EMERGENCY MANAGEMENT OF SEVERE BURNS

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MANAGEMENT IN THE EMERGENCY DEPARTMENT

Patients who have suffered severe burns are a complex cohort requiring rapid and specialised assessment and management. All burns patients should be stabilised in the Emergency Department before being transferred to the appropriate destination. NHS Lothian burns unit is at St John's Hospital, Livingston with the National Burns Centre being Glasgow Royal Infirmary.

The following are pertinent aspects of the **HISTORY:**

- Mechanism of the burn – scald/flame/flash/electrical/chemical/friction
- Was the patient in an enclosed space? If so, inhalation injury is more likely.
- Was there any loss of consciousness?
- Is there any evidence of ETOH or recreational drug use?
- What time was the burn? This will guide resuscitation.
- Mechanism of the burn - scald/flame/flash/electrical/chemical/friction
- Any other injuries
- Any significant past medical history or drug history/allergies
- Any concerns of non-accidental injury (delay in presentation, inconsistent history, previous abuse, injury pattern doesn't fit history, multiple presentations, burns to buttocks or genitals, cigarettes burns)

The revised Baux score can be used to predict mortality and length of hospitalisation in adult burns injury. This considers age, %TBSA burned and the presence of inhalation injury.

Following handover from the ED/ Paramedic team, a Primary Survey should be performed as per ATLS guidelines. Important things to note:

A AIRWAY + C-SPINE

Give high flow oxygen – assume carbon monoxide poisoning until proven otherwise. Consider Cyanide poisoning if haemodynamically unstable and patient has been exposed to burning plastic/vinyl/wool or silk (see Appendix 1).

Inhalational injury in a thermal burn to the airway. Inhalational injury with burns increases mortality significantly in comparison to burn injuries alone. Consider early intubation in the context of facial,

neck, airway burns. Look for nasal hair singes, hoarse voice, stridor, dysphagia or carbonaceous sputum. If intubating, use an UNCUT endotracheal tube and expect a difficult airway. BE AWARE that black soot in the airway can make the use of a videolaryngoscope difficult. Established airway oedema may require an awake fibreoptic intubation or awake tracheostomy under local anaesthesia. Get expert help from ENT and Anaesthesia.

C- spine immobilization should only occur if the patient has suffered trauma or there are concerns about the spine. If you decide to immobilise, clear the spine clinically and/or radiologically as soon as possible using the established guideline.

B BREATHING + VENTILATION

Remove all clothing and look, listen and feel the chest.

Special attention should be paid to any circumferential burns to the chest or torso – these are likely to reduce chest wall compliance and make ventilation difficult. Consider early intubation.

Circumferential full thickness burns to the chest or torso with poor ventilation are an indication for chest escharotomies – get surgical review urgently.

ABG – check carboxyhaemaglobin(COHb) levels. If > 10% of total Hb, this is diagnostic of carbon monoxide poisoning. (see Appendix 1)

Remember Spo2 can be falsely reassuring and be aware of the rare possibility of cyanide poisoning.

C CIRCULATION + HAEMORRHAGE CONTROL + FLUIDS

On the floor and four more (retroperitoneal, long bone, chest, abdomen) – look for obvious and concealed haemorrhage in the patient with burns and major trauma.

Establish large bore IV access quickly – oedema will deteriorate, and fluid resuscitation will need to be commenced.

Calculate the total body surface area of the burns and start fluid resuscitation based on the Parkland formula (see Appendix 2) in those with >15% TBSA burns or 10% with concurrent inhalation injury.

Insert a urinary catheter to monitor urine output during resuscitation.

D DISABILITY + NEUROLOGICAL ASSESSMENT

GCS score + focal neurology to be documented. Check blood glucose.

Ensure the team are aware of the GCS (specifically the motor score) at the scene of the incident.

Consider neurological reasons for endotracheal intubation as well as airway/ breathing issues.

Ensure the neurovascular status of affected limbs is documented.

