MANAGEMENT OF THE MAJOR BURN

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The medical management of burns is both urgent and predictable.

DEFINITION OF A MAJOR BURN

A major burn can defined as any burn that requires intravenous fluid resuscitation (10% Body Surface Area (BSA) in a child, 15% in an adult) and / or a burn to the airway.

TYPES/CLASSIFICATION

Beyond simple erythema, burns are either partial or full thickness depending on whether the basement membrane has been lost. On examination a full thickness (3rd degree) burn is usually pale, bloodless and insensitive to the firm touch of a sterile needle. Partial thickness burns can be further divided into superficial (1st degree) and deep (2nd degree), which refers to the depth at which the dermal layer is injured. Sensation is preserved and healing of the skin more likely.

The mechanism of the burn can be classified into six categories

- *Contact* - direct contact with a hot surface.
- *Scald* - hot fluid/gas usually causing a superficial burn.
- *Flash* - a brief burn, usually partial thickness
- *Flame* - usually full thickness
- *Chemical*
- *Electrical*

BURN PATHOLOGY

Local

Within moments the capillaries of the injured tissue become leaky. Plasma is lost, drawing water with it. This continues for between 3 and 36 hours and results in oedema of the tissues involved. Local airway swelling may lead to loss of the airway by both internal and external oedema. Chest wall oedema may make ventilation difficult and oedema of the limbs may cause ischaemia leading to limb loss (especially if the burn is circumferential).

Hypovolaemia and haemoconcentration of the blood leads to a rising haematocrit which will result in poor systemic tissue perfusion. This is 'Burns Shock'. Red blood cells are lost both directly in the burn and as a result of increased fragility.

Systemic

Damaged tissue will release 'middle molecules' (leukotrienes, prostaglandins, oxygen free radicals and histamine) into the circulation leading to a systemic increase of capillary permeability.

Burn Shock is defined as the inability of the circulation to meet the needs of tissues for oxygen and nutrients and the removal of the metabolites. The clinical picture of severe shock consists of pale cold skin and a rapid yet thready pulse. Respiration is rapid and shallow leading to gasping ('air hunger'). Urine output falls and the patient becomes increasingly restless and disorientated. Often consciousness is lost only as a preterminal event.

MANAGEMENT PRINCIPLES

First aid

Remove the casualty from further injury. Extinguish flames, remove clothing, turn off the electrical source, or douse the chemically burnt patient with water. Flames ascend so lie the patient down. Cover the burn with a clean dressing, avoid the patient getting cold and transfer to a hospital as soon as possible. Additional oxygen should be given during transfer.

Primary management

- *Airway* - check the airway is clear. Endotracheal intubation is necessary if there are deep burns to the face and neck, soot in the nostrils, burns of the tongue and pharynx, stridor or hoarseness.
- *History* including time and nature of the incident (Wet or dry burn /chemical /electrical /inside or outside).
- *Weigh* the patient.
- *Examine* the burn and assess the size with the 'rule of nines' (figure 1) to give a %BSA.
- *Intravenous access* - obtain large bore venous access, even through burnt tissue.
- *Blood sampling* –samples for haematocrit, electrolytes, crossmatch, arterial blood gases and carboxyhaemoglobin levels.
- *Analgesia* - intravenous morphine, ketamine, or Entonox
- *Catheterise* - assess urine output as a gauge of tissue perfusion and adequate resuscitation.

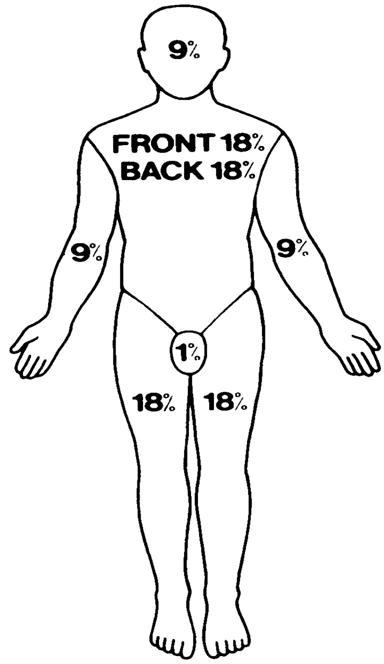

Figure 1. The 'rule of nines' for rapid assessment of the % BSA.

- *Reassess* the patient thoroughly at regular intervals and also the burn.

Fluid resuscitation

This should be instituted as soon as possible. There are two simple protocols that both depend upon the %BSA, time passed since injury and patients weight. The rule of nines may over-estimate the BSA, but the Lund and Browder chart gives a more accurate assessment. (Figure 2.) Fluid requirements may be greater than the protocols suggest.

> ***Parklands:*** Crystalloid resuscitation with Hartmanns
>
> 24 hour fluid requirement = 4 x %BSA x Wt (Kg)
>
> Give half over the first 8 hours, andthe remainder over the next 16 hours

Although there may be pronounced generalised oedema initially, as large volumes are required, it is cheap and produces less respiratory problems later on.

