Immediate management of burn injury

Hugh Martin

Abstract

- Simple manoeuvres such as first aid, fluids, feeding, pain relief, basic physiotherapy, and emotional support can make enormous differences to the outcome after most burns.
- The depth of a burn continues to increase over the 48 hours following injury. Correct first aid can minimise or prevent this progression.
- Correct first aid consists of flowing cool water over the burned area.
- People with large burns (more than 25% of body surface area) require fluid resuscitation with water and electrolytes.
- After good first aid, the principles of wound care are to minimise bacterial contamination, to prevent desiccation, and to remove necrotic material.
- Extra nutrition is required for all patients with major burns (ie, more than 25% of body surface area).
- Burns are extremely painful, so it is important to provide adequate analgesia.
- It is important to maintain the patient's confidence in the quality of care, but be cautious about making predictions about long-term outcome.

ADF Health 2007; 8: 60-62

CURRENT AUSTRALIAN Defence Force deployments frequently require personnel to treat civilians. Conflicts and natural disasters tend to affect the most vulnerable individuals most severely. Following Cleland's excellent article on recent advances,[1] this article deals with the more immediate problems that may face personnel dealing with ADF casualties, and the civilian population close to the scene of the trauma. The civilian group is likely to have a high proportion of children, so there is some emphasis on this age group.

First aid

If you have ever had the opportunity to see a burn soon after injury, and the same one 3–5 days later, you would have observed a dramatic change in appearance. The major reason for this is that the depth of the burn continues to increase over the 48 hours following thermal injury. This is not due to retained heat. It is due to the intense inflammatory response generated by the injury causing vascular changes (and possibly some others) in the tissue immediately adjacent to that which was killed by the initial exposure.[2] These two layers of tissue are termed the Zone of Stasis and the Zone of Necrosis, respectively.

Correct first aid can minimise or totally prevent this progression. Correct first aid consists of flowing cool water over the burned area. Surprisingly, for such a simple manoeuvre, and such an important subject, there is not much good science about the time in which it is most effective, what temperature is optimal (or what range of temperature is effective), or how long it should continue for, much less the basic physiology behind it. Even worse, there are some contradictory studies.

The temperature of the fluid can probably be anywhere between 8°C and 23°C. Although the research is not unanimous, the balance of evidence is that fluid <4°C is harmful. Certainly, the colder the fluid, the more likely is the one complication of this therapy, hypothermia, to occur. With their smaller mass to surface area, children are much more prone to this complication than adults.

Because the inflammatory response to the injury is a cascade of events, first aid should start as soon as possible. Turning off a cascade is much more effective the earlier it is started. Once it has gathered momentum, it is hard to stop. At what point it becomes impossible is unknown; first aid started 2 or even 3 hours after injury may still be of benefit.

First aid is most effective for partial thickness burns. If the zone of necrosis extends into the subcutaneous fat, first aid may reduce the cytokine storm that the patient will suffer (although this is unproven), but it will not salvage any skin, whereas in a partial thickness burn it may make the difference between grafting or not grafting, or scarring and not scarring. So in scalds, flash burns, and burns due to brief exposure, or exposure to relatively low temperatures, first aid is likely to make an enormous difference to the ultimate outcome.

***Dr Hugh Martin** has been involved as a consultant in the Burns Unit at the Royal Alexandra Hospital for Children since 1977. He was one of the group that introduced Advanced Burn Life Support courses to Australia and New Zealand. This group then went on to write the Emergency Management of Severe Burns Course, which is now administered by the Australia and New Zealand Burn Association (ANZBA) and is also run in Britain, Holland, and South Africa. He has been Chairman of the Education Committee of ANZBA, and President of ANZBA. He is an Honorary Member of the British Burn Association and the South African Burn Association.*

The Children's Hospital at Westmead, Westmead, NSW.
Hugh Martin, AM, FRACS, FRCS, Senior Surgical VMO.
Correspondence: Dr Hugh Martin, The Children's Hospital at Westmead, Locked Bag 4001, Westmead, NSW 2145. **HughM@chw.edu.au**

Fluids

Early mortality after burning is mostly due to fluid shifts causing hypovolaemia. Once the burn involves more than 25% of body surface area (BSA) this problem becomes highly significant. If the burn involves 15%–25% BSA, the patient may develop problems. For these reasons, it is recommended that all people with burns over 15% BSA (or 12% in children < 30 kg) have fluid resuscitation.[3] Traditionally, this has been given intravenously, but there is increasing evidence that oral rehydration may be effective for people with up to 40% BSA burns.

