Burns in the UK are very common with approximately 10,000 patients injured seriously enough each year to warrant hospital admission. Of these, approximately 10% need formal fluid resuscitation and ultimately surgery to remove and graft the burnt area. Adult burns are usually caused by flame and paediatric burns by scalds. Most occur in the home and are preventable.

**First aid**
Correct initial first aid includes stopping the burning process (e.g., removal of clothing) and the irrigation of the burnt area with tepid water (at least 15°C for 20–30 min). This has been shown to markedly limit the eventual depth and area of the resulting burn.

**Initial care in the accident and emergency department**
It is important to obtain as full a history as possible from relatives or ambulance staff, as the mechanism of the burn will often give clues to subsequent management. In addition, universal precautions should be taken as higher than average percentages of burned patients are intravenous drug abusers. With these two important points in mind, we can proceed with the primary survey.

**Primary survey**

*Airway and control of cervical spine*
Initial compromise of the airway is almost always due to a low Glasgow Coma Score and not the burn. Coma may be due to trauma, drugs and alcohol, as well as the effects of carbon monoxide and smoke inhalation. If there is any history of trauma, the cervical spine should be immobilised and, if necessary, the airway supported with simple manual techniques or the use of a basic airway adjunct. Once the airway is clear, high flow oxygen should be applied by facemask (15 l min⁻¹ with an inspiratory reservoir on the mask).

*Breathing and control of ventilation*
Compromise is most likely due to a low Glasgow Coma Score but potential effects of trauma, smoke inhalation or a constricting circumferential burn to the chest must be excluded. Breathing should be assessed clinically and it should be borne in mind that pulse oximetry cannot distinguish between carboxyhaemoglobin (COHb) and oxyhaemoglobin and will, therefore, give spuriously high readings in the presence of significant levels of COHb. Particular attention should be given to the tracheal position, as a tension pneumothorax is a common and life threatening complication of trauma and blast injury.

If intubation is required at this early stage, it is usually technically very easy (swelling of the airway has not yet occurred). Suxamethonium can be used in the first few hours following injury, but must be avoided thereafter as it may cause dysrhythmias or even cardiac arrest due to acute hyperkalaemia. Full thickness circumferential chest burns and full thickness upper abdominal burns in children can severely limit respiratory excursion and relieving escharotomies may have to be performed at this early stage to allow adequate oxygenation. Escharotomies are cuts through the complete depth of the burn until viable tissue is reached and are associated with significant pain and potential large blood loss. General anaesthesia is usually required for the procedure.

*Circulation and control of bleeding*
A rapid assessment should be made of the circulatory status, including blood pressure, pulse and capillary refill. This should be performed in both burned and unburned limbs since inadequate

**Key points:**
Management should follow established ATLS principles of the primary and secondary survey

Hypovolaemic shock in the first few hours after a burn is never due to the burn alone

Crystalloid is the fluid of choice for resuscitation

In general, patients with facial burns require intubation while patients with facial scalds do not

Transfer of patients with thermal injuries must be co-ordinated with the receiving burn centre where advice regarding initial management should be sought early

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perfusion may be due to the burn itself. Pressure should be applied to superficial bleeding points. It must be understood that the presence of hypovolaemic shock (tachycardia, low blood pressure and prolonged capillary refill in an unburned limb) is never due to the burn alone and underlying trauma must be sought.

Intravenous access should be established at this point and blood sent for baseline measurements as well as COHb levels. The measurement of blood glucose is particularly important in children. Two large bore intravenous cannulae should be inserted, preferably through unburned skin. Other options include saphenous cutdown, femoral venous cannulation (the groins are usually spared in severe burns) and intra-osseous needles in children < 6 years. Warmed lactated Ringer’s solution should be started and titrated to correct hypovolaemic shock if present, whilst its cause is searched for. If shock is not present, fluids can be run fairly slowly at this stage until the burn calculation is made. Isolated poor perfusion in a limb with a circumferential full thickness burn identifies the need for a subsequent escharotomy.

Disability
A brief assessment of conscious level should be made at this stage using the AVPU score (alert, vocalising, responding to pain, unconscious) and the pupils should be inspected for their reaction to light.

Exposure and estimation
The patient should now be completely exposed with jewellery and watches removed from any burned limb. Burned patients, particularly children, lose heat rapidly and every effort should be made to keep patients warm at this stage. If there is a history of trauma, a log roll must be performed and the back inspected for injuries and burns. With the patient now completely exposed, an estimate can be made of the extent of the burn using the rule of 9s (Fig. 1) or a specific burn chart.

