1. INTRODUCTION

The skin is the most extensive organ of the human body: it keeps it separate from the external environment, regulates its temperature and protects it from infection. However, this barrier can be destroyed in 1 second when burned.

Burns still constitute one of the main accidents in homes and industry, and are also linked to social and economic risk factors. A good education and awareness of this problem is the first pillar in decreasing the morbidity and mortality rates caused by burns. The second fundamental pillar is prompting assistance and adequate treatment to improve outcomes and avoid complications.

Despite the advances in tissue engineering and surgical techniques, burn wounds are a constant challenge for health-care professionals, from the emergency department doctor to the plastic surgeon.

2. EPIDEMIOLOGY

Burns are responsible for around 265,000 deaths every year worldwide and are an important cause of temporary and permanent disability in children. Approximately 11 million people worldwide required medical care for burns in 2004. According to recent data, the number of patients killed by exposure to smoke, fire and flames was 193 in 2012 in England and Wales.

Paediatric burn injuries usually occur at home while cooking. However, while most burns in women mostly occur at home, most burns in men occur outdoors and at work and most burns in the elderly occur in the bathroom (Randic et al., 2002; WHO, 2008; CDC, 2008; Peck, 2011; Office of National Statistics, 2012).
3. TYPES OF BURNS

It is important to mention that different types of burns are classified according to the mechanism of injury; however, in general, burns are classified according to their depth and surface area (Table 5.1 and Figure 5.1). These are the most relevant types of burns (a complete description of cold-induced injuries is not included in this chapter).

3.1. Thermal burns

3.1.1. Flash and flame burns

Flame is the most common cause of burns in adults and elderly individuals are the main population affected by this type of burn in England and Wales. Flames produce deep burns especially if clothes have been on fire, and are usually associated with inhalational injury and trauma. On the other hand, flash burns produce injuries that differ depending on the type and amount of fuel that explodes (Hijar-Medina et al., 1992; Forjuoh, 1998; Lentz, 2009; Sanford and Gamelli, 2014).

3.1.2. Scalds

Scalds are the main cause of burns in children and frequently in elderly people. In Europe, 25% of patients hospitalised for thermal injuries are children aged 0–4 years; of these, 90% suffer from scalds and in 90%, the total body surface area (TBSA) affected was <20%. Scalds are usually caused by spilling hot water or by using too hot water for bathing. Toddlers that accidentally fall into a bath of hot water will struggle and move about, thus producing multiple splash burns and making the border of the injury ill-defined. This type of burn depends not only on the water temperature but also on the skin thickness and duration of exposure (Hijar-Medina et al., 1992; Forjuoh, 1998; Lentz, 2009).

Scalds can also be caused by grease and hot oils, which produce deeper burns. Usually, patients who have grease burns on their lower extremities require surgery (Schubert et al., 1990; Bill et al., 1996; Klein et al., 2005).

3.1.3. Contact burns

Contact burns are common in industry; loss of consciousness (for different reasons) is the main cause. Hot metal, plastic, glass and coal are the main elements that produce this type of burn. Their severity hinges on the time of exposure (Steinstraesser and Al-Benna, 2013; Sanford and Gamelli, 2014).
3.1.4. Tar burns

Tar is a viscous, waxy substance derived from petroleum that has a high boiling point (140–232°C) and various industrial applications, such as surfacing roads and roofing (Stratta et al., 1983; Steinstraesser and Al-Benna, 2013).

Tar is associated with deep burns for three reasons: (1) when splashed, it cools rapidly to between 93°C and 104°C in the air; (2) when it contacts the skin, it cools and solidifies; and (3) it adheres to the skin, producing a continuous injury (Demling et al., 1980; Bose and Tredget, 1982; Stratta et al., 1983).

If the tar is still hot when the patient arrives to the medical facility, it should be rapidly cooled with room temperature water to prevent deeper burns; however, removal is not essential despite allowing an early assessment of the injury. Mechanical or manual debridement is painful and will also remove viable underlying skin; therefore, the tar should only be removed by qualified personnel (Demling et al., 1980; Bose and Tredget, 1982; Stratta et al., 1983; Robinett et al., 2010; Steinstraesser and Al-Benna, 2013).