E EXPOSURE+ ENVIRONMENT

Remove clothing and jewellery. If any clothing is attached to the skin, use warm, wet gauze to 'unstick ' the item. Deroof blisters if tense and >6mm as long as doesn't delay surgical debridement - a helpful guide is found on the BBA website (see references 6). Pay close attention to circumferential burns which can cause compression of underlying structures as oedema progresses. If circumferential deep dermal/full thickness burns are present urgent plastic surgery review is required for consideration of escharotomies (see Appendix 3)

Calculate extent of burns using tools such as Wallace rule of 9s, Lund and Browder charts, Mersey Burns app. Assess depth of the burns and populate on a chart. Take swabs of the burns.

Monitor temperature – actively rewarm if less than 36 degrees. This is often forgotten when there is a lot of activity in the emergency department. Please keep the patient warm with warm blankets/huggers and warm fluids.

Look for entry and exit points in electrical burns and monitor for signs of compartment syndrome in between.

Take wound swabs on admission and treat Strep infections with antibiotics as this will cause skin grafts to fail.

SUMMARY OF MANAGEMENT

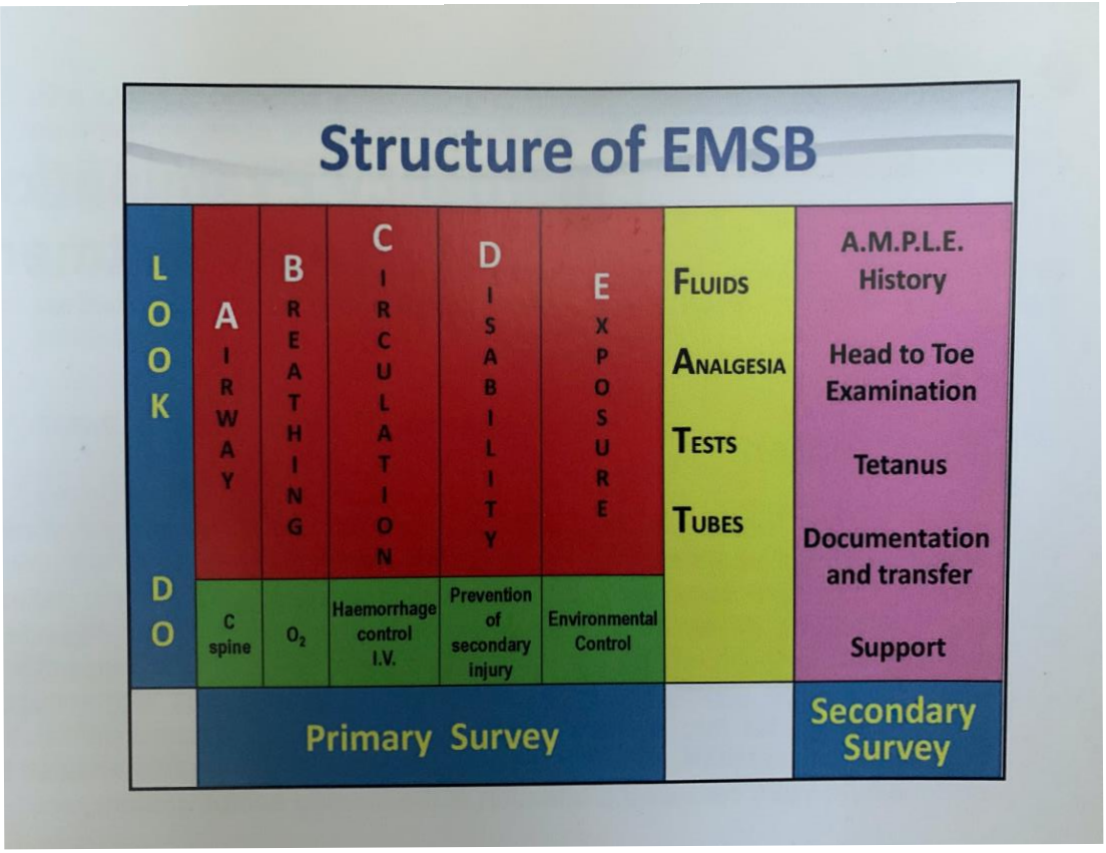

Figure 1. Summary of the Emergency Management of the Severe Burn

FURTHER MANAGEMENT

Analgesia – Burns can be extremely painful, especially partial thickness. Ensure adequate analgesia with opiates is prescribed and given. If trained, consider small doses of adjuncts.

