

Children's burns making a difference

Burns are a common injury in the home. Their severity varies widely so it is important to be able to assess them. Correct treatment, particularly early after injury, will minimise the long term impact, and appropriate referral is important to optimise the outcome.



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Burns are a common injury in children, particularly scalds in preschoolers. Most burns are minor, but in about 10% of cases the child will need hospitalisation. Most of us have seen a burn that looked no more than erythema shortly after the injury, but developed a yellow, sloughing surface after a few days. This article attempts to answer the questions that these observations raise – namely:

- Why does the burn wound progress?
- What can be done to prevent this from happening?
- How can I tell how deep a burn is?
- How should a minor burn be treated?
- Which patients need hospitalisation or referral?

Why does a burn progress?

In 1953 Jackson, on the basis of detailed observation of the macroscopic changes seen in limb burns after inflation and deflation of a tourniquet, described three zones of injury:¹

- a zone next to the heat source that has undergone coagulative necrosis (zone of coagulation)
 - an adjacent zone of severe, progressive inflammation (zone of stasis)
 - an outer zone of less severe and potentially reversible inflammation (zone of hyperaemia).
- The zone of stasis is narrow (Figure 1), probably only a few millimetres thick, but in many burns this includes a significant proportion of the dermis. In the 12 to 48 hours after injury, flow in the microcirculation slows to a standstill, so causing progressive necrosis. Macroscopic evidence of this is observable over the first two to three days after injury. Good first aid can minimise this progression.²

The zone of hyperaemia is wide: in a burn greater than 25% of the body surface area it includes the whole body. Inflammatory changes in this zone are less severe, and if no deleterious events occur, it will recover.

The changes in these two zones are the result of

IN SUMMARY

- Thermal injury provokes an inflammatory cascade that increases the depth of tissue destruction and changes the appearance of the burn in the first days after exposure.
- Good first aid makes a major difference to the depth of injury, but is not without risk.
- Many patients with burns can be managed in general practice.
- Referral is needed for patients with large or deep burns, burns in special areas or evidence of infection, and in patients in whom nonaccidental injury is suspected; this should be done as early as possible.
- Knowledge of the optimal conditions for wound healing and the characteristics of the multitude of dressings now available will allow a treatment plan to be made that fits best with the family's practical and social situation.

First aid for burns

Stop the burning process

- Put out flames (stop, drop and roll)
- Remove or cool clothing soaked with hot fluid
- Turn off electrical current or break circuit

Cool the burn wound

- Apply water (8 to 25°C) to the burn as soon as possible and continue for at least 20 minutes
- Avoid the patient developing hypothermia
- Cooling is useful if started up to three hours after the injury was sustained

a cascade of inflammation mediated by a large number of cytokines. Like most physiological cascades, it gathers momentum and soon becomes irreversible. Thus it can only be influenced early.

What can be done to prevent progression?

The first thing to do to prevent progression of a burn is to halt whatever process is causing the injury – for example, put out the flaming clothes (stop, drop, and roll) or turn off the electrical current, etc (see the box on this page). In scald injuries the hot fluid, either on the skin or in the clothes, should be removed or cooled (by applying cold fluid) as soon as possible. It may be quicker to put a struggling child under a shower rather than trying to remove the clothing; however, if cold fluid is not immediately available, the clothing should be removed.

The next step is to cool the surface of the burn. If done immediately this removes heat, reverses the heat gradient and reduces penetration of heat, thus allowing survival of tissue that is at a temperature that is not rapidly lethal. But this is not the main benefit of cooling. It has been shown that cooling is beneficial for some time after exposure to heat even after the temperature of the skin has returned to near normal levels.³ This is because cooling has a direct effect on the inflammatory process, suppressing cytokine production and so reducing the cascade of events that leads to progression in the zone of stasis. This suppression must continue for some time if

Children's burns

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Burns, particularly scalds, are common in children. Thermal injury provokes an inflammatory cascade that increases the depth of tissue destruction and changes the appearance of the burn in the first days after exposure. Good first aid can minimise the progression of the burn, but is not without risk.

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the effect is to be noticeable in practice.⁴

Thus, application of cold water should start as soon as possible and continue for some time. No good evidence exists on how to cool or for how long.^{4,6} Ice or iced water (less than 8°C) is harmful,^{5,7} deepening the extent of necrosis. Ice relieves pain because it rapidly lowers the temperature of the pain receptors to a point where they no longer function, but this is at the expense of deepening the burn. Probably, water at about 15°C is best, and should be applied for 30 minutes or longer.⁴

Starting to apply cold water up to about three hours after exposure is helpful,⁴ but after this time the inflammatory cascade cannot be influenced. Analgesia is also achieved when cold water is applied within this time, but its onset is slower than when ice is used, which explains the popular belief that ice is superior to water.

