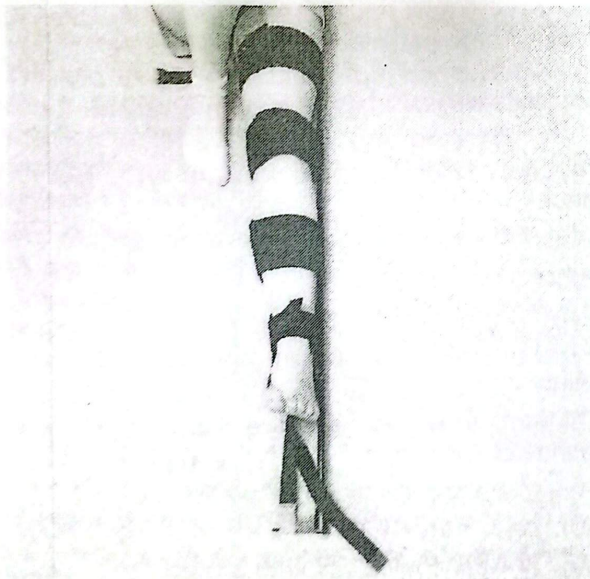




9. Apply traction by pulling on the RED tab. As a guide, apply around 10% of body weight (up to 7kg) tension. Use patient comfort as the main objective. Traction can be applied smoothly by grasping the strap either side of the buckle and simultaneously feeding and pulling with equal pressure



10. Finish packaging by applying upper and lower straps. Re-check and record MSC

6 Burns

6.1 Learning objectives

By the end of this lesson you will be able to:

- Explain what is meant by the term 'burn'
- Describe the types of burn and their causes
- Explain the safety considerations when dealing with burns
- State the rules associated with estimating the size of burns
- Explain time-critical factors that affect the management of burns
- Explain the complications associated with burns
- Explain the treatment of burns
- Explain why burns patients are transported to definitive care.

6.2 Introduction

A burn is an injury caused by energy transfer to the body's tissues, causing necrosis and an associated inflammatory reaction [Greaves, 2008].

It is estimated that there are 250,000 burn injuries a year in the United Kingdom, resulting in 175,000 visits to an emergency department [NBCRC, 2001]. In England and Wales, serious burn injury (defined as requiring at least a 72-hour stay in hospital) is responsible for 5.4% of all serious trauma [Kalson, 2012].

Burn injury most commonly occurs in the home (over 30%) with the kitchen being the favoured location. The most common sources of injury are [NBCG, 2008]:

- Cup of tea in children
- Petrol ignition in adults
- Bathing, kettle spills and central heating radiators in elderly people.

Burns are commonly split into a number of types [AACE, 2013]:

- Chemical
- Cold
- Electrical
- Friction
- Radiation
- Thermal.

Note: Cold injury was discussed in the EXTREMES OF TEMPERATURE lesson (chapter 13).

6.3 Assessment of burns

History

It is important to identify the mechanism, including the cause of the burn, how it came into contact with the patient and any first aid undertaken. Note when the injury occurred, how long the patient was exposed to the source and the duration of any cooling. Don't forget to be alert for signs of non-accidental injury.

Assessment

Pre-hospital estimation of total body surface area (TBSA) of burn injury is poor, with the 'rule of nines' (Figure 6.1) underestimating burns of less than 20% and overestimating burns over 40%; also, it is not suitable for children under 14 years of age [Hettiaratchy, 2004; AACE, 2013].

The whole hand (palm and fingers) represents about 0.82% TBSA in adults and 0.77% in children, making accurate calculations tricky. However, the palm alone is 0.5% TBSA [Muehlberger, 2010] and is suitable for estimating burns less than 15% or greater than 85% TBSA. Note that these methods will generally underestimate %TBSA in obese patients [Berry, 2001].