3.2. Chemical burns

Different sorts of chemicals can affect not only the skin but also other organs. The most frequent substances that produce chemical burns are sodium hypochlorite, phenol, white phosphorous, sulphuric acid, mustards, arsenicals and halogenated oximes.

3.2.1. Sodium hypochlorite

Commonly known as household bleach, this is a strong alkaline solution that causes protein coagulation and, when ingested, oesophageal constriction and perforation of the stomach. This type of burn depends on the concentration of the solution rather than the duration of exposure. Therefore, skin should be washed thoroughly with a large volume of water (Racioppi et al., 1994; Steinstraesser and Al-Benna, 2013).

3.2.2. Phenol (carbolic acid)

Carbolic acid or phenol is an aromatic hydrocarbon that was first used for its antiseptic properties by Joseph Lister in 1865 (Lister, 1867). It is also used in chemical face peels and as a topical anaesthetic for skin and mucous membranes. Superficial burns caused by phenol produce a light grey lesion and deep burns are black. This type of burn is usually painless or somewhat uncomfortable because it causes demyelination of nerves and the destruction of nerve endings. It is highly lipid-soluble and therefore easily absorbed through the skin causing, in the worst cases, death from dysrhythmias, haemolysis and cerebral oedema. Therefore, emergency treatment is cleaning the skin with a large volume of water and gently wiping away the chemical with a sponge soaked in undiluted polyethylene glycol (PEG 300 or
400). After that, the affected area should be washed with soap and water (Warner and Harper, 1985; Horch et al., 1994; Newsom, 2003; Lin et al., 2006).

### 3.2.3. White phosphorous

There are two forms of phosphorous: red, which is insoluble, non-absorbable and non-toxic; and yellow, better known as white phosphorous, which has a scent like garlic and is highly toxic because of its high lipid solubility and easy penetration of the skin. White phosphorous is a yellowish, waxy, translucent solid element that melts at 44°C and spontaneously ignites at 34°C unless kept in oil. It is used in munitions, incendiary weapons, fireworks, insecticides and fertilisers. On the skin, white phosphorous causes both chemical and thermal injury. It oxidises adjacent tissue and generates heat to produce a painful thermal burn. The aim of treatment is to prevent further absorption and thus avoid systemic toxicity such as hypocalcaemia and acute central nervous system depression. Therefore, the skin should be cleaned with a large volume of water and removable pieces of phosphorous should be picked out. Non-removable pieces require excision in the operating theatre and should be kept wet to prevent spontaneous combustion (Eldad and Simon, 1991; Chou et al., 2001).

### 3.2.4. Sulphuric acid

Sulphuric acid is a desiccant that has many industrial applications. It is used in lead–acid batteries, fertilisers, wastewater processing and chemical production. Its reaction with water is highly exothermic and it produces almost immediate coagulative necrosis of the skin and subcutaneous tissues. Deep dermal burns have a bronzed leathery appearance with deep ulceration underneath. The immediate treatment is to irrigate the skin with copious amounts of water and soap, and irrigation should continue until there is no pain or pH paper shows no acidic reaction. An experimental study showed that if sulphuric acid is left for more than a minute without treatment, then the burn will become full thickness, needing early excision and repair (Van, 1962; Husain et al., 1989).

### 3.2.5. Sulphur mustard

Sulphur mustard is a transparent, amber-coloured, oily alkaline agent. It easily penetrates clothing and the skin, and inhalation causes necrosis of lung parenchyma. It binds to the DNA of skin cells, causing cell death and the formation of vesicles. Despite its well-known mechanism of action toward DNA, it is still not understood why the epidermis separates from the dermis to form vesicles. Immediate treatment is to remove contaminated clothing and perform skin decontamination with either a passive (Fuller’s earth) or active substance (reactive skin decontamination lotion or Dutch powder). Superficial injuries will not require surgical intervention and will spontaneously resolve within a few days to a week; however, they are painful. A recent in vivo study showed that dermal application over the exposed area of a formulation composed of \( N,N'\)-dichloro-bis[2,4,6-trichlorophenyl]urea plus Aloe vera plus betaine (DRDE/WH-01) promotes re-epithelialisation, angiogenesis and fibroplasia and could be used as
decontaminant and wound healant for injuries caused by sulphur mustard (Mellor et al., 1991; Wormser, 1991; Casillas et al., 2000; Evison et al., 2002; Lomash and Pant, 2014).

