THE NORTHERN HOSPITAL

BURNS (MAJOR)

"The Great Fire of London", oil on canvas 1666, Lieve Verschuier (1630-86), Museum of Fine Arts, Budapest, Hungary

On Sunday, September 2, 1666, a fire began accidentally in the house of Thomas Farriner, the King's baker in Pudding Lane near London Bridge. Sir Thomas Bludworth, the Lord Mayor of London, whom Pepys described as "a silly man, I think…mean of understanding and despatch of any public business", was called to the scene. Pudding lane was too narrow for the Lord Mayor's coach to enter and so most irate, he was forced to descend the lane on foot. Looking at the blazing building he said, "Pish, a woman might piss it out!" and with that jumped back into his coach and rumbled off into the night. Pepys himself recognized very quickly the potential danger of the fire and personally sought an urgent audience with the King to warn him of the grave danger that London faced. The older parts of the city at that time were almost entirely composed of wooden buildings and the riverside wharves and warehouses were stacked with wood, coal, tar and every combustible material known to seventeenth century humanity. Over the next five days a gale blew without interruption and despite the heroic efforts of King Charles II and the Duke of York, the resulting firestorm devastated a vast area of the old city. Medieval London was gone forever. King Charles set up a committee led by Christopher Wren and Robert Hooke whose Herculean efforts enabled the rise of modern London. A Parliamentary report of the fire to the committee included a sarcastic special mention of Sir Thomas "…for providing utensils for the speedy quenching of the fire…"

In cases of burns it is important to recall Sir Thomas' lack of insight and take a leaf out of Pepys' book (or diary) by anticipating potential problems early, such as shock and airway compromise.

BURNS (MAJOR)

Introduction

The priorities in patients who suffer major burns include the airway, fluid resuscitation and adequate analgesia.

Traditional formulae exist for the planning of fluid requirements; however these provide an initial guide only and in practice fluid resuscitation must be a dynamic process titrated to the patient's ongoing clinical parameters.

Any patient who has suffered major burns should be considered for transfer to a specialist burns unit. If there is any uncertainty in this regard the case should be discussed with the specialist burns unit.

The following refers to Adult patients.

Classification of Burns

The most useful way to classify burns is according to whether they are likely to need surgery or not, ie to differentiate between superficial -mid dermal (not usually needing surgery) and deep dermal (possibly needing surgery) - full thickness burns (always needing surgery).

Burn depth can be assessed according to the following chart:

EPIDERMAL	SUPERFICIAL DERMAL	MID DERMAL	DEEP DERMAL	FULL THICKNESS
				
Painful, epidermis damaged but intact. red	Blistered, painful pale pink/red, raw Brisk capillary return within burns wound	Sluggish capillary return Less painful, dark pink to red	Deep red or white colour, dull sensation, severely delayed or absent capillary return	No sensation, no capillary return, leathery, white/black or yelllow

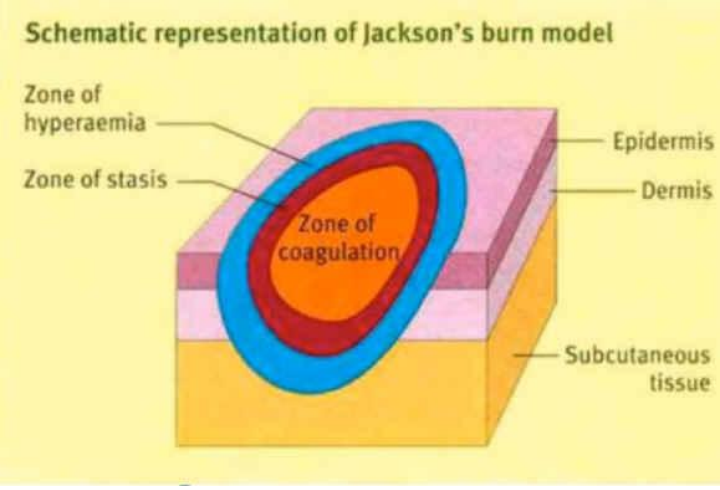
See also Burns Depth Characteristics Chart (Victorian Burns Unit) for more detailed description.