Lund and Browder charts are more accurate, but these are cumbersome to complete in the back

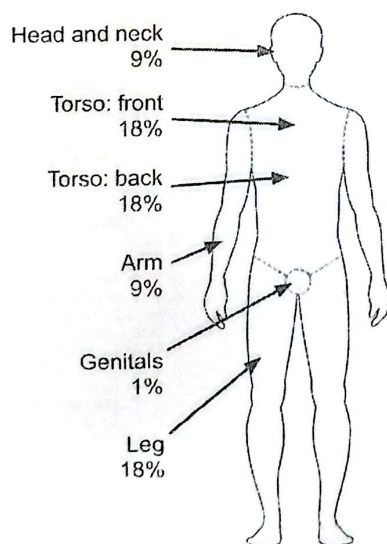


Figure 6.1 The 'rule of nines'

of an ambulance. An alternative that has been advocated is serial halving [Allison, 2004]. This involves determining whether greater than or less than 50%, 25% and finally 12.5% of the TBSA is burnt. This approximation is sufficient to determine whether the patient requires referral to a burns unit (if direct access is an option) and the need for intravenous fluids. Erythema (reddening) should not be included when calculating TBSA of burn injury [Enoch, 2009].

6.3.1 Classification

Although important for subsequent burns management, the depth of a burn does not affect pre-hospital treatment, but may provide some indication as to the cause (Table 6.1) [NZGG, 2007].

6.3.2 Burns requiring transport to hospital

The National Network for Burn Care (NNBC) has set out a suggested minimum threshold for patients who may require specialised burn care services. These patients will usually require transport to hospital, but check with your own ambulance service's local arrangements [NNBC, 2012]:

- All burns $\geq 2\%$ TBSA in children or $\geq 3\%$ in adults
 - All full thickness burns
 - All circumferential burns
 - Any burn not healed in 2 weeks
 - Any burn with suspicion of non-accidental injury
 - All burns to hands, feet, face, perineum or genitalia
 - Any chemical, electrical* or friction burn
 - Any cold injury
 - Any unwell/febrile child with a burn.
- *May not apply to low (domestic) voltage injury

6.4 Thermal burns

Pathophysiology

The most common type of thermal burns are flame, scald and contact. Flame burns are more common in adults and are often associated with smoke inhalation and other traumatic injuries. These are more likely to result in deep dermal or full-thickness burns.

Table 1: Burns classification

Classification	Other names	Example causes	Appearance	Sensation
Epidermal	Superficial, 1st degree	Ultraviolet light	Dry and red, blanches with pressure, no blisters	May be painful
Superficial dermal	Superficial, partial thickness, 2nd degree	Scald (spill or splash)	Pale pink, fine blisters, blanches with pressure	Very painful
Mid-dermal	Superficial, partial thickness, 2nd degree	Scald (spill), flame	Dark pink with large blisters, delayed capillary refill	May be painful
Deep dermal	Deep partial thickness, 2nd degree	Scald (spill), flame	Blotchy red, may blister, no capillary refill	No sensation
Full thickness	3rd degree	Scald (immersion), flame, steam, high-voltage electricity	White, waxy or charred. No blisters or capillary refill Children: dark lobster red with mottling	No sensation

Scalds are the most common cause of burn in children, usually due to spillages of hot drinks or immersion in hot bath water. They generally cause epidermal or superficial dermal burn injury [Hettiaratchy, 2004].

Direct contact burns are caused by brief contact with a very hot object, or (more commonly) prolonged contact with a cooler object. Typical patient groups include epileptics and those who misuse alcohol or drugs.

Irreversible damage to the epidermis can be caused by exposure to 44°C heat for six hours, or 65°C for one second [Moritz, 1947]. Burns injuries are characterised by a local response and, if the total body surface area (TBSA) burned is greater than 20%, a systemic response [Greaves, 2008].

Local response

At skin level, burns form three zones of injury [Hettiaratchy, 2004]:

- **Zone of coagulation:** The point of maximal injury, with irreversible damage to tissue due to protein coagulation

- **Zone of stasis:** Surrounding the zone of coagulation and characterised by reduced tissue perfusion. Potentially salvageable with adequate resuscitation
- **Zone of hyperaemia:** Surrounds the zone of stasis and is characterised by increased tissue perfusion. Usually recovers.

The zones spread out from the point of injury in three dimensions, including deeper into dermal tissue.