3.3. Electrical burns

Electrical burns are also caused by certain hazardous occupations (e.g. railway workers, electrical workers); therefore, a good diagnosis of the damage relies on a good medical history. Electrical burns are classified as high voltage (≥1000V), low voltage (<1000V) and those caused by lightning (Mangelsdorff et al., 2011; Sanford and Gamelli, 2014).

The degree of damage is usually more extensive than perceived on initial examination. Electricity generates heat while flowing through the body, thus affecting not only the skin but also all other tissues and organs it passes through on its way to the bone. Low-voltage burns cause a small partial-thickness injury in most cases. However, high-voltage injuries usually cause large skin lesions with necrosis at the contact point and even deeper, and thus a series of damage types from compartment syndrome to multiorgan injury need to be quickly identified so that the correct treatment can be started. These wounds are potentially life-threatening or disabling (Mangelsdorff et al., 2011; Steinstraesser and Al-Benna, 2013; Sanford and Gamelli, 2014).

3.4. Burns as a sign of abuse

Burns can be a sign of abuse: this is more common in the paediatric population but can also be seen in the elderly and people with disabilities. A thorough clinical and social history is especially important if there is a suspicion that burn wounds could be caused intentionally by another person. An inadequate social environment such as young parents, a dysfunctional family or a previous history of abuse should raise suspicion (O’Neill et al., 1973; Hight et al., 1979; Peck, 2012; Wibbenmeyer et al., 2014).

Children aged less than 5 years are most commonly affected. Burns represent 44% of cases of abuse and scalds are the most common; most compromise <5% of TBSA (Figure 5.4; Hobbs, 1986; Wibbenmeyer et al., 2014).

3.5. Recognise an accidental scalding

In the case of a true accidental burn, most adults are alarmed by the injuries produced and look for medical assistance. When taking the medical history of a burned patient, especially toddlers, the first thing to do (if possible) is to corroborate the history given by the care giver with the history given by the child, the social context and the appearance of the burn wounds. Accidental scalding burns tend to have an irregular shape and distribution, and children commonly suffer this type of burn because of their lack of stature. Hot liquid usually comes from above, giving a typical cascade scald involving the chin, neck, shoulder and chest regions (Daria et al., 2004; Wibbenmeyer et al., 2014).
3.6. **Indicators for suspicion**

Suspicion should be raised when there is a delay in seeking medical help, when burn injuries have clear edges, no splash marks and a limited anatomical distribution, and when an inconsistent history is provided by the carer, especially if the mode and time of injury given in the history do not correlate with the pattern and appearance of the wound. Suspicion should also be raised when the child does not seek the carer for comfort or when a toddler is quiet or unresponsive. There may also be other lesions that indicate physical abuse (Hobbs, 1986; Wibbenmeyer et al., 2014).

3.7. **Recognised patterns on injury**

The same objects that cause accidental burns can also be used to cause intentional burns, but certain recognised patterns are useful for distinguishing these burn types. Usually accidental contact occurs for a short period of time and involves a small part of the hot object, leaving a burn area with unclear margins. However, premeditated burns are usually formed by a larger portion of the hot object, leaving a symmetrical deep injury with clear margins, sometimes affecting covered areas such as the buttocks and perineum (Daria et al., 2004; Wibbenmeyer et al., 2014).

3.7.1. **Cigarette burns**

As a sign of abuse, cigarette injuries are usually multiple, are often found on the palms, soles and buttocks, and present as deep, circular burns approximately 1 cm in diameter. It is common to also find older scars on other parts of the body. In contrast, an accidental cigarette burn caused by the child brushing against a glowing cigarette tends to be oval or elongated in outline, superficial and single (O’Neill et al., 1973; Hobbs, 1986).

3.7.2. **Electrical burns**

Abusive electrical burns also tend to be multiple, affecting areas such as the face, trunk and upper limb and producing deep coagulative necrosing injuries. Accidental electrical burns in young children frequently occur at the corners of the mouth or on the hands (Hobbs, 1986).

