Foundations Frameworks

Approach to Thermal Injuries

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Burn management requires a prioritized approach to rapidly assess and rule-out potential life threats. The following is a brief description of one strategy in caring for patients with thermal burns.

1. **Airway**
    a. Emergency Physicians (EP) are often taught that early airway control is necessary for thermal injuries to the upper thorax & face. Securing the airway was taught to be vital in the resuscitation of a burn patient. However, newer research has shown that an aggressive intubation strategy may lead to worse outcomes.[1]
    b. When examining the burned patient, the presence of upper thorax and facial burns alone is not an indication for intubation.[2]
    c. The best approach is to directly examine the supraglottic area to evaluate for edema or soot.[2,3] This can be done with direct visualization or with the use of a nasopharyngeal scope.
    d. The concerning features that should raise the EP's concern for inhalation injury and the possibility of the need for intubation can include:
        i. Edema or soot in the supraglottic area
        ii. Inability to handle secretions or drooling
        iii. Hypoxic on 100% Fi02 (15L NRB)
        iv. Facial burns, singed hairs in the nares, &/or carbonaceous sputum
        v. Stridor, wheezing
            1. It may be beneficial to use nebulized β-agonists (i.e., Albuterol) for bronchodilation
    e. If the patient is obtunded or severely burned, run the evaluation as if it were a trauma resuscitation. Make sure to go through the A, B, C, D, E.[4]
        i. Airway & c-spine
        ii. Breathing & ventilation
        iii. Circulation status and hemorrhage control
        iv. Disability (neuro)
        v. Environment: undress & then actively prevent hypothermia
    f. If the EP feels that intubation is necessary:
        i. Intubate the critical/nearly critical or obtunded patient
        ii. Direct visualization of the supraglottic area by NP/OP scope
            1. Setup: make sure that the tube is pre-loaded on scope in preparation to intubate if necessary. It can take too long and be disastrous if you must take out the scope and then reload it or lie the patient down in preparation for RSI.
        iii. Cricothyroidotomy: rarely necessary unless upper airway obstruction
    g. Medications for direct visualization and possible awake intubation by NP/OP scope[5]
        i. Sedation with Ketamine for visualization
            1. Does not compromise pt's breathing
            2. Dosing
                a. 0.3 mg/kg IV initially
                b. May titrate up to full 1 mg/kg IV if necessary or need to intubate
        ii. Pre-treatment ~10-15 mins prior to intubation (if possible)
            1. Glycopyrrolate: 0.2 mg IVP to dry out the airway

2. Ondansetron 4 mg IVP to prevent nausea/vomiting

iii. Provide topical anesthesia to the airway
1. Nebulized 4% lidocaine, 5cc in nebulizer
2. Viscous lidocaine (4%), put on tongue depressor and coat the anterior of the tongue. Then put more on the tongue depressor and slowly advance the depressor to the back of the tongue.
3. Use an atomizer device (EZ atomizer or Mucosal Atomizer Device (MAD)) with 4% lidocaine (3 cc) to anesthetize the mucosa of the posterior oropharynx
4. Also have an additional syringe of 4% lidocaine available to use in the adjunct port of the scope to spray the mucosa or cords during the procedure.

iv. RSI
1. Medications drawn up if able to visualize airway and you decide that you need to intubate
2. Induction
a. Ketamine
i. If already sedated with 0.3 mg/kg of ketamine initially you can easily titrate up to the full 1-2 mg/kg dosing
b. Propofol
i. If using ketamine, start with half dose of propofol (0.5-1 mg/kg slow push)
c. Midazolam
i. Can use to help with anxiolysis during awake intubation
ii. Dose: 0.1-0.3 mg/kg IVP
3. Paralytics
a. Succinylcholine
i. Careful to use in burn patients: do not use if the burn was > 3-5 days ago. Over a 3-5 day period there is a sensitization of the extrajunctional receptors that can lead to a clinically significant increase the serum potassium (documented with as little as 8% TBSA burns).[3]
ii. There is not a good correlation between the size of the burn and the increase in the potassium from the use of Succinylcholine.[3]
iii. This effect lasts until there is complete healing of the burned area(s).[3]
iv. Depolarizing agent
v. 1-1.5 mg/kg IV
b. Rocuronium
i. Safe to use: no adverse effects on burn patients.[3]
ii. Non-depolarizing
iii. 0.6-1.2 mg/kg IV (1 mg/kg IBW is preferred)

h. Post-Intubation Sedation
i. Make sure to have these medications ordered and set up so that the nursing staff can start them after the intubation.
ii. Don't allow the patient to pull the ETT out!
iii. Fentanyl (Sedation and analgesia)
1. 25-200 mcg/hr
iv. Propofol (sedation)
1. 5-50 mcg/kg/min
v. Dexmedetomidine (sedation)

