

*ABC of burns***Management of burn injuries of various depths**

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Accurate assessment of burn depth on admission is important in making decisions about dressings and surgery. However, the burn wound is a dynamic living environment that will alter depending on both intrinsic factors (such as release of inflammatory mediators, bacterial proliferation) and extrinsic factors (such as dehydration, systemic hypotension, cooling). It is therefore important to review the wound at regular intervals until healing.

Optimum treatment of the wound reduces morbidity and, in larger injuries, mortality. It also shortens the time for healing and return to normal function and reduces the need for secondary reconstruction.

When epithelialisation is delayed beyond three weeks, the incidence of hypertrophic scarring rises. Hypertrophic scars occur in 60% of burnt children aged under 5 years. Early grafting of those burns that have not healed at three weeks has been shown to improve the result, but because of delays in the referral process, all injuries, which show no sign of healing by 10 days, should be referred for assessment.

Treatment**Epidermal burns**

By definition these affect only the epidermis and are typified by sunburn. Blistering may occur but is not common. Supportive therapy is usually all that is required, with regular analgesia and intravenous fluids for extensive injuries. Healing occurs rapidly, within a week, by regeneration from undamaged keratinocytes within skin adnexae.

Superficial partial thickness burns

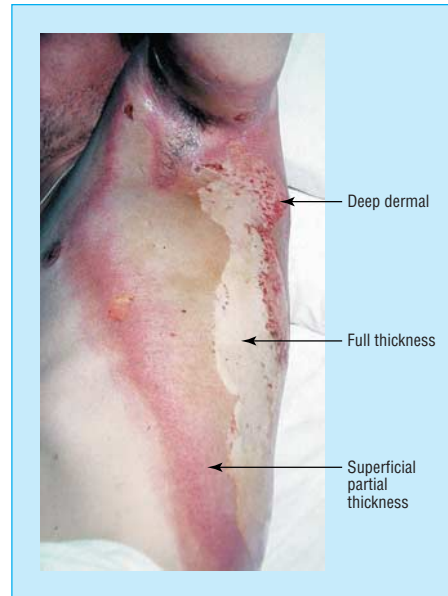
These affect the upper dermis and the epidermis. Blistering is common. The exposed superficial nerves make these injuries painful.

Healing is expected within two weeks by regeneration of epidermis from keratinocytes within sweat glands and hair follicles. The rate of regeneration depends on the density of these skin adnexae: thin hairless skin (inner arm, eyelids, etc) heals more slowly than thick or hairy skin (back, scalp, and face). Progression to a deeper burn is unlikely but can occur if the wound dries out or becomes infected or the patient becomes systemically unwell or hypotensive.

Treatment is aimed at preventing wound progression by the use of antimicrobial creams and occlusive dressings, since epithelialisation progresses faster in a moist environment. Hypafix applied directly to superficial wounds can be useful to preserve mobility and allow washing of the affected part with the dressing intact. It must be soaked in oil (such as olive oil) for an hour before removal, and should be changed at least weekly until the burn has healed.

Alternatively, tulle gras dressing or Mepitel (a silicone dressing) can be applied with or without silver sulfadiazine cream, or Acticoat and gauze, and changed on alternate days. Some burns units treat difficult wounds such as facial burns by leaving them exposed and applying antimicrobial ointment.

If a burn has not healed by two weeks, the depth has probably been assessed incorrectly and referral should be made to a burns unit.



Flame injury showing all burn depths



Hypertrophic scar in a child



Hypafix dressing applied to a burn wound allows movement and washing

Deep partial thickness

These injuries are the most difficult to assess and treat. They may initially seem superficial, with blanching on pressure, but have fixed capillary staining on re-examination after 48 hours. The density of skin adnexae (and hence islands of regeneration) is lower at this depth, and healing is slower and associated with contraction. Therefore, if these injuries are extensive or in functional or cosmetically sensitive areas, they are better excised to a viable depth and then skin grafted to reduce morbidity and to accelerate return to normal function.

