Inhalation Burns

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CONFLICT OF INTEREST: NONE

I HAVE PERMISSION TO USE ALL THE PICTURES IN THIS PRESENTATION

DISCLAIMER: GRUESOME PICTURES

Objectives

- Three classes of inhalation burns
- Diagnosis Inhalation burns
- Discuss treatment option for inhalation burns

Inhalation Injuries

- Inhalation injury is a nonspecific term that refers to damage to the respiratory tract or lung tissue from heat, smoke, or chemical irritants carried into the airway during inspiration.
- Smoke inhalation is one of the most encountered inhalation injuries
- Severity of injury depends on temperature, duration of exposure and composition.
- Increased morbidity and mortality with inhalation injury.

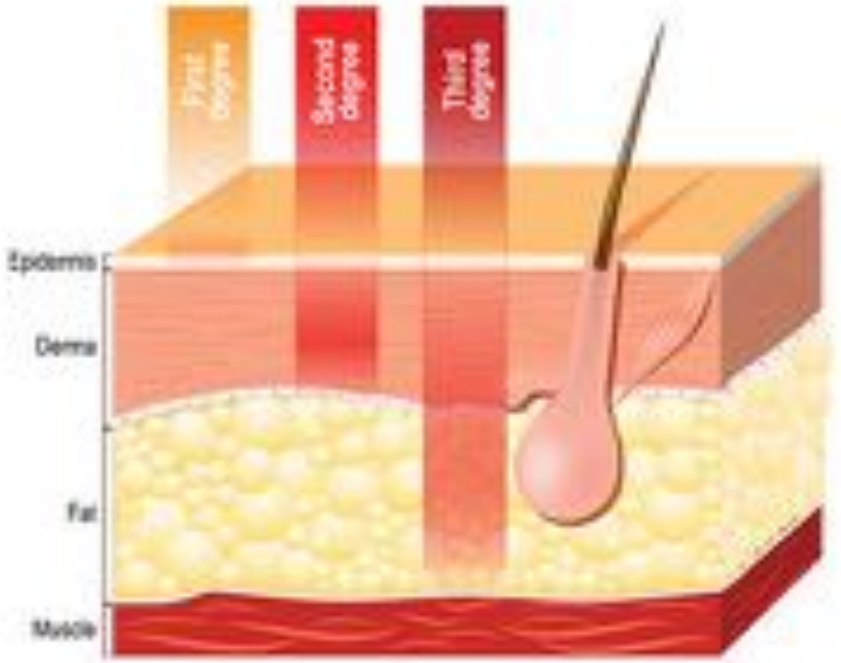
Inhalation Injury

- Damage to airway tissue causes increased mucus production, edema, shedding of epithelium, and mucosal ulceration and hemorrhage.
- Tissue edema causes narrowing of the airways and trachea often causing obstruction of airflow. Mucus/blood/fluid can also impede air flow.
- Pseudomembranes may also form in the trachea or bronchi causing pneumonia.
- When there is damage to the lung parenchyma, the epithelial and endothelial damage result in pulmonary edema and possibly acute respiratory distress syndrome (ARDS) because of widespread alveolar-capillary leak

Types of Skin Burns

- First degree
- Second degree
- Third degree
- Fourth degree

Degrees of Skin Burns



First Degree Burns

- Superficial burns
- Affect only the outer layer of skin, the epidermis.
- The burn site is red, painful, dry, and with no blisters.
- An example is sunburn

Second Degree

- Partial thickness burns
- Involve the epidermis and part of the lower layer of skin, the dermis.
- The burn site looks red, blistered, and may be swollen and painful.

Third Degree Burns

- Full thickness burns.
- Destroy the epidermis and dermis. They may go into the innermost layer of skin, the subcutaneous tissue.
- The burn site may look white or blackened and charred.

Fourth Degree Burns

- Goes through both layers of the skin and underlying tissue as well as deeper tissue, possibly involving muscle and bone.
- There is no feeling in the area since the nerve endings are destroyed.

