Sub-Acute / Chronic Burns

Thermal injuries are a major cause of preventable morbidity & mortality with > 1.5 million cases/y in the US; survival improvements result from a multidisciplinary burn team, early aggressive surgical approach to major burns, and improved understanding of burn pathophysiology; the sub-acute phase of burns involves anesthesia for escharotomies, tracheotomies, debridements & grafting, burn baths, wound closures, & contracture releases

ANESTHETIC CONSIDERATIONS:

- Potential difficult A/W d/t burn / edema / contractures
- Key considerations of sub-acute phase:
  - SCh & hyperkalemic arrest if >8% TBSA burn (> 24 h < 2 y) / resistance to NDMB > 48 h
  - Hypermetabolic state
  - Potential for ALI / ARDS
  - Potential for SIRS +/- sepsis
  - Difficult IV / monitoring issues (ECG patches, BP cuffs etc.)
  - Thermoregulation challenges
  - Hypercoaguable (may need DVT prophylaxis)
- Considerations of debridement / grafting / wound care:
  - Potential for massive blood loss
  - Large analgesic requirements & opioid tolerance
  - Burn bath changes occur in remote location

ANESTHETIC GOALS:

- Safe, secure A/W
- Maintain normothermia, adequate volume & hemostasis
- Provide lung protective ventilation given hypermetabolic state
- Provide adequate analgesia (multimodal approach +/- antidepressants)

HISTORY

- Review of chart & course in hospital:
  - Type of burn (chemical / electrical / thermal) & associated injury
  - A/W involvement
  - TBSA burned
  - ICU patients – degree of multiorgan system failure (shock, renal failure, respiratory failure etc.)
  - Narcotic requirements
  - Adequacy of fluid resuscitation
  - HDU flow-sheets with labs & trends

PHYSICAL

- **VITALS** - Full set of vitals (HR, BP, SpO_2, temperature)
- **HEENT** - A/W:
  - Intubated: ETT size, method to secure, depth at teeth
  - Unintubated: is there any abnormality that would lead you to perform an awake FOI (edema, facial burns, contracture)
- **RESP** - examine for associated injury, ventilator settings (necessity for high-performance ventilator), FiO_2, circumferential chest eschar
- **CVS** - volume status, current IV access & any additional support

INVESTIGATIONS

- **Labs**
  - CBC for dilutional **anemia** or leukocytopenia in septic patients
  - ABG for level of hypoxemia, acidosis, adequacy of ventilation, possibly to assess carboxyhemoglobin
  - Lytes for hypo- / hyper-Na d/t topical burn creams
  - Mg, PO_4 for hyperPO_4 and hypoMg
  - BUN, Cr, urine myoglobin for ARF or rhabdomyolysis
  - PTT, INR
  - X-match up to 6-8 units pRBC as large debridements are very bloody
- **Imaging**
  - CXR for ETT position, signs of ARDS or volume overload
  - ECG especially in elderly or electrical burns (myocardial irritability)

OPTIMIZATION

- Ensure adequately volume resuscitated (0.5-1 mL/kg/h) & initial acute phase has been optimally managed
- Ensure adequate end organ perfusion
- Aspiration prophylaxis & fasted if not intubated
- Non-narcotic analgesic adjuvants

ANESTHETIC OPTIONS

- GETA for OR
- MAC for burn wound care
- RA is less useful d/t increased blood loss, large surface area of body involved & concern of infection at skin surface
- Local by surgeon for skin graft harvest (with epinephrine to reduce bleeding)

ANESTHETIC SETUP

- **Drugs**

- Avoid SCh
- **Equipment**
  - Warm room to 25-28°C, fluid warmers (high volume), Bair Huggers
  - Monitors may become displaced - consider suturing or stapling them on or using modified monitors specifically for burns (needle ECG)
  - A-line (consider pre-induction if not already in situ), CVP, +/- PAC depending on patient hemodynamic status
  - Consider use of ICU ventilator in difficult to manage patients (i.e. if OR ventilator will not match ICU ventilator mode → consider ICU ventilator)
  - Ensure adequate amount of x-matched blood is available

MANAGEMENT OF ANESTHESIA

- **Induction**
  - Depends on situation: no drugs (if obtunded), awake (look or FOI) if compromised airway, RSI
  - Ketamine good induction choice as potentially better hemodynamic response (though patients are usually already maximally sympathetically driven) and has good analgesic properties
  - SCh okay if < 24 h post injury (however assess K^+ as tissue injury / rhabdomyolysis / ARF may lead to hyperkalemic state)
  - May require increased dose of NDMB if > 48 h post injury, peak resistance 5-6 weeks
- **Maintenance**
  - Lung protective ventilation strategy if inhalational injury / ALI / ARDS
  - Likely high narcotic tolerance - consider ketamine, adjuvants, remifentanil / fentanyl (for wound care), PCA
  - May require increased minute ventilation in hypermetabolic state
  - Catecholamine resistance is common in burn victims (up to 2 months post-burn) – require large doses
  - Blood loss can be minimized by:
    - Short OR
    - Restricting escharotomies to 15-20% of TBSA
    - Use of extremity tourniquets
    - Use of dilute topical epinephrine soaked bandages
    - Avoid hypothermia
- **Emergence**
  - Consider delaying extubation in previously unintubated patient if:
    - Large debridement with major fluid requirements and potential for edema
    - Hypothermia ensues despite attempts to control temperature
    - Pain control will likely be a major problem

