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The EM Educator Series

Mini-case #8: Why is my burn patient so sick?

Author: Alex Koyfman, MD (@EMHighAK) // Edited by: Brit Long, MD and Manpreet Singh, MD

Questions for Learners:

1) Pearls/pitfalls of fluid resuscitation

2) Who needs a burn center?

3) Special type of trauma patient – airway; blast injury; escharotomy; pain management

4) Special type of tox patient – CO and CN

5) Approach to the burn airway

Suggested Resources:

- ✓ Articles:
  - http://www.emdocs.net/modern-day-burn-resuscitation-moving-beyond-parkland-formula/
  - http://www.emdocs.net/blast-injuries/
  - http://www.emdocs.net/carbon-monoxide-poisoning/
  - http://www.emdocs.net/the-scary-airway-series-part-ii-mastering-obesity-peds-and-burns/
- ✓ Cases:
  - https://lifeinthefastlane.com/trauma-tribulation-032/
  - https://lifeinthefastlane.com/trauma-tribulation-005/
- ✓ Podcast:
  - http://foamcast.org/2014/05/19/episode-1-emcrit-episode-122-cyanide-and-carbon-monoxide-toxicity/

Answers for Learners:

1) Pearls/pitfalls of fluid resuscitation

- In order to determine the volume of fluid resuscitation required for a burn patient, the Rule of Nines for adults and the Lund and Browder chart for children should be utilized.
    - Remember: do not include first degree burns in the calculation of % TBSA.
    - 2-4mL x kg body weight x % TBSA burn = volume of LR required for adult resuscitation (formula adjusted to 3-4mL x kg body weight x % TBSA burn for pediatric patients).
        - 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 0.5mL/kg/hr for adults and 1mL/kg/hr for children).
- The over-estimation of % TBSA may result in hypervolemia, predisposing to a number of dangerous conditions:
    - abdominal compartment syndrome
    - extremity compartment syndrome(s)
    - intraocular compartment syndrome
    - pleural effusions
- All resuscitation measures should be guided by perfusion pressure and urine output:
    - Target a MAP of 60 mmHg, and urine output of 0.5-1.0ml/kg/hr for adults and 1-1.5mL/kg/h for pediatric patients.
    - The placement of a radial or femoral catheter is advised.
    - Heart rate, pulse pressure, capillary refill, and mental status should also be assessed when determining resuscitation adequacy.
    - Additional markers, i.e. – lactate, base deficit, intestinal mucosal pH, and pulmonary arterial catheters are of limited use, and demonstrate varied mortality benefit.

2) Who needs a burn center?

TABLE 1 Advanced Burn Life Support (ABLS) burn center referral criteria

• Partial-thickness burns >10% of total body surface area
• Burns on face, hands, feet, genitalia, perineum, or major joints
• Third-degree burns in any age group
• Electrical burns, including lightning burns
• Chemical burns
• Inhalation burns
• Burn injury in patients with preexisting medical conditions that could complicate management, prolong recovery, or affect mortality
• Any patient with burns and concomitant trauma (eg, fractures) in which the burn injury poses the greater risk of morbidity or mortality. If trauma poses the greater immediate risk, the patient may be stabilized in a trauma center before transfer to a burn unit. Physician judgment in these cases should reflect the regional medical control plan and triage protocols.
• Children with burns in hospitals without qualified personnel or equipment for pediatric care
• Burn injury in patients who will require social, emotional, or rehabilitative interventions

Adapted from American Burn Association.[3]

3) Special type of trauma patient – airway; blast injury; escharotomy; pain management

- Pure blast injury can result in little evidence of external trauma.
    - First treat any blast injury patient with ATLS algorithms. After stabilization, evaluation of those organ systems specifically affected by blast injury should be initiated.
    - Blast lung injury can be diagnosed on repeat physical exam by looking for tachypnea, respiratory distress, hemoptysis, hypoxia, etc.9
- Lung contusions are the hallmark of blast lung; they are often multiple, diffuse, and bilateral.
    - Blast lung injury is radiographically identified by patchy or fluffy ill-defined infiltrates resembling a "butterfly" or "bat wing". Occasional pneumothoraces may also be seen. These infiltrates are usually abrupt in onset and rapidly clear. If it does not clear it usually signifies a more significant underlying disease such as ARDS, PNA, or aspiration. Limit fluid administration for blast injury patients as they are at risk of pulmonary edema. Blast lung injury is arguably the most challenging blast injury to treat; the clinical picture is a mix of ARDS and air embolism. Mechanical ventilation with positive pressure ventilation can decrease the work of breathing and improve gas exchange, but it can increase the incidence and severity of both arterial air embolism and thoracic barotrauma. In the event of mechanical ventilation for primary blast lung injury, a lung protective strategy should be employed. Tidal volume, respiratory rate, inspiratory flow rate, and I:E ratio should be adjusted to minimize peak airway pressures. If necessary, permissive hypercapnea may be used.
- Although not extensively studied, advanced ventilator support technologies for blast lung injury include pressure control ventilation, jet ventilation, high frequency oscillatory ventilation (HFOV), use of nitric oxide and even the use of ECMO as a last resort.
- ER thoracotomy is discouraged in those with significant blast lung injury. The noncompliant contused lung coupled with hemothorax will not allow adequate exposure for safe placement of an aortic clamp.