Some deep partial thickness injuries will heal if the wound environment is optimised to encourage endogenous healing. This includes keeping it warm, moist, and free of infection. Some of the newer tissue engineered dressings are designed to encourage this by supplying exogenous cytokines. An example is TransCyte, which contains allogeneic non-viable fibroblasts that have produced wound healing factors during manufacture. However, these dressings are highly expensive and need to be applied by trained staff in theatre.

Full thickness injuries

All regenerative elements have been destroyed in these injuries, and healing only occurs from the edges and is associated with considerable contraction. All such injuries should therefore be excised and grafted unless they are < 1 cm in diameter in an area where function would not be compromised.

Timing of surgery

Ideally, all wounds should have epithelial cover within three weeks to minimise scarring, but in practice the decision whether to refer a patient must be made by day 10 to achieve this.

The burn eschar is shaved tangentially or excised to deep fascia. From the surgical viewpoint, the best time to graft burns is within five days of injury to minimise blood loss, and injuries that are obviously deep at presentation must be referred early.

With major burns, treatment is skewed towards preservation of life or limb, and large areas of deep burn must be excised before the burnt tissue triggers multiple organ failure or becomes infected. In such cases more superficial burns may be treated with dressings until healing occurs late or fresh skin donor sites become available.

The ideal covering is split skin autograft from unburnt areas. Thickness is usually tailored to the depth of excision to obtain good cosmesis, although thinner grafts are thought to contract more. Donor sites should ideally be harvested adjacent to the injury to improve colour match, and sheet graft is preferred to improve the cosmetic result.

If donor sites are sparse, however, or the wound bed is likely to bleed profusely (because excision is carried out late, for instance) then the graft is perforated with a mesher to allow expansion. Although this improves graft "take" where the wound bed is bleeding after tangential excision, the mesh pattern is permanent and unsightly. Unmeshed sheet graft is used on hands and faces, and over any future site for intravenous central lines and tracheostomies to obtain rapid cover. Where unburnt split skin donor sites are in very short supply, there are two possible solutions:

- Rotation of donor sites is practised, and unexcised burn covered with antimicrobial creams
- The excised wound is resurfaced with a temporary covering until donor sites have regenerated and can be re-harvested.

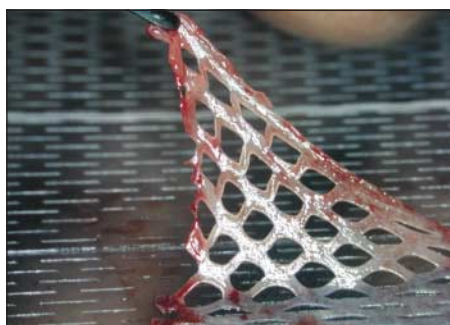
Examples of a temporary covering are cadaveric allograft from an unrelated donor, xenograft (such as pigskin), synthetic products, and cultured epithelial autograft. Development of synthetic products (such as Integra dermal regeneration



Shave excision to healthy tissue



Thick and thin split skin grafts



Meshed graft



Persistent mesh pattern in patient whose extensive burns were covered with meshed skin grafts

template) has allowed us to excise extremely large burns and still achieve physiological closure, with potentially lower mortality in these injuries. Cultured epithelial autografts also permits us to extend the available donor sites. The cultured cells can be applied as sheets (available after three weeks) or in suspension (available within one week). A few burns units use these cells for superficial skin loss or in combination with mesh graft to improve the cosmetic result.

Major burns

These include injuries covering more than 20% of the total body surface area, and represent a real challenge to burn surgeons. Survival depends on accurate assessment and prompt resuscitation initially, as well as on patients' premorbid conditions and associated injuries such as smoke inhalation.