The exact depth of intermediate depth burns (especially the distinction of mid from deep dermal) is often very difficult to ascertain clinically in the first few hours and usually requires observation over the ensuing 2-3 days.

- Deep partial burns have a high incidence of delayed hypertrophic scarring.
- Full thickness burns will require grafting.

Pathophysiology

The Jackson's Burn Wound Model



Jackson's Burn Wound Model provides a model for understanding the pathophysiology of a burn wound.

The zone of coagulation nearest the heat source is the primary injury. This zone has irreversible tissue necrosis at the centre of the burn due to exposure to heat, chemicals or electricity. The extent of this injury is dependent on the temperature (or concentration) and the duration of exposure.

Surrounding the central zone of necrosis is a zone of ischaemia in which there is a reduction in the dermal circulation. This is damaged but potentially viable tissue. This ischaemic zone may progress to full necrosis unless the ischaemia is reversed. If the ischaemia is not relieved, for example when resuscitation and wound care are suboptimal, then persisting ischaemia will worsen, and the burn depth will increase.

At the periphery of the burn is a third zone of hyperaemia characterised by a reversible increase in blood flow and inflammation.

Clinical assessment

Evaluation of Burns Extent:

See also Burns Charts, below (appendix 1 and 2).

The Rule of palms:

Rule of "palms": the surface area of the **patient's** palm is approximately 1% B.S.A. (Good for smaller areas, irregular patches).

Rule of 9s: set out below; good for more extensive areas.

The Wallace Rule of 9s for Adults:

Head and Neck = 9%.

Each Arm (including Hand) = 9% (18% for both).

Each Lower Limb = 18% (36% for both).

Front of Trunk (Chest and Abdomen) = 18%.

Back Of Trunk, (Chest, Abdomen and Buttocks) = 18%.

Perineum = 1%.

The Lund and Browder chart For Children:

There is the **Lund and Browder** chart for children, but as a guide:

Up to one year of age: Head & Neck are 20% of B.S.A. and each LOWER LIMB is 12.5%.

Then with each 1-year of life between 1-10 years subtract 1% from the Head and Neck and ADD to the LOWER EXTREMITIES (i.e. ½ to each LOWER LIMB).

Evaluation of Burn Severity:

Factors Affecting Burn Severity:

1. Extent of body surface area (B.S.A) affected.
2. Depth (see chart above).
3. Associated injuries / conditions (eg trauma, smoke inhalation).
4. Age (the very young and the elderly).
5. Site (hands, feet, face and inhalational, perineum, major joint).
6. Nature of burn (eg. electrical / radiation / chemical / thermal).
7. Pre-existing medical problems.
8. Circumferential burns.
9. Burns to the **respiratory tract / inhalational injury:**

   Risk factors for smoke inhalation (and carbon monoxide poisoning), and airway / respiratory tract injury include:

   - Facial burns (45%)
   - History of burns sustained within an enclosed area.
   - Carbonaceous sputum.
   - Altered conscious state.
   - Intra-oral oedema.
   - Change in voice/hoarseness.
   - Respiratory distress.

Respiratory tract injury can be classified as:

Type 1: Upper airway, with risk of early obstruction.

Type 2: Lower respiratory tract, with risk of ARDS/pneumonia.

Type 3: Systemic intoxication, (CO, cyanide).

Investigations

Blood tests

1. FBE.

2. U&Es/ glucose.

   - Potassium is the most urgent (because of rhabdomyolysis).

3. Group and save blood:

   - For possible pre-operation workup.

   - Extensive burns, can result in significant red blood cell destruction associated with destroyed deep skin layers.

Others as clinically indicated

4. ABGs.

   - Co-oximetry for CO levels.

Management

1. Airway:

   - Oxygen therapy.

     ♥ Especially for inhalational injury, or CO poisoning, (see separate guidelines for CO poisoning).

     ♥ Give 100 % humidified oxygen.

   - Intubation for extensive facial / oro-pharyngeal burns, should be done **early before** significant airway problems develop.

   In general terms the indications for intubation in burns victims include:

   - Stridor is an immediate indication for intubation.