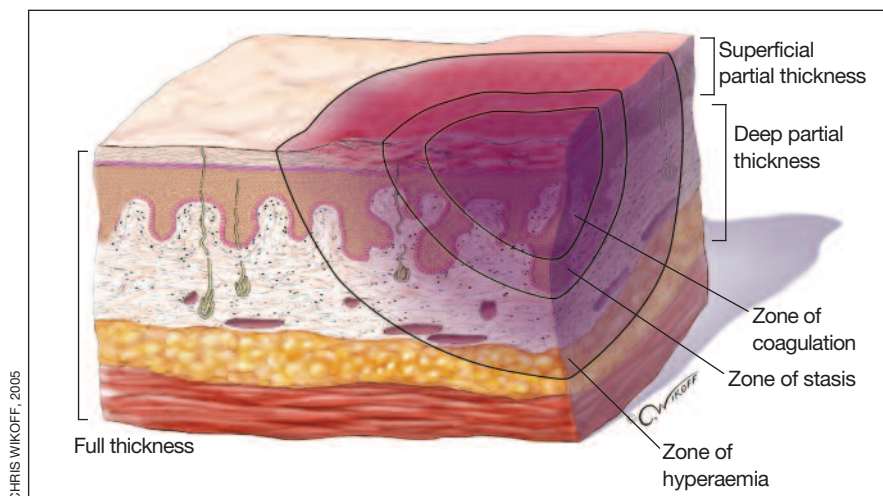


Figure 1. Cross section of the skin showing Jackson's zones of injury.

The one danger from first aid is hypothermia. To avoid this, warm the environment (if possible to tropical levels – i.e. 28 to 33°C), wrap the patient well, and continue to apply cold water only to the burnt areas. Hypothermia is life threatening, so if a choice has to be made between prolonged cooling and normothermia, choose the latter.

The next step in reducing the progression of damage is to provide an optimal environment for healing, avoiding harmful factors such as desiccation and infection (see below).

How can I tell how deep a burn is?

Early, accurate assessment of burn depth is often not possible, particularly in the first 24 hours. However, very deep burns are usually obvious early on: charring; hard, lucent areas; or pale, waxy, leathery skin may be seen. Pain sensation is rarely possible to test in children, and deep burns have a zone of partial thickness injury around them, so they are always painful to some degree.

Erythema that blanches with pressure and refills rapidly when released, and

with no blisters, usually indicates a superficial burn (Figure 2). Once blistering is seen, or the surface is moist, injury extends into the dermis. Blanching on pressure and refilling on release shows that circulation to the skin (at the point of testing) is intact at the time of testing, and implies a potential for spontaneous healing. However, the test is by no means 100% accurate.

Dark, blotchy erythema that does not blanch on pressure is the hallmark of deep dermal or full thickness injury that will require grafting.

Children's scald burns are the most difficult to assess, and they are almost impossible to assess in the first six to eight hours. Although the depth may be more obvious at 24 hours, it is common to need to wait until day 3 to 5, and sometimes even day 10, before a definite diagnosis of depth can be made. The heterogeneity of most burns adds to the difficulty in assessing depth.

How should a minor burn be treated?

Most burns treated in general practice will be small, not crossing joints, not requiring difficult dressing techniques, and judged (at least initially) to be of partial thickness.

After first aid, clean the wound with dilute aqueous chlorhexidine (0.1% or 0.2%) or saline, or soap and water. Remove foreign material, including hair; shave the area if it is hair-bearing skin.

Blisters are a problem, and there is no scientific evidence on the best way to manage them. Many experienced practitioners have noted that leaving blisters intact gives good results, particularly on the palms and soles. In the first six to 12 hours after injury, blister fluid contains inflammatory cytokines,⁸ so some authorities recommend aspiration or deroofing. Certainly the crumpled dead keratin of widely broken blisters should be removed.

Prophylactic antibiotics should not be given routinely.



Figure 2. A superficial burn after a fall into a hot bath. The ill-defined, irregular margins are consistent with this history; nonaccidental injury is unlikely. Immediate application of cold water is needed. Most of the area is only erythema. The blistered areas healed in less than 14 days.

The next step is to choose a dressing. There is almost no place for exposure treatment nowadays as desiccation causes death of the surface of the wound. Even the face is best treated with something to cover the burn, albeit only a gel or ointment – for example, paraffin or

chloramphenicol eye ointment.

