Timely and appropriate management of burns can improve the outcome for victims

Burns

management

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The treatment of burns must be timely and appropriate to ensure the best outcome for patients. Basic first aid measures are described in Box 1 (p250). Pharmacists involved in the management of patients with burns must have an understanding of factors such as altered pharmacokinetics in burns patients, nutritional requirements and appropriate wound dressings.

Pharmaceutical considerations

Pharmacokinetics

Patients with burns have altered pharmacokinetics for a variety of reasons. In the first 48 hours following a burn, hypovolaemia, hypoalbuminaemia and oedema lead to reduced organ perfusion and, therefore, decreased renal drug clearance. Once the body becomes hypermetabolic, clearance is increased. This is caused by increased cardiac output and contractility leading to higher blood flow to the kidneys and liver, as well as potential loss of drugs via the exudate. Hence, burns patients may require higher doses or more frequent administration of medicines than non-burns patients.

Extensive fluid shifts and an increase in the synthesis of liver proteins can cause abnormal distribution of protein-bound drugs. Therapeutic drug monitoring may be of use for some medicines, particularly antibiotics and drugs with narrow therapeutic windows.1

Drug administration

Initially, patients with extensive burns are likely to be sedated and intubated. There may be difficulty obtaining venous access because the skin is either burnt or a potential donor site for grafting; a central line may be required. Intubated patients will usually have an enteral feeding tube since drug administration is important and adequate nutrition essential. The most appropriate route for drug administration must be established to ensure that patients do not miss essential medicines.

Intravenous fluids

As discussed in the accompanying article (p245), burns patients have a reduced circulating blood volume. This is caused by exudating fluid from the burn site, elevated skin temperatures (leading to evaporation) and capillary leakage.2 Early fluid resuscitation increases tissue perfusion (particularly to the burn site) and blood flow to organs. Adequate fluid resuscitation is essential for patients with burns to more than 15% (10% for children) of body surface area (BSA), particularly in the first 48 hours following the burn.3 The Parkland formula calculates the volume of fluid (in litres) that should be given in the first 24 hours:

\[
\text{Fluid (L/24h)} = 3–4 \times \text{patient weight (kg)} \times \text{BSA burnt (}%
\]

Half of the volume should be given in the first eight hours after the burn (not from the time the patient presents for treatment) and the other half over the subsequent 16 hours. The infusion rate should be adjusted according to response; requirements are affected by factors such as burn depth, age, delay in resuscitation, escharotomies (see below), and drug or alcohol abuse.

SUMMARY

Appropriate management of the patient in the first 48 hours after a burn is essential for optimal recovery. Principally, this will include fluid resuscitation and emergency surgery. Later, optimum conditions for healing and tissue regeneration must be maintained and skin grafting may be needed.

The patient will require a range of therapeutic interventions, including nutritional supplementation, use of antimicrobials, analgesia and appropriate wound dressings. In the long term, patients are at greater risk of sun damage and the healed burns can form contractures and are often itchy.

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Surgeon transplanting a meshed skin graft onto a patient’s burn

Michele del Guercio, Peter Arnold Inc | SPL

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Ensuring your own safety, remove the person from the source of the burn. For electrical burns, the power must be switched off before going close to the patient.

If the person’s clothing is alight, her or she should be told to drop to the floor and roll over to extinguish the flames (“drop and roll technique”).

The burn should be immediately cooled with lukewarm running water for at least 20 minutes (not too cold as this can cause too much vasoconstriction and can lead to hypothermia). The same technique is vitally important for chemical injuries to dilute the toxic substance.

The patient should be assessed for severity of the injury. Be aware of the risk of inhalational injury, which can result from fire in an enclosed space.

Cling film can be used as an initial dressing that protects the wound, while the patient has increased vascular permeability and this may prolong oedema.\(^2,5\) A Cochrane meta-analysis\(^6\) demonstrated an increased mortality with albumin administration for burns patients. One possible reason for this is an increased incidence of oedema caused by albumin redistribution via capillary leakage. Despite this, a recent survey of fluid practice in burns units showed that albumin is widely used.\(^7\)

Although fluids are essential in the initial management of burns patients, they should be assessed regularly and adjusted, where appropriate, to minimise the risk of fluid overload. Fluid overload can increase oedema leading to impaired healing and can also worsen respiratory problems such as acute respiratory distress syndrome. The target minimum urine output is 0.5ml/kg/h unless rhabdomyolysis or myoglobinuria is suspected, in which case the target should be doubled.