> ***Muir and Barclay:*** Colloid resuscitation with plasma
>
> The first 36 hours are divided into time periods of 4,4,4,6,6,12 hour intervals
>
> Each interval = 0.5 x %BSA x Wt (Kg)

With colloid resuscitation, less volume is required and the blood pressure is better supported. However they are expensive, often unavailable and tend to leak out of the circulation and may result in later oedema especially in the lungs.

Controversy remains as to which fluid should be used. Inhalational injury may increase fluid requirements by 50%. Both regimes require regular assessment as to the adequacy of resuscitation. This includes blood pressure, pulse, capillary return, urine output, level of consciousness and haematocrit. Additional fluid should be given if resuscitation is inadequate.

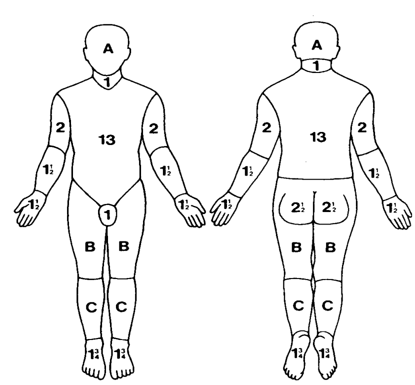

CHART FOR ESTIMATING SEVERITY OF BURN WOUND

NAME______ WARD______ NUMBER______ DATE______
AGE______ ADMISSION WEIGHT______

LUND AND BROWDER CHARTS

REGION	% PTL	% FTL
HEAD		
NECK		
ANT.TRUNK		
POST.TRUNK		
RIGHT ARM		
LEFT ARM		
BUTTOCKS		
GENITALIA		
RIGHT LEG		
LEFT LEG		
TOTAL BURN		

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

AREA	AGE 0	1	5	10	15	ADULT
A=½ OF HEAD	9½	8½	6½	5½	4½	3½
B=½ OF ONE THIGH	2¾	3¼	4	4½	4½	4¾
C=½ OF ONE LEG	2½	2½	2¾	3	3¼	3½

Figure 2. The Lund and Browder chart for accurate assessment of the % BSA.

Water loss is related to evaporative and other extrarenal losses and may lead to a hypernatraemia. Salt intake should be balanced against the plasma sodium concentration, but is usually about 0.5mmol/kg/%BSA. If the burn is left exposed in an hot environment, sodium free water intake must be increased, but only to achieve a moderate hypernatraemia. Aggressive water load may lead to a low plasma sodium and result in 'burn encephalopathy'. Hyperkalaemia usually associated with severe muscle damage may require correction with insulin and dextrose .

Airway management

A high index of suspicion is required regarding the patient's airway. Laryngeal oedema develops from direct thermal injury leading to early loss of the airway. With signs of an airway burn (soot in the nostrils/stridor/hoarse voice) consider early intubation of the patient. If in doubt it is better to protect the airway (and be able to provide tracheo-bronchial toileting) than to risk losing the airway altogether. A tracheostomy may be necessary if there is any delay in securing the 'at risk' airway.

The airway is further endangered by an associated loss of respiratory drive due to a depressed level of consciousness (eg head injury or carbon monoxide poisoning). Again intubation may be required.

BURN MANAGEMENT

Dressings are necessary to reduce infection and adsorb exudate. Bactericidal agents, such as silver sulphadiazine 1% and silver nitrate are used. Antibiotic preparations should be avoided to prevent resistant colonisation developing. Regular, often daily, dressing changes are recommended, and the patient should be washed with clean warm water.

Surgery

Circumferential burns will require immediate surgery to improve circulation to distal extremities or to permit adequate breathing if the chest wall is burnt. Early excision and grafting is preferred as it minimises infection and hastens wound healing. The whole burn should be excised with in 48 hours. Regular dressing changes, further excision and grafting may be required. It should be remembered that blood loss may be excessive at these times. Blood loss can be reduced by using diathermy and/or applying gauze soaked in adrenaline (1: 200,000) during the burn excision.

The problem with excision of a large burn is often the lack of donor skin to cover the excised burn. The patient's donor skin can be meshed, so as to increase the size. It can then be covered with cadaveric skin which acts as a biological dressing with growth stimulating properties. Artificial bovine skin (such as *Integra*®) may also be used but are expensive.

Anaesthesia

If there is any concern over the airway a gas induction following pre-oxygenation or a fibre-optic intubation are the safest options. Suxamethonium should be avoided after the first 48 hours up to 2 years after a major burn because it may result in a large increase in serum potassium. Analgesia requirements are increased. Give Entonox, ketamine or morphine (titrated to response).

Consideration should be given to altered pharmacokinetics:

- Volume of distribution increases for water soluble drugs (resistance to non-depolarising agents occurs.)
- Increased extracellular fluid:intracellular fluid ratio
- Albumin falls - less protein binding
- Increased metabolic rate / temperature leading to altered half life

Monitoring must include vital signs, temperature and urine output. Invasive monitoring may be necessary. The ECG leads can be placed with the use of staples if the chest wall is burnt.

