trace element supplementation. Modern burn centres implement volume-based feeding strategies, which compensate for any interruptions in enteral feeding within a 24 hour period. Feeds should generally not be withheld preoperatively and should preferably be continued throughout surgical interventions.[21]

Wound care

A wide variety of dressings are now available for the management of burn injuries. Dressing choice may be influenced by the adherence of the wound contact layer, its required duration and interval, the wound's moisture balance, and the presence or absence of necrosis, slough, infection or eschar. Wound practitioners should recognise that all antiseptics, including silver, are inherently cytotoxic and should be used with caution. Selected agents can be diluted to offer a more biocompatible balance of antimicrobial efficacy and keratinocyte survival. Negative pressure wound therapy is an effective bolster for skin grafts and skin substitutes, and options to instill antiseptics have augmented its value in wound bed preparation in other contexts.[22,23]

Silver sulfadiazine is still a widely used inexpensive ointment that is generously applied to gauze and then applied to the wound, but while soothing and offering antimicrobial benefits, its use is compromised by the need for twice daily applications, and the development of pseudoeschar. Interface dressings of the *Tulle gras* type that may be impregnated with substances to facilitate a period of relative non-adherence, are also widely used daily dressing options, and moist saline or topical antiseptic-soaked gauze options are typically applied over these. Antiseptic soaks in widespread use include povidone iodine, sodium hypochloride, mafenide acetate and acetic acid.

Newer dressing modalities have offered the ability to keep dressings intact for longer periods, and sometimes even until the burn wound has healed in the context of a superficial partial thickness burn injury. Frequently these contain and/or elute antimicrobials such as nanocrystalline silver.

The ideal dressing for donor site management is still an area of intense debate, but authorities believe that the ideal product should allow a single application, peels off when the area heals, offers some antimicrobial efficacy, facilitates ambulation and therapy, and is relatively inexpensive. A variety of impregnated gauzes, foams, films and skin substitutes are available for this purpose.

Outcomes

Several models have been developed to assist in the prediction of mortality or futility after major burn injury. The best known of these is the Baux score which is based on the sum of patient age and body surface area; the revised version also incorporates inhalation injury. The predictions based on this score are now somewhat outdated given the improvements in management strategies over the last three decades, but it is still frequently cited. The management of elderly patients is often the most challenging, given that patients with Baux scores over 90 are unlikely to return home after their injury and those with scores over 130 will almost certainly not survive under any circumstances. There is an increasing recognition that biological or physiological age is more important a consideration than chronological age, adding impetus to scoring systems like the frailty score.[24,25] Almost all children are expected to survive their burn injuries. The social worker is absolutely fundamental to the effective and compassionate functioning of a burn centre during all stages of a patient's care from admission to discharge and beyond, not least when communicating with patients and families regarding advanced care planning and end of life decision making.

Burn centres should prioritise audit, academic research and quality improvement processes, and report these regularly to regional and national bodies to ensure compliance with standards of care and so as to address systems issues. If available, they should also participate in verification and accreditation processes of their facilities and staff. Measures that should be included in reporting of outcomes include length of stay in days per percentage burn, time to wound closure, time to first surgery for major burns, time to initiation of enteral feeding, incidence of thromboembolic events and infections like ventilator-associated pneumonia, catheter-associated urinary tract infections, wound infections, as well as sepsis. A database of all admissions and patients' hospital course should be accurately maintained, and be readily accessible for audit and research purposes. All morbidities and mortalities should be discussed at a multidisciplinary forum with participation from objective senior peers from the surgical and critical care team. Burn centre staff should also endeavour to be involved in community outreach, regional conferences and consensus meetings, burn management training, and engagement at regional and national government level when required.

Reconstruction and rehabilitation

Reconstructive burn surgery, usually undertaken after discharge from the inpatient component of management, is an important subspeciality of plastic surgery and focuses on the surgical treatment of scar contractures, as well as other functional and aesthetic considerations through reorienting and lengthening procedures like z-plasties,[26] and the resurfacing of scarred areas with skin grafts, as well as local, regional and free flaps.[27] Splinting, pressure garment use, steroid injection and silicone gel sheeting are modalities that may reduce the need for surgical intervention.[28-30] Of all these strategies, pulsed-dye and fractional carbon dioxide laser therapy is the most promising method of modulating the maturation and hypertrophy of burn scars.[31]

Conclusions

Severe burns are one of the most devastating forms of trauma. There is widespread recognition that well-resourced specialist burn centres deliver the optimal care for these patients. Within such facilities, modern burn care has become a carefully orchestrated and goal-directed exercise in resuscitation, infection control, critical care, surgical wound care, pain relief, nutrition, as well as psychosocial and physical rehabilitation. These interventions have been effectively augmented by advances such as skin substitutes, the pharmacological amelioration of the hypermetabolic response, and laser therapy.

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