   - Prophylactic intubation prior to transfer if history or signs indicate likelihood of inhalation and thus possible airway obstruction

   - Increasing swelling of head and neck.

- Unprotected airway.
- GCS < 9.
- Uncooperative/combative/disoriented patient.

A patient with a history or signs suggestive of inhalation injury requires careful and repeated assessment of the airway over time if not intubated.

2. Breathing:

- Treat any bronchospasm, pulmonary oedema.
- Carefully assess the chest: Deep circumferential burns of the chest or abdominal skin can restrict chest expansion and compromise ventilation. Escharotomies may be required.

3. Circulation:

Shocked patients, (especially those with *delayed* presentations) will need initial fluid bolus resuscitation of 20mls/kg crystalloid.

Assess extent and depth of burns to estimate fluid requirements over next 24 hours.

Current ANZBA recommendations are that for burns greater than **15 % (greater than 10 % for children)**

- IV fluids will be necessary.

Two larger bore IV cannulae are recommended. A CVC is also desirable for major burns (but not essential initially).

IV lines may go through a burnt area (they are sterile) if necessary (but is best avoided if possible)

Normal saline or **Hartman's solution** may be given.

While albumin may be lost from the circulation, colloid solutions have **not** been shown to reduce tissue oedema in the first 8 hours, or to improve clinical outcomes.

Formulas for fluid requirements in burns: [1]

BROOKE FORMULA 2 mls / kg / % BSA burnt over 24 hours

PARKLAND FORMULA 4 mls / kg / % BSA burnt over 24 hours

CONSENSUS FORMULA 2-4 mls / kg / % BSA burnt over 24 hours.

As a general rule:

Less than 30 kg:

2-4 mls / kg / % BSA + maintenance over 24 hours.

Maintenance is added in paediatric patients because the formula tends to underestimate requirements due to the increased surface area to volume ratio. There are also relatively greater insensible losses compared to adults.

Half of the **formula** volume is given in the first 8 hours (*from the time of the burn*) and half of the **formula** volume is given over the next 16 hours.

Maintenance is **then** added to the above. The preferred paediatric *maintenance* fluid is Half normal saline & 5 % dextrose.

Greater than 30 kg:

2 - 4 mls / kg / % BSA over 24 hours (ie maintenance is not included).

Half of the calculated volume is given in the first 8 hours (*from the time of the burn*) and half of the volume is given over the next 16 hours.

If burns are mainly superficial, the lower end, i.e. 2 mls / kg / % BSA may be used.

If burns are deeper or very extensive (or an electrical / inhalational injury), then 4 mls / kg / % BSA should be used.

- The formula is an initial guide only.
- **If there is delay in presentation, the patient will require greater amounts of fluids initially.**

Ongoing fluids must be judged according to the ongoing clinical picture, especially:

- Observations, (pulse and blood pressure).
- CVP.
- Peripheral perfusion.
- Urine output, *(which is the best clinical indicator, other parameters often being difficult to assess in burns)*
  - ♥ Adults 30-50 mls / hour.
  - ♥ Children (less than 30 kg) 1 ml / kg / hour.

Emergency initial resuscitation in the field:

A useful rule for **initial** fluid resuscitation **in the field** (i.e. ambulance officers) is:

Weight in kg X % TBSA = mls of Normal saline in the *first 2 hours* post injury, (in adult patients).

4. Immediate first aid:

- Cool running water is best in the setting of more minor burns.

- In major burns, there will usually be more urgent priorities, and cool water to **large areas for prolonged periods** should be avoided due to the risk of hypothermia.

  Prolonged cooling to deep burns is unlikely to be helpful. It is most beneficial for minor partial thickness burns, where hypothermia is unlikely.

- Timely pharmacological analgesia will often be the best approach for major burns.

- Where possible, burnt parts should be nursed in an elevated position. This is especially important in the case of *circumferential* burns.

5. Analgesia:

- **Opioid** analgesia will usually be required.

  Morphine titrated to clinical effect: [3]

  Morphine 2.5 to 5mg IV as an initial dose, then titrated to effect every 5 to 10 minutes with further incremental doses of 2.5 to 5mg IV.