Epidemiology

- Over the 10 years from 2008 to 2017, the United States had an annual average estimate of 1,344,100 fires, resulting in 3190 civilian deaths, 16,225 civilian injuries, and $14.7 billion in direct property loss each year
- Pulmonary complications following burns and inhalation injury are responsible for up to 77 percent of the deaths
  - Majority were due to carbon monoxide poisoning

Examination

- Look for facial burns, loss of facial hair and nasal hair
- Soot in mouth or sputum
- Accessory muscle use
- Shortness of breath
- Productive cough
- Tachypnea, cyanosis, stridor, rhonchi/rales/wheezing

Workup

- Blood work: CBC, CMP, lactate
- Pulse oximetry **could be falsely elevated
- ABG
- Carboxyhemoglobin level
- Cyanide level
- Chest x-ray: usually normal on presentation

Types of Injury

- Carbon Monoxide
- Injury above the glottis
- Injury below the glottis

Carbon Monoxide

- It is an odorless, tasteless gas
- It decreases oxygen delivery to the tissue by binding to hemoglobin and displacing oxygen. The affinity of CO to hemoglobin is much higher than O2: 200 times the affinity of oxygen
- A Carboxyhemoglobin level exceeding 10% total
- Risk factors include any exposure to smoke or fumes.
- An unexplained metabolic acidosis

*** Pulse Ox may be a normal value because it only measures bound hemoglobin levels. It cannot tell difference between carboxyhemoglobin and oxygenated hemoglobin.

Effects of Carboxyhemoglobin

Saturation %	Symptoms
0-10	None
10-20	Headache, Confusion
20-40	Disoriented, fatigue, nausea, visual changes
40-60	As above; plus increase in respiratory and heart rates, hallucination, combativeness, coma, shock
60 or above	Cardiopulmonary arrest, Death

Treatment for Carbon Monoxide

- Awake patient: 100% non-rebreather until carboxyhemoglobin is less than 10
- Obtunded patient: Intubate, give 100% oxygen via positive pressure ventilation
- Metabolic acidosis: Cardiovascular support and resuscitation

Above the Glottis Injury

- Direct heat injury caused by the inhalation of air heated 150’ Celsius or higher
- Air is cooled before reaching the lower respiratory tract because of the oropharynx and nasopharynx (example drinking hot coffee that could cause a skin burn)
- Results in burns to face, oropharynx, and upper airway above the vocal cords
- Airway edema usually occurs within the first 24 hours
- Intubate for airway edema
- Edema usually resolves in 48 hours

Below the Glottis

- Chemical irritation to the lungs
- Lining of respiratory tract in irritated
- Epithelium is lost
- Surfactant does not work

Below the Glottis con't

- Alveoli collapse
- Leads to atelectasis
- Lung damage results in pulmonary capillary leak syndrome
- Increased intravascular lung water which leads to VQ mismatch
- More resuscitation is needed to increase pulmonary arterial pressures so there is no hypoperfusion and lung injury

Chemical burns

- A burn to internal or external organs of the body caused by a chemical substance that is a strong acid or base
  - lips, oral cavity, pharynx, upper airway, distal injuries
- Most common causes of chemical burns are acids such as sulfuric, hydrofluoric, hydrochloric and acetic acid, bases such as sodium and potassium hydroxide and calcium hydroxide, oxidants used in the home such as chlorides and peroxides
    - Toilet bowl cleaner
    - Metal cleaners
    - Drain cleaner
    - Bleach
    - Car battery fluid
    - Fertilizer

Chemical Burns

Symptoms

- Irregular heartbeat or cardiac arrest
- Low blood pressure
- Shortness of breath
- Headache
- Coughing
- Dizziness
- Seizures
- Muscle twitching

