Burns

Burns are common usually preventable injuries associated with significant morbidity and mortality. The can be due to electrical, chemical or most commonly thermal insult. A major burn (>10%BSA 3^o , >25% 2^o) is associated with significant physiologic alterations in multi organ system function with complications of: hypovolemic / cardiogenic shock, ALI/ARDS, ARF, sepsis etc.

Burn injury stages: acute phase (first 24-48 hours) which is associated with severe hypovolemia, endothelial injury, cardiac suppression, second phase/hypermetabolic phase (>48h til primary skin recovery) involves hyperdynamic circulation, normal endothelial function, increased metabolic demands (nutritional support)

ANESTHETIC CONSIDERATIONS:

1. Trauma Patient – ATLS approach
2. Airway compromise / Inhalational injury (see inhalational injury seminar)
    a. Potential difficult airway
    b. CO/CN poisoning
    c. ALI
3. Volume Resuscitation Needs
    a. Significant hypovolemia in acute phase
    b. Parkland Formula 4cc/Kg/%BSA/24hr of RL (50% first 8hours)
4. Associated multiorgan system failure
    a. ALI/ARDS
    b. Cardiogenic shock
    c. Rhabdo/Myoglobinuria/ARF
    d. Sepsis
5. Metabolic/Pharmacologic considerations
    a. Hyperkalemia from tissue destruction
    b. Contra indication to Sux if >8% TBSA burn >24hrs <2yrs (hyperK) /Resistance to NDMR >48hrs
    c. Temperature control
    d. Hypermetabolic state (require early feeding/nutrition)
    e. Large analgesic requirements & opioid tolerance with repeated debridements and dressing changes
6. Burn Surgery
    a. Blood loss – potential for massive blood loss (but decreased if surgeon infiltrates local with epi)
    b. Pain
    c. +/- remote location
    d. Potentially difficult monitoring/IV access (ecg patchs, BP cuffs etc)

ANESTHETIC GOALS:

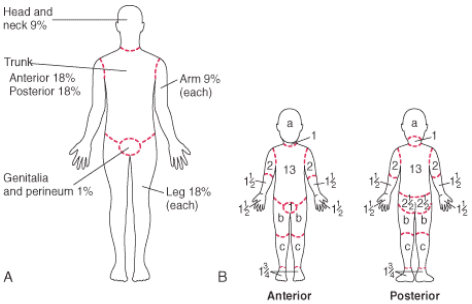
- ATLS approach
- Rapid & safe definitive airway (if facial/neck/inhalational or Major burn)
- Timely volume resuscitation (guide: Parkland formula)
- Avoid end organ dysfunction (lung protective vent if ALI, U/O >1ml/Kg/hr)
- Avoid Sux >24 hours after burn
- Adequate analagesia (high requirements, use multimodal approach +/- antidepressants)

HISTORY

- AMPLE Hx
- Events: time of injury, type of burn (chemical/electrical/thermal), enclosed space, inhalational exposure, explosion
- Associated injuries
- Symptoms of CO exposure: HA, N/V, confusion etc.
- ICU patients: degree of multiorgan system failure (shock, renal failure, resp failure etc.)

PHYSICAL

- Vitals: HR, BP, Sp02, Temp
- Primary Survey: ABCDE
- Airway: facial/ neck burn, carbonaceous sputum, singed hair, hoarseness
- Resp: look for : crackles, cyanosis, circumferential chest burn
- Cardiac: volume status, end organ perfusion (cap refill, UO, LOC etc)
- Extent of Burn= 1st, 2nd or 3rd degree. Sum of 2^o and 3^o. Rule of 9's for adults.
- Children estimates are usually lower than actual with either method, as children are more complex = look at Lund and Browder chart



Relative percentage of body surface area (% BSA) affected by growth

	Age				
Body Part	0 yr	1 yr	5 yr	10 yr	15 yr
a = 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2
b = 1/2 of 1 thigh	2 3/4	3 1/4	4	4 1/4	4 1/2
c = 1/2 of 1 lower leg	2 1/2	2 1/2	2 3/4	3	3 1/4