Whichever route is used, water and electrolytes must be delivered. For intravenous or intra-osseous delivery, the standard solution is Hartmann's (using only normal saline leads to an excess intake of chloride). The best mixture for oral administration is debated, but oral rehydration fluid as used in gastroenteritis is usually available and is safe.[4]

The volume must be calibrated to the patient's needs, but internationally the formula (area burned as %BSA × patient's bodyweight [kg] × 3 to 4 mL) gives a figure for the initial estimate of the requirements for the first 24 hours, half of this being given in the first 8 hours after the burn incident. Once this has been started, the patient's urinary output is used to guide therapy. Adults should pass 30–50 mL per hour. Children should put out 1 mL/kg per hour (range, 0.5–2 mL/kg per hour). For children < 30 kg, maintenance fluid containing glucose, at the usual rates, should be added.

Apart from the maintenance of perfusion to vital organs, resuscitation is important in maintaining perfusion to the burnt area, and thus maximising tissue preservation in the Zone of Stasis.

Burns surgeons have for years observed that patients in whom resuscitation is delayed do worse than those who have timely resuscitation, even if renal failure does not develop. Recently, we have realised that this is at least in part due to factors arising from the gut. Immediately after a major burn, there are changes in the gut that are identical with those seen in ischaemia. With resuscitation, reperfusion injury is seen.[5] The longer the delay in resuscitation, the greater are the injurious effects of both. These are predominantly translocation of bacteria and endotoxin, and production of inflammatory cytokines locally. Absorption of these is predominantly into the lymphatics of the gut, so they travel via the thoracic duct to the venous circulation, the lungs being the first organ where they pass through a capillary bed. Pulmonary and systemic effects are unmitigated by the liver's ability to detoxify as it processes portal venous blood, not intestinal lymph.

Wound care

After good first aid, the principles of wound care are to minimise bacterial contamination, to prevent desiccation, and to remove necrotic material.

Cleaning the wound is the first step in minimising bacterial contamination. Mechanical cleaning to remove particulate matter is extremely important. This can be combined with some antibacterial activity by using chlorhexidine 0.1%, but if this is not available, sterile saline, or soap and water can be used. Saline stings less than water because it is isotonic.

Desiccation deepens the burn wound. Exposure was popular in the past, because covering the wound then almost invariably resulted in infection, which is a worse outcome than desiccation. Any dressing should be capable of keeping the wound surface moist (but not sloppy, see below). As a temporary measure, plastic kitchen film (Gladwrap, Clingwrap) applied to the wound, but not wrapped in a constrictive manner, is an ideal dressing as it keeps the surface moist and prevents evaporation, thus lessening the risk of hypothermia, as well as being easy and painless to remove. Unless definitive treatment is going to be significantly delayed, say more than 8–12 hours, topical antibacterial agents such as Acticoat (Smith and Nephew, Melbourne, Vic) or silver sulfadiazine should not be applied until the patient arrives in a centre where definitive care is started. An alternative is to use two or three thicknesses of chlorhexidine-impregnated Vaseline gauze (Bactigras, Smith and Nephew, Melbourne, Vic). Whatever is placed on the wound surface, the retention dressing should not be constrictive, either at the time of application or subsequently as swelling develops. Elevation of the burned part reduces swelling significantly.

The place of burn gels is not yet defined. They can be used as a paste, or impregnated into a dressing sheet. They appear to be reasonably effective as a first aid measure.[6]

Removal of necrotic tissue starts with trimming away loose keratin. The best way to deal with blisters is uncertain, as no good evidence exists about their treatment. Many experienced surgeons leave blisters on the palms and soles. Generally, if the blister is broken by wiping during cleaning and dressing, it is best removed.

Nutrition

The inflammatory response to a burn releases a multitude of chemical mediators. These have many effects on the patient's metabolism, one of which is to create a catabolic state. There is end organ resistance to anabolic hormones, and increased secretion of catabolic hormones, especially catecholamines. In the first days after injury, this manifests as tachycardia and hyperthermia, but over the long term it causes muscle wasting and debilitation. Extra nutrition is therefore required for all patients with major burns (ie, more than 25% BSA). Burns of between 15% and 25% BSA are the transition zone where extra nutrition is desirable but perhaps not as vital as in larger burns. The preferred route is enteral: parenteral nutrition depresses the immune response and there is good evidence that patients do much better when the gut is the portal of entry.[7]

Starting enteral nutrition early has another, major advantage. Providing the gut with substrate as early as possible minimises the intestinal changes mentioned above. Apart from the need to have an empty stomach during transport, starting intragastric feeding with milk or any enteral formula as soon as possible after injury is desirable.[8]

Pain relief

Burns are extremely painful. As with other major traumatic events, pain is not always prominent in the first hour or so, but once the patient starts being aware of pain it is important to provide adequate analgesia. Early, this should be given as intravenous morphine. The intramuscular route should be avoided as absorption is less certain, allowing the drug to be sequestered in the muscle without exerting its desired effect, so prompting further doses, only to be mobilised as the patient's circulation improves with resuscitation.[9]

Dressings are also very painful. Combinations of drugs are useful for this event. A background of paracetamol with oral morphine and an anxiolytic such as midazolam can be used. If nitrous oxide is available, it is extremely useful.