The choice of dressing involves consideration of the optimal environment for wound healing, the site of the burn, the patient's circumstances and the cost. It is now well established that wounds heal best when they are moist but kept

free of infection and necrotic tissue, including exudate. A dressing that locks all fluid and exudate on the surface of the wound serves only to provide a culture medium for bacteria and to keep a layer of necrotic tissue over it, both of which are undesirable. Modern, semipermeable,

Table. Evaluation of some dressing materials available in Australia*

Type of dressing (trade names)	Advantages	Disadvantages
Silver sulfadiazine plus chlorhexidine antibacterial cream (Silvazine)	Excellent protection against infection. Cheap. Soothing when applied.	Needs absorbent dressing and bandage to keep in place. Daily change needed (thus needing repeated expert attention). Painful to remove old cream. Suppresses epithelial growth.
Porous, adherent, stretch material (Hypafix, Fixomull, Mefix)	Easy to store and apply. Cheap. Versatile. Protects wound and prevents desiccation. Exudate can move through it and be wiped away.	Needs normal skin around wound to adhere securely. Can wrinkle and dislodge near joints and in first 48 hours (exudative phase). No antibacterial properties.
Adherent polyurethane film (Opsite, Tegaderm)	Easy to store and apply. Cheap. Versatile. Protects wound and prevents desiccation. Water vapour permeable. Excludes bacteria. Analgesic.	Needs normal skin around wound to adhere securely. Can wrinkle and dislodge near joints and in first 48 hours (exudative phase). Exudate remains beneath, not removed. No antibacterial properties.
Absorbent hydrocolloid membrane (Duoderm, Comfeel, Cutinova)	Easy to store. Moderately cheap. Absorbs some exudate. Excludes bacteria. Waterproof so surface can be wetted. Analgesic. Prevents desiccation.	Needs normal skin around wound to adhere securely. Inelastic, will not tolerate movement. Stiff: does not conform; tends to lift at edges. May not absorb all exudate in first 48 hours. Needs changing every 72 hours. No antibacterial properties.
Silver impregnated dressing (Acticoat, Acticoat 7, Avance, Aquacel Ag)	Good antibacterial action. Remains in place for days at a time. Absorbs exudate. Prevents desiccation. May have anti-inflammatory action.	Expensive. Requires retention dressing. Some require changing every three days (Acticoat). Inelastic. Some get stiff after getting moist then drying (Aquacel Ag). Some experience in their use is desirable.
Chlorhexidine impregnated petroleum gauze (Bactigras, Chlorhexitulle)	Antibacterial. Easy to store and long shelf life. Versatile. Conforms well. Cheap.	Needs changing daily in exudative phase. No analgesic effect. Adheres to wound: removal causes pain and trauma to wound. Wound tends to desiccate even with two or three layers of dressing. Limited antibacterial properties.
Polyurethane absorbent membrane (Omiderm)	Easy to store. Absorbs exudate and highly water vapour permeable. Prevents desiccation. Conforms well. Protects against bacteria. Analgesic. Only dressing that adheres to wound surface. Does not need changing; separates as wound heals. Moderately cheap. Comes in meshed (allows egress of exudate and more conforming) and plain sheets.	Only useful for partial thickness burns. Takes 24 hours to adhere to wound. Needs nonadherent dressing over it. No antibacterial activity. Some experience in its use is desirable.

* The evaluation of dressing materials expressed here is based on opinions derived from personal experience and from the experience of the staff in the Burns Unit at The Children's Hospital at Westmead. It is not based on published data.

continued



Figure 3. Exhaust pipe burn. The history and appearance show that this burn is deep. The patient needs immediate referral for grafting.

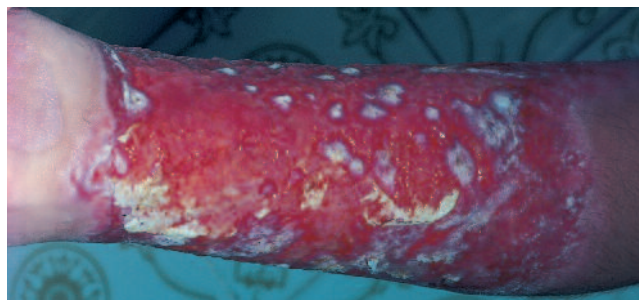


Figure 4. A neglected burn. Six weeks after injury the area is mostly granulation tissue with a little residual slough (yellow) and some epithelial islands (keratinised white centres with thin translucent epithelial haloes appearing dark red). Referral for grafting should have occurred at day 10 at the latest, avoiding unnecessary scarring and weeks of painful dressings for the patient.

absorbent dressings, many of which contain antibacterial agents, attempt to provide an optimal environment for healing.

The most widely used dressing for the past four decades has been silver sulfadiazine to which, in Australia, chlorhexidine 0.2% has been added (Silvazine). This is covered by an absorbent retention dressing (pad and bandage). Its great advantage is that it has excellent antibacterial properties: it has a wide spectrum of activity, and is infrequently associated with bacterial resistance. The main disadvantage of this dressing is that it must be

changed every day to remove exudate: dressing changes are painful, the cost in skilled care and dressing materials is high, and disruption to the patient's family is considerable. Another disadvantage is that it retards epithelial multiplication, but this is of less practical importance than its ability to prevent infection.