3.7.3. **Scalds**

Scalds are the most common type of abusive injury. Although it may be difficult to determine whether a scald is accidental (e.g. because the whole body may be affected), some small details should be considered. If scalding happens in a sink or bath, the bottom of the vessel remains at a lower temperature than the water inside it; therefore, if a child is immersed in the water, the palms and soles will often not be
burned because they are in contact with the bottom of the bath. A similar pattern will appear in children who held their knees in a flexed position against their abdomen: the flexor areas of knees and the lower abdomen will not be affected, and nor will the anterior part of thighs. If the hands or feet were forcibly held in hot water, the typical scald pattern resembles a glove or stocking. In addition, in these cases the margins of the burn will be clear and it is rare to find splash marks.

Another scald burn pattern commonly called ‘head first, face down’ (Figure 5.3) occurs when the head (facing down) is immersed in a sink containing hot water. In this type of burn, the neck usually has little or no damage because it is compressed against the back wall of the sink; there may also be little damage around the eyes because the child has closed the eyes tightly (O’Neill et al., 1973; Feldman et al., 1978; Hight et al., 1979; Hobbs, 1986; Stratman and Melski, 2002; Daria et al., 2004; Wibbenmeyer et al., 2014).

To summarise, some of the main aspects of burns as a sign of abuse are (see also Figure 5.4; Hobbs, 1986):

1. Repeated burns or burns occurring in a pattern of repeated injury
2. Injury incompatible with the history
3. Inappropriate parental response – delay seeking treatment, blaming the child or a sibling, denial that the lesion is a burn
4. Changes in the history; absence of eye-witness accounts
5. Site – hand, especially back and wrist, buttocks, and feet and legs
6. Type – contact burns in unusual sites showing clear outline of object or scalds with clear-cut edges or a glove and stocking distribution.

4. PATHOPHYSIOLOGY

Exposure of the skin to high temperatures results into two responses: local and systemic

4.1. Local response

In 1947, Jackson introduced the three areas of local response: zones of coagulation, stasis and hyperaemia. The zones are three-dimensional. Therefore, increased tissue loss will lead to both deepening and widening of the wound (Figure 5.2).

4.1.1. Zone of coagulation

Cells in the immediate area of contact die and the surrounding tissue coagulates and denatures. There is no blood circulation in this area.
4.1.2. Zone of stasis

Blood perfusion is decreased but the tissue may be salvageable. Burn resuscitation is essential to prevent additional damage. Increased damage could occur because of prolonged hypoperfusion, oedema and infection.

4.1.3. Zone of hyperaemia

This is the outermost zone; perfusion is increased and tissue here will recover unless there is another insult such as sepsis or hypoperfusion (Hettiaratchy and Dziewulski, 2004; Evers et al., 2010).

4.2. Systemic response

The whole body is affected by the release of cytokines and other inflammatory mediators from the wound site. However, when the TBSA exceeds 30%, a systemic effect becomes apparent. Systemic effects may be (Hettiaratchy and Dziewulski, 2004; Neligan et al., 2013):

- **Cardiovascular** – decreased myocardial contractility, increased capillary permeability, and peripheral vasoconstriction, which may lead to systemic hypotension and end-organ hypoperfusion.
- **Respiratory** – bronchoconstriction caused by inflammatory mediators that, in severe cases, could result in adult respiratory distress syndrome.
- **Metabolic** – if the metabolic rate is increased to three times the original rate, early and aggressive enteral feeding may be needed to maintain gut integrity.
- **Immunological** – the immune response is downregulated, affecting both cell-mediated and humoral responses.

5. WOUND HEALING

Wound healing is a complex process requiring a number of biological and physiological phases to accomplish proper wound closure. These phases are haemostasis, inflammation, proliferation and remodelling.

5.1. Haemostasis

Loss of blood from damaged capillaries and vessels is halted by vasoconstriction and the formation of blood clots. Blood clots formed from fibrin and platelets act as a temporary matrix for the wound and prevent foreign body infiltration.
5.2. **Inflammation**

The degranulation of platelets and the release of different cytokines and growth factors act as a chemo-attractant for inflammatory cells, epithelial cells and inflammatory factors. For the wound to proceed to the next phase, it must be sterile. This usually occurs after 2–3 days for normal wounds.

5.3. **Proliferation**

Macrophages at the wound site release a number of growth factors that activate and attract endothelial cells, fibroblasts and keratinocytes. As granulation tissue forms, a microvascular network infiltrates the wound for perfusion. Together, the wound filling with granulation tissue and complete epithelialisation signal the end of the proliferative phase.

