Recent Advances in Paediatrics



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Chapter 4

Advances in burns treatment

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Burns are a leading cause of injury in children. If not treated appropriately and in a timely manner, they can have lasting effects including scarring and psychological trauma. There have been many recent advances in surgical management, resuscitation, wound care, and rehabilitation. Though many of the smallest injuries can be treated in primary care, new techniques, dressings and therapies designed to encourage rapid healing, reduce infection and subsequent scarring, now require a lower threshold for referral to specialist services [1].

All clinicians can improve the outcomes for children with burns. An understanding of first aid, wound care and recognition of signs of infection can decrease morbidity. Learning to recognise the serious burn and when and how to resuscitate a child with burns will ensure a safe and timely referral to an appropriate burns service. It is also important for paediatricians and emergency department (ED) professionals to understand key aspects of burn aetiology to identify children at risk of neglect or abuse.

EPIDEMIOLOGY

United Kingdom and worldwide

Worldwide, children account for 70% of all victims of burn injury. The leading cause in low and middle-income countries is flame burns, from cooking stoves, poor housing and industrial accidents. In higher income countries, scalds (burns due to hot liquid) predominate, typically from hot drinks.

An estimated 23,000 children with burns present to EDs each year in England and Wales; over 5,000 require hospital admission [2]. The most common injury mechanisms are contact burns and scalds, with scalds accounting for 60% of admissions. Most occur at home (95%), with 50% in the kitchen. Although the majority are accidental, clinicians need to be aware of the risk of nonaccidental injury (NAI) and neglect.

Age, development and mechanism

The peak incidence of burn injury is between 6 and 18 months old, the age at which children become mobile. Injuries occur when parents have not realised how far their

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children can get or how high they can reach. At this age, children do not understand warnings and have not learnt what items or situations are dangerous. Their reflexes and motor coordination are not mature enough to enable them to manoeuvre away from a hazard or to extricate themselves from a hot surface.

Contact burns are typically sustained on cooker fronts and hobs, producing blisters and skin loss to the fingertips and palms. Scalds occur when hot drinks, and less commonly food, are pulled down from a height. A typical distribution is the side of the face, neck, shoulder and anterior chest. These burns can cover a large area as hot fluid tracks down the body and soaks into clothes.

A lesser peak in incidence occurs amongst adolescents, when injuries are sustained as a result of 'risky behaviour.' This can begin as early as eleven years old with experimentation such as flash burns from deodorant 'flame-throwers' and progresses into teenage years with more extensive injuries from pouring petrol onto bonfires. More unusual pattern burns can result from dares, including salt and ice burns, cigarette lighter burns and cold burns from repeatedly spraying the same spot with an aerosol at close proximity. Such injuries may be a sign of bullying. Forearm and thigh contact burns and burns caused by salbutamol inhalers may be caused by deliberate self-harm, predominantly in teenage girls. Adolescent burns are rarely associated with alcohol.

The majority of burns in children are small in size, covering <10% of the total body surface area (TBSA). Large burns are rare and decreasing in incidence. They often arise from bath water, typically when the parent runs the bath with hot water and is distracted and the child climbs in. Larger burns also result from clothing fire in older children playing with cigarette lighters and matches. House fires are uncommon owing to fire safety campaigning, but are still a hazard, predominantly in cities.

Emerging trends in burn injury mechanisms

A range of new mechanisms of injury have been observed, related to fashion trends and new technology.

Many burns are now seen due to hair straighteners (**Figure 4.1**). These devices consist of two heated metal plates which can reach temperatures of 230°C. The main mechanism is the child touching hair straighteners that have been left to cool. Studies show that they can stay hot enough to burn infant skin in one second for up to 15 minutes after turning off [3]. Stepping into the open jaws of the device creates a deep injury, as there is an element of entrapment. When the device falls from a height, as in a cord-pull type mechanism, the open jaws can land either side of a limb, causing burns on two surfaces. This has resulted in the injury being misinterpreted as being intentional.