Analgesia

Pain control is important in the acute phase and long term. Multiple factors influence pain, including the nature and extent of the burn, anxiety (and other psychological conditions), environment and an individual’s pain threshold. Pain can originate from the burn itself, dressing changes, donor graft sites or nerve regrowth.\(^8,9\) Regular pain assessment and appropriate analgesia are essential.

Strong opioids are a good choice for initial analgesia. Morphine can provide the additional benefit of a reduced incidence of post-traumatic stress disorder.\(^7\) Variable pharmacokinetics in burns patients means that careful titration of opioids, based on response, is necessary. The dose should be stepped down as the patient’s pain improves; this is done gradually to minimise the risk of symptomatic withdrawal. It is worth noting that opioids can cause hyperalgesia, exacerbating the existing pain.\(^10\)

Simple analgesia, including paracetamol, should be prescribed as an adjunct to opioid therapy.

Regenerating nerves frequently cause pain or altered sensation. Patients with nerve damage may benefit from treatment with medicines that target neuropathic pain, such as gabapentin or amitriptyline. Gabapentin also has an opioid-sparing effect and may reduce itching associated with burns.\(^11\) Medicines for neuropathic pain should be initiated early in treatment (since they can take weeks to reach their full analgesic effect).

Patients requiring higher levels of analgesia for short periods (eg, for dressing changes) have been shown to benefit from an infusion of the very-short-acting opioid remifentanil.\(^12\) Remifentanil should be administered by staff trained in anaesthesia because of the risk of respiratory depression. The patient’s background pain relief should be managed appropriately to ensure there is no break in analgesia once the infusion is stopped. Inhaled nitrous oxide or the anaesthetic ketamine may be alternatives to remifentanil for short-burst analgesia; ketamine provides pain relief and causes a dissociative state.

Sedation

Patients with extensive burns or burns affecting their airway are routinely intubated and mechanically ventilated.\(^13\) The neuromuscular blocker suxamethonium should be avoided during intubation because it can exacerbate hyperkalaemia to a potentially fatal level.\(^1\)

Initially patients will be continuously sedated. This is achieved using a combination of sedatives (usually propofol and an opioid such as morphine or fentanyl). Sedated burns patients who require paralysis may need substantially higher doses of neuromuscular blockers compared with non-burns patients because of altered pharmacokinetics.\(^1\) The patient should be sufficiently sedated to allow essential procedures to be carried out and to minimise distress. However, the patient should be regularly assessed for over-sedation (since this may lead to complications such as ventilator-associated pneumonia).

As the patient’s condition improves, sedation should be weaned. During weaning, it is important to ensure analgesia remains adequate — patients with insufficient pain relief are at an increased risk of delirium once sedation is ceased.
Patients should be screened regularly for delirium and, if it is found, underlying causes should be treated.9

**Nutrition**

Patients with extensive burns are in a catabolic state and, therefore, require 50–75% more calories than non-burns patients.1 Inadequate nutrition can impair wound healing, increase risk of infection and cause more pronounced catabolism. Enteral, rather than parenteral, nutrition is preferred. For patients with burns covering more than 20% of BSA, nutritional requirements will not be met with oral intake alone; additional enteral feeding will be required.5

The 2006 European Society for Clinical Nutrition and Metabolism guidelines10 recommend that trace elements, specifically copper, zinc and selenium, should be given for ongoing supplementation when oral administration is appropriate. Glutamine should also be added to standard enteral feeds because, along with trace elements, it has been shown to reduce infection, shorten hospital stay and reduce mortality.11 One paper suggest that, because of its free radical-scavenging properties, high-dose ascorbic acid may benefit burns patients.1

**Infection**

Burns patients will often display a systemic inflammatory response syndrome (which includes raised temperature, heart rate, respiratory rate and white cell count) and so can appear septic in the absence of infection.5 Systemic antibiotics should therefore be guided by cultures and sensitivity testing and should not be given prophylactically.

Topical antimicrobials or antiseptics are often used to prevent the development of infection in the burn areas, grafted tissue or donor sites (see Box 2).4 Localised infection in a wound can impair healing or cause failure of grafted tissue. Choice of treatment is usually governed by the results of wound swabs and physical inspection of the wound.11 Common pathogens include *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii*.