5.4. **Remodelling**

This phase lasts for 1–2 years and may take longer. It is characterised by increasing tension and strength of the tissue and by type 3 collagen being replaced by type 1. Normal dermis contains 80% type 1 collagen and 20% type 3; however, in injured wounds, the proportion of type 3 collagen may increase up to 40% (Velnar et al., 2009; Zahedi et al., 2010).

6. **ACUTE MANAGEMENT AND ASSESSMENT**

The first step in managing a burn victim is to remove them from the harmful environment. Burn patients are handled as critically ill patients by conducting an initial primary survey and then a detailed secondary survey. Initial assessment of the airway is crucial, accompanied by an assessment of breathing and circulation. Basically, ‘ABC’ (see Section 6.1) assessment is performed, followed by assessment of any coexisting injury that needs prompt attention. It is important to remember to remove any material that retains heat such as jewellery, clothing and watches. Oxygen should be delivered as soon as possible and an inhalation injury that needs prompt attention. It is important to remember to remove any material that retains heat such as jewellery, clothing and watches. Oxygen should be delivered as soon as possible and an inhalation injury that needs prompt attention. Cooling of the wound with room temperature water to disperse heat from the wound can then be done, but cold water or ice water should not be used because they can cause hypothermia. Some burn injuries can be treated in primary care units but others need a specialised burn centre, including (Cancio, 2014):

- Those requiring burn shock resuscitation.
- Partial-thickness burns affecting >10% TBSA, especially in medically fragile patients.
- Burns involving the face, hands, feet, genitalia, perineum or major joints.
- Deep and full-thickness burns in any age of patient.
Circumferential burns in any patient group.
- Special types of injuries – electrical, chemical and lightning.
- Where there is suspicion of an inhalation injury.
- A burn of any size accompanied by concomitant trauma or disease.

### 6.1. Primary survey

When arriving at the emergency department, the primary survey assesses ‘ABCDEF’:
- A – Airway with cervical spine control
- B – Breathing
- C – Circulation
- D – Neurological disability
- E – Exposure
- F – Fluid resuscitation.

A proper history is vital for appropriate treatment planning. Some key points in history taking are:
- The mechanism of the injury
  - The nature of the injury (scald, flame, flash, electrical, chemical)
  - Time of the injury
  - What the treatment was started
  - Any risk of associated injury (such as fall or explosion)
  - Loss of consciousness.
- Suspicion of inhalation injury
  - Whether it occurred in a closed or open area
  - How long the patient was exposed to smoke
  - When fluid resuscitation was started.
- Past medical history
  - Allergy
  - Medical illness
  - Asthma
  - Tetanus status.

Early intubation should be performed to secure the airway because smoke inhalation causes more than 50% of fire-related injuries. The airway can be examined by a laryngoscope and the bronchial tree by a bronchoscope. Patients who are breathing spontaneously and at risk of inhalation injury should be placed on high-flow humidified oxygen to reduce the risk of airway collapse. A chest X-ray should be done, although it lacks sensitivity for inhalation injuries. Carbon monoxide poisoning is a recognised complication of inhalation injury. Pulse oximetry does not accurately calculate carbon monoxide exposure, so other means such as arterial blood gas analysis and bronchoscopy should be performed. Patients
with carbon monoxide poisoning should be placed on 100% oxygen using a non-rebreather face mask (Neligan et al., 2013; Cancio, 2014).

Signs of inhalation injury are:

- Flame burns
- Burns that occur in an enclosed space
- Full or deep-thickness burns to the face or neck
- Singed nasal hair and eyebrows
- Carbonaceous sputum
- Hoarseness, stridor or wheezing.

Indications for intubation are:

- Swelling of the oropharynx on direct visualisation
- Change in the voice, with hoarseness or a harsh cough
- Stridor, tachypnea or dyspnoea
- Carbonaceous particles on patient’s face.