DISPOSITION & MONITORING

- Burn center
- HDU 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)

SYSTEMS INVOLVEMENT

- Cardiovascular
  - Early
    - Burn shock, hypovolemia
    - Impaired cardiac contractility
  - Late
    - Increased CO, HTN, tachycardia
- Respiratory
  - Direct effects
    - Early
      - Upper airway obstruction
      - Smoke inhalation, asphyxia
    - Late
      - Chest wall restriction with thoracic burns
  - Indirect effects
    - Early
      - Effects of inflammatory mediators
      - Complications of resuscitation (pulmonary edema)
    - Late
      - Complications of ventilation (O2 toxicity, barotrauma, infection)
      - Complications of intubation (laryngeal damage, tracheal stenosis, fistula)
- Metabolism
  - Increased metabolic rate
  - Increased CO2 production and O2 utilization
  - Impaired thermoregulation
- Coagulation and hematology
  - Early
    - Hemoconcentration
    - Hemolysis
    - Activation of thrombotic and fibrinolytic systems
  - Late
    - Anemia

- Renal
  - Early
    - Decreased renal blood flow and function
    - Myoglobinuria
  - Late
    - Increased renal blood flow
    - Variable drug clearance
- Infection and immunity
  - Impaired immune function (burn wound sepsis, pneumonia)
  - Endotoxemia
  - Multiple organ failure
- Gastrointestinal
  - Stress ulceration (Curling's ulcers)
  - Impaired intestinal barrier function
  - Endotoxemia

PATHOPHYSIOLOGY

- Key Pathophysiology - more depth, but similar to Acute Burns Seminar:
  - Dynamic changes occur between initial event and up to several days after
  - First 24-72 hours:
    - At minimum there is a release of local inflammatory mediators & in burns > 10% BSA, this release is systemic
    - Mixed shock state with decreased CO & increased SVR results from:
      - Hypovolemia a large amount of protein-rich fluid leaking from capillaries
      - Cardiogenic shock
    - See Smoke Inhalation & Hypothermia Seminars for further info on respiratory effects and thermoregulation issues
  - After 24-72 hours:
    - Capillaries regain integrity and fluid leak stops
    - HD picture varies:
      - CO increases up to 2 x & SVR normalizes - may be hypertensive
      - Distributive shock may occur with SIRS / sepsis
    - Hypermetabolic state occurs:
      - Fever & loss of thermoregulation
      - Increased minute ventilation (increased O_2 consumption & CO_2 production)
      - Increased gluconeogenesis
      - Insulin resistance
    - Increased extra-junctional ACh receptors allow massive release of K^+ & cardiac arrest when given SCh from 24 hours up to ? 6 month or ? 2 years (peaks at 2 months)
    - Potential for NDNMB resistance (extra-junctional receptors, altered protein binding)
    - Immune suppression occurs
    - Potential for ALI / ARDS
    - Dilutional & consumptive coagulopathy (rarely severe)
    - Decreased GI function
    - Risk of ATN ARF d/t rhabdomyolysis
- For electrical, chemical, & burns in parturient - see Acute Burns Seminar
- In depth table of pathophysiologic changes:

- Common OR procedures include:
  - Initial wound excision / biological closure (requires debridement & grafting or dressing changes)
    - Started 2-3 days post-burn
    - Debridement & grafting usually limited to 20-30% TBSA at a time (Q2days)
  - Definitive wound closure
  - Tracheotomies
    - Required in prolonged intubations
    - Initially avoided d/t high incidence of infection (especially if through burn!)
  - Rehabilitation / reconstruction (may require contracture releases or reconstructive surgery)
  - Remote location burn baths & wound care
- Aggressive surgical treatment of burns has significantly reduced mortality (from septic complications)
- Topical burn creams control pain, decrease vapor loss, prevent desiccation and slow bacterial growth:
  - Hypernatremia can accompany water-based creams (silver sulfadiazine)
  - Hyponatremia can accompany aqueous creams (silver nitrate)
- Patients are generally enterally fed within 24-48 hours to maintain gut integrity (prevents gut bacterial translocation)
- IV and invasive monitoring access can be problematic (non-burned tissue entry is preferred, but not absolute)

REFERENCES

- Stoelting
- Lange
- ATLS Manual. Seventh Edition 2004.
- MacLennan et al. Anesthesia for Major Thermal Injury. Anesthesiology. 89(3): Sept 1998; 749-777.
- Kuczkowski. Thermal Injury In Pregnancy: Anaesthetic Considerations. Anaesthesia 2003 (58)930-931.