It has been suggested that selective decontamination of the digestive tract in burns patients can reduce the incidence of hospital-acquired pneumonia.12 The aim is to kill gastrointestinal pathogens before they transfer to the lungs. However, the evidence to support this practice is inconclusive and practice varies widely between units.

**Management of chemical burns**

Before the severity of strong acid or alkali burns can be assessed, the burn must be irrigated with water for as long as possible (at least 20 minutes) to dilute the chemical and normalise the pH; indicator paper can be used to check wound pH. Identification of the chemical is important (alkali burns tend to be deep and hydrofluoric acid [HF] burns require specific management).7

**Hydrofluoric acid burns** HF is one of the strongest inorganic acids and is used mainly for industrial purposes (e.g., metal processing). If any concentration of HF affects more than 5% of BSA, or if concentrated HF affects as little as 1% of BSA, injury will be severe. Deaths have occurred following concentrated HF burns affecting as little as 2.5% of BSA.

**HF causes direct tissue injury by two mechanisms:** corrosive burn and chemical damage. Hydrogen ions cause corrosive injury typical of a strong acid, which tends to be superficial. Absorbed fluoride ions cause chemical tissue damage. Additionally, fluoride ions cause systemic toxicity through formation of insoluble salts with calcium and magnesium ions (resulting in hypocalcaemia and hypomagnesaemia).

Solutions of HF often penetrate tissues deeply before corrosion of the digestive tract in burns patients can reduce the incidence of hospital-acquired pneumonia.12 The aim is to kill gastrointestinal pathogens before they transfer to the lungs. However, the evidence to support this practice is inconclusive and practice varies widely between units.

**Initial treatment of a HF burn is to decontaminate with copious amounts of water, even if there is no apparent injury. Repeated topical application of calcium gluconate gel 2.5% to any HF burn may limit damage and give some pain relief.**

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**Box 2: Topical antimicrobial treatments**

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>AVAILABLE VEHICLES</th>
<th>ACTIVITY</th>
<th>USES AND LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver sulfadiazine</td>
<td>Cream (Flamazine)</td>
<td>Broad spectrum against Gram-negative and Gram-positive bacteria including <em>Pseudomonas</em> spp</td>
<td>Used on wounds with known or suspected <em>Pseudomonas</em> spp colonisation. Penetrates eschar well. Not for initial use since it alters appearance of wound making assessment difficult</td>
</tr>
<tr>
<td>Silver matrix dressings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ointment in combination with cerium nitrate (Flammacemer)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honey dressing</td>
<td>Ointment or sheet dressings</td>
<td>Natural antimicrobial properties</td>
<td>Used to aid autolysis when surgery is not appropriate and on sloughy wounds</td>
</tr>
<tr>
<td>Nitrofurazone</td>
<td>Cream (Furacin)</td>
<td>Wide range of Gram-negative and Gram-positive bacteria; limited activity against <em>Pseudomonas</em> spp</td>
<td>Unlicensed product used on infected wounds or grafts in conjunction with dressings</td>
</tr>
<tr>
<td>Alginate/ glucose oxidase/ lactoperoxidase</td>
<td>Gel (Flaminol Hydro and Flaminol Forte)</td>
<td>Meticillin-resistant <em>Staphylococcus aureus</em> (MRSA), <em>Candida albicans</em>, <em>Pseudomonas</em> spp, <em>Escherichia coli</em></td>
<td>Used on heavily colonised wounds to reduce microbial load and aid healing</td>
</tr>
<tr>
<td>Povidone iodine</td>
<td>Solution, spray, ointment, dressings (Inadine)</td>
<td>Antimicrobial activity against a wide range of organisms, including MRSA, viruses and fungi</td>
<td>Used on infected wounds or grafts Systemic toxicity is seen if applied over large wounds</td>
</tr>
</tbody>
</table>
The patient displays symptoms (eg, weakness, paraesthesia, tetany, convulsions, coagulation disturbances or electrocardiogram changes), intravenous calcium injected subcutaneously under the burnt tissue. Gradually remove thin layers of necrotic tissue until a circumferential burn (one that extends all the way around) on a limb can restrict blood flow critically. To release this tourniquet-like effect, deep longitudinal excisions are made in the affected area; this is called an escharotomy.2,4

**Surgical management**

Surgical procedures for burns patients include escharotomy (see below), debridement, skin grafting and scar revision. Extensive burns can require multiple operations separated by periods of recovery to allow for wound healing and regrowth of donor skin for skin grafts.