  In elderly patients or those with cardiorespiratory compromise, an initial morphine dose of less than 2.5mg IV and incremental doses of 0.5 to 1mg should be considered.

  If morphine is contraindicated, consider fentanyl at 25 to 50 micrograms IV as initial equivalent dose.

  For children 0.1 mg/kg titrated to clinical effect 5 minutely, (up to of maximum of 0.3 mg/kg).

  The **IV route** is preferable (the IM route is unreliable due to variable absorption in a shocked state). Fentanyl can be given intranasally until access is established.

- **Ketamine:**

  - ♥ In very severe cases, or very distressed patients sedation/ anaesthesia with **ketamine** may be required to adequately assess and provide initial dressings.

- Infusions:

  - ♥ For significant ongoing analgesic requirements, a morphine infusion should be considered.

  - ♥ Additional low dose ketamine infusions are also very useful for intractable pain/ distress.

6. Establish monitoring

- Blood pressure (non invasive or invasive as clinically required).

- Pulse oximetry.

- Continuous ECG.
- IDC.
    - ♥ With a **core body temperature** measuring device is desirable.
    - ♥ Aim for a urine output of 0.5 - 1 ml/kg /hour in adults and 1 ml/kg /hr in children.
- A CVC is desirable for major burns (but not essential initially).

7. Nasogastric tube:

- This should be considered, *according to patient toleration*, (gastric stasis and ileus can occur in major burns). It is *not* suitable for patients with facial/ airway burns.
- In general terms nasogastric tubes are considered for burns >15 % body surface area in adults and > 10 % body surface area in children.

8. In multitrauma cases:

As for any multitrauma:

- Full primary survey.
    - ♥ Assess for and treat any other immediately life-threatening injuries.
    - ♥ Immobilize cervical spine, as clinically indicated.
- Full secondary survey.

9. Wound debridement:

- Hair should be shaved at least 2 cm away from the wound.
- The wound should be irrigated to clear any foreign material or tissue debris. This can be done with sterile saline or with aqueous chlorhexidine solution.
- Devitalized skin/ tissue should be removed with sterile scissors.
- Larger blisters can be aspirated with a sterile needle.

10. Dressings:

Most major burns will require transport to a specialist Burns Unit, and so "definitive" dressings will often not be required in the first instance.

The type of dressing will be largely determined by the timeliness of transfer.

In general terms:

If transfer within 6 hours of injury is possible:

- Burns can be dressed with **Burnshield (or similar such as Burn Aid)** and then covered with simple Plastic Cling Wrap for the transfer. (Hydrogels are not generally used in children however).

- Plastic Cling Wrap should be applied **longitudinally.**

  Avoid wrapping affected area circumferentially with plastic film wrap as this can have a tourniquet effect as oedema worsens.

If transfer is to be > 6 hours following injury:

- Use paraffin gauze (e.g. **jelonet or bactigras**) or a silver dressing (e.g. **Acticoat-flex**), depending on the depth of the major part of the burns.

- **Burns of mid-dermal or greater depth should have a silver dressing.**

11. Protect against hypothermia (especially with extensive burns) with a "space blanket".

    - This will also help protect the patient from air currents (which may cause significant pain with partial thickness burns as well as increase evaporative fluid losses).

12. Tetanus immunoprophylaxis as indicated.

13. IV omeprazole to protect against "stress ulceration".

14. Surgery:

    Surgical grafting will be required for:

    - Full thickness burns.

    - Deep partial thickness burns which take longer than 2-3 weeks to heal should be treated with excision and grafting as there is a high incidence of hypertrophic scarring otherwise.

    Note that with severe burns > 30 % that will clearly need grafting, surgery should be done as soon as possible even if this means ongoing resuscitation whilst in the operating theatre. This is to reduce the incidence of "SIRS", (systemic inflammatory response syndrome), which can rapidly lead to "MODS", (multiple organ dysfunction syndrome), one of the commonest causes of death in the ICU)

    In cases of **circumferential** burns:

    - Remove any rings / bracelets.

    - Assess circulation.

