Airway Respiratory Irritants

Aliases

Respiratory irritant, airway injury, respiratory injury, chemical respiratory injury, toxic inhalation

Patient Care Goals

Rapid recognition of the signs and symptoms of confirmed or suspected airway respiratory irritants.

Patient Presentation

Inclusion Criteria

1. Inhalation of a variety of gases, mists, fumes, aerosols, or dusts may cause irritation or injury to the airways, pharynx, lung, asphyxiation, or other systemic effects.
2. Inhaled airway or respiratory irritant agents will interact with the mucus membranes, upper and lower airways based on solubility, concentration, particle size, and duration of exposure.
3. The less soluble and smaller the particle size of the agent, the deeper it will travel into the airway and respiratory systems before reacting with adjoining tissues, thus causing a greater delay in symptom onset.

Exclusion Criteria

No recommendations

Signs and Symptoms

1. As the type, severity, and rapidity of signs and symptoms onset depends on agent, water solubility, concentration, particle size, and duration of exposure, the below signs and symptoms are often overlapping and escalating in severity.
2. Many airway and respiratory irritant agents have "warning properties" such as identifiable or unpleasant smells or irritation to eyes or airways.
3. Some agents do not have clear warning properties and will often have delayed onset of any sign or symptom:
    a. Unusual odor or smell
    b. Tearing or itchy eyes
    c. Burning sensation and burns to the nose, pharynx and respiratory tract
    d. Sneezing
    e. General excitation
    f. Cough
    g. Chest tightness
    h. Nausea
    i. Shortness of breath or dyspnea
    j. Wheezing
    k. Stridor
    l. Dyspnea on exertion
    m. Dizziness
    n. Change in voice
    o. Airway obstruction includes laryngospasm and laryngeal edema
    p. Pulmonary edema (non-cardiogenic)
    q. Seizures
    r. Cardiopulmonary arrest
4. High water solubility or highly irritating (oral, nasal, and pharynx; particle size greater than 10 micrometers)
    a. Acrolein
    b. **Ammonia**
    c. Chloramine
    d. Ethylene oxide

e. Formaldehyde
f. Hydrogen chloride
g. Methyl bromide
h. Sodium azide
i. Sulfur dioxide

5. Intermediate water solubility (bronchus and bronchiole; particle size 5 to 10 micrometers)
    a. **Chlorine**
6. Low water solubility and less irritating (alveolar, particle size less than 5 micrometers)
    a. Cadmium fume
    b. Fluorine
    c. **Hydrogen sulfide (rotten egg odor; olfactory fatigue)**
    d. Mercury fume
    e. Mustard gas (also delayed blistering skin manifestations)
    f. Nickel carbonyl
    g. Ozone
    h. Phosgene
7. Asphyxia agents (two categories)
    a. Oxygen deprivation below 19.5% oxygen atmosphere ("simple asphyxiants") *Any gas that reduces oxygen fraction or displaces oxygen from the inspired air*
        i. Argon
        ii. **Carbon dioxide**
        iii. Ethane
        iv. **Helium**
        v. **Methane**
        vi. Natural gas (e.g. heptane, propane)
        vii. Nitrogen
        viii. Nitrogen dioxide (delayed symptom onset)
    b. Chemical interfering with oxygen delivery or utilization ("chemical asphyxiants")
        i. Carbon monoxide [see Carbon Monoxide/Smoke Exposure guideline]
        ii. Cyanide [see Cyanide Exposure guideline]
        iii. Hydrogen sulfide
8. Inhalants of abuse
    a. These agents or substances are a diverse class of substances that include volatile solvents, aerosols, and gases.
    b. These chemicals are intentionally inhaled to produce a state that resembles alcohol intoxication with initial excitation, drowsiness, lightheadedness, and agitation.
    c. Users of these inhaled agents are often called huffers, sniffers, baggers, or snorters.
        i. These individuals often present after inhaling an aerosol or gas with a loss of consciousness, and with the presence of the aerosol can or residue or paint around or in the mouth, nose, and oral pharynx.
    d. Common household products that are used as inhalants of abuse:
        i. Volatile solvents
            1. Paint remover
            2. Degreasers
            3. Dry-cleaning fluids
            4. Gasoline
            5. Lighter fluid
            6. Correction fluid
            7. Felt tip markers
            8. Glue
        ii. Cosmetic or paint spray
            1. Deodorant spray
            2. Vegetable oil spray
            3. Fabric protector spray
            4. Spray paint
        iii. Propellants, asphyxiants, nitrous oxide