Ensure tetanus prophylaxis / treatment guidelines are adhered to.

Consider an NGT in major burns to maintain nutrition and minimise the risk of stress ulcers.

VTE prophylaxis should be considered after discussion with the burns team.

Imaging – if the patient has suffered a burn injury and major trauma, they are likely to require CT Trauma series and contact medical photography if available.

If indicated after discussion with Edinburgh Burns Unit discuss the patient with the Burns Centre in Glasgow (see Appendix 2) - see COBIS guidelines for most up to date referral criteria.

TRANSFER

Qualified personnel required – consider if the patient needs anaesthetic support for the transfer.

Ensure preparation of equipment, drugs, personnel, and meticulous notes of what has already been done and anything outstanding.

Ensure the patient has been accepted by a named Consultant.

Remember to keep the patient as warm as possible during the transfer.

Ask the team who has accepted the patient what dressings they would like - usually cling film (not wrapped tightly but rather laid on the burn is sufficient)

Update patient relatives.

ASSESSMENT OF BURNS ON ADMISSION TO ICU

Effects of inhalation injury and hypovolaemia are likely to be more detrimental to the patient in the first few hours than the burn itself.

Repeat the A to E assessment with a specific focus on how much fluid has been given pre- hospital, in the emergency department and during transfer. Treat any outstanding associated injuries.

Ensure wounds have been assessed adequately (see Appendix 3). In reality, burns are rarely one depth and are normally a mixture of varying tissue destruction.

Check again for circumferential burns. Any evidence of high compartment pressures should prompt review by the plastics team +/- escharotomy within 3 hours.

REASSESS repeatedly.

Specific aspects to focus on:

Cardiovascular support – shock is multifactorial - fluid leak, inflammation and vasodilatation and secondary sepsis. Invasive monitoring with a combination of fluid and vasopressors will be required. Significant cardiovascular instability on admission is rarely due to the burn injury itself. Consider HCN poisoning or occult blood loss if the patient is requiring high doses of vasopressors on admission to ICU.

Respiratory – Lung protective ventilation and early bronchoalveolar lavage can be helpful. In those with a concurrent inhalation injury it is reasonable to trial nebulised heparin at 5000units 4 hourly. It is also reasonable to trial N-acetyl-cysteine (NAC) nebuliser in conjuction wth nebulised heparin at 3ml of 20% solution 4 hourly.

Infection- Patients with severe burns are at high risk of infection and identification of sepsis can be difficult. Early excision and grafting can help. The use of prophylactic antibiotics however, is not recommended. A high index of suspicion for infection should be maintained.

Nutrition – Days 7-10 post injury are peak times for muscle wasting in this hypermetabolic state. Adequate assessment by dieticians and nutritional support is key. Consider supplementation of micronutrients including Cu, Zi, Se and Vitamins B,C,D and E.

SPECIFIC ANATOMICAL GUIDELINES

BURNS OF THE HANDS

Remove jewellery including watches and bracelets. Burns of the hands are best treated with the use of handbags. A polythene bag is generously coated with liquid paraffin or Prontosan Gel and the hand placed in the bag. The hands are kept elevated, except when in active use, and frequent passive and active exercises are carried out – this should be done daily by nurses as well as physiotherapists. Although an unpleasant looking exudate collects in the bag, and any undamaged skin within the bag becomes macerated, the patient's ability to use his/her hands is a great advantage in the preservation of active hand function. Hand burns should be washed daily with soap and water, or saline/betadine mix and a new handbag applied.

