Early management of paediatric burn injuries

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Abstract

Burns are a common form of trauma in children, resulting most frequently from scalds but also contact, flame, electrical and chemical sources. Burn patients have a wide spectrum of injury severity and diverse outcome, ranging from superficial burns with no lasting physical signs to deep, large body surface area burns which are profoundly life-changing, affecting all physiological systems. Size, site and depth are important factors affecting treatment and outcome. There are important anatomical, physiological and psychosocial differences between adults and children. Their body proportions are different, they have thinner skin, smaller airways, reduced blood volume and high levels of distress. They are vulnerable to non-accidental injury. Children require formal fluid resuscitation and maintenance fluids for burns more than 10% total body surface area. Complications include infection, toxic shock syndrome, adverse scarring and psychological sequelae. This paper discusses how correct assessment and management in the acute stage can reduce later morbidity and mortality.

Keywords children's burns; non-accidental injury; paediatric burns; toxic shock syndrome

Introduction

The WHO lists burns as the eleventh leading cause of death in 1–9 year old children and the fifth most common presentation of non-fatal childhood injuries. The majority of burns occur in resource-poor countries where rates of child death from burns are seven times higher than in high-income countries.

Children are particularly vulnerable for sustaining burns, especially in the home. In the UK, approximately 6400 children are admitted to hospital for treatment of burns each year. The mechanism of injury reflects developmental ability at different ages. The most frequent mechanism of injury in children is scald, followed by contact burns (high resource countries) or flame burns (low resource countries). There is a significant economic burden for treating burns, with UK costs being £1850 for a typical small paediatric burn and more than £60,000 for major paediatric burns.

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Understanding a burn injury

A burn is damage to the skin caused usually by heat, but also by cold, chemicals and electric current. The skin is a complex organ with multiple functions including barrier and sun protection, immunity, vitamin D synthesis, temperature control, sensation, flexibility and cosmesis. Small areas of skin loss produce a localised response but with increasing area burned, the response becomes generalized with significant effects on all body systems.

Burn injury is therefore a form of trauma with a wide spectrum of injury pattern and diverse outcome. Burn injuries range from the superficial, minor burn with no lasting physical signs to large body surface area burns which are profoundly life-changing, affecting all physiological systems and which can lead to many years of hospital interventions in survivors. However, even small, deep burns can lead to significant morbidity and scarring, resulting in permanent aesthetic and functional disability and there can be long-lasting psychological effects on children and their care-givers. Prompt and correct early management of burn injury is therefore essential to reduce later morbidity.

Assessing a burn

The severity of a burn is dependent on body surface area, depth and anatomical site.

Total body surface area (TBSA)

The size of the burn is expressed as a percentage of the total body surface area (TBSA). Inflammatory mediators released by damaged endothelial cells, platelets and leucocytes cause vessel vasodilatation leading to extravasation of albumin and fluid from the circulation into the interstitial space. This causes oedema and, if untreated, can result in hypovolaemic shock. Children with burns over 10% TBSA require formal fluid resuscitation to replace these losses.

For burns over 25% TBSA, the inflammatory response impacts all body systems. Secretion of cortisol, catecholamines and glucagon produces a hypermetabolic state and mortality increases with increasing TBSA. These children are critically ill.

Measurement of TBSA is commonly estimated using the 'Rule of Nines', the Lund and Browder chart or the Rule of Palm. In the 'Rule of Nines', the body is divided into regions of 9% or a multiple thereof (Figure 1). Children have different body proportions to adults. They have bigger heads (18% TBSA) and smaller legs (14% TBSA); they develop adult proportions by approximately 14 years old. For patchy burns, the *patient's* palm and adducted fingers can be considered as approximately 1% TBSA.

The Lund and Browder Chart (Figure 2) is a more accurate representation of the changing body proportions depending on age. The area of the burn is marked on the chart and the TBSA calculated accordingly.

Depth

The depth of a burn is important to ascertain as it determines the likely timescale for healing. Delayed healing leads to suffering, high infection rates and increased mortality. Healing is complete when keratinocytes are confluent over the wound surface. Keratinocytes migrate from the wound edges and the linings of hair follicles, located in the dermis. With increasing depth of injury,