1. 0.2-1.5 mcg/kg/hr

vi. Midazolam (sedation)
1. 1-10 mg/hr

2. Consider CO and CN toxicities

a. Carbon monoxide[6]
i. Must consider in any patient with AMS (or HA, nausea, ataxia, confusion, LOC) involved in structural fire
ii. Colorless, odorless gas
iii. Case fatality has been reported as high as 30%
iv. CO is formed from incomplete combustion of hydrocarbons such as automotive exhaust, space heaters using propane, wood/coal burning heaters, gas-powered motors, and structural fires.
v. The binding affinity of CO to hemoglobin is significantly greater than that of O2 and thus leads to poor tissue oxygen delivery.
vi. The half-life of CO binding to hemoglobin is dependent on the oxygen delivery method used.
1. Room air: approximately 5 hrs vs 100% FiO2 approximately 1 hr
vii. Clinical presentation: can present with symptomatology ranging from flu-like symptoms to coma
1. Headache, vision changes, confusion, ataxia, dizziness, seizure, focal neurologic deficits, obtundation
2. Vomiting, CP, SOB,
a. Carboxyhemoglobin 10-20% - confusion, HA
b. Carboxyhemoglobin > 20% - worsening obtundation
viii. Diagnosis: ABG (preferred) or VBG w/ carboxyhemoglobin level, pulse CO-oximetry
1. Normal is < 3% in non-smokers
2. CO hemoglobin can be as high as 10% in smokers
ix. Treatment: 100% O2 – NRB vs ETT
1. Consider Hyperbaric Oxygen Therapy – discuss with hyperbaric specialist
a. Indications: syncope, AMS, seizure, CO level > 25%, elevated troponin, pregnant + CO > 15%
x. Disposition
1. Consider discharge if mildly symptomatic after observation period
2. Admit anyone with severe symptoms (neurologic, AMS)

b. Cyanide Toxicity
i. Formed by burning of nitrogen-containing compound (plastics, wool, silk)
ii. Inhibits electron transport and forces anaerobic metabolism
iii. Typically, from exposure in an enclosed space
iv. Clinical presentation
1. HA, anxiety, confusion progressing to coma, seizures
2. SOB, nausea, vomiting
3. Can cause arrhythmias, bradycardia, hypotension
v. Diagnosis: assume CN poisoning in any patient with AMS and exposure to closed space fire
1. Elevated lactic acid (typically > 8 mmol/L), metabolic acidosis
2. RBC or serum cyanide levels (unlikely to return in time to be clinically useful)
vi. Treatment

1. Supportive care: supplement oxygen, fluids and vasopressors for hypotension, consider bicarb if acidemia
2. Antidotes
    a. Cyanokit (Hydroxocobalamin)
        i. Give empirically if cyanide poisoning suspected
        ii. Hydroxocobalamin 70 mg/kg IV over 15 min, may repeat x1
        iii. Sodium thiosulfate 1.65 ml/kg over 10 min
        iv. Can interfere with CO testing, obtain prior to giving cyanokit

3. Fluid Resuscitation

a. Fluid resuscitation is indicated for TBSA in adults with > 20% burns and children with > 10% burns.[7,8]
b. Avoid fluid creep[7,8]
    i. This is an overly aggressive fluid resuscitation
    ii. May lead to edema, compartment syndrome, cerebral edema, and pulmonary edema.
c. Multiple methods for calculating the amount of fluid to give, some listed below:[2]
    i. TBSA% should exclude superficial burns
    ii. Parkland Formula
        1. Use LR
        2. 4 mg/kg x TBSA%
        3. Half within 1st 8 hours from time of injury
    iii. Brooke Formula
        1. LR (1.5ml/kg * TBSA%) + colloid (0.5ml/kg*TBSA%) + 2L D5W
    iv. Modified Brooke Formula
        1. Use LR
        2. 2 ml/kg x TBSA% in adults
        3. 3 ml/kg x TBSA% in children
    v. Rule of Ten
        1. TBSA% x 10 = ml/hr (rate) in the 1st 8 hours
        2. Needs hourly adjustments based on clinical response to treatment.
    vi. The Advanced Burn Life Support (ABLS) handbook:
        1. 2-4 mL x kg body weight x % TBSA burn = volume of LR required for adult resuscitation (formula adjusted to 3-4 mL x kg body weight x % TBSA burn for pediatric patients).
        2. Half of the total resuscitation volume is given over the first 8 hours, with administration of the remaining half titrated to patient response (urine output of 0.5 mL/kg/hr for adults and 1 mL/kg/hr for children).
d. Which method to choose
    i. The American Burn Association recommends either the Parkland or the Modified Brooke Formulas +/- albumin (after 12 hours).[8]
    ii. Careful monitoring of response to resuscitation is more important than strict adherence to any formula.
        1. Target a MAP of 60 mmHg, and urine output of 0.5-1.0 ml/kg/hr for adults and 1-1.5 mL/kg/h for pediatric patients.
        2. Minimal to no UOP despite adequate fluid resuscitation is a very poor prognostic factor.
        3. Heart rate, pulse pressure, capillary refill, and mental status should also be evaluated when determining resuscitation adequacy.