**Escharotomy** A complication of an extensive burn is that the burnt tissue (eschar) quickly loses elasticity. A large burn on the thorax can compromise chest expansion or a burn on the thorax can compromise chest expansion or a circumferential burn (one that extends all the way around) on a limb can restrict blood flow critically. To release this tourniquet-like effect, deep longitudinal excisions are made in the affected area; this is called an escharotomy.2,4

**Excision and grafting** Blistered skin (unless small) is removed if broken or “deroofed” in the case of large blisters.4 When treating deep dermal burns, using a combination of excision and grafting is common. For successful grafting, all necrotic tissue needs to be removed. This is achieved using a device called a dermatome (see Figure above) or a specially designed knife that can gradually remove thin layers of necrotic tissue until a viable wound bed is reached (identified by capillary bleeding in the wound).4 An alternative technique is to use a high pressure water jet system that is sprayed parallel to the wound bed to remove non-viable tissue. Once haemostasis is achieved, a skin graft or skin substitute can be applied. The most successful technique is to use a portion of the patient's own skin, which is removed from an unaffected part of their body (donor site). Most commonly a “split skin graft” is performed, where a dermatome is used to remove a thin layer of skin at a controlled depth (usually mid-dermal). This can then be applied to the wound bed intact (sheet graft) or, where a larger area of coverage is needed it can be meshed, using a device that makes regular small incisions (fenestrations) in the graft, and then stretched to up to six times the original area. The graft can be stapled, stitched or applied using tissue glue. Mesh grafts result in a fishnet-like appearance after healing, so sheet grafts should be used in areas where cosmetic appearance is important (ie, face, hands, neck).

Donor sites should heal within two to three weeks, providing the graft taken is not removed too deeply and that the area is protected and does not become infected.14,15 If donor skin is in short supply, skin substitutes (eg, Integra) or donated cadaver skin (allografts) can be used. These are only temporary measures because infection rates are higher when skin substitutes are used and cadaver skin will eventually be rejected (unless immunosuppressants are used).13 In the case of full-thickness or fourth-degree burns, a “skin flap” may be required. This involves using full-thickness donor tissue including underlying muscle and blood supply.14

**Dressings**

Optimum management of burn sites, skin grafts and donor sites relies on the expertise and experience of practitioners (particularly nurses) who have worked in specialist burns centres for many years. A burn site is typically covered with two or more layers of dressings (see Box 3, p.254).

A primary dressing should provide an optimum environment for wound healing (moist, oxygenated and protected from trauma and microbes). It should also allow inspection of the wound, absorb exudate and be easily removable with minimal trauma to underlying healing tissue. A secondary dressing should absorb any excess exudate and provide protection to the wound from pressure and shearing forces.13 The primary and secondary dressings may need to be secured in place by suitable bandages. Many modern dressings are manufactured in multiple layers so that a single dressing has several properties previously only available using a combination of dressings (eg, a non-adherent layer bonded to absorbent foam).

New skin grafts are often covered with dressings impregnated with antibacterials (eg, silver) or are used in conjunction with topical antibacterials or antiseptics to prevent infection that can cause a graft to fail. Donor sites will also require dressings to aid healing and to prevent infection.

**Other therapies**

**Laxatives** Because burns patients often receive high doses of opioids, constipation can become a problem. Patients should be assessed regularly and laxatives prescribed as appropriate. Patients with burns on the back or around the buttocks are at risk of infection following contamination if they soil themselves while in bed. As such, some patients have a bowel management system inserted to remove faeces. Faeces need to be fluid for the system to work so patients may be given laxatives for this purpose.

**Anticoagulation** Burns are a risk factor for developing venous thromboemboli and therefore most patients should...
be treated prophylactically with a low molecular weight heparin.¹

**Acid suppression** Burns are a risk factor for developing duodenal ulcers (Curling’s ulcers). Patients should receive a proton pump inhibitor or H₂-receptor antagonist.¹

**Long-term management**

Patients who have severe burns will need ongoing follow-up in an outpatient clinic for months or years.