DO NOT use flamazine initially in the handbag as it masks appearance due to a pseudo eschar – stick to liquid paraffin in the initial phase.

Burns of the hand are often mixed depth and Nexobrid (a proteolytic enzyme derived from pineapple) can be considered by the plastic surgery team for targeted debridement.

BURNS OF THE FACE

Facial burns are best left exposed. Once burnt skin has been removed, soft paraffin or Prontosan Gel can be applied until review by the plastic surgery team. Due to the excellent blood supply, facial burns generally heal very well with minimal surgical input in most burns. Facial cleaning/toileting should be performed 2 hourly initially then at least 4 hourly and as required with saline.

BURNS OF THE EYES

The goal of treatment for burn injury to the eyes is to prevent further damage and complications. Damage to the eyes can involve the eyelid, conjunctiva, and cornea as well as the deeper tissues. Singed eyelashes and eyebrows can indicate more extensive occular burn damage. The injury can be severe enough to cause significant infections, eyelid contractures/ectropion, corneal ulceration, and even permanent loss of vision. Review of the eyes can be done with fluorescein stain and a blue light. Consult ophthalmology with any concerns.

Caring for burns of the eyes involves thorough cleansing with saline 4 hourly and as required (PRN). This will need to be more frequent with chemical burns. Instillation of eye lubricant as per

ophthalmology advice will prevent drying of the cornea. A topical ophthalmic antibiotic ointment, e.g., chloramphenicol should be instilled if prescribed.

BURNS OF THE EARS

Burn injury to the external ear is not an uncommon consequence of burns occurring on the face and neck. Because of its exposed anatomical position, poor vascularity, and lack of subcutaneous tissue, burns of the ear are often deeper than other areas of the body. The goal of treatment of burn injury to the ears is to minimise cartilage damage, ear deformity and loss of the ear. Caring for the patient who has sustained burns of the ears involves thorough cleansing of the entire ear with soap and water, e.g. baby bath or normal saline, 4 hourly and PRN. Cotton buds are helpful in getting into the small areas of the ear. This helps to remove products previously applied so that they do not cake onto the ear. Ensure exudate is removed from the ear canal. Then apply a generous amount of a topical antimicrobial agent, e.g. chloramphenicol / flamazine to the external meatus and auricle.

BURNS OF THE BUTTOCKS AND PERINEUM

In perineal burns, oedema formation of the genitals may cause obstruction of the urethra. A catheter should be inserted as soon as possible. Attention to cleanliness is necessary because of the risk of contamination and infection with faeces. Treatment of perineal burns consists of local wound care, using an open technique, if possible, i.e. exposure and the application of a topical antimicrobial e.g. flamazine.

For burns to the buttocks, a sacral pad – flamazine, jelonet and gamgee – can be applied. Change sacral pad as required ensuring that the area is washed before the new sacral pad is inserted. Flamazine impregnated jelonet can be applied to skin folds but must be washed off before a new application is applied as the old flamazine will build up on the skin. Position legs spread apart.

Wounds should be washed daily with soap and water e.g. baby bath, after each bowel movement and PRN. Perform regular catheter care to remove exudates/crusting. Such patients are often immobilised for weeks while their burn heals and so ensuring VTE prophylaxis and support at home is essential.

If significant burn to the perineum/anal canal region which requires surgical input, then consideration of temporary stoma via the general surgeons will be needed to allow burn to be debrided and grafted without becoming contaminated.

ELECTRICAL BURNS

The key here is establishing whether the injury is secondary to low (<1000V) voltage or high voltage as the pattern of injury is different.

Low voltage is less likely to cause deep tissue injury but is likely to cause cutaneous burns from contact points. Cardiac arrythmias with cardiac arrest is possible.

High voltage is associated with increased risk of significant injury including full thickness burns, rhabdomyolysis, compartment syndrome, arrythmias and myocardial damage.