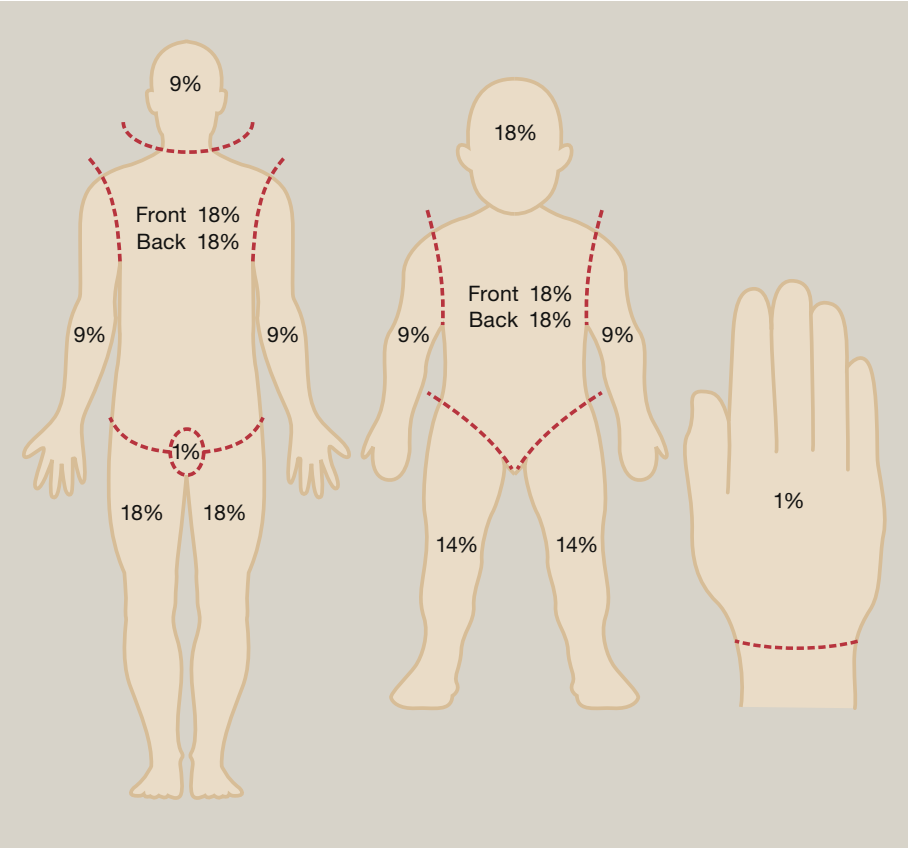

Figure 1 Rule of Nines for adults and children and Rule of Palm.

fewer keratinocytes are available for healing and skin grafting is needed.

Burn depth is classified according to the degree of damage to the epidermis and dermis. Superficial burns affect the epidermis only (epidermal) (Figure 3a) or epidermis and upper part of the dermis (superficial dermal) (Figure 3b). Deep burns involve more than the mid-dermis (deep dermal) (Figure 3c) or the whole dermis (full thickness) (Figure 3d).

However, burn wounds are dynamic and may deepen over time; assessment of depth, particularly for scalds, may be difficult initially and serial review over several days is necessary. Clinical assessment should consider: colour, exudate, capillary refill and sensation (see Table 1).

Specialised investigation of burns

The moorLDI2-BI (Moor Instruments Ltd) laser Doppler blood flow imaging system non-invasively maps blood flow in burned skin. It is recommended by the National Institute for Clinical Excellence (NICE) as a diagnostic adjunct in burns of indeterminate depth when predicting healing times and need for surgery. In conjunction with clinical examination, between 2 and 5 days post-injury, it is more reliable than clinical examination alone.

Site

The anatomical site of the burn can have significant impact on management priorities and outcome. Burns across joints may lead to future contractures and functional disability if not positioned and splinted correctly. Burns around the face and neck may cause airway obstruction if there is subsequent swelling. In situations where the patient has been exposed to smoke or blast, there may be inhalation injury. This can be direct thermal insult to the upper respiratory tract mucosa, chemical pneumonitis in the lower respiratory tract or systemic toxicity from cyanide and other poisons. Inhalation injury significantly worsens mortality. Suspect it in patients with a history of exposure, head and neck burns, singeing of nasal hairs, change in voice, wheezing or stridor and increasing respiratory difficulty. These patients require oxygen, early endotracheal intubation and mechanical ventilation (Figure 3d).

Circumferential burns and escharotomy

Deep burn eschar is inflexible. Circumferential or deep burns to the chest and/or abdomen in children can restrict ventilation, and circumferential burns to a digit or limb may impede circulation; these situations necessitate escharotomy (incision of the eschar) (Figure 4). Impending or existing ischaemia in a limb is recognized by increasing swelling and tightness, cool peripheries, reduced capillary return, increasing pain and loss of pulses.

Referral

The complexity and potential morbidity of burn injury means that many paediatric burns should be referred on for specialist care (Table 2).