Fluids and Foley catheter
A burn greater than 15% of the total body surface in adults and 10% in children requires intravenous fluid resuscitation. The Parkland formula, developed in 1971 and now widely used in the UK, predicts a total fluid requirement of 3–4 ml kg⁻¹ (% burn)⁻¹. The resulting volume of fluid is given over the 24 h from the time of the burn (not from the time of presentation) with half the volume given in the first 8 h and the remaining half in the subsequent 16 h. Lactated Ringer’s solution is the fluid of choice. In children, additional maintenance fluid should be given using a glucose containing solution. Frequent clinical re-assessment is important to judge the effectiveness of resuscitation. The higher initial volume of fluid reflects the early outpouring of oedema into the burn wound.

A urinary catheter should be passed and hourly urine production used to monitor the adequacy of resuscitation. In adults, at least 0.5 ml kg⁻¹ h⁻¹ of urine should be passed and at least 1 ml kg⁻¹ h⁻¹ in children. If these targets are not met, then resuscitation fluids should be increased by up to 50% to achieve this.

Invasive monitoring should be avoided initially, because the nature of the fluid loss is relatively predictable and invasive techniques expose a vulnerable patient to septic complications. It has been observed that the central venous pressure during the resuscitation of a patient with severe burns rarely exceeds 3 cm of water and despite rapid fluid administration is difficult to raise above this level.

Having completed the primary survey, the patient should be reassessed to ensure stability. If traumatised, X-rays are indicated at this point (cervical spine, chest and pelvis) and a nasogastric tube should be passed. If it is a pure burn, uncomplicated by traumatic shock, analgesia may be given, if required. Doses of intravenous morphine are titrated to analgesic response. Subcutaneous and intramuscular injections should be avoided as absorption will be erratic and analgesia delayed.

Secondary survey
It is now reasonable to proceed to the secondary survey, which will include a close examination of the burn with an assessment of depth by observing capillary refill and sensitivity.
Confirmation of the need for escharotomies can be made at this time. Tetanus prophylaxis should be given. The burn is dressed with either a clean sheet or with cling film, which is relatively sterile within the roll, permits inspection of the wound and shields raw nerve endings from air, therefore reducing pain. It also reduces evaporative losses from the wound.

Contact should now be established with the local burn unit. All but the most minor burns warrant transfer (Table 1) and, if distances are small, escharotomies can usually wait until arrival at the unit. Transfer arrangements should follow established guidelines and must be co-ordinated with the receiving unit.

The above gives a very broad outline of the management of acute burns where it can be seen that the burn itself remains in the background. It is important to realise that even very major burns do not kill immediately but ruptured livers and tension pneumothoraces do. It is quite possible to have a 100% full thickness burn and be haemodynamically stable, lucid and indeed pain-free since all the nerve endings have been destroyed.

**Inhalation injury**

This is likely to be present if the burn was received in an enclosed space. As hot gases and smoke are inhaled, three distinct clinical entities are possible.

**Injury above the larynx**

Since the function of the upper airway is to exchange heat and the heat content of gas is low, by the time hot gases reach the larynx virtually all the heat energy will have been dissipated. However, this may result in thermal injury to the upper airway, particularly to the pharynx and epiglottis. Patients presenting with thermal injury above the larynx (usually associated with facial burns and a history of being in an enclosed space) must always be intubated, since pharyngeal mucosa swells alarmingly, particularly when resuscitation fluids are commenced. Worrying clinical signs are inspiratory stridor, change in voice or hoarseness and examination of the mouth will usually reveal a swollen uvula. A slightly head-up position may delay swelling but early intubation is strongly advised. If swelling has already occurred, muscle relaxants should be avoided and the patient anaesthetised using an inhalational induction. Fibre-optic intubation techniques do not have a place since the swollen upper airway is impossible to anaesthetise and airway instrumentation may cause further trauma and swelling. For intubation, an oral tube should be used and left at least 5 cm longer than calculated to allow for further swelling. Only very rarely will tracheostomy be required at this stage. Facial scalds, although causing dramatic swelling, do not require intubation since the airway is unaffected.

**Injury below the larynx**

Cooled gases and smoke are inhaled deeply depositing carbon and other more toxic chemicals within the bronchial tree. This ‘smoke inhalation’ can be best thought of as a chemical pneumonitis with bronchial irritation. Injury below the larynx causing a chemical pneumonitis can vary from mild to severe. Mild smoke inhalation (if not accompanied by an upper airway thermal burn) can be managed supportively with oxygen, bronchodilators and physiotherapy. More severe cases will need ventilatory support because of deteriorating lung function, but this is rarely immediate and occurs over the ensuing 12 h. Clinical signs include dyspnoea, bronchial irritability with coughing and wheezing as well as the production of copious amounts of secretions. Fibre-optic bronchoscopy in the already intubated patient with suspected inhalation injury has been advocated by several authors. The procedure allows better diagnosis of smoke inhalation and enables aggressive pulmonary toilet, which is particularly important in children with small airway diameters. For intubated patients with severe smoke inhalation, bronchial lavage with 1.4% bicarbonate solution has been recommended as this may be beneficial both in neutralising acidic deposits and removing soot contamination. It should be noted that the majority of patients with severe smoke inhalation will suffer permanent pulmonary dysfunction.