4. TBSA and burn severity[2,4,7]

a. Burn Severity
    i. Superficial (1st degree)
        1. Clinical Findings
            a. Erythema without blistering
            b. Blanching
    ii. Superficial Partial Thickness (2nd degree)
        1. Clinical Findings
            a. Erythema with blistering
            b. Blanching
    iii. Deep Partial Thickness (2nd degree)
        1. Clinical Findings
            a. Erythema or white without blistering
            b. +/- Blanching
            c. Tense
    iv. Full Thickness (3rd degree)
        1. Clinical Findings
            a. white, leather-like, charring
            b. No blanching
b. Total Body Surface Area (TBSA) estimation
    i. Rule of Nines (adults)
        1. Patient's palm = 1%
        2. Arm = 9%
        3. Head = 9%
        4. Chest = 9%
        5. Abdomen = 9%
        6. Back = 18%
        7. Leg = 18%
        8. Groin = 1%
    ii. Rule of Nines (modified for children)
        1. Patient's palm = 1%
        2. Arm = 9%
        3. Head = 18%
        4. Chest = 9%
        5. Abdomen = 9%
        6. Back = 18%
        7. Leg = 13.5%
        8. Groin = 1%
    iii. Classification of Severity [adapted from Rosen's, table 56.2][2]
        1. Children
            a. Mild
                i. <5% TBSA
                ii. Dispo: Outpatient
            b. Moderate
                i. 5-10% TBSA
                ii. Dispo: Admission
            c. Severe
                i. >10% TBSA
                ii. Dispo: Burn Unit
        2. Adult

a. Mild
    i. <10% TBSA
    ii. Dispo: Outpatient
b. Moderate
    i. 10-20% TBSA
    ii. Dispo: Admission
c. Severe
    i. >20% TBSA
    ii. Dispo: Burn Unit

3. Elderly
    a. Mild
        i. <5% TBSA
        ii. Dispo: Outpatient
    b. Moderate
        i. 5-10% TBSA
        ii. Dispo: Admission
    c. Severe
        i. >10% TBSA
        ii. Dispo: Burn Unit
4. All-comers
    a. Mild
        i. <2% Full-thickness
        ii. Dispo: Outpatient
    b. Moderate
        i. 2-5% full-thickness, high voltage, inhalation, circumferential, comorbidities
        ii. Dispo: Admission
    c. Severe
        i. >5% full-thickness, high voltage, sig burns to face, eyes, ears, genitalia, joints, or sig trauma
        ii. Dispo: Burn Unit

5. General Treatment of Thermal Burns

a. Careful fluid resuscitation as noted above
b. Aggressive pain management, typically with opioids
c. Update tetanus as needed
d. Anticipate and treat hypothermia
e. Consider associated injuries such as blunt trauma, non-accidental trauma (especially for pediatric patients), carbon monoxide or cyanide poisoning (see above)
f. Deep, circumferential burns may lead to compartment syndrome and may require escharotomy by burn surgery
g. General burn wound care
    i. Gently clean area with soap and water
    ii. Use topical antimicrobial such as bacitracin or mupirocin
    iii. Silver sulfadiazine may interfere with healing, it is no longer routinely recommended
    iv. Cover with non-stick occlusive dressings
    v. Blisters: fine to leave as biologic dressing but may be debrided if large (defer to burn)

6. Transfer Criteria

- a. Outpatient treatment: partial thickness < 10% TBSA -likely OK for discharge
  - i. Children and elderly may warrant more conservative management
- b. Hospital admission/Burn Center Transfer
  - i. Partial thickness > 10% TBSA
  - ii. Consider transfer to burn center if
    1. if > 20% likely needs transfer to burn center
    2. > 5% full thickness burn
    3. Inhalational injury
    4. Burns involving face, eyes, ears, hands, feet, genitalia

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