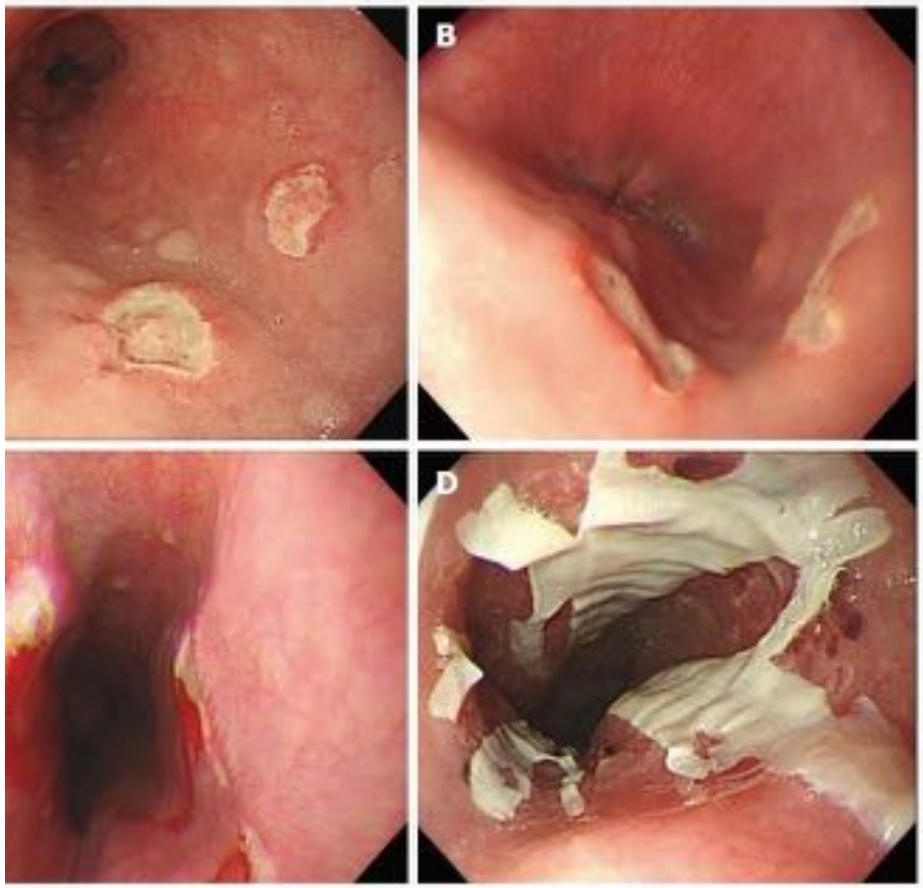
Examination

- Complete blood count [CBC],
- Platelets
- Electrolytes
- Arterial/venous blood gas
- Liver and kidney studies
- Lactic acid level
- Chest Xray
- Non-contrast CT scan
- Endoscopy

Injury	Findings
Grade 0	Normal mucosa
Grade 1 (mucosal)	Edema, hyperemia of mucosa
Grade 2a (transmucosal)	Blisters, hemorrhages, erosions, whitish membranes, exudates
Grade 2b	Grade 2a findings plus deep or circumferential ulceration
Grade 3a (transmural)	Small scattered area of ulceration and areas of necrosis
Grade 3b	Extensive necrosis

Treatment

- Intubation if airway is unstable
- NPO
- Aggressive hydration and fluids
- Avoid neutralization of caustic material. It may worsen the existing injury
- NG tube
- Stent placement
- Antibiotics
- Pain control
- Surgery



When to intubate

- Deep burns to the face or neck
- Blisters or edema of the oropharynx
- Stridor
- Use of accessory muscles
- Respiratory distress
- Hypoventilation
- Altered mental status
- Other complications such as sepsis, acute respiratory distress syndrome, pneumonia, pulmonary toilet, and for operative procedures.