Other mechanisms include barbecues and beach bonfires. Inquisitive children often reach out and touch the hot casing, grills or food from barbecues. Barbecues and fires on the beach can heat up the sand, which may remain hot enough to burn for several minutes [4]. Motorcycle exhausts burn, termed 'muffler burns' in the United States are also increasing in incidence. Friction injuries from treadmills occur when a child falls near a treadmill and gets their hand caught in the moving belt mechanism [5]. They do not usually contain a thermal component, but are often managed similarly to a burn wound.

NAI and neglect

Burns are a recognised method of intentional physical abuse in children. Four key factors need to be taken into consideration when assessing the possibility of NAI:

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Figure 4.1 Burns caused by hair straighteners.

- Is the mechanism of injury consistent with developmental ability? This may be at a younger age than presumed [6]
- Is the pattern of injury consistent with the history? The history should be taken several times to identify any inconsistencies

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- Is the burn of an appearance that would correspond to the reported injury time? Was there any unexplainable delay in presentation
- Are there any other burn injuries of different ages or nonburn injuries

There are also specific features that should arouse suspicion of NAI. In immersion and scald injuries, these include extremity, buttock and perineal burns, symmetrical limb burns with no splash marks and burns to the soles [7]. Cigarette burns may be intentional if they leave circumscribed deep burns, as opposed to a superficial ill-defined mark from glancing contact with a cigarette end [8].

INITIAL MANAGEMENT

First aid

The depth of a burn wound is directly proportional to the temperature of the heat source and the length of skin contact time. The mainstay of first aid is to remove the heat source and cool the wound. Any clothing should be removed and the area cooled under running water for a minimum of 20 minutes. Running water has a greater ability to cool burned skin than wrapping in water soaked towels or immersing in still water [9]. The water does not need to be very cold and the water that comes from a UK cold water tap (between 5°C and 15°C) is adequate [10]. Water that is too cold may lead to hypothermia.

Running a burn under cool water can be beneficial in reducing the size and depth of a burn for up to 3 hours after the injury. Ice or bags of frozen food should not be used in direct contact with the skin as they may induce a cold burn injury on top of a hot burn injury.

Once adequately cooled, the area should be covered with a nonadherent dressing to keep it clean and reduce pain. Clingfilm is ideal as it is readily available, virtually sterile, easy to apply, comfortable and the wound can be observed without the need to remove it. Creams such should not be used until the burn has been definitively assessed as many topical creams can macerate the skin obstructing adequate wound assessment.

Fluid resuscitation and 'permissive hypovolaemia'

Children with severe burns are at risk of dehydration from wound-associated fluid loss. It is currently recommended that burns over 10% TBSA in children should receive formal fluid resuscitation.

The most commonly used formula for the fluid resuscitation of burns is the Parkland formula. This formula is for crystalloids (Hartmann's solution) and calculates the additional fluid to be given on top of maintenance fluid (usually calculated as 80% of the Holliday-Segar formula [11]). The Parkland Formula is: 2-4 ml per kilogram per percentage surface area of burn. The first half should be given over the first 8 hours, and the second half should be given over the next 16 hours.

There are increasing concerns that routine use of any of the current formulae may lead to 'over-resuscitation' with the threat of pulmonary oedema, particularly in children with moderate scalds of 10–20% TBSA, and in those managed with biosynthetic dressings which reduce fluid loss from wounds. There is an emerging trend towards 'permissive hypovolaemia' using a reduced resuscitation protocol [12]. Children requiring formal fluid resuscitation should be catheterised and managed in high-dependency areas with frequent measurements of serum electrolytes. Fluid administration should be carefully titrated to the hydration status of the child. Hyponatraemia and an increased oxygen requirement are early signs of hypervolaemia. Urine output should be monitored, although a low urine

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output may be a sign of the syndrome of inappropriate antidiuretic hormone, commonly seen in children with burns, rather than of hypovolaemia.