**Systemic intoxication**

Toxins and chemicals reaching the alveoli can be absorbed into the systemic circulation. The two most significant chemicals are carbon monoxide and cyanide, although it is likely that there are many others which cannot be routinely measured. The majority

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**Table 1** British Burns Association referral criteria for patients with burn injuries

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<thead>
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<th>Criteria</th>
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<td>Burns &gt; 10% total body surface area (TBSA) in adults and &gt; 5% TBSA in children</td>
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<tr>
<td>Burns of special areas: face, hands, feet, genitalia, perineum, major joints</td>
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<tr>
<td>Full thickness burns &gt; 5% TBSA</td>
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<tr>
<td>Burns with associated inhalation injury</td>
</tr>
<tr>
<td>Electrical and chemical burns</td>
</tr>
<tr>
<td>Circumferential burns of limbs and chest</td>
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<tr>
<td>Burns at the extremes of age</td>
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<tr>
<td>Burns in patient with pre-existing disease which may affect management, recovery or mortality</td>
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<tr>
<td>Any burn with associated trauma</td>
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of patients dying at the scene of a fire will do so from lethal levels of carboxyhaemoglobin (COHb 60% or greater).

Those surviving should be managed as early as possible with high flow oxygen which at inspired concentration of 1.0 will reduce the half life of carboxyhaemoglobin from 240 min to 30–40 min. The value of hyperbaric oxygen therapy for patients acutely exposed to carbon monoxide is doubtful and poses many logistical problems. Non-lethal but abnormal levels of carboxyhaemoglobin are useful as a chemical marker of the likelihood of thermal injury and smoke inhalation, but rarely cause a clinical problem.

Similarly, cyanide toxicity (produced by burning plastics and foams) is best treated by high flow oxygen and, if necessary, circulatory support. Severe systemic intoxication often results in a chronic metabolic acidosis which can be managed with intravenous 1.4% bicarbonate as a continuous infusion or, in more severe cases, renal support. Antidotes are available but not routinely used in our practice. Cyanide is slowly removed from the blood and metabolised.

It is vital to understand that the three components of inhalation injury can either occur in isolation or more commonly in some form of combination. A patient who has been trapped in a burning building may well present with all three elements of inhalation injury while, more rarely, only one will be present.

High tension electrical burns

High voltage injuries characteristically cause small entry and exit burns, but with a massive underlying muscle damage, as the current flows along the path of least resistance. Frequently, the history is unclear and industrial workers presenting with small cutaneous burns and a vague history should be monitored carefully. Potential myocardial damage requires prolonged ECG monitoring as delayed arrhythmias are common. Compartment syndrome may develop and perfusion, as well as neurological function in suspect limbs, should be observed carefully.

It is more than likely that a fasciotomy will be required to allow distal perfusion. Myoglobinuria, if present, must be vigorously treated with intravenous lactated Ringer’s solution sufficient to produce a high urine output (1.5–2 ml kg⁻¹ h⁻¹). Mannitol is recommended to preserve renal function once adequate fluid resuscitation has been achieved.

High tension injuries should not be underestimated, as many of them will be lethal, if not treated correctly.

Chemical burns

Minor chemical burns are extremely common and can be divided into those caused by acids, alkaline and organic substances such as petrol. Management is the same as for a flame burn with the exception that irrigation with water for several hours is indicated to fully remove the corrosive substance. A rare but important chemical burn is caused by hydrofluoric acid (used for etching of glass), which can cause significant and life threatening systemic hypocalcaemia with involvement of as little as 2% total body surface area.

Burns in children

Whilst principles of management remain the same, several important points should be considered when dealing with children. Their thinner skin ensures that, for a given thermal injury, the burn will be deeper and more extensive than in adults. They have different body proportions and, in particular, the head is relatively large (see Fig. 1) making it difficult to assess burn size accurately. Non-accidental injury is common and should be considered in every child.

Great care must be taken to minimize heat loss as exposed burned skin rapidly loses heat. Children have greater fluid requirements and maintenance fluids as glucose containing solutions should be given in addition to 4 ml kg⁻¹ (% burn)⁻¹ of lactated Ringer’s solution. In very small children with extensive burns, intra-osseous access is probably the route of first choice and time should not be wasted trying to establish peripheral venous access. Remember that facial scalds in children, although dramatic to look at, do not need intubation.

Further training in burns

Readers interested in undertaking an intensive one-day course on the emergency management of severe burns (EMSB) should contact the British Burns Association, c/o Susan Hodgkinson, PO Box 74, Morpeth, Northumberland NE65 8YT.

Key references


See multiple choice questions 69–72