4) Special type of tox patient – CO and CN

- Carbon monoxide (CO) poisoning may manifest with non-specific symptoms, persistent neurologic symptoms or even as cardiac arrest. Despite the board-style vignette stated above, cherry-red skin is a neither sensitive nor specific finding.
    - If you suspect CO poisoning, order a carboxyhemoglobin level. In a patient with CO poisoning, pulse oximetry readings will be falsely normal, and the PaO_2 and % hemoglobin saturation on ABG will be unaffected.
- How do you use a carboxyhemoglobin level? Subtract the carboxyhemoglobin level from the pulse oximetry level to determine true oxygen saturation.
    - Interpreting levels:
        - Non-smokers: up to 1% normal
        - Smokers: 4-6% common
        - Any reading >10% = concern for significant exposure
    - To treat the toxic exposure administer 100% O_2. Half-life of CO from ~4 hrs to 90 minutes.
        - Hyperbaric oxygen (HBO) or "diving" patients in controversial but if a patient is near-dead, pregnant with significant toxicity (level >15), consider HBO, at least on the boards.
- The spectrum of the clinical presentation of cyanide poisoning varies from mydriasis, to tachypnea and central apnea, to hypotension, to loss of consciousness and seizures.

- If concerned for cyanide toxicity, initiate 100% O2 therapy and administer hydroxocobalamin, with consideration for sodium thiosulfate (slower mechanism of action). Note: The commercially available cyanokit contains hydroxycobalamin.
    - Hydroxocobalamin 5 g IV for adults or 70 mg/kg IV for pediatrics
        - Cyanide binds to hydroxocobalamin, forming cyanocobalamin (vitamin B12) which is renally excreted. It also turns everything red, which can interfere with labs and dialysis.
        - Note: Tintinalli cautions that there's no good evidence on hydroxocobalamin over the traditional sodium nitrite kits.
    - There's also the traditional cyanide antidotes which include: inhaled amyl nitrite, Sodium nitrite 3% – 300 mg IV (10 mL), and sodium thiosulfate.
        - Sodium nitrite forms methemoglobin from hemoglobin, for which cyanide has enormous affinity. Cyanide leaves the cytochrome, setting the mitochondria free, forming cyanmethemoglobin. This is transformed to thiocyanate by an enzyme (rhodanese) and renally excreted.
        - If using this approach in a patient with carbon monoxide poisoning, use only sodium thiosulfate given these patient already have impaired tissue oxygenation and methemoglobinemia only further exacerbates this.
- Be sure to rule out other etiologies of lactic acidosis: under-resuscitation, CO poisoning, or missed traumatic injury.

5) Approach to the Burn airway

- Some literature suggests several potential intubating criteria, but there are no hard and fast rules.
    - If the airway is not protected: intubate.
    - Signs of impending airway compromise include: stridor, wheezing, subjective dyspnea, and a hoarse voice.
        - Severe burns to the lower face and neck may develop significant edema predisposing to airway obstruction.
        - A history of the inhalation of superheated air, or steam in a confined space, is concerning for severe bronchial injury.
        - Keep in mind that perioral burns and singed nasal hairs mandate an examination of the oropharynx for mucosal injury, however, these findings alone do not indicate airway involvement.
        - Smoke inhalation victims may develop delayed respiratory failure: when in doubt, admit for observation and bronchoscopy.
    - Projected Course: patients with burns involving >60% total body surface area (TBSA) tend to deteriorate rapidly: consider immediate intubation.
    - Keep in mind that patients possessing burns involving a lower percentage of TBSA (e.g. < 40%), may require intubation if significant volume resuscitation is required.
    - If the airway is intact, and the history and physical are not consistent with inhalational injury, it is prudent to administer oxygen by nasal cannula or face mask.