Assessment of burn severity

Area

Burn size is most reliable in informing clinicians about risks of complications and prognosis. Size is used in determining appropriate management pathways and referral criteria to specialised services.

Burn size is described using the percentage of the TBSA injured, most commonly using Lund and Browder charts [13]. This involves calculating burn size using head and limb proportions corrected for age (**Figure 4.2**). An alternative method is to use '1% palms.' The patient's palm including fingers is equivalent to 0.8% TBSA allowing a quick assessment of burn size. In recent years, a number of applications for portable devices have been developed which enable you calculate TBSA by colouring in the burn area and inputting age.

Depth

*A*ssessment of burn depth becomes important when deciding on treatment options. The only way to assess depth accurately is by histological analysis. An initial assessment is based on appearance. 'Erythema' is red skin that has not blistered and has the appearance of sunburn. These burns do not require additional fluid, will not scar and require moisturising only. Partial thickness burns are blistered, moist and painful. Full thickness burns are dry, insensate and painless. Burns can change over time and may progress in severity if not adequately cooled or the patient is unstable physiologically.

Laser Doppler imaging (LDI) is a method for assessing burn severity of intermediate depth. It is a noninvasive technique which maps blood flow in burned skin and gives an estimation of healing time [14]. National Institute for Health and Care Excellence (NICE) has approved its use as an adjunct to clinical assessment to assist in deciding whether to excise and graft a burn or allow it to heal by secondary intention [15].

Burn networks and referrals

Burns care is high cost and low volume and is classified as 'specialised.' Care is centralised in most higher-income countries. Specialist burn services in England and Wales are combined into four burn networks. In the United Kingdom, burns services have to adhere to nationally agreed standards [16] and from 2012 are overseen with regards to policy making and commissioning by the Burn Care Clinical Reference Group [17].

There are three different levels of service offered by hospitals within each burn network. Burn facilities have the ability to look after smaller noncomplex burns, burn units moderately sized burns and the most severe and complex burns are managed in burn centres. Referral criteria for each service level are based on age, TBSA, depth, anatomical site and mechanism (**Table 4.1**).

DRESSINGS

The traditional dressing for burn wounds is paraffin-soaked gauze – 'tulle gras.' This is a good temporary dressing but will dry if left for longer than 48 hours, resulting in painful

