There are many causes of burns. Patients with complex burns should be referred to a specialist burns unit

Burns
clinical features
and prognosis

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Each year, around 175,000 cases of burns, of varying severity and cause, present for treatment at UK accident and emergency departments. Severe burns can be fatal, with 378 deaths from exposure to smoke, fire or contact with heat or hot substances reported in England and Wales in 2008. Patients who survive are likely to stay in hospital for lengthy periods.

Types of burn
There are several causes of burns, ranging from direct heat (including flames and hot liquids) to chemical or electrical injury. Presentations differ depending on the cause, and severity is dependent on both contact time and the temperature to which the skin has been exposed.

Flame burns account for approximately 50% of adult cases, whereas in children scalding predominates, accounting for 70% of injuries. Flame burns can be associated with other injuries, including airway trauma.

Electrical burns may present with an entry and exit point where the current has passed through the body. Internal damage, following the path of electricity, can occur along with the external burns. Cardiac involvement, particularly arrhythmias, may be present; damage is voltage-dependent.

Chemical burns can be caused either by household products or, more usually, by an industrial accident; wet cement is a common cause. With the exception of hydrofluoric acid, alkaline substances generally cause more damage than acids, although pain is often minimal in the initial stages. Alkali damage is due to saponification of fat, creating further heat and damage.

Other causes of burns or burn-like injuries include direct contact thermal burns (from radiators, motorbike exhausts, etc) friction burns and prolonged exposure to ultraviolet radiation (eg, sunburn).

Clinical features
Burn injuries can be divided into primary and secondary injuries, with the former being the immediate damage caused by the burn and the latter the morbidity resulting from the initial injury.

Large burns present with local as well as systemic symptoms. Locally, there may be redness, blistering, swelling and pain or altered sensation. Systemic effects such as hypovolaemic shock, hypothermia, deranged blood test results and metabolic changes may occur as discussed below. Compartment syndrome (see below) can be a problem depending on the burn site.

Hypovolaemic shock may be seen in patients with burns greater than 25% of body surface area (BSA) and is caused by increased vascular permeability that continues for at least the first 36 hours following the burn. Proteins, including albumin, leak out into the interstitial space pulling fluid with them leading to oedema and dehydration. Additionally, the body loses fluid via the burn area, which compounds dehydration. To compensate, the peripheral and splanchnic vessels vasoconstrict and this can lead to hypoperfusion. In the initial phase, cardiac output also decreases because of reduced myocardial contractility, increased afterload and reduced plasma volume. Tumour necrosis factor-α, released as part of the inflammatory response, appears to play a role in the

SUMMARY

Burns are sustained by approximately 175,000 people in the UK each year and vary widely in severity and cause.

The presentation depends of the cause of the burn (eg, from heat, chemicals, electricity or other miscellaneous causes such as friction) and the severity of the burn (which depends on percentage of body surface area burnt and thickness of the burn). Sequelae of large burns include hypovolaemic shock, hypothermia, deranged blood test results, metabolic abnormalities and compartment syndrome.

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reduction of myocardial contractility. Early fluid resuscitation is essential to minimise the effects of shock.

Initially, core body temperature is substantially reduced with large burns. This is a result of heat loss from the burn (caused by high skin temperatures around the area of the burn leading to evaporation of fluids) and hypovolaemic shock. Because of this, patients should be kept in a warm, humid room.

Blood test results are often deranged, with high potassium (caused by damage to cells), low calcium (caused by hypoalbuminaemia), and abnormal clotting (resulting from disseminated intravascular coagulopathy).

About 48 hours after the burn injury, a patient with large burns will become hypermetabolic (the metabolic rate can increase up to threefold). The patient's cardiac output, and therefore organ perfusion, will increase. The baseline temperature will increase to 38.5°C as part of the systemic inflammatory response associated with burns. The patient's immune response is reduced because of receptor downregulation, increasing the risk of infection (which may already be high due to damage to the body's natural shield, the skin).

Inhalational injuries may accompany flame burns, creating problems such as bronchoconstriction or adult respiratory distress syndrome. Patients with inhalational injuries may present with wheezing, hoarseness, increased respiratory secretions, tachypnoea, stridor and hypoxaemia. Carboxyhaemoglobin should be checked to assess the degree of carbon monoxide exposure and patients should receive 100% oxygen. Airway tissues may become inflamed leading to obstruction, so a secure airway is vital.