**Scarring** Hypertrophic (erythematous, pruritic and raised) scars¹⁰ can occur following treatment and may need to be managed using excision surgery or topical silicone gel (eg, Kelo-cote). Over-granulation during healing can also cause scarring that can be reduced using corticosteroids (eg, topical betamethasone ointment or intralesional injection of triamcinolone).¹⁷

**Contractures** Grafted skin, particularly across joints, will contract and tighten causing reduced mobility. This can be lessened with regular physiotherapy and scar massage using topical emollients.¹ Contractures may require revision surgery to release tight areas.

**Dry skin and itching** Lack of normal sweat and oil glands in grafted areas means that patients will have a lifelong requirement to use emollients and will often need to take antihistamines to control itching.¹⁷

**Sun sensitivity** All patients are advised to avoid sun exposure or use total sunblock following significant burn injury.¹¹ Depigmented areas are common, especially in patients with darker skin — skin camouflage products can improve the cosmetic appearance of these areas.

**Recovery**

Recovery from extensive burns is often slow and painful and can involve frequent bouts of infection and multiple trips to theatre for skin grafts. Intensive physiotherapy is required to ensure the patient has maximal movement. Psychological trauma following the burn is common and may require psychiatric input or counselling to aid recovery.¹⁴

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**Box 3: Burn dressings**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffin and chlorhexidine gauze (eg, Paratulle, Jelonet, Bactigras)</td>
<td>Simple gauze mesh impregnated with white soft paraffin or chlorhexidine</td>
<td>Inexpensive, easy to use. Relatively non-adherent so useful for first aid</td>
<td>Does not absorb exudate or aid haemostasis; adheres to deeper wounds making removal difficult</td>
</tr>
<tr>
<td>Hydrocolloid (eg, Granuflex, Aquacel)</td>
<td>Forms gel with exudate. Sheet dressing</td>
<td>Helps absorb exudate, good on small or difficult areas such as hands</td>
<td>Layer of gel may be difficult to remove and obscures inspection</td>
</tr>
<tr>
<td>Film dressing (eg, Opsite)</td>
<td>Transparent semipermeable film</td>
<td>Barrier to bacteria and reduces moisture loss from wound. Allows easy inspection of wound</td>
<td>Not suitable for heavily exuding wounds. Can macerate wound</td>
</tr>
<tr>
<td>Non-adherent dressing (eg, Mepitil, Telfa, Urgotul)</td>
<td>Non-adherent silicone sheet or foam dressing</td>
<td>Easily removed and provides mechanical protection of wound</td>
<td>Silicone sheet is non-absorbent. Unsuitable for exuding or bleeding wounds</td>
</tr>
<tr>
<td>Alginate dressing (eg, Sorbsan, Kaltostat)</td>
<td>Alginate gel or sheet — forms gel with calcium ions from plasma</td>
<td>Suitable for exuding or bleeding wounds. Can be left in place until it falls off during healing</td>
<td>Gel quickly falls off full-thickness or heavily exuding wounds requiring frequent reapplication</td>
</tr>
<tr>
<td>Hydrogel (eg, Intrasite, Mesitran)</td>
<td>Amorphous, cohesive substance that hydrates wound</td>
<td>Suitable for cavities or dry, sloughy wounds. Promotes autolysis of necrotic tissue so is useful for burns unsuitable for surgery</td>
<td>Not suitable for heavily exuding wounds</td>
</tr>
<tr>
<td>Antimicrobial-impregnated dressing (eg, Allevyn-Ag, Iodosorb)</td>
<td>Allevyn-Ag: Silver-impregnated polyurethane foam Iodosorb: Hydrogel containing iodine</td>
<td>Useful for infected wounds and skin grafts</td>
<td>Expensive</td>
</tr>
<tr>
<td>Multilayer dressing (eg, Acticoat, Moisture Control)</td>
<td>Dressing with three layers (silver, foam and waterproof backing)</td>
<td>Useful for infected wounds with exudate. Backing controls moisture level</td>
<td>Expensive</td>
</tr>
</tbody>
</table>

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**References**

¹ Blanchet B. Influence of burns on pharmacokinetics and pharmacodynamics of drugs used in the care of burn patients. Clinical Pharmaceutics 2008;47:635-54.
⁹ Gregoretti C. Analgo-sedation of patients with burns outside the operating room. Drugs 2008;68:2427-43.
¹⁷ Shelley OP, Dzielewski P. Late management of burns. Surgery 2006;24:15-7.