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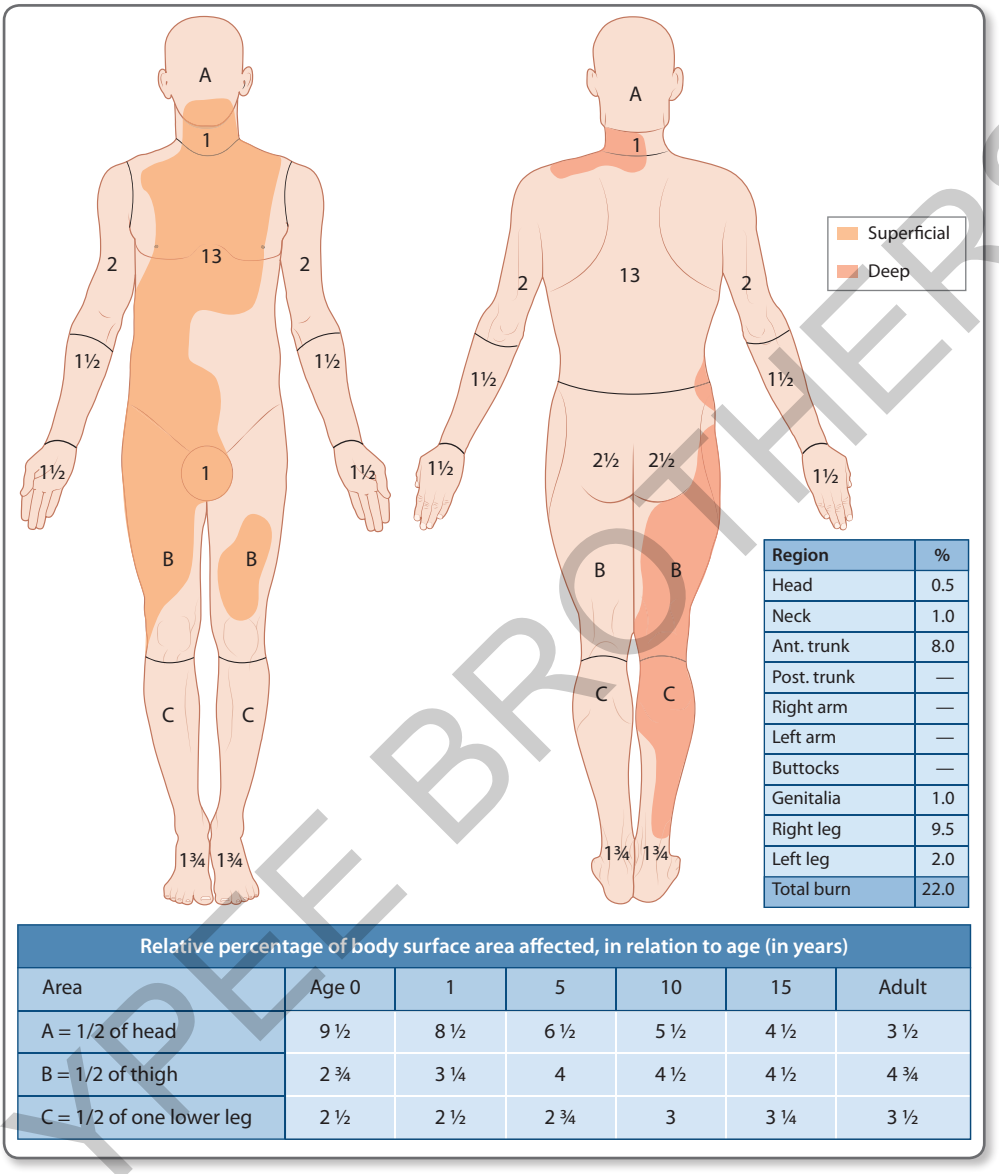

Region	%
Head	0.5
Neck	1.0
Ant. trunk	8.0
Post. trunk	—
Right arm	—
Left arm	—
Buttocks	—
Genitalia	1.0
Right leg	9.5
Left leg	2.0
Total burn	22.0

Relative percentage of body surface area affected, in relation to age (in years)						
Area	Age 0	1	5	10	15	Adult
A = 1/2 of head	9 ½	8 ½	6 ½	5 ½	4 ½	3 ½
B = 1/2 of thigh	2 ¾	3 ¼	4	4 ½	4 ½	4 ¾
C = 1/2 of one lower leg	2 ½	2 ½	2 ¾	3	3 ¼	3 ½

Figure 4.2 Example of a completed modified version of the Lund and Browder chart for 22% TBSA flame burn in an 11-year-old boy.

dressing changes. To combat this, a range of silicone-based dressings have come to market allowing pain-free removal with minimal disturbance of the fragile re-epithelialising tissue underneath.

Hydrocolloid dressings are sticky-backed laminar sheets which form a gel when the underside comes into contact with wound exudate. The moist environment facilitates autolytic debridement of the wound and these dressings are effective in small low-exudat wounds. Large wounds with higher exudative loads are better managed with alginate fibre

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Table 4.1 UK thresholds for referral to paediatric burns services (2012) [1]

