The Burning Man: Approach to emergent burns

**Objectives:** define classifications of burns, what makes a burn potentially “severe”, algorithmic approach to burn evaluation, initial resuscitation and complications of inhalational burns, describe special cases of burn injuries.

Burns are common injuries but often approached with trepidation by so many healthcare providers. Today we are focusing on **severe burns**—those which require intervention and typically need to be seen at a designated Burn Center. Severe burns in adults that need a Burn Center = any chemical burn, any high-voltage burn (including lightning injury), >2nd degree burns covering >10% of body surface area, any 3rd degree burns, burns to sensitive areas (face, hands, feet, genitalia, perineum), circumferential burns, any airway concern/ inhalational injury. Consider Burn Center referral for patients with preexisting medical conditions that could complicate management or prolong recovery or affect mortality.

Baux Formula = age + %BSA = Mortality risk

<table>
<thead>
<tr>
<th>Where is it</th>
<th>Appearance</th>
<th>Healing time</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial Epidermis</td>
<td>Dry, red (like sunburn), Painful</td>
<td>&lt;1 week</td>
<td>Scalding from splash water from cooking, short heat flash</td>
</tr>
<tr>
<td>Superficial partial thickness Epidermis and partial dermis</td>
<td>Blistering, moist, blanches, Painful</td>
<td>1-2 weeks</td>
<td>Scalding from immersion, flame, oil/grease/chlorinated/ electrical</td>
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<tr>
<td>Deep partial thickness Deep dermal border</td>
<td>Blistering, white-red color, no blanching, Painful only to pressure.</td>
<td>&gt;4 weeks</td>
<td>Burns, oil/grease, but-spill scalings</td>
</tr>
<tr>
<td>Full thickness Through the subcutaneous fat all the way to the fascia</td>
<td>Leathery white-gray to charred black, Dry, inelastic. No blanching. Pain only to deep palpation.</td>
<td>Never</td>
<td>Scaldings from immersion, flame, oil/grease/chemical/ electrical</td>
</tr>
</tbody>
</table>

- **Airway:** is the patient verbalizing/talking? **Inhalation injury is the #1 cause of death in burn patients.** Look for airway burns, singed hairs on the throat, face, charred nostrils, hoarseness, circumferential or deep neck burns, charred sputum, altered mental status. All imply smoke inhalation and/or burns to the throat and trachea. This is a high risk for airway compromise due to rapid airway edema. **Carbonaceous sputum is a reliable sign of inhalation injury.**

- For every patient gets nasal cannula at a minimum. **--if you need to intubate, you can use suxamethonium but only if <72 hours (tissue breakdown + suxamethonium = HyperK**

- **Breathing:** bilateral breath sounds? Wheezing? Altered mental status and breathing rapidly? You need to think...

**Cyanide poisoning:** most commonly seen in fires within enclosed space > industrial exposure > medical use (nitroprusside).

In fires, cyanide gas derives from combustion of items containing carbon and nitrogen. This is most common in rubber, wool, plastics, and other common synthetic materials.

2 ways cyanide affects the body:

1) Cyanide binds electron complexes in mitochondria ⇒ No H+ shunting ⇒ lactic acidosis due to no cellular respiration
2) Binds Fe	extsuperscript{3+} and converts hemoglobin to cyanohemoglobin ⇒ Hypoxia ⇒ lactic acidosis due to lack of oxygen delivery

Presentation: headaches, nausea/vomiting, flushing, paresthesia, confusion, seizures ⇒ coma. Rhabdomyolysis. That famous “almond odor” is rarely present. No cyanosis is seen because oxygen content is actually quite high in the venous system. (We encourage you to listen to our podcast on cyanide poisoning, Episodes 8 and 63).

Diagnosis: difficult and high clinical suspicion needed. **VBG shows high oxyhemoglobin levels ⇒ “bright red venous blood”**. Lactic acidosis >8 mmol

Different differential diagnosis: check glucose/Tylenol/salicylate levels, EKG, CMP, lactate, carboxyhemoglobin, methemoglobin

*Always think cyanide poisoning in those with a lactate >8 with history of smoke inhalation*

When you should think cyanide poisoning:

- Winter months, fire in enclosed space
- More than one person affected (even the dog). This makes one think it is an exposure-related event and not an infection/overdose.
- History of nitroprusside usage
- Industrial exposure: metallurgy
- Intentional overdose

**Commented [MCO1]: Weird fact: not only that the cyanide “does not always have the [bitter almond] odor”… but “not everyone is able to detect the odor.”**

Per CDC [here](https://emergency.cdc.gov/agent/cyanide/basics/facts.asp)

**Treat cyanide poisoning:**

1. Remove all clothing ⇒ 1st line: **Hydroxocobalamin** (causes bright red skin, red urine, red blood).
2. 2nd line: Na-thiosulfate: converts cyanide to thiocyanate, which is excreted in urine.
3. 3rd line: Amyl nitrate/Na-nitrate (lowers BP; converts Fe	extsuperscript{2+} ⇒ Fe	extsuperscript{3+} (left shift) ⇒ methemoglobinemia ⇒ binds cyanide better ⇒ give methylene blue to convert back to hemoglobin)

**Note:** Nitrates should not be used in suspected concomitant CO poisoning as methemoglobinemia could be lethal as it would exacerbate the left shift induced by CO.
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CO poisoning: this is the other bad boy to watch for. CO binds to Hgb with 300x more affinity than oxygen. It causes a left shift on the dissociation curve and therefore oxygen has difficulty offloading into tissues.

Presentation: nonspecific really. AMS and lactic acidosis, much like cyanide poisoning except that it rarely skin flushing.