Management:

- Manage as per ATLS - look for entry and exit points in electrical burns and monitor for signs of compartment syndrome in between.
- Cardiac monitoring for > 24hrs if symptomatic (loss of consciousness), abnormal initial ECG, high voltage >1000 volts, pre-existing myocardial disease
- Measure blood CK, high risk of rhabdomyolysis
- Monitor U+Es, catheterise
- If fluid resus is required aim for urine output of 2ml/kg/hour

CHEMICAL BURNS

Most occur in industry or household and involve prolonged tissue destruction.

- Acids cause coagulative necrosis.
- Alkalis cause liquefactive necrosis.

Management:

- PPE to avoid exposure
- Remove contaminated clothing
- Take baseline pH from wound
- Irrigation ++
- Consider diphoterine
- Trim fingernails if hands affected

HYDROFLURIC ACID

Hydrofluoric acid is usually used in the glass/pharmaceutical industry. It binds calcium and causes profound hypocalcaemia and hypomagnesemia. Have a low threshold for considering the possibility of Hydrofluoric acid injury as even a 2% burn can be fatal. Involve a senior early.

Management:

- Measure serum calcium and consider calcium gluconate (topical/infusions)
- Continuous cardiac monitoring

CARE OF THE PATIENT WITH SKIN GRAFTS

Graft take can be affected by –

- bleeding, the blood can push the graft off.

- infection, exudates can push the graft off or cause cell lysis.

- movement/shear, the graft can slide off, which is why the patient does not have physiotherapy to the grafted area.

DRESSING CHANGES

1st change of dressing depends on the surgeon's preference and will be documented in the post-operative instructions, either the 3rd, 5th or 7th day post-op. Careful removal of the dressings is necessary: in case some of the graft edges lift off, and some fragile graft is removed with the dressings. The healed graft should be washed gently with soap and water and gently dried.

CARE OF DONOR SITE

The donor area should heal within 14 days, in the absence of infection. If the donor area has been shaved too deeply it will take longer. The healed donor area is treated in the same way as a healed graft. If strike through occurs the wet dressings should be replaced.

APPENDIX 1 : CARBON MONOXIDE AND CYANIDE POISONING

Inhalational injury is a thermal injury to the airway which rarely occurs in the abscence of facial burns but can occur with or without CO and HCN toxicity. Carbon monoxide poisoining occurs more commonly following fires in enclosed spaces and whilst cyanide poisoining is rare, suspect it if the fire has involve synthetic furnishings such as polyurethanse and polyvinyls.

In addition to the history of a fire in enclosed spaces or those victims with a reduced level of consciousness, a venous or arterial blood gas sample with a COHb level of >10% of total Hb is diagnostic for carbonmonoxide poisoning.

Key aspects in the management of carbon monoxide poisoining injury include rapidly securing the airway with an uncut ETT and ventilating on 100% humidifed high flow O2 (with LPV) until COHb <10%.

Consider cyanide antidotes (Hydroxycobalamin is first line) in those with:

1. Fire in enclosed space
2. Altered level of consciousness
3. Cardiovascular compromise out of keeping with the injury including unexplained hypotension
4. High serum lactate (>10mmol/l)

APPENDIX 2: FLUID RESUSCITATION + FLUID MAINTENANCE

Calculating Body Surface Area of Burns can be done using a number of methods. Classically the 'rule of nines' was used and this can be useful in the emergency department. Alternative methods such as the Lund- Browder Chart and the Mersey Burns App can also be used for calculations.

Intravenous fluids of a balanced salt solution (e.g. Hartmann's or Plasmalyte) should be given in all adults patients with >15% TBSA burns or those with smaller burns but have smoke inhalation, co-morbidities, hypotension or other reasons for a fluid deficit.

Fluid resuscitation volume is calculated using the Modified Parkland Formula:

Adults – 2-4mL x Actual patient body weight (kg) x % TBSA

Give ½ in first 8h since the time of injury

Give ½ in the next 16 hours

Once on the Intensive Care unit, the rate of fluid administration should be based on urine volume.