Criteria		Facility threshold	Unit threshold	Centre threshold
TBSA	Refer	≥2% to <5%	≥5% to <30%, or ≥5% <15% if under 1 year old	≥30%, or ≥15% if under 1 year old
	Discuss			≥20%, or ≥10% if under 1 year old
Depth	Refer	All full thickness burns	≥2% full thickness if under 10 years old ≥1% full thickness if under 6 months old	≥ 20% TBSA if full thickness
Site	Refer		Any significant burn to special areas (hands, feet, face, perineum, genitalia) Any circumferential burn	
	Discuss	Any burn to special areas (hands, feet, face, perineum, genitalia)		
Mechanism	Discuss	Any chemical, electrical, friction burn Any cold injury		
Other factors	Refer	Any burn not healed in 2 weeks	Any predicted or actual need for HDU/PICU (including those predicted to require support for reasons other than the burn injury – e.g. smoke inhalation) Any significant deterioration in physiology Any burn with suspicion of non accidental injury should be referred to a burn unit/ centre for expert assessment within 24 h	All those predicted to require assisted ventilation specifically for their burn injury for >24 h. Any child who is physiologically unstable as a result of burn injury
	Discuss	Unwell/febrile child with a burn Any concern regarding burn injury Any comorbidities that may affect treatment or healing of the burn	All children with major trauma and burn injury (post-treatment within major trauma centre) where the burn injury meets unit level thresholds Any burn injury in a neonate should be discussed with a burn unit or centre	All children requiring respiratory support All children with major trauma and burn injury (post-treatment within major trauma centres) where the burn injury meets centre level thresholds Any burn injury in a neonate should be discussed with a burn unit or centre

dressings which absorb and limit wound secretions whilst maintaining a barrier against bacterial contamination [18].

Biosynthetic dressings are adherent dressings designed to mimic the epidermis. They allow re-epithelialisation whilst acting as a barrier against microbial invasion and mechanical trauma. As a result they are comfortable and well tolerated by children. In order

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to avoid trapping bacteria and precipitating infection, such dressings must be applied to burn wounds that have been scrupulously cleaned, with all dead tissue removed under general anaesthetic or sedation. The dressings self-adhere to the wound, but may also be secured with glue (**Figure 4.3**). As the underlying tissue recovers, the dressing loosens and lifts off. The most widely used preparation of such dressings is Biobrane which consists of a bilaminar structure of a silicone membrane bonded to a layer of nylon fabric mesh and coated with a layer of porcine collagen. Biobrane has been shown to be superior to standard dressings for larger area partial thickness burns in pain reduction, improved healing time and reduced inpatient stay [19].

Autologous cell delivery systems

ReCell Spray-On Skin is a system for harvesting and delivering skin cells to an area of skin loss. The system has been developed for partial thickness burns and can be used in combination with biosynthetic skin substitute dressings. The system involves separating keratinocytes, melanocytes, fibroblasts and Langerhans cells from an autologous skin biopsy using an enzymatic preparation. The resulting suspension is then sprayed onto the area of epidermal loss in an attempt to repopulate the wound bed. NICE is currently compiling guidance on the use of ReCell for treating skin loss, de-pigmentation and scarring after burn injury, at the time of going to press [20].

Antibacterial preparations and silver

The loss of the barrier function of the skin, the presence of necrotic tissue and the immunosuppression from burn injury puts burn wounds at high risk of infection. Providone-iodine, honey, chlorhexidine and mupirocin preparations are all used in dressings for their antiseptic properties.

Dressings containing silver are widely used for their antibacterial properties. Silver sulfadiazine containing creams have been used for decades to encourage separation of the eschar from the wound bed. The Acticoat dressing range incorporates nano-crystalline silver which is continuously released into the wound, the aim being to kill bacteria residing on the surface of the wound or within the dressing. A systematic review has shown little evidence that silver-containing dressings have any effect on wound healing time and may



Figure 4.3 Biobrane applied to a superficial scald burn in an infant, secured with purple-coloured skin glue.

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actually inhibit healing, and suggests there may be no cost benefit [21]. Despite this they remain popular as they are well tolerated by most patients, though there have been reports of irritation and a burning sensation associated with their use.