INVESTIGATIONS

- CBC, lytes, Bun, Cr, glucose, group & screen (specifically looking at Hb, K, Cr)
- ABG + Co-oximetry = to assess degree of hypoxemia/acidosis/COHb
- UA for myoglobinuria
- CXR = if inhalational exposure/ lines/tubes
- Consider bronch for inhalational exposure

OPTIMIZATION

- Timely definitive airway as indicated (facial/ airway burn, shock etc.)
- Stop the burning processes: remove clothes, wash/irrigate chemical exposure
- Volume resuscitation
    - For acute burns: calculate 1st 24 hour fluid requirement by Parkland Formula:
        - Parkland formula: 4 mL x weight in kg x %TBSA burned = 1st 24 h fluid requirement (from time of burn)
        - Give 1st half in first 8 hours, and 2nd half in next 16 hours
        - Generally given as Ringer's, but you can use any balanced crystalloid
        - Colloid are usually avoided in 1st 24 hours, but many regimes support its use later with 5% Albumin (in burns > 30% TBSA – may give 0.4 mL/kg/%burn/24 h)
        - Most HDUs use the Parkland formula as a start and fluid OD, since 3rd & 4th degree burns require even more fluid and titrate to U/O at 0.5-1 mL/kg/h in adults
    - For inhalational injury, add 1-2 mL/kg/%burn/24 hour to the Parkland's formula
    - Also Modified Brooke: 2 mL/kg RL / %TBSA in first 24 hours
    - Maintain U/O 0.5-1ml/Kg/hr
        - In children the U/O should be 1-2 mL/kg/h
- Ensure adequate end organ perfusion if pt (volume, pressors, inotropes, blood etc.)
- No role for IV ABX prophylaxis

ANESTHETIC OPTIONS

16. Can present to OR for multiple reasons, commonly: burn surgery (debridement/grafting/escharotomy), trach or trauma related injuries
17. ICU patients usually already intubated and sedated therefore GA +/- NMB is easy, consider local / regional if appropriate
18. Burn Baths: GA +/- ETT/LMA, MAC sedation

ANESTHETIC SETUP

- Standard CAS monitors + temperature monitoring, heated OR
- Difficult airway cart
- Large uncut ETT
- Good IV access
- Arterial line for hemodynamic monitoring and assessment of ventilation in acute burns
- Foley for U/O
- Ventilator capable of supporting patient with ALI/ARDS (ie. ICU ventilator)

MANAGEMENT OF ANESTHESIA

- **Induction**
    - Difficult IV / monitoring issues (ECG patches, BP cuffs etc.) depending on area burnt
    - Depends on situation: no drugs (if obtunded), Awake (look or FOB) if compromised airway, RSI
    - Ketamine good induction choice as potentially better HD response (though patients are usually already maximally sympathetically driven) also good analgesic properties
    - Sux okay if <24hrs post injury (however assess K as tissue injury/ rhabdo/ARF may lead to hyperK state)
    - May require increased dose of NDMR if >48hrs post injury, peak resistance 5-6 weeks
- **Maintenance**
    - Lung protective vent if inhalational injury/ALI/ARDS
    - Balanced technique appropriate
- **Emergence/Disposition**
    - Burn center
    - ICU for all major, airway and inhalational burns (don't extubated as high risk for airway edema)
    - Multimodal analgesia (acetaminophen, NSAIDS if normal renal function, narcotics, PCA, ketamine)

DISPOSITION & MONITORING

- Burn unit/ ICU

COMPLICATIONS

- Rapid A/W obstruction (esp. in larger burns, facial burns or inhalational injury)
- Potential for ALI / ARDS
- Mixed hypovolemic & cardiogenic shock state requiring massive fluid replacement
- Rhabdomyolysis / myoglobinuria / ARF
- Sepsis
- Hypothermia
- Hypercoaguable (may need DVT prophylaxis)
- Possible carbon monoxide or cyanide poisoning
- Survival influenced by %SA burn involved and age of patient

PATHOPHYSIOLOGY

- Criteria for Major burn:
    - Full-thickness burns involving >10% of TBSA
    - Partial-thickness burns involving >25% of TBSA in adults and >20% at the extremes of age
    - Burns involving the face, hands, feet, or perineum
    - Inhalation, chemical, and electrical burns
    - Burns in patients with serious pre-existing medical disorders

Thermal:

- Mortality related to the TBSA of the burn and the degree of burn
- Children, elderly and patients with burden of coexisting disease at greatest risk
- Mortality 10-20% in a 50% burn; 90% in 90% TBSA burn

Inhalational:

- Direct thermal injury to upper & lower airways: decreased surfactant and mucociliary function, tissue sloughing & secretions leading to bronchial obstruction, air-trapping and bronchopneumonia
- 5-30% of burn patients
- Mortality of isolated inhalational injury < 10%, but doubles mortality associated with a cutaneous burn of any size

Electrical:

- Concealed injury (usually severe) along path of entry and exit wounds due to differential rate of heat loss from superficial and deep structures (injury inversely proportional to resistance). Alternating current induces muscle tetany – may be unable to release electric source; may cause suffocation.
- Extensive rhabdomyolysis requiring fluid, mannitol and bicarbonate
- Cardiac dysrhythmias up to 48 hours post-injury
- Fractures, haematomas, visceral injury, compartment syndrome, cardiac muscle injury

Chemical:

- Acids, alkalis, or petroleum products
- Burn influenced by: duration of contact, concentration of chemical & amount of chemical as well as toxic interactions with
- Brush away debris, flush > 30 mins with tapwater or normal saline (eyes). Do not neutralise chemicals as reaction will release heat.
- **Alkali ingestions:** airway oedema from liquefaction necrosis necessitating intubation under direct vision, ALI if aspirated, viscus haemorrhage and rupture. Generally worse than acid burns as there is greater tissue penetration.
- **Acid ingestions:** airway oedema from coagulation necrosis (which tends to limit spread) necessitating intubation under direct vision; ALI if aspirated; potential for perforation and haemorrhage (oesophageal, gastric, mediastinal, peritoneal)

Toxic effects of combustion

- Carbon monoxide poisoning – tx 100% O2 vs hyperbaric O2 if COHb > 30% and patient otherwise stable
  - <20% headache, tinnitus, nausea
  - 20-40% nausea, visual impairment, disorientation
  - 40-60% hallucinations, coma, shock, rarely "cherry red"
  - > 60% fatal cardiac dysrhythmias and brain damage
- Cyanide toxicity – tx O2, specific therapies rarely indicated (sodium nitrate, thiosulfate) because the short t1/2 responds to rescue from toxic environment
  - Presentation: agitation, confusion, unexplained lactic acidosis
- Toxic effects of smoke inhalation: ammonia, nitrogen dioxide, sulphur dioxide and chlorine may dissolve in upper airway causing acid & alkali burns, chemical tracheobronchitis and pneumonia

BURNS IN PEDIATRICS

- Consideration of unintentional vs intentional injury (child abuse)
- Children with < 15% TBSA burns have less capillary leak (local rather than systemic process) and may be managed with 1.5 x maintenance
- Children younger than 5 years with > 15% TBSA should be managed with Parkland + maintenance fluids; those < 20 kg should have a maintenance of 5% dextrose solution
- Silver sulfadiazine cannot be used in sulfa allergy or in neonates (kernicterus)

BURNS IN PREGNANCY

- ~7% of burn patients who are females of reproductive age are pregnant
- Mortality of mother and fetus increases with %TBSA burn
- A/W & cardiorespiratory complications are increased secondary to interactions of physiologic changes of pregnancy & pathophysiologic changes of burn; hypotension can compromise blood flow to the uetroplacental unit; carbon monoxide freely crosses the placenta
- Complications include preterm labour (secondary to increased circulating prostaglandins from burns & sepsis, hyponatraemia, acidosis) and intrauterine foetal demise (RF: anoxia, sepsis)
- Obstetric management is unclear:
  - near term, most advocate delivery of fetus
  - preterm labour in burn < 40% TBSA, may attempt tocolysis to attain foetal maturity of 24-32 weeks as long as FHR is reassuring
  - tocolysis avoided in sepsis, abruption, intrauterine demise
- Possible teratogenicity if povidone-iodine (thyroid) and silver sulfadiazine (kernicterus)
- Fetal survival relates to maternal injury, resuscitation and gestational age; most survive when mother survives without complications of sepsis, hypoxia & hypotension

REFERENCES

- Barash Chpt 36
- Miller Chpt 54
- Coexisting Chpt 24