Systemic response

The level of inflammatory response is related to the %TBSA that is burned. Once the burn covers more than 20% TBSA, the inflammatory response can exert systemic effects. Capillary permeability increases, leading to loss of intravascular proteins and fluid into interstitial space. Peripheral and splanchnic vasoconstriction occur and myocardial contractility decreases. Combined with fluid loss from the burn, this results in hypotension and end-organ hypoperfusion. In the lungs, there can be bronchoconstriction and the development of acute respiratory distress syndrome in any severe burns. Initially, there is a reduction in metabolic

rate ('ebb phase'), but this can double in the days following burn injury ('flow phase') [Sheridan, 2012].

Acute smoke inhalation injury

Smoke inhalation is a killer. Between 80% and 90% of fire-related fatalities are attributed to smoke inhalation, and it has a greater contribution to overall mortality and morbidity of burn injuries than either %TBSA or age [Kimmel, 1999]. Naso-oropharyngeal and mucosal burns are common [Toon, 2010], but thermal injury below the vocal cords is rare since heat is effectively exchanged in upper airway passages [Prien, 1988]. When air, steam and/or smoke are at sufficiently high temperatures to cause thermal injury to the lower airways, rapid oedema of the glottis develops, resulting in fatal airway obstruction.

Systemic toxins are the products of incomplete combustion and include carbon monoxide (CO) and hydrogen cyanide. CO is an odourless, colourless gas that binds to haemoglobin with 250 times the affinity of oxygen. This results in a decrease in the oxygen-carrying capacity of the blood. Cyanide adversely affects internal respiration by preventing aerobic production of adenosine triphosphate (ATP, the energy source for cells) [Toon, 2010].

Particulates and irritants have the greatest effect on the pathophysiological processes that occur due to smoke inhalation. Soot impregnated with toxins can reach the alveoli suspended in air. The types of chemicals vary, depending on what has been burning, but they trigger a cascade of events, resulting in pulmonary oedema and other respiratory problems [Murakami, 2003]. Water-soluble gases such as ammonia and hydrogen chloride react with the mucous membranes, producing strong alkalis and acids, leading to intense and prolonged inflammatory reactions. Lipid- (fat) soluble irritants act more slowly as they dissolve into cellular membranes.

Friction burns

Although friction burns are strictly speaking a thermal burn, they are the result of heat production caused by friction between the skin and another object. This can result in not just a burn, but abrasions too (see the lesson on WOUNDS AND BLEEDING above) [Gregory, 2010b].

Management

Safety first! The patient needs to be removed from the source of the burn if it is safe to do so, but don't get burnt yourself. Clothing should be removed unless it is sticking to the patient, as should jewellery, which may become constrictive as tissues swell.

Follow the <C>ABC approach for burns as you would any traumatic injury. However, inhalation injury is a particular concern and occurs in around 22% of all burns, 60% if facial burns are present [Toon, 2010].

Signs of inhalation injury include [Singer, 2010]:

- Full thickness or deep dermal burns to face, neck or upper torso
- Singed nasal hair
- Soot in sputum or oropharynx
- Dyspnoea, hoarseness, cough or stridor
- Cyanosis
- Altered level of consciousness.

Administer high-flow oxygen via a non-rebreather mask. CO poisoning may make pulse oximetry readings unreliable [AACE, 2013].

Cooling

Thermal burns should be cooled for 20 minutes [Bartlett, 2008], preferably with running water (between 8°C and 15°C) [NZGG, 2007]. There is little evidence that ice causes damage to underlying tissues, but it runs the risk of making the patient hypothermic so is not recommended [Cuttle, 2008, 2009]. Cooling should commence immediately after the burn has occurred, but there is limited evidence to suggest that cooling up to an hour after the burn has occurred is still beneficial [Cuttle, 2010]. If running water is not available or practicable, then gel-based body blankets can be used without causing hypothermia [NZGG, 2007; Singer, 2006; Martineau, 2006].