SURGICAL MANAGEMENT

Early cleaning and debridement

Early excision and wound closure is the basis of modern burns management [22]. The traditional approach was to wait for necrotic tissue (the eschar) to separate from healthy tissue prior to reconstruction. However, the presence of necrotic tissue promotes colonisation and invasion of bacteria, perpetuates the presence of inflammatory mediators and stimulates hypermetabolism and a catabolic state [22]. The current approach is to excise dead tissue and close wounds as soon as possible after injury, to reduce the bacterial and toxic load and lessen any systemic response; this is particularly important in burns >20% TBSA where the systemic effects are more profound.

An early thorough cleaning is important, as a proper assessment cannot be made until all debris has been removed. Blisters are de-roofed and loose skin removed by soft debridement using gauze. This requires sedation (if a small area) or general anaesthetic in children.

Following debridement, partial thickness burns are managed conservatively with dressings; aiming to keep wounds clean, protected from trauma and free from bacteria while the skin regenerates and heals. Epidermal skin substitute dressings may be used (see above). Re-epithelialisation occurs by migration of epithelial cells from surrounding undamaged skin and from dermal skin appendages such as hair follicles and sebaceous glands. The new epithelium is fragile at first and it is advantageous to keep dressing changes to a minimum to avoid disturbing the neo-epithelium.

Full thickness and deep partial thickness burns require formal sharp debridement down to healthy tissue by tangential excision using a Watson (or similar) knife. Thin layers of burn are shaved away until healthy bleeding tissue is reached avoiding over-debridement and loss of healthy tissue. Such debridement creates a skin defect which must be covered to provide protection and prevent desiccation of underlying structures achieved most commonly by split thickness skin grafting. Specialised areas such as the hand or foot may require full thickness grafting and exposed tendons, bone, vessels, or nerves will required composite tissue coverage with a flap. In children, these procedures are likely to result in significant blood loss and specialised and experienced perioperative teams are essential.

Split skin grafting

Full thickness and large area deep dermal burn wounds and wounds that have not healed within 2–3 weeks are excised and closed with split thickness skin grafts (SSGs). SSGs are taken from a flat donor area, often the buttock or thigh, using a knife or an electronic or pneumatic device with an oscillating blade at a fixed depth called a dermatome. Grafts are taken through the upper layers of the dermis at depths of <10/1000 of an inch to allow the donor site to regenerate. Grafts may be 'meshed' prior to application allowing expansion to cover a larger surface area and allowing fluid to seep out. Meshing will, however, result in healed grafts having a characteristic stippled appearance.

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Reconstruction

The scar tissue of untreated burned skin that has been slow to heal contracts, as do skin grafts. Scar contractures around joints and on the head, neck and hands can be unsightly and debilitating. Scar manipulation in children is considered when the contractures affect appearance, mobility, development or growth. Contractures can be released using z-plasty techniques and hypertrophic scars can be improved by the use of intralesional steroid injection, topical pressure, silicone and with laser therapy [24].

Scarred skin has limited mobility and pliability and contracture release may not be sufficient. In recent years, dermal substitutes have been developed that enable the resurfacing of an area of excised scar with a more pliable covering. They consist of an acellular dermal matrix that is incorporated into the wound bed, providing a scaffold allowing cellular infiltration and angiogenesis to support a skin graft placed on top. Once mature, this skin remains pliable and soft, enabling greater movement and functionality in an area of previous scarring.

INFLAMMATION, INFECTION AND TOXIC SHOCK

The systemic inflammatory response syndrome and hypermetabolic response

Major burns will elicit a systemic inflammatory response (SIRS) (**Table 4.2**). This definition differs from the adult criteria in that one of either a high temperature or leucocytosis must be present, as tachycardia and tachypnoea are common presenting symptoms in a range of paediatric conditions. The difficulty in applying the SIRS definition to burns is that burn injuries themselves are associated with an elevation in the body's baseline temperature alongside other physiological changes.