Aim: Urine output of 0.5ml/kg/hour (Ideal Body Weight) and normal HR and BP, haematocrit of 0.3.

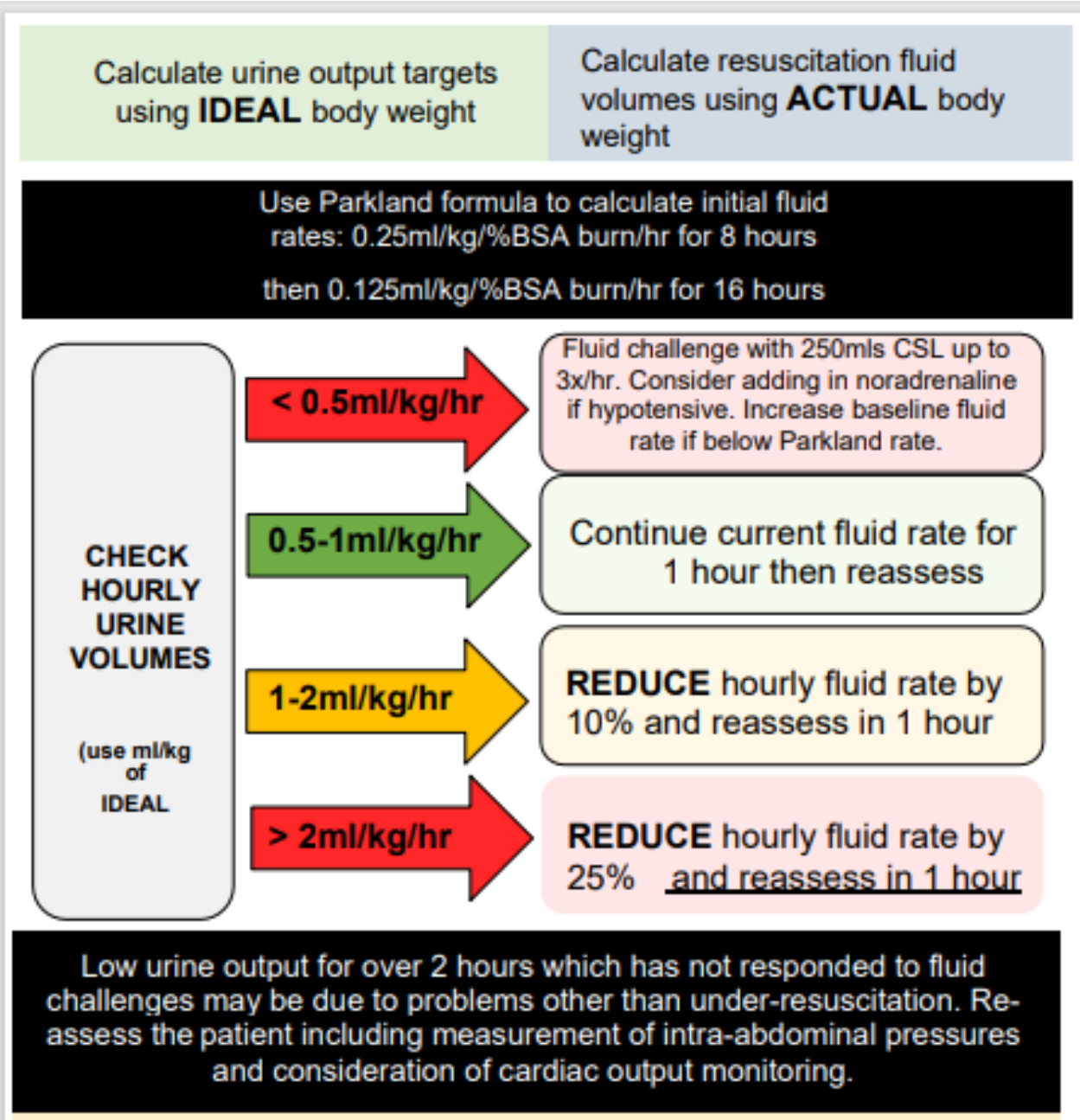

Figure 2. Fluid Resuscitation on the ICU from COBIS website

Typically, more fluid is required if the patient has inhalational injury, electrical burns or delayed resuscitation.