Long-term background pain is a constant problem. Slow release oral morphine can be titrated against the patient's response. Deep, burning pain in the scars after healing is common and difficult to treat.

Emotional care

The aim of treatment of any condition is to give the patient the opportunity to participate in any of life's activities unrestricted by their previous illness. The ability of burned patients to return to a full, active life depends more on their emotional adjustment than their physical disability. We all know of people with major physical disabilities who lead full and active lives, even to the point of competing in international sporting events. Experience shows that the amount of emotional disturbance is largely independent of the extent of the burn.

What does this mean to the personnel treating the patient in an emergency situation, or deployed to a disaster area? Maintaining the patient's confidence in the medical care they are getting is important. Because prediction of depth is so difficult, when the patient first arrives, avoid saying that the injury will heal, or that they will heal without scarring, or making any other prediction unless such a prediction is certain. Do reassure the patient that they will receive good care, and make sure that analgesia is adequate. Adopt the same attitude to family if they are present. Do not be hesitant to say that you cannot tell how deep the burn is, or what the long-term outcome is going to be.

If you have the task of looking after the patient for longer, remain honest ("Sorry, this is going to hurt" as you wipe the burn during dressing changes), but positive. If there is anybody with expertise in emotional care available, involve them. Be patient with explanations, and repeat them if needed.

Ongoing care

If your deployment involves treating civilian casualties, you may be required to conduct the whole of the patient's treatment. Although a detailed course in definitive burn care is impossible here, two points can be made.

The first is that excision and grafting are needed if the burn is not healed by 10–14 days.[10]

The second is that any burn that crosses a joint will need physiotherapy. This does not have to be complicated. Move the joint through its full range at dressing times when analgesia is best. If an extensive burn involves a joint, especially a flexor surface, it should be splinted in the overcorrected position for most of the time during healing and after grafting, coming out for periods of a few hours at a time to exercise, for the first 3–6 months after injury.[10] After that, splint the joint at night and encourage exercise during the day. All scars contract: the major morbidity of small and medium burns in underdeveloped countries is due to scar contractures that can usually be largely prevented by these simple means.

Summary

Simple manoeuvres such as first aid, fluids, feeding, pain relief, basic physiotherapy, and emotional support can make enormous differences to the outcome after most burns because the majority of burns are small to medium in size. For medium and large burns, the first few hours are important to start treatment before evacuation and to keep the patient stable during the journey to a centre for definitive care.

Competing interests

None identified.

References

1. Cleland HS. The modern management of burns. *ADF Health* 2007; 8: 2-7.
2. Herndon D, editor. Total burn care. London: WB Saunders, 1996.
3. Australia and New Zealand Burns Association. Burn shock and fluid resuscitation. In: Emergency management of severe burns (EMSB) course manual. Brisbane: ANZBA, 1996.
4. Cancio LC, Kramer GC, Hoskins SL. Gastrointestinal fluid resuscitation of thermally injured patients. *J Burn Care Res* 2006; 27: 561-569.
5. Ocal K, Avlan D, Cinel I, et al. The effect of *N*-acetylcysteine on oxidative stress in intestine and bacterial translocation after thermal injury. *Burns* 2004; 30: 778-784.
6. Jandera V, Hudson DA, de Wet PM, et al. Cooling the burn wound: evaluation of different modalities. *Burns* 2000; 26: 265-270.
7. Chen Z, Wang S, Yu B, Li A. A comparison study between early enteral nutrition and parenteral nutrition in severe burn patients. *Burns* 2007; 33: 708-712.
8. McDonald WS, Sharp CW, Deitch EA. Immediate enteral feeding in burn patients is safe and effective. *Ann Surg* 1991; 213: 177-183.
9. Australia and New Zealand Burns Association. Emergency examination and treatment. In: Emergency management of severe burns (EMSB) course manual. Brisbane: ANZBA, 1996.
10. NSW Health. Severe burn injury service: model of care. Sydney: NSW Health, 2004.

(Received 3 May 2007, accepted 13 Aug 2007) ❑