Covering/dressing

Patients with burns lose heat from non-epithelialised areas of skin due to evaporation. With the thermoregulatory function of the skin disrupted, patients are at risk of hypothermia, even on a warm day [AAOS, 2011]. Hypothermia is part of the lethal triad in trauma, and for each 1°C reduction in body temperature the mortality rate increases significantly [Lonnecker, 2001],

although there is no evidence currently to suggest that pre-hospital cooling causes hypothermia [Lonnecker, 2001; Singer, 2010]. Once cooling has been completed, cover the burn with a clean sheet or Clingfilm, but take care not to apply it circumferentially as it can become constrictive as oedema develops [NZGG, 2007].

Time-critical features

A blue light transfer to the most appropriate location is required for any of the following conditions [AACE, 2013]:

- Any major ABCD problems
- Airway burns
- History of hot air or gas inhalation
- Respiratory distress
- Evidence of circumferential (completely circling the neck, torso or limb) burns
- Significant facial burns
- Burns more than 15% TBSA in adults or 10% TBSA in children
- Presence of other major injuries.

Note that transfer may not be to your nearest hospital, but to a major trauma or specialised burns centre. Check local guidance.

Chemical burns

Chemical burns generally result from exposure to acids, alkalies and other corrosive materials. Alkali burns are generally more serious as they penetrate more deeply than other chemicals [ATLS, 2008]. Their severity depends on the concentration of the chemical, the duration of exposure and the speed in applying first-aid measures [Greaves, 2008].

Management

Safety first! It is important that you do not become exposed to the chemical. If in doubt, do not approach the scene but wait for the Hazardous Area Response Team (HART) or the fire and rescue service to attend.

Speed is of the essence when treating chemical burns so flush the exposed area with copious quantities of water as soon as possible. However, brush off any chemical powder from the patient first. In industrial settings, decontamination showers may be available, but at home, the shower or a hosepipe is an alternative. While

flushing, contaminated clothing should be removed, although do not pass anything over the patient's head, cut it off [Pilbery, 2013].

Chemical burns should be irrigated for at least 15 minutes, and ideally for up to an hour (although alkali burns may require much longer periods of irrigation), but watch for hypothermia [NZGG, 2007].

Radiation burns

Radiation burns are most commonly caused by ultraviolet radiation from the sun or sunlamps (sunburn). However, in rare cases, it can be caused by exposure to radioactive materials [Gregory, 2010b].

Approximately 80% of skin cancer is preventable, and avoiding sunburn is key [Simon, 2010]:

- Take care not to burn
- Cover up with loose cool clothing, a hat and sun glasses
- Seek shade during the hottest part of the day
- Apply high-factor sunscreen (at least sun protection factor 15) to sun-exposed body parts
- Take extra care to protect children in the sun.

Management

Safety first! If the burns are due to exposure to radioactivity, do not approach but wait for the Hazardous Area Response Team (HART).

Sunburn

Basic first-aid measures are usually sufficient [SJA, SAA, BRC, 2014]:

- Cover the patient's skin with light clothing or a towel. Move them out of the sun, preferably indoors
- Encourage them to drink frequent sips of cold water while cooling the affected area with cold water. If the area of sunburn is large, it may be more practical for the patient to soak the area in a cold bath for 10 minutes
- If burns are mild, calamine or an after-sun lotion may help. Patients should be advised to stay inside or in the shade.

Most sunburn will manifest as reddening of the skin (erythema), but blistering is evidence of a partial thickness burn and transport to hospital should be considered if it meets the criteria for review by specialised burns care services [NNBC, 2012].

Electrical injuries

Electrical injuries are thankfully uncommon, but they cause significant damage and even death when they occur. The majority of electrical injuries in adults occur in the workplace and involve high voltages, whereas in children most injuries occur in the home with domestic voltage. Electrocution from lightning strikes is very rare, leading to around 1000 deaths each year worldwide [Nolan, 2010].

Electrical burns arise when a source of electrical power makes contact with the patient's body. They are frequently more serious than they appear, since rapid heat loss from the surface of the skin may leave it relatively undamaged, whereas the underlying tissues may have sustained serious injury, particularly between the entry and exit points (don't forget to look for both!) [ATLS, 2008].