If at 12 hours post burn, the patient's total 24 hour resuscitation volume is likely to be >6ml/kg/&BSA, consideration of albumin should be given. See guidelines on COBIS website for further details of this.

N.B Fluid resuscitation volume does not include maintenance fluids or other losses.

Don’t forget to test for creatinine kinase. If positive, you need to rule out rhabdomyolysis and resuscitation parameters may change:

(1) Get a surgical review for consideration of escharotomy/ fasciotomy.

(2) Aim for a higher urine output

Fluid creep

Excess fluid loading is also termed ‘fluid creep’and can be common in burns patients due to:

- inaccurate fluid requirement calculations
- lack of vigilance in reducing unnecessary fluid infusions
- increased use of sedation and analgesic agents
- excess crystalloid use
- inappropriate use of parameters for monitoring fluid replacement

Remember to monitor urine output HOURLY.

Be mindful of abdominal compartment syndrome during fluid resuscitation due to fluid creep.

Be guided by fluid balance monitoring in ITU with parameters such as HR, BP, U/O, core/peripheral temperature monitoring, CVP monitoring.

APPENDIX 3: ASSESSMENT OF BURN DEPTH

Importance of First Aid – Jackson Model

- Zone of Coagulation
    - Point of maximum damage
    - Irreversible tissue loss due to protein coagulation

- Zone of Stasis
    - Decreased tissue perfusion
    - Potentially Salvageable with main aim of resus to prevent irreversible damage
    - Additional insults e.g. infection, prolonged hypotension can convert this into complete tissue loss

- Zone of Hyperaemia
    - Increased tissue perfusion
    - Will recover unless severe sepsis or prolonged hypoperfusion
    - In major burns, this zone affects the **whole body**
    - Not usually included in TBSA calculation