Postoperatively the patient should be admitted to a high dependency unit, so that the continuing fluid loss following burn excision can be maintained.

SYSTEMIC MANAGEMENT

Pulmonary Smoke may damage the lungs in three ways:

- Intoxication /hypoxaemia
- Respiratory tract injury due to irritants
- Thermal damage

Carbon monoxide has a higher affinity for haemoglobin than oxygen, and will lead to tissue anoxia. The severity of the poisoning depends on the proportion of Hb combined with carbon monoxide. Symptoms range from a throbbing headache with nausea and vomiting (<30%) to coma, convulsions and cardiac arrest (>60%). 100% oxygen is the initial treatment and may necessitate intubation and ventilation. The half-life of carboxyhaemoglobin (COHb) in air is 4 hours and in 100% oxygen, 80 minutes. Hyperbaric oxygen may be useful especially if there are significant neurological signs but may be difficult in a severely burnt patients. Pulse oximeters are inaccurate in the presence of carboxyhaemoglobin and cannot be relied upon.

Other gases such as hydrogen sulphide, hydrogen cyanide and hydrogen chloride may be inhaled, particularly if paints or furniture have been involved in the fire. Cyanide poisoning is difficult to diagnose but a high index of suspicion should be had if the patient is apnoeic and has a metabolic acidosis indicating tissue hypoxia. Treatment is beyond the scope of this article but ventilation and antidotes (sodium thiosulphate) will be necessary. It is also important to consider the rescuers who may have been exposed to this gases.

Soot is an irritant that will cause chemical injury if left in the airway. It can be treated with Bicarbonate (1.8%) nebulisers. Chemical toxins formed from combustion include chlorine, ammonia and phosgene. They have variable penetration into the respiratory tract but may cause serious airway injury.

Thermal injury from flame or hot gases may also injure the upper respiratory tract although it is rarely severe as the upper airway will rapidly cool 'dry heat' and thereby minimise injury. Stream inhalational, however, can cause lower alveolar damage and carries a poor prognosis.

Suspicion of a potential inhalational injury should be aroused if there is a history of a fire in an enclosed space, disturbed consciousness, facial burns, coughing, hoarse voice, airway soot and cyanosis. Specific investigations include COHb levels, arterial blood gases, and fibreoptic bronchoscopy. The management involves oxygen therapy and mechanical ventilation along with physiotherapy and tracheo-bronchial toileting. Increased fluid requirements will be necessary. If acute respiratory distress syndrome develops the patient will require specialist intensive care support.

Renal failure may occur as a complication of renal hypoperfusion (inadequate resuscitation), septicaemia or haemoglobinuria/myoglobinuria. The latter may require alkalinisation of the urine in addition to maintaining an adequate perfusion pressure and the administration of mannitol (1g/Kg). Early renal dialysis may become necessary. Renal failure in association with burns has a high morbidity and mortality.

Haematology Intravascular haemolysis along with wound losses will increase blood transfusion requirements. Haemoglobinuria may occur.

Nutrition Patients are profoundly catabolic with a BMR peaking at 4 days. These patients require early and aggressive feeding preferably enterally to maintain intestinal mucosal integrity. Glutamine rich feeds may further reduce mucosal breakdown and also improve immune function. Curling's ulcers are associated with severe burns but can be prevented by early feeding and antacid prophylaxis.

Cerebral Hyponatraemia complicating resuscitation may result in the *burn encephalopathy syndrome*. This is seen as cerebral irritability.

Sepsis

Burn injury is associated with a generalised loss of immunocompetence, and sepsis remains a major cause of death in burns. Early sepsis (1-3 days post burn) is usually streptococcal or staphylococcal. Late sepsis is usually due to Pseudomonas, acinetobacter and fungi. Prophylactic antibiotics should be avoided and instead regular cultures taken and appropriate therapy given when indicated. Some specialist burns centres recommend systemic decontamination of the digestive tract (SDD). Tetanus toxoid must be given.

Other problems

Consider the possibility of underlying medical conditions that may have led to the burn injury for example epilepsy, a cerebrovascular event, hypoglycaemia, drug or alcohol overdose. Always attach an ECG if there is a history of heart disease or carbon monoxide inhalation.

Conclusion

Effective management of the burnt patient depends upon early and adequate fluid resuscitation, a high level of suspicion over the airway safety and continuous assessment of the whole patient. Early transfer to a specialist centre is desirable.

<u>Example of fluid management</u>:

A 70kg patient with 50% body surface area burn would require:

4 x 50 x 70 =14000mls of Hartmanns solution over 24 hours.

Therefore 7 litres should be given in the first 8 hours and 7 over the following 16 hours.

(Calculated with the Parklands formula)

Regular reassessment of the adequacy of resuscitation should be performed. Blood products and colloid may also be given in addition to these requirements.