Diagnosis: pulse oximetry not reliable at all. AIG needed with a carboxyhemoglobin. Co-oximeter is often used as a screening tool as it distinguishes between the wavelengths of hemoglobin, methemoglobin, and carboxyhemoglobin.

Intubate and give high flow oxygen. Hyperbaric is debated still but it is not needed in emergent situations.

Circulation: every trauma patient no matter what gets a minimum of 2, large gauge PIVs, preferably antecubital fossa.

Fluid resuscitation is critical in burns. Burn shock can occur in the initial 24 hours and is a major cause of death. Due to the loss of the water-proof barrier that is the skin, there will be large fluid shifts out of the capillary and subsequent myocardial depression due to poor venous return.

Monitor urine output, +/- placing an arterial line to closely monitor blood pressure.

However, over-hydration can be just as deadly and in patients whose body is systemically inflamed, intrinsic pathology can arise including ARDS, multiorgan failure and abdominal or extremity compartment syndrome.

So how do we avoid all this? Formulas. The only patients who require fluid resuscitation are those with >15% BSA burns. Patients need 2 large bore IVs, preferably not through burned tissue but in emergent situations that is acceptable.

Lactated ringers is preferred over normal saline (saline is more acidotic).

So how do we avoid all this?

* Parkland Formula: 4 mL x %BSA x weight (kg)
  - ½ in the 1st 8 hours
  - ½ in next 16 hours

- In evaluating %BSA of burns, there are simple rules to follow: superficial burns do NOT count. “Rule of Nines” in calculating %BSA in adults: (head is 9, neck is 1, each arm is 9, each leg is 18, anterior/posterior trunks are each 18).

Palm Method is another way and is used more because patients typically do not have burns over their entire extremities. The palm of the patient’s hand is 1%.

Disability and Exposure: patients need all articles of clothing, jewelry, debris should be removed. Once examined fully, burns should be covered with cool water or saline-soaked gauze (54 F for 15-30 minutes). Avoid ice or freezing temperatures.

The key here is to examine the body for full thickness burns that are circumferential, meaning they wrap around the patient, most commonly in an extremity but can occur anywhere (neck, trunk, chest, etc). When full thickness burns occur, the dermis becomes stiff and forms an eschar. An escharotomy will need to be performed. Usually after 8 hours the occurrence of this is very low but needs to continually assess the patient for clinical changes.

Secondary Survey: head to toe physical exam with rolling the patient over on his/her side to examine the back trunk and rectal tone.

Pain control: burns suck. Be generous in giving these patients pain medications.

Antimicrobial therapy: No systemic antibiotics are indicated for prophylaxis. However, topical antimicrobial therapy should be applied to all nonsuperficial burns. Of all the agents available, really none are the clear favorites. All can delay wound healing. Superficial burns do not require topical antimicrobials but Xeroform (bismuth petroleum gauze) can be used and is more than satisfactory.

- Silver sulfadiazine (SSD) is preferred due to its cost, tolerance, and availability. Do not use it in pregnant women, newborns, or near the eyes or mouth (toxic). It does reduce colonization but there is actually no evidence that it helps healing or reduces infection rates. SSD should be stopped once reepithelization is evident as it can delay this process. Bacitracin is a great alternative and is preferred for tar injuries.

- Honey? Not routinely found in hospitals but it has been found in several studies to be superior to SSD.

- Polymyxin-B is a great alternative and can emulsify residual tar/asphalt if present.

- Chlorhexidine is good for superficial, partial-thickness burns.

- Don’t use iodine. It delays healing and is cytotoxic.

Tetanus vaccine: should be given.

Wound management: burns should be cleaned. Get rid of foreign bodies via irrigation. Tar/asphalt/minerals can be removed with irrigation and mineral oil. Never needle aspirate intact blisters. There is much debate regarding the de-roofing of painful intact blisters, as this can increase the rate of infection if done improperly. Ruptured blisters can be removed without issue during debridement. All burns should be dressed. Dressings decrease pain, reduce infection rates, and absorb drainage.

Nutritional support: patients with burns can have subsequent mesenteric vasoconstriction via the actions of the SNS and are prone to Curling ulcers. NG tubes should be placed in those with >20% total BSA burns, and PPI’s should be scheduled.

Rhabdomyolysis: concern only in severe >3rd degree thermal burns or electrical burns. Always order CK with these types of burns as it can clue you into deep tissue damage and the need for further resuscitation.

High voltage burns: >1000 V. Mortality >600V. Household is about 100V. V = I x R.

All the damage is deep inside tissue = heat.

AC vs DC: AC 3x more lethal, causes tetany, fibrillation. DC throws you away, causes asystole.
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Both at high voltage = asystole.
Cardiac arrest = #1 cause of death. Immediate. Never delayed (hours later).

Other pathology from electrical burns:
- Vascular spasm vs thrombosis
- Fractures from being thrown from high voltage. Dislocations: posterior shoulder.
- Neuro: AMS, head bleeds, peripheral neuropathies.

Low voltage: asymptomatic. Home, no tests or EKG.
Watch high voltage injuries for 12-24 injuries regardless of symptoms. CK with trauma labs.

Toddler lip burn from wire: can go home if all normal and good history. Labial artery bleed in 5 days.

**Lightning**: Huge DC voltage zap. Asystole and/or apnea. Do not give up on them if not breathing and asystole. Give breaths.
Keraunoparalysis: current goes up one leg, down the other. Leg is pulseless, insensate, cold and this is temporary.
Trauma common (TM rupture).
Lichtenberg figure: disappears in hours but looks like lightning on the skin.
Serious burns are very uncommon.