Pain Burn-associated pain comes from a variety of sources including the burn itself, surrounding tissue, dressing changes and donor graft sites. Following a burn, the inflammatory response leads to the release of mediators, such as bradykinin and histamine, which trigger pain signals. A full-thickness burn (Figure 1) may damage the nerve to the extent where the pain signal cannot be felt. However, the surrounding tissue may not have been burnt to the same depth, meaning that pain is still present. Primary hyperalgesia is the heightened response to pain at the burn site. Secondary hyperalgesia develops minutes later and is caused by nerve transmission from the surrounding undamaged skin. Hyperalgesia may last for days. Pain alters during the treatment period but tends to be worst at donor sites or areas of upper- or mid-dermal skin loss.

Once the burn site is covered with either a graft or appropriate dressing the pain usually reduces. Donor site pain may persist for 10–14 days after harvesting. Five to six weeks post-burn, nerve regeneration occurs, and nerve endings growing back into healing tissue can cause altered sensations and neuropathic pain. It is estimated that 52% of burn survivors suffer from long-term or chronic pain.

Assessment

There are two common methods used to assess the extent of a patient's burns: Wallace's "rule of nines" and the Lund and Browder chart (see Figure 2). The rule of nines splits the body into 12 sections: 11 of the areas are each estimated. The Lund and Browder chart is the more accurate of the two methods because it takes into account the change in body proportion relating to age (eg, children have relatively larger heads than adults). Erythematous regions should not be included in BSA estimations.

Burn depths can be classified by degree. They can also be described as superficial, partial thickness or full thickness. The extent of burn injury (percentage of burn area) and depth of burn injury determine the treatment plan. Partial thickness burns are classified into two types: superficial partial thickness (less than one-third thickness of skin) and deep partial thickness (more than one-third thickness of skin). Full-thickness burns are those that penetrate all layers of the skin. Complete destruction of the skin results in a devascularization syndrome, and if left untreated, will lead to amputation and death. Partial thickness burns may involve the removal of the epidermis and partial destruction of the dermis or full thickness burns with involvement of the epidermis, dermis and subcutaneous tissue.
Inhalational injury
High tension electrical burn
Chemical burn >5% BSA
Suspicion of non-accidental burn
Dermal or full-thickness burns >10% of BSA (=5% if over 16 years old)
Dermal or full-thickness burns to face, hands, perineum, feet or flexures
Age under five or over 60 years old
Exposure to ionising radiation

Box 1: Burn damage according to depth

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>DEGREE</th>
<th>EXTENT OF DAMAGE</th>
<th>APPEARANCE</th>
<th>HEALING TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>First</td>
<td>Epidermis</td>
<td>Pink, moist, bleeding, painful</td>
<td>Days</td>
</tr>
<tr>
<td>Partial thickness: superfi</td>
<td>Second</td>
<td>Papillary dermis</td>
<td>Pink, blistering, moist, bleeding, painful</td>
<td>One to two weeks</td>
</tr>
<tr>
<td>Partial thickness: deep dermal</td>
<td>Second</td>
<td>Reticular dermis</td>
<td>Patchy red and white, dry, no bleeding, reduced sensation</td>
<td>&gt; Four weeks</td>
</tr>
<tr>
<td>Full thickness</td>
<td>Third</td>
<td>Whole thickness of skin</td>
<td>White/black, dry and leathery, no bleeding, lack of sensation</td>
<td>&gt; Four weeks</td>
</tr>
<tr>
<td>Fourth</td>
<td></td>
<td>Skin plus tendons, tissue, muscle and bone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Jackson's burn model splits the burn into three distinct zones: the zone of coagulation, the zone of stasis and the zone of hyperaemia (see Figure 3). The zone of coagulation is at the centre of the burn and is an area of severe damage resulting in irreversible tissue loss. Although the zone of stasis contains less damaged tissue, perfusion is affected and the correct treatment must be provided to prevent progression to necrosis and allow full recovery. The zone of hyperaemia contains tissue that is well perfused and this usually recovers well.

Assessment techniques

In the first few days after injury it is often difficult to determine the depth of a burn and, thus, the prognosis and need for surgery to aid recovery. Various methods have been employed to supplement visual inspection of the burn. Techniques that assess tissue perfusion in the injured area give a more objective assessment of prognosis. Increasingly, a technique called laser Doppler imaging (LDI) is being used and appears to give the most accurate measurement of burn depth among the available techniques. Depth is assessed by taking a thermal image of the burn area which correlates with skin blood flow. The disadvantage of LDI is that it is expensive and requires a high level of expertise to interpret the results (so is not routinely available in many centres that treat burns).

Admission criteria

To ensure that treatment is appropriate, the British Burn Association has published criteria for complex burn injury. (see Box 2). Patients meeting these criteria should be referred to a specialist unit within six hours of injury since swift assessment and treatment of burns is crucial to optimise patient outcomes. The very young and the elderly are particularly at risk of complex burn injuries.

References