Management

Safety first! Do not approach the patient until you are certain that the source of electricity has been cut off.

When dealing with electrical injuries, the thermal burns sustained may not be your highest priority. The patient may be in cardiac arrest, have airway or facial burns, have cardiac arrhythmias (also perform electrocardiogram monitoring) and be traumatically injured (fractures, serious internal

injuries) that will need addressing first. Associated thermal burns can be managed as previously described.

The problem with burns

Without appropriate intervention and management, patients with serious burns can die due to [Sheridan, 2012]:

- Burn shock due to excessive fluid loss in the first 24 hours
- Respiratory failure in the subsequent 3–5 days
- Burn wound sepsis in the following few weeks.

Thankfully, because of prompt transfer by ambulance staff to burn centres and the subsequent specialised management that patients receive, this is less common. However, it does underline the importance of transporting patients to definitive care.

There are four general phases of burn care, with the ambulance service only playing a small part in the initial management stage [Sheridan, 2012]:

- Initial evaluation and resuscitation (0–72 hours)
- Initial surgery and temporary closure of wounds created by removal of full-thickness burns (days 1–7)
- Definitive wound closure (weeks 1–6)
- Rehabilitation and reconstruction (up to 2 years).

ELECTRICAL INJURIES



RESCUE 1122

PUNJAB
EMERGENCY SERVICE



BURNS

- A burn injury is caused by an interaction between energy (thermal, chemical, electrical, or radiation) and biological matter



Electrical Trauma

- Electrical injuries are not just isolated to skin; large burns are a multisystem injury capable of life-threatening affects to the heart, lungs, kidneys, GI tract, and immune system



ELECTRICAL BURNS

- Electrical injuries (including lightning injuries)
 - Result from direct contact with an electrical current or arcing of electricity between two contact points near the skin



ELECTRICAL BURNS

- Tissue damage produced by electrical current depends on six factors
 - Amperage
 - Voltage
 - Resistance
 - Type of current
 - Current pathway
 - Current flow —→
- An exit wound



ELECTRICAL BURNS



RESCUE 1122

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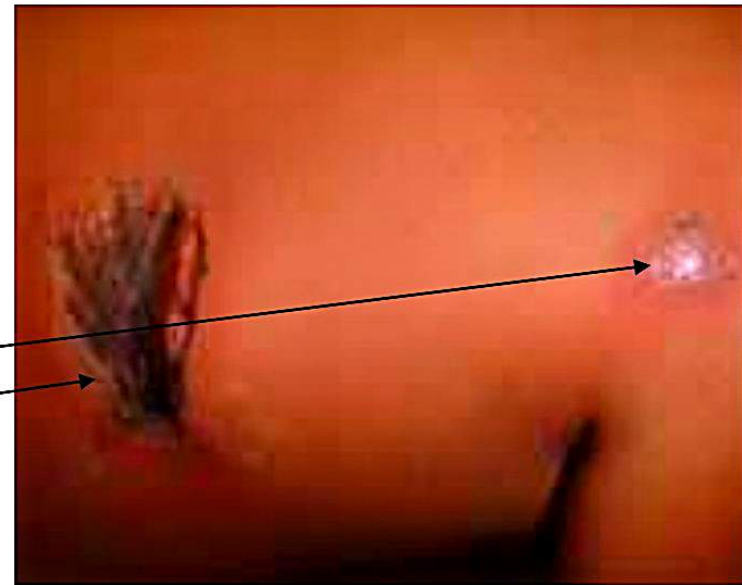


ELECTRICAL BURNS

- Contact with high voltage wires



- Note entry and exit



PATHOPHYSIOLOGY OF BURNS

- The degree of tissue destruction depends on the temperature and duration of the exposure
- Factors that influence the body's ability to resist burn injury include:



PATHOPHYSIOLOGY OF BURNS

- Water content of the skin tissue
- Thickness and pigmentation of the skin
- Presence or absence of insulating substances (e.g., skin oils, hair)
- Peripheral circulation of the skin, which affects dissipation of heat