    - Assess the adequacy of ventilation in the case of chest circumferential burns.

    - Assess the adequacy of the airway in the case of circumferential neck (& facial) burns.

    - Elevate the part.

- Consider the need for escharotomy, this should be discussed with a specialist Burns Unit

Disposition

Consider the need for transfer to a specialized burns unit:

In Victoria this is:

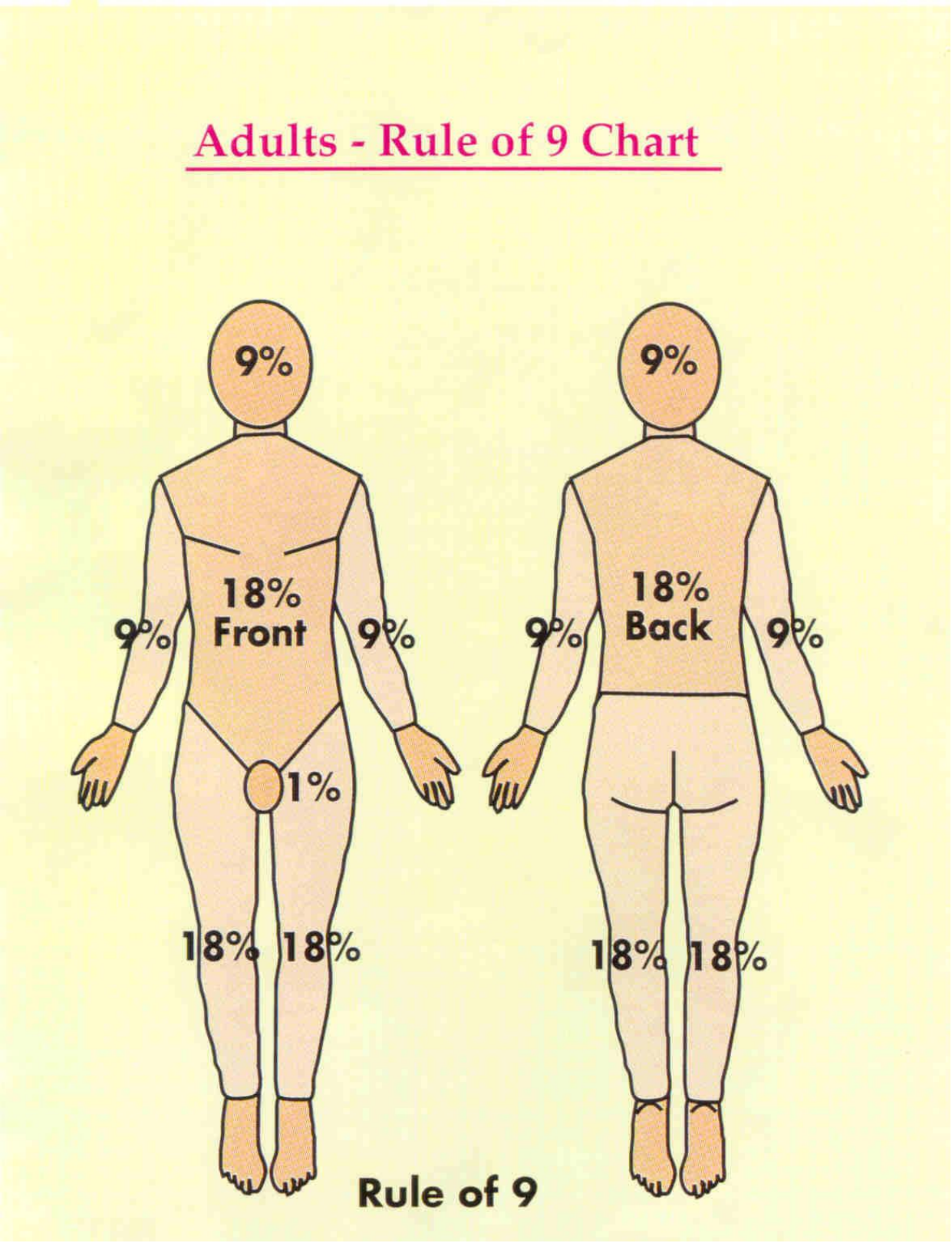
- The Alfred Hospital for adults.
- The Royal Children's Hospital for children.