Fluid resuscitation should be initiated for adults with more than 20% of TBSA affected and for children with 10–15% of TBSA affected. The Parkland formula for burn resuscitation is the most used formula: 4 ml × kg × TBSA. This calculates the amount of fluid that should be given in 24 hours: half in the first 8 hours and the other half over the next 16 hours. If intravenous access cannot be established, an interosseous line should be placed through the tibia. Urine output should be measured by inserting a Foley catheter to assess the fluid balance. Urine output should be maintained at 0.5–1.0 ml/kg per hour and any signs of change in the urine should be noted. The pulse rate and blood pressure should be monitored closely. Non-invasive blood pressure measurements are sometimes unreliable because of interference by tissue oedema. A radial arterial line is the first choice, but if this is not possible then a femoral catheter could be established (Neligan et al., 2013; Brown et al., 2014).

### 6.2. Secondary survey

After completing the primary survey, a secondary survey should include an assessment of the depth and percentage TBSA of burn wounds. TBSA can be calculated in adults by the Wallace ‘rule of nine’; for children, a unique calculation should be performed (see Figure 5.5). Depths of wounds are categorised into four parts (see Figure 5.1; Vojvodic et al., 2014):

- **Epidermal** – only the epidermis is involved and sensation is still intact, wound can be painful and should be allowed to heal by itself for about 7 days.
- **Superficial partial thickness** – epidermis and part of the papillary dermis is damaged, usually very painful. Blistering may occur and the wound blanches. These wounds should be left alone to heal for about 14 days.
- **Deep partial thickness** – the entire epidermis and the papillary dermis is destroyed with part of the reticular dermis. Sensation can be lost and large blisters may form. Proper care for this type of wound should be provided with surgery and dressing. These take about 14–21 days to heal.

- **Full thickness** – the entire thickness of the skin is lost, possibly with deeper tissue. There are no blisters or sensation. They don’t heal spontaneously; a skin graft is needed if depth exceeds >1 cm.

## 7. WOUND MANAGEMENT

### 7.1. Topical ointments

Silver sulfadiazine is the most common ointment used. It has a half-life of 10 hours and a good antibacterial spectrum. It is important to consider that in some patients it causes temporary leucopaenia when used on large body areas; however, it does not increase the risk of infection (Caffee and Bingham, 1982; Choban and Marshall, 1987).

Mafenide is another ointment often used for full-thickness burns; it has a bacteriostatic action. It has two main side effects: it causes pain during initial applications; and when used for wide burns, it produces metabolic acidosis due to inhibition of carbonic anhydrase (Shuck and Moncrief, 1969; Liebman et al., 1982; Lee et al., 1988).

Silver nitrate is another compound used for burn wound healing. An alternative version of this compound (Acticoat) was developed using silver nanoparticles; however, studies have not proven its safety with regard to keratinocyte and fibroblast toxicity. Recently, a safer hydrogel was developed by modifying this compound using γ-irradiation. It has good antibacterial action against *Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus*, but further research should be done to corroborate this effect (Fong and Wood, 2006; Boonkaew et al., 2014).

### 7.2. Wound dressings

An ideal dressing should (Schiestl et al., 2013):

- Provide maximal support for wound healing
- Provide maximal protection against infection
- Cause minimal pain during dressing changes without anaesthesia
- Have a minimal cost.

However, the ideal wound dressing does not exist and so research is continuing to find the best biomaterial. The most basic and common wound burn dressing is gauze covered with soft paraffin, which
helps prevent adherence to the wound. A topical antiseptic can be applied and covered with gauze. However, this type of dressing is only useful for first- and second-degree burns (Schiestl et al., 2013).

7.2.1. Biological wound dressings

The treatment of choice for excised burn wounds is an autograft but, in patients in whom a considerable surface area is affected, donor site may be very limited. Therefore, they need a temporary skin substitute that can be applied while donor sites re-epithelialise. For these patients, the main biological wound dressing is a skin allograft from a cadaver. If it is properly preserved, this skin is viable and revascularises in the patient wound bed. Patients with massive burns are immunocompromised, but will eventually start to develop an inflammatory infiltrate and this skin allograft will be rejected (Chan et al., 2012; Steinstraesser and Al-Benna, 2013).

A good, cheaper alternative to this biological dressing is a cultured epidermal autograft made with cultured keratinocytes taken from neonatal foreskins obtained from circumcisions. However, they are only a temporary coverage because they are also rejected (Steinstraesser and Al-Benna, 2013).

Recent research focussing on the development of skin substitutes using stem cells obtained from debrided burn skin has shown promising results. The different layers of the skin can develop if they are added to an appropriate scaffold (Table 5.2; Chan et al., 2012).