A hypermetabolic response is also seen in large burns (>20% TBSA) due to the rise in proteolytic enzymes released by leucocytes attracted to the burn wound. This induces high-energy requirements and a catabolic state. Children with large burns require nursing in a thermo-neutral environment and enteral feeding via a nasojejenal tube and trace element supplementation. They should be treated with anabolic steroids (oxandrolone) or beta-blockers (propranolol) to ameliorate the effects of the hypermetabolic state [22].

Table 4.2 Definition of systemic inflammatory response (SIRS) in children [23]

Temperature	**Core temperature of >38.5°C or <36°C**
Heart rate	Tachycardia, as defined as a mean heart rate >2SD above normal for age in the absence of external stimulus, OR For children under 1 year old – bradycardia, as defined as a mean heart rate <10th percentile for age in the absence of external stimulus.
Respiratory rate	Mean respiratory rate >2SD above normal for age or mechanical ventilation for an acute process
Leucocyte count	Leucocyte count elevated or depressed for age.

At least two of the above criteria must be present, one of which must be abnormal temperature or leucocyte count.
SIRS, systemic inflammatory response.

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Colonisation, burn wound erythema, infection and sepsis

All burn wounds may have identifiable organisms that usually reflect normal skin flora. The presence of bacteria in a burn wound without clinical signs of infection is normal and termed 'colonisation.'

Burn wounds may appear erythematous without being infected. This is redness around the wound not caused by burn injury. It appears 2–3 days postinjury is a cytokine-mediated response, is not painful and resolves spontaneously at around day 5 or 6 [22].

Burn wound infection is defined as 'Bacteria present in the wound and wound eschar in high concentrations; no invasive infection' [25]. Infection can be identified pathologically if $>10^5$ bacteria per gram tissue are found in a tissue sample. A positive wound swab is not sufficient to determine infection as wounds may simply be colonised. The diagnosis is usually made clinically in the presence of cardinal signs: advancing erythema, warmth and tenderness. The wound may have colours or odours suggestive of infection, e.g. *Pseudomonas* has a characteristic sweet 'grape-like' smell and leaves a green colour on dressings. The most common pathogen is *Staphylococcus*. Management should be with fastidious wound cleaning. Systemic antibiotics should only be used if there is cellulitis, proven sepsis or suspected toxic shock syndrome (TSS).

An infection is considered invasive when there is early separation of the eschar, graft loss, or a systemic response. This can occur with or without sepsis, but usually requires urgent surgical excision of the wound.

Sepsis is defined as: 'SIRS in the presence of, or as a result of suspected or proven infection' [24]. Infection may be directly related to the wound or from an alternative source such as pneumonia, urinary tract infection or gastroenteritis. The American Burns Association state that a leucocytosis is unhelpful in identifying sepsis as white cell counts are elevated in the presence of large wounds; leuco- or lymphopaenia is more significant. A low platelet count is also a reliable indication of sepsis in a burned patient [25]. Another common sign of sepsis in the burn patients is vomiting or failure to absorb enteral feed. This sign should always be taken seriously in children. Sepsis should be managed with appropriate cardiovascular support, intravenous fluids and broad-spectrum systemic antibiotics.

Prophylactic antibiotics

Prophylactic antibiotics are not routinely given to children with a burn injury. This is due to concerns regarding antibiotic resistance. There is some evidence to support the use of prophylactic antibiotics perioperatively in certain situations [26].

Toxic shock syndrome (TSS)

TSS is an acute and profound systemic deterioration as a response to circulating levels of a bacterial toxin and is reported in young children with burns. The typical presentation is in a child who 'is two years old, has <10% TBSA burns, and is two days post-thermal injury' [27]. It may occur without an identifiable septic source, as relatively few bacteria are required to elicit the toxic effect. Burn wounds typically look clean. The difficulty in diagnosing TSS is that if treated promptly, children do not go on to develop all the symptoms and signs as defined by the Centre for Disease Control [28]. Cole and Shakespeare modified the diagnostic criteria for TSS in paediatric burns to make allowances for this (**Table 4.3**). It is these criteria that are commonly used in the United Kingdom.