Current ANZBA guidelines for consideration for transfer to a burns unit include:

1. Inhalational injury.
2. Burns > 10 % body surface area.
3. Burns to special areas: face, hands, major joints, feet, genitalia.
4. Full thickness burns greater than 5% total body surface area.
5. Electrical burns.
6. Chemical burns.
7. Circumferential burns of limbs or chest.
8. Burns with associated trauma.
9. Burns in the very young or older people.
10. Burn injury in patients with pre-existing illness or disability that could adversely affect patient care and outcomes.
11. Suspected non-accidental injury in children.
12. Burns in children under the age of 12 months.
13. Small area burns - in patients with social problems, including children at risk.
14. Burns occurring in pregnant women .
15. Burn injuries which the referring unit is concerned about or are slow to heal.

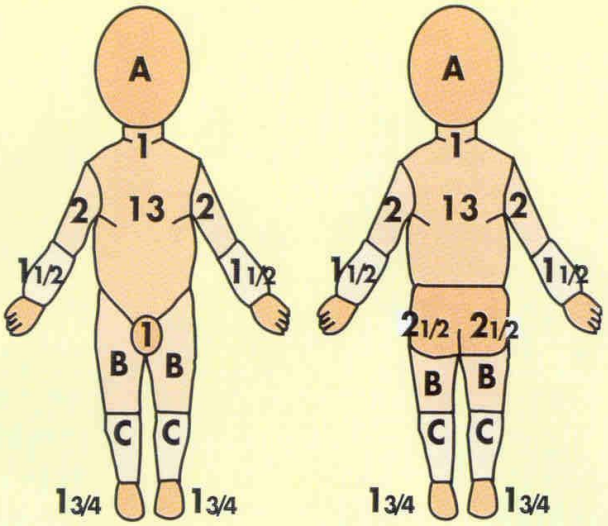
If there is any uncertainty about the need for transfer, the case should be discussed with the Alfred Hospital or RCH Burns Unit.

Appendix 1


Adults - Rule of 9 Chart
9%
9%
18%
Front
9%
9%
18%
Back
9%
1%
18%
18%
18%
18%
Rule of 9

Appendix 2

Children - Lund & Browder Chart



Relative percentage of areas affected by growth

Age in Years	0	1	5	10	15
A 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2
B 1/2 of one thigh	2 3/4	3 1/4	4	4 1/4	4 1/2
C 1/2 of one leg	2 1/2	2 1/2	2 3/4	3	3 1/4

Black Saturday 7th February 2009, Victoria Australia

"Hope from the Ashes", the iconic image of CFA fireman David Tree helping a distressed Koala (Sam), from the time of the Black Saturday bushfires, Victoria, Australia 7th February 2009. These fires were fed by 10 long years of drought together with sustained record high temperature in the mid-forties. Despite many people having fire plans in the affected regions, and the superhuman efforts of firefighters from across the nation, the ferocity of the Black Saturday fires were like nothing ever seen before in recorded Australian history. Recurring themes from survivors included the overwhelming speed of the fires, its random encircling nature, the unimaginable heat, but most terrifying of all, "the trees, houses, anything in its path did not simply "catch fire"- they spontaneously exploded without apparent warning, there was nothing anyone could do" 173 people lost their lives, over 1800 people lost their homes including every personal belonging –their histories and identities – devastating physical and emotional scarring will remain forever for many thousands more.

Photograph taken from the roof at Doncaster shopping centre in the northern suburbs of Melbourne on the night of Black Saturday. The inferno consumes the regions of Kinglake and Marysville, barely half an hour from the outskirts of Melbourne.

An exhausted and emotional firefighter momentarily rests, (and perhaps prays), amid the inferno.

References

1. Australian & New Zealand Burns Association (ANZBA)

   http://www.anzba.org.au/

2. Burns Management Guidelines, Victorian State-wide Burns Service:

   http://www.vicburns.org.au/

3. The Acute Pain Management Manual NHMRC, 2011.

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