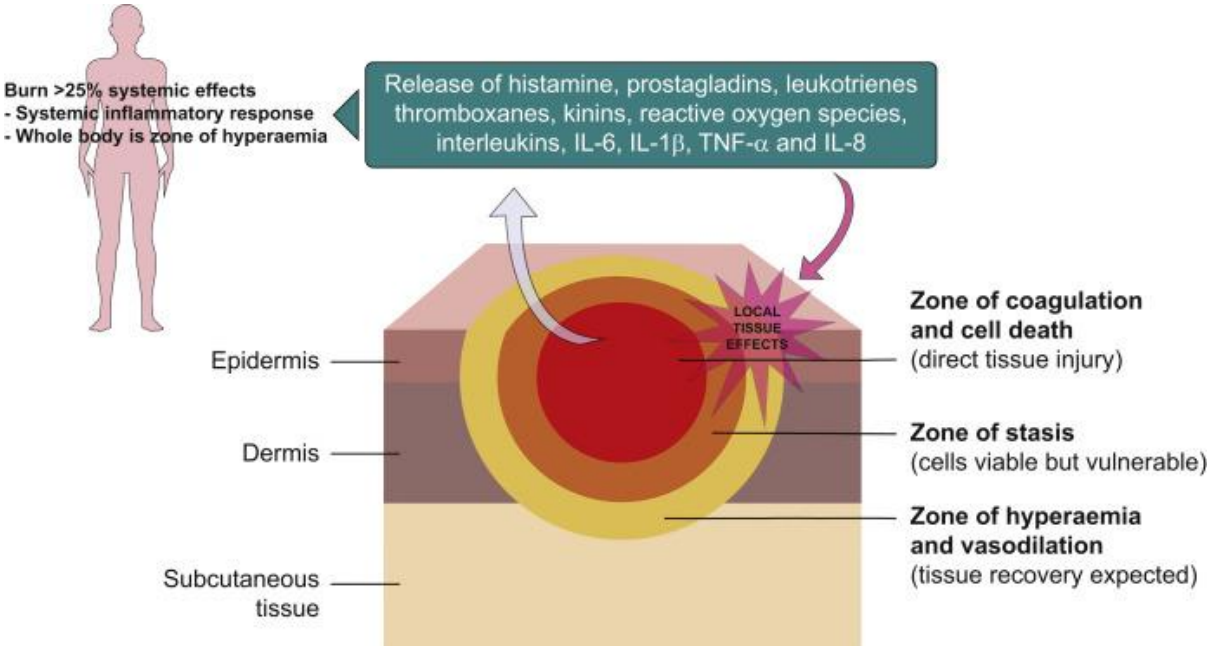

Figure 3. Pathophysiology of a burn

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EPIDERMAL

- Skin Erythema E.g. Sunburn
- Should **not** be calculated as part of the burned surface area
- dry, erythematous, blanch with pressure, no blistering

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Figure 4. Epidermal Burn

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SUPERFICIAL DERMAL (PARTIAL THICKNESS)

- Painful (sensory nerves still intact)
- Blanches on pressure with Rapid capillary return
- Blistering with a moist pink tissue base (reroof blisters to minimise infection and enhance healing)
- Will heal by re-epithelisation

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Figure 5. Superficial Dermal (Partial Thickness) Burn

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DEEP DERMAL

- Salmon pink/white
- Varied sensation
- Does not demonstrate a capillary refill return
- Often fixed cherry red staining

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Figure 6. Deep Dermal Burn

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FULL THICKNESS

- Dry, leathery
- White, brown or black
- Insensate
- No healing Capacity, requires surgery

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Figure 7. Full Thickness Burns

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In both superficial and partial thickness burn cases spontaneous healing can occur from undamaged epidermal appendages – hair follicles, sweat and sebaceous glands – epithelium will regenerate and resurface the remaining dermis. Deep dermal burns can heal via secondary intention although this can take time and so to minimise scarring and infection they are often debrided and grafted. Full thickness burns will not heal and thus need debridement and grafting.

APPENDIX 4: TRANSFER TO BURNS CENTRE

Burns Centres - For the highest level of injury complexity. Offers a separately staffed, geographically discrete ward. The service is skilled to the highest level of critical care and has immediate operating theatre access.

Burns Units – For moderate levels of injury complexity and offers a separately staffed, discrete ward.

Burns Facilities – Standard plastic surgical ward for the care of non-complex burns.

As per the COBIS Website (https://www.cobis.scot.nhs.uk/clinical-guidelines-new/):

Referral Criteria for Transfer of Patients to National Burn Centre in Scotland

Basic Triage

All adults >25%TBSA and Children >15%TBSA, expedite transfer to National Centre, but safest transfer may be via local regional burns unit first.

Adults

All major burn Injuries more than 25%TBSA.

All burn patients requiring both Level 3 ICU care and substantial early excision and grafting surgery during ICU stay.

All deep burn injuries requiring more than 10% TBSA deep burn excision.

Frail or elderly patient requiring more than 10% full thickness burn treatment.

Other burn patients deemed very complex by referring hospital and requiring prolonged or complex in-patient care (eg some high voltage electrical injuries; some patients with 10 to 25% partial thickness burns).

The regional burns unit clinicians must feel able to refer any patient whose needs exceed the capacity of the available clinical team (eg during periods of leave of their specialist clinicians).

Children

All major burn Injuries >15%TBSA.

All deep burn injuries requiring more than 7% TBSA early burn excision. All high voltage electrical conduction injuries.

All children requiring level 3 PICU care and significant early excision and grafting surgery.

Very young babies with complex burns.

The services without specialist PICU services must feel able to refer and child whose condition causes concern of significant risk to life.

Transfer Pathway

Many patients can have their initial treatment in their regional burns unit whilst discussions between referring team and burn centre team take place. Transfer can then occur at the safest time for the patient.

In extreme circumstances, burn centre staff may travel to a regional burns unit to treat a patient together with local staff.

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