Subsequently, constant attention to wound cleanliness and to nutritional, respiratory, cardiovascular, and renal support is necessary. Relentless but carefully timed removal of burnt tissue and replacement with definitive wound cover is the key to survival and return to function. Such injuries are best managed in large centres where the necessary expertise is concentrated. Early excision and grafting have been shown to reduce pain, shorten hospital stay, and accelerate return to normal function in moderate injuries. It is more difficult to show that this approach improves survival in massive injuries because these are uncommon and many factors other than surgery play a part.

Most major centres treating burns believe early aggressive excision is the treatment of choice, and advances in intensive care and the development of skin substitutes have facilitated this.

Summary

- Full thickness injuries have no regenerative elements left. Unless they are very small they will take weeks to heal and undergo severe contraction. They should be referred for surgery as early as possible.
- Deep dermal injuries are unlikely to heal within three weeks. The incidence of unsightly hypertrophic scarring rises from 33% to 78% if healing is delayed from three to six weeks. Therefore these injuries should also be excised and grafted within the first 5-10 days.
- Superficial wounds should heal by regeneration within two weeks. They should be cleaned, dressed, and reviewed on alternate days to optimise the wound healing environment. Any burn not healed within two weeks should be referred for assessment.
- Clean wounds can be dressed with a non-adherent primary dressing such as tulle gras or Mepitel and an absorbent secondary dressing such as gauze or Gamgee Tissue. Antimicrobial agents are added where infection is likely (perineum, feet) or heavy colonisation is evident on the dressings or invasive infection is suspected.

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The ABC of burns is edited by Shehan Hettiaratchy, specialist registrar in plastic and reconstructive surgery, Pan-Thames Training Scheme, London; Remo Papini; and Peter Dzielwski, consultant burns and plastic surgeon, St Andrews Centre for Plastic Surgery and Burns, Broomfield Hospital, Chelmsford. The series will be published as a book in the autumn.

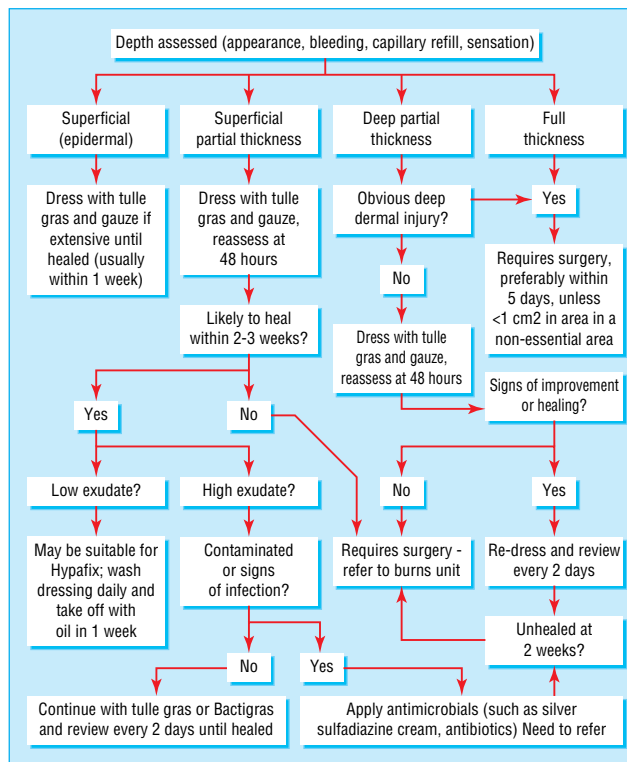
Competing interests: RP has been reimbursed by Johnson & Johnson, manufacturer of Integra, and Smith & Nephew, manufacturer of Acticoat and TransCyte, for attending symposia on burn care.



Top: Deep dermal injury from bath scald. Bottom: Six weeks after tangential excision and grafting with 3:1 mesh and cultured epithelial autograft in suspension. Note biopsy site for cell culture on buttock



Major burn in elderly patient



Algorithm for assessing depth of burn wounds and suggested treatment