Ideally, it would be better to have a dressing technique that did not have these disadvantages. Industry and researchers have devised many alternatives, all of which have some advantages and some disadvantages (Table).

Which patients need hospitalisation or referral?

Some patients need not only hospitalisation but also referral to a specialist unit. The referral criteria listed in the box on this page, with only minor variations, are fairly well accepted internationally. While such criteria need to be defined, commonsense must be used in applying them. For example, a child with a 1 cm blister on the tip of a finger would not automatically need to be transferred to hospital. If doubt exists, the best plan is to ring the relevant unit and discuss the patient's management.

Burns that are treated in general practice should have healed (i.e. have epithelialised or no longer be moist) by day 10.

Any patient with a burn that is still moist after this time should be referred because the burn is deep and probably needs a graft. Outside a burns unit, a plastic, general, or paediatric surgeon with experience in burns may be able to treat small burns that are not on 'special' areas such as the face, hands, feet, perineum or over joints. Patients with all other types of burns should be referred to a specialised burns unit.

If the burn is deep at presentation (white or charred; Figure 3), grafting should be performed as soon as possible. Delay in grafting increases scarring (Figure 4).

Infection is another reason for referral.

This may manifest as:

- increasing exudate after day 2
- brown or mottled patches on the burn surface
- increasing pain and erythema
- fever and toxicity.

Although some children will have an exaggerated febrile response to a minor noninfected burn, it is never safe to assume that the febrile patient is not septic. In particular, toxic shock syndrome can occur in patients with small burns that are not macroscopically infected. Thus, a sick, febrile child with a small burn must be examined carefully to make sure that toxic shock syndrome is not present. Diagnostic

Burns unit referral criteria

- Deep burns greater than 10% body surface area in adults
- Burns greater than 5% body surface area in children
- Burns in special areas: face, hands, feet, perineum, or crossing joints
- Inhalation injury, known or suspected
- Electrical burns
- Chemical burns
- Burns associated with significant pre-existing disease or concomitant trauma
- Nonaccidental injury, known or suspected

Diagnostic criteria of toxic shock syndrome⁹

- Temperature: greater than 38.9°C
- Rash: diffuse macular erythroderma
- Shock: hypotension and poor peripheral perfusion
- Multisystem involvement of three or more of the following:
 - gastrointestinal: vomiting or diarrhoea (occurs early)
 - musculoskeletal: myalgia or elevated creatinine phosphokinase (2 x normal)
 - renal: raised urea or creatinine levels (2 x normal), sterile pyuria
 - hepatic: increased transaminases (2 x normal)
 - CNS: altered level of consciousness
 - haematological: thrombocytopenia <100,000 x 10⁹/L
 - hyperaemia of conjunctivae or oropharynx
- Negative blood, throat, or CSF cultures (except *Staphylococcus aureus* in blood)
- Desquamation, particularly of the palms and soles one to two weeks after onset (helps diagnosis retrospectively)

criteria of toxic shock syndrome are summarised in the box on this page.⁹

Another reason for referral is any suspicion of nonaccidental injury. Features

that should alert you to the possibility of nonaccidental injury include:

- a pattern of injury not consistent with the history

- scald burns in children not yet mobile
- a delay in presentation
- 'unwitnessed' accidents
- multiple presentations with burns or other trauma
- the presence of other injuries at the time of presentation.

Because this accusation is extremely damaging to a family if it is untrue, it is best simply to refer the patient without specifying a reason to the family, but passing your concern on verbally to one of the medical officers of the receiving unit.

Generally, the types of burns suitable for outpatient, nonspecialist care are those outlined in the box on the next page. The decision to refer must take into account the practitioner's experience and the family's circumstances. However, failure to refer solely on the grounds of geography or family convenience is likely to lead to a worse result in the long term.

Criteria for outpatient treatment of burns

- Small burns, less than 2% body surface area
- Superficial burns
- Burns that are not in special areas or crossing a joint
- Analgesia achieved is satisfactory for the patient
- Social situation is appropriate for patient
- Management plan, including dressing technique, is clear

Summary

Burns in children are common, the usual mechanism (particularly in preschoolers) being scalds. The injury produces an inflammatory reaction that deepens the burn unless good first aid is given, and makes the appearance of the surface

change in the first days after injury.

There are internationally agreed guidelines to help make a decision on whether a patient needs referral to a specialist unit, but in making such decisions local circumstances need to be taken into account. Small burns in noncritical areas can be treated in general practice: cleaning and dressing with follow up to ensure that healing occurs within 10 days is needed. If epithelialisation is not complete in this time or if infection is feared, the patient should be referred without delay. **MT**

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