7.2.2. Physiological wound dressings

Synthetic dressings are an excellent alternative for covering burn wounds, especially for second-degree burns. Their function is to stimulate skin regeneration and act as a barrier to prevent infections. Therefore synthetic dressings do not work properly on full-thickness burn injuries because they do not adhere properly and become a risk factor for infections as they do not have antimicrobial properties. However, more complex synthetic dressings are not becoming widely available because of their cost (Singer and Dagum, 2008; Schiestl et al., 2013; Steinstraesser and Al-Benna, 2013; Wasiak et al., 2013).

8. CONCLUSION

Burn injuries are rarely conventional; most are associated with a number of insults. Each type of injury needs proper identification, assessment and management. The main goal in burn management is to deliver the necessary support for the cardiac, respiratory and renal systems and avoid end-organ damage. Secondary treatment includes the adequate debridement of dead tissue, repair of salvageable tissue with wound care and dressing changes, and skin grafting. Finally, the rehabilitation stage aims to return the patient to their pre-injured state. Proper judgement and actions contribute to decreased mortality and morbidity rates.
## 9. APPENDIX

### Table 5.1. Classification of burns by depth and surface area.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Depth</th>
<th>Total body surface area</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>First degree</td>
<td>Superficial</td>
<td>&lt;10% in adults, &lt;5% in children or elderly, &lt;2% for full-thickness burn</td>
<td>Erythematos, Painful</td>
</tr>
<tr>
<td>Second degree</td>
<td>Superficial partial thickness</td>
<td>10–20% in adults, 5–10% in children or elderly, 2–5% for full-thickness burn</td>
<td>Clear blisters, Painful, Sensitive, Blanch to touch, Haemorrhagic blisters</td>
</tr>
<tr>
<td></td>
<td>Deep partial thickness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third degree</td>
<td>Full thickness</td>
<td>&gt;20% in adults, &gt;10% in children and elderly, &gt;5% for full-thickness burn</td>
<td>Dark brown or tan, Leathery texture, Insensitive to touch</td>
</tr>
</tbody>
</table>

### Table 5.2. Skin substitutes.

<table>
<thead>
<tr>
<th>Product</th>
<th>Category</th>
<th>Wound uses</th>
<th>Method of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human allograft</td>
<td>Split thickness skin</td>
<td>Partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Human amnion</td>
<td>Epidermis–dermis</td>
<td>Partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Xenograft-pig skin</td>
<td>Dermis</td>
<td>Partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Biobran®</td>
<td>Synthetic epidermis and dermis</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Oasis®</td>
<td>Bioactive dermal-like matrix</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Transcyte®</td>
<td>Bioactive dermal matrix</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Duoderm®</td>
<td>Synthetic epidermis and dermis</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Opsite®</td>
<td>Synthetic epidermis and dermis</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Suprathel®</td>
<td>Synthetic epidermis and dermis</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Tegaderm®</td>
<td>Synthetic epidermis and dermis</td>
<td>Superficial partial thickness</td>
<td>Temporary</td>
</tr>
<tr>
<td>Apligraf®</td>
<td>Composite of epidermis and dermis</td>
<td>Deep partial thickness</td>
<td>Permanent</td>
</tr>
<tr>
<td>OrCel®</td>
<td>Composite of epidermis and dermis</td>
<td>Deep partial thickness and donor site</td>
<td>Permanent</td>
</tr>
<tr>
<td>Epicel®</td>
<td>Epidermis</td>
<td>Deep partial and full thickness</td>
<td>Permanent</td>
</tr>
<tr>
<td>Aloderm®</td>
<td>Dermis</td>
<td>Deep partial and full thickness</td>
<td>Permanent</td>
</tr>
<tr>
<td>Integra®</td>
<td>Biosynthetic dermis</td>
<td>Full thickness</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

*Sources: Neligan et al. (2013), Snyder et al. (2012) and Shevchenko et al. (2010).*
**Figure 5.1.** Depths of burn wounds.

**Figure 5.2.** Jackson’s areas of local response.
Figure 5.3. ‘Head first, face down’ sink immersion. Source: Daria et al. (2004).

Figure 5.4. Distribution of inflicted and unintentional burns on young children. Source: Daria et al. (2004).
**REFERENCES**