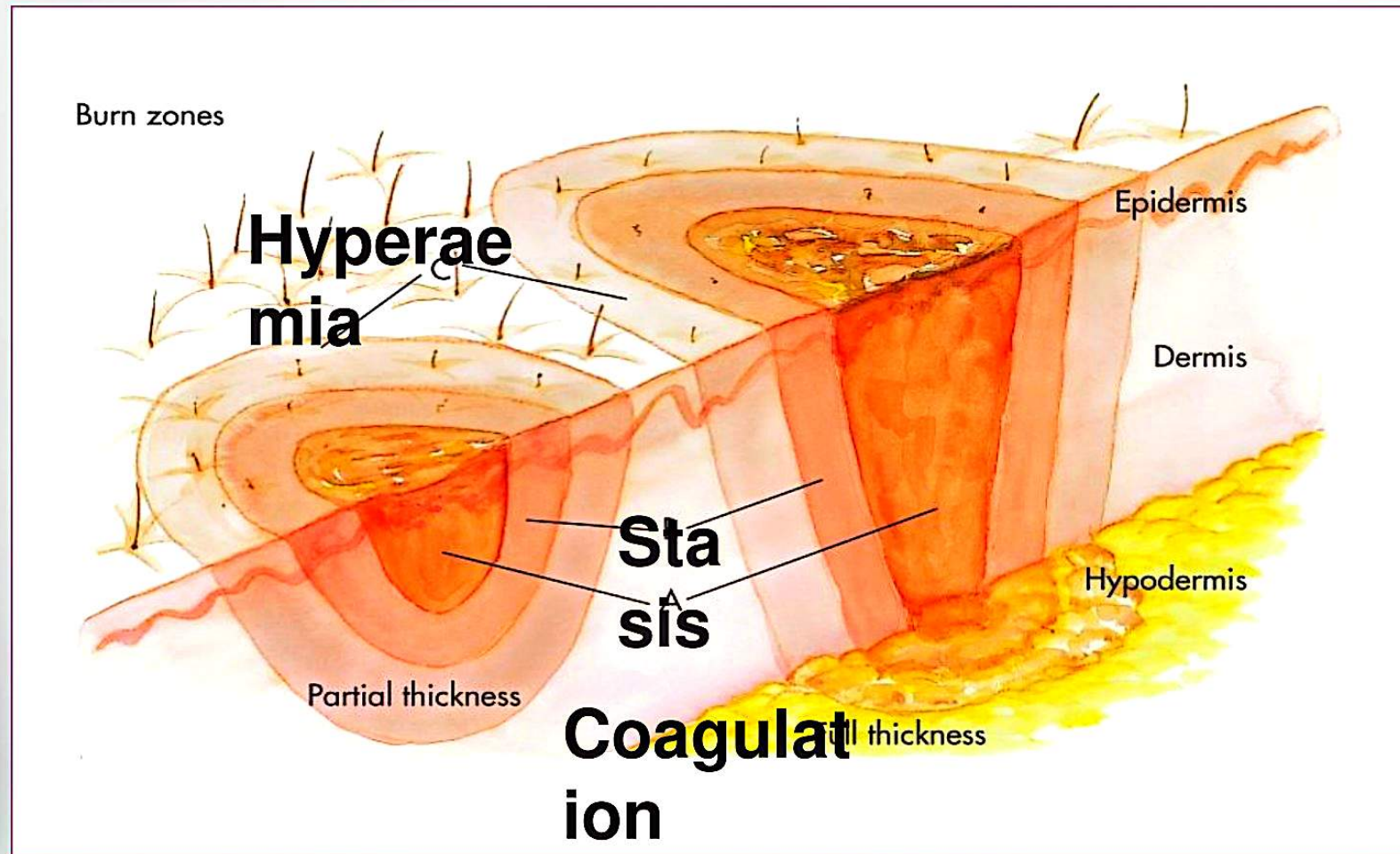


LOCAL RESPONSE TO BURNS

- Major burns have three distinct zones of injury that usually appear in a "bull's eye" pattern
 - Zone of coagulation (A)
 - Zone of stasis (B)
 - Zone of hyperaemia (C)