Securing the ETT

- Tape does not stick to burned skin
- Always use twill tie to secure
- The security of the tube needs to be checked frequently as airway edema increases or decreases.
- Elevate head of bed
- Do not use pillows with ear or neck burns

Mechanical Ventilation

- Optimal ventilator strategy for patients with burns and inhalation injury is not well defined
- May differ from typical ventilator management practices
  - larger-than-typical tidal volumes
- Based upon the Acute Respiratory Distress Syndrome (ARDS) Network Study, low tidal volumes and limiting plateau pressures are the currently accepted lung-protective practices for mechanical ventilation

Breathing Treatments

Aimed at relieving bronchospasm, reducing pulmonary secretions, and clearing the airways of fibrin casts and sloughed, necrotic bronchial epithelium

- **Bronchodilators:** Albuterol, levalbuterol
- **Mucolytic agents:** N-acetylcysteine, HCO_3

Heparin???

- Inhaled anticoagulants decrease the formation of fibrin casts following inhalation injury
- In some studies, inhaled anticoagulants have reduced morbidity
- Significantly reduced reintubation rates
- Resulted in better lung compliance, less pulmonary edema, and less airway obstruction
- Significantly decreased the duration of mechanical ventilation in patients with inhalation injury
- It's combined with 3 mL normal saline and given every four hours

Outcomes Following the Use of Nebulized Heparin for Inhalation Injury

- Retrospective, case-controlled study by McIntire, et.al looked at the efficacy and safety of nebulized heparin administered to mechanically ventilated adults admitted within 48hr of confirmed IHI
- They looked at 2 things:
  - Duration of mechanical ventilation
  - Lung injury score, ventilator free days during the first 28 days, 28 day mortality, hospitalization length, VAP, bronchoscopy incidence and bleeding events
- They collected data on 72 patients: 36 received nebulized heparin and 36 were in the control group
- Patients receiving nebulized heparin demonstrated a statistically significant **decrease** in median (interquartile range) duration of initial mechanical ventilation compared with controls [7.0 (4.0, 13.5) vs. 14.5 (5.3, 22.3) days; P = .044]. They also had a significantly **increased** number of median (interquartile range) ventilator-free days in the first 28 days [21.0 (14.5–24.0) vs 13.5 (4.3–22.8) days; P = .031].
- There were no differences in hospitalization length, lung injury score during the first 7 days post injury, 28-day mortality, ventilatorassociated pneumonia rate, or bleeding events.

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Complications:

- **Pneumonia**
- **Acute respiratory distress syndrome (ARDS)** may also develop several days after the exposure. The presentation, diagnosis, and management of ARDS are similar to those for ARDS due to other etiologies
- **Fluid overload** –close monitoring of fluid balance is needed to ensure adequate resuscitation and to avoid complications. Burn injuries require an increase in fluids
- H**ypermetabolism/malnutrition** – Patients with inhalation injury may also demonstrate marked hypermetabolism. An increased production of carbon dioxide requires a high minute ventilation to maintain a normal pCO_2 and may require ventilatory support to achieve. Enteral nutrition formulas with a low respiratory quotient may help limit carbon dioxide production, improving the patient's ability to keep up with respiratory demands.

Extubation

- Suggested Criteria:
  - PaO_2/FiO_2 ratio >250 mmHg
  - Stable vital signs
  - Vital capacity at least 15 to 20 mL/kg
  - Spontaneous tidal volume 5 to 7 mL/kg
  - Resolution of the need for intubation
  - Audible leak around the endotracheal tube

Escharotomy

- Burns can produce a tourniquet effect which compromises circulation and limits muscle movement. This is due to the inflexibility of the damaged tissue, which is the eschar that is formed.
- Surgical procedure where incisions are made in the areas of burnt skin to release the eschar and its constrictive effects
- The incisions should extend from unburnt skin to unburnt skin down to subcutaneous fat, to release any constrictions.
- Incisions are made in the mid-axillary lines, which can be joined by a transverse incision below the costal margin to allow adequate release.

Case Study

- 52-year-old man who was drinking jumped into a campfire
- Intubated at scene and transferred to the ER
- The patient had second and third degree burns over 60% of his body
- Fluids, fluids and more fluids were hung
- The patient swelled and he eventually went into ARDS.
- Pt was eventually trached

The RT working in the Burn Unit

- Hard emotionally and physically
- It's a lot of work
- It smells
- It's so rewarding!!!

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