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Table 4.3 Cole and Shakespeare criteria for toxic shock syndrome in paediatric burns

- Pyrexia of >39°C
- Rash
- Shock
- Diarrhoea and/or vomiting
- Irritability
- Lymphopaenia

TSS, toxic shock syndrome.

Any child with a potential diagnosis of TSS should be resuscitated and stabilised in a high dependency area, have their burn wound inspected and cleaned, treated with systemic antistaphylococcal antibiotics, and provided with passive immunity by way of fresh frozen plasma or intravenous immunoglobulin [29].

REHABILITATION

The multidisciplinary team is central to successful burns care and to the long-term management and rehabilitation of patients. Physiotherapy is key with interventions to improve range of movement in affected limbs, as well as strength building exercises after periods of immobility. Much is delivered through play. Occupational therapists provide splinting of joints to help prevent scar contractures or to protect scar release surgery. They also assist families in adapting the home environment and provide children with aides and the skills needed to reintegrate back into normal daily routine. Play therapists, who can provide distraction techniques, enable children to cope with sometimes painful and often long dressing changes.

Scar management

The two most commonly used methods to reduce or improve the appearance of scarring in children are pressure garments and topical silicone. Pressure garments are custom-fitted elasticated sleeves, masks and body garments that provide compression over scarring or skin grafts. They have to be worn for 23 hours a day and potentially for years to achieve a result. Though routinely prescribed, their use remains controversial as there is little evidence to either support or dispute their efficacy [30]. In 2012, the UK's National Institute of Health Research commissioned a research grant call to look at the efficacy of pressure garment therapy.

Silicone is applied directly to the healed scar in the form of a spray or gel. It can also be incorporated into the skin-contact side of pressure garments. The most common theory regarding mechanism is that the occlusive nature of the silicone prevents evaporative water loss maintaining hydration of the scarred skin. Over time, this allows modulation of the collagen deposition to reduce scar thickness and improve pliability [31].

Psychology

All paediatric burns services should have access to a clinical psychologist whose role is to support the child and family in issues and fears around the burn incident, hospital admission and appearance of their scars. They may lead on school reintegration programmes. Many burns services have support networks for children and families in the

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form of burns clubs and camps. Burn camps were developed on the American model and became popular in the United Kingdom in the 1990s.

Key points for clinical practice

- Children between the ages of 6 and 18 months are at highest risk of burns. The most common cause is scalds from hot drinks accounting for 60% of admissions.
- Practitioners should be vigilant for signs of non-accidental injury including an inconsistent history, a mechanism that does not correlate with developmental ability, multiple or recurrent injuries and a pattern of injury suggestive of intentional injury.
- The optimal first aid is removal of clothes, cooling for a minimum of 20 minutes with cold running tap water and covering with cling film.
- Children with burns should be managed in an environment appropriate to the extent and severity of the injury. Prompt referral to the burns network will ensure optimum care.
- Increasing centralisation of complex paediatric burn care (while allowing smaller injuries to be managed closer to home with outreach teams) will achieve sustainable highly specialised teams for these rare injuries.
- Early fluid management is key to best outcomes for larger burns, but over-resuscitation is common and leads to significant morbidity.
- For large, full thickness wounds, early debridement and wound closure performed by burns surgeons in a specialist environment is essential to ameliorate the systemic inflammatory and hypermetabolic response, and to reduce the risk of infection.
- Management of the hypermetabolic response is evidence-based and should be included in the management of children with burns >20% TBSA.
- Infection is the most common complication. Antibiotics should not be given prophylactically, but reserved for when there are signs of local or systemic infection. More research is required to allow earlier and specific diagnosis of infection.
- The multidisciplinary team is an essential part of the successful care and rehabilitation of the burnt child. Physiotherapists, occupational therapists and psychologists augment the work of specialist surgeons and nurses.

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