Local Response to Burns



Zone of Coagulation

- Central Zone
- Region of greatest tissue destruction
- Necrotic
- Not capable of tissue repair



Zone of Stasis

- Cells are injured but not irreversibly
- Unless deprived of O₂ or blood flow, viable cells will die and become necrotic
- Adjacent to zone of necrosis
- Blood flow to the region is stagnant
- Failure of appropriate resus, causes:
 - Death of the cells
 - Partial thickness converts to full thickness burns



Zone of Hyperaemia

- Minimal cellular injury
- Characterised by:
 - Increased blood flow
 - Secondary to an inflammatory reaction initiated by the burn injury



SYSTEMIC RESPONSE TO BURNS

- An early manifestation of the systemic effects of a large thermal injury is hypovolaemic shock. Due to the following:
 - A decrease in venous return
 - Decreased cardiac output
 - Increased vascular resistance



SYSTEMIC RESPONSE TO BURNS

- Other physiological responses can lead to renal failure
- Haemolysis (destruction of RBCs)
- Rhabdomyolysis (muscle necrosis resulting in hypovolaemia, hyperkalaemia, and sometimes acute renal failure)



Class of Burns

- Classified as **superficial** (1st degree), **partial** (2nd degree) and **full** (3rd degree).
- First- and second-degree burns are partial-thickness burns (if uncomplicated by infection or shock)
 - Usually heal without surgery
 - Third degree burns are full-thickness burns that usually require skin grafts



Smoke Inhalation

- Leading cause of death in fires
- Steam – 4000 times the heat carrying capacity of dry heat
- Capable of burning the distal airways and bronchioles
- Asphyxiation/smoke inhalation
 - Carbon monoxide (CO)
 - Cyanide gas (CN)
 - Causes cell death by cellular hypoxia or asphyxia



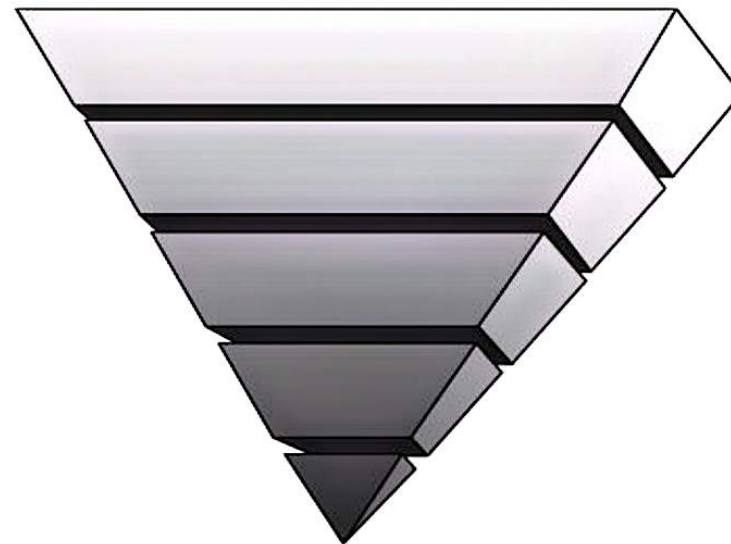
THINGS TO CONSIDER

- Burns of the face swell rapidly and may be associated with airway compromise
- Upper airway structures are particularly susceptible to injury if exposed to high temperatures



PREDICTORS FOR AIRWAY COMPROMISE

-
- Burns around nose or mouth
 - Soot in mouth or nose: singed nasal hairs
 - Intraoral burns: burned tongue
 - Intraoral swelling (no stridor)
 - Hoarseness of voice
 - Visible pharyngeal edema
 - **Inspiratory stridor**



GOALS OF MANAGEMENT

- Preventing further tissue injury
- Maintaining a patent airway
- Administering oxygen and ventilatory support
- Pain relief (CPG-A)
- Providing fluid resuscitation (per CPG-A)
- Providing rapid transport to an appropriate medical facility
- Using clean technique to minimize the patient's exposure to infectious agents