1. Propane gas
2. Balloon tanks (helium)
3. Computer keyboard cleaner
4. Ether
5. Halothane
6. Chloroform
7. Butane
8. Propane
9. Whipped cream dispensers

9. Riot control agents [see Riot Control Agent guideline]
10. A prototype agent is identified with each region of the affected airway respiratory tract for ***mild to moderate exposures***, as severe concentrated exposures of many of these agents overlap in signs and symptoms. The deeper the symptoms are in the respiratory tract and the slower the rate of symptom onset, the less water-soluble the airway respiratory irritant.
    a. Nasal and oral pharynx irritation: highly water-soluble agents (ammonia)
    b. Bronchial irritation (chlorine)
    c. Acute pulmonary edema or deep alveolar injury: poorly water soluble (phosgene)
    d. Direct neurotoxin (hydrogen sulfide)
    e. Asphyxia agent with additional symptoms (nitrogen dioxide, Silo Filler's disease)
    f. Inhalants of abuse (volatile solvents, cosmetics, paints, propellants, asphyxiants, nitrous oxide)
    g. Riot control agents [see Riot Control Agents guideline]
    h. Anticholinesterase inhibitors [see Acetylcholinesterase Inhibitors guideline]
11. Ammonia
    a. Immediate detection of unique sharp smell
    b. Nasal pharyngeal burning or irritation sensation
    c. Ocular tearing and irritation
    d. Sneezing
    e. Altered mental status: sleepy to agitated
    f. Cough
    g. Shortness of breath
    h. Chest tightness
    i. Bronchospasm wheezing
    j. Change in voice
    k. Upper airway obstruction includes laryngospasm and laryngeal edema
    l. Corneal burns or ulcers
    m. Skin burns
    n. Pharyngeal, tracheal, bronchial burns
    o. Dyspnea or tachypnea
    p. High concentrations and or protracted exposure may develop non-cardiac pulmonary edema
    q. Esophageal burns
12. Chlorine
    a. All the above (Ammonia)
    b. Increased likelihood of the following
        i. Bronchiole burns
        ii. Bronchospasm wheezing
        iii. Non-cardiac pulmonary edema develops within 6 to 24 hours of higher exposures
13. Phosgene
    a. Often have **none** of the above symptoms for first half hour to several hours, then are much milder until more severe lower respiratory tract symptoms develop
        i. Only warning is report of "fresh mowed hay" odor
        ii. Mild airway irritation or drying
        iii. Mild eye irritation
        iv. Fatigue
        v. Chest tightness

vi. Dyspnea or tachypnea
vii. Significant delay up to 24 hours for
1. Exertional dyspnea
2. Bronchospasm wheezing
3. Hypoxia
4. Severe non-cardiac pulmonary edema
5. Cardiopulmonary arrest

14. Hydrogen sulfide is a direct neurotoxin and is rapidly absorbed through lungs, generating systemic effects.
a. Distinctive rotten egg smell which rapidly causes olfactory fatigue or loss of sense of smell
b. Cough
c. Shortness of breath
d. Rapid alternations in cognition or consciousness
e. Bronchiole and lung hemorrhage or hemoptysis
f. Non-cardiac pulmonary edema
g. Hydrogen sulfide is known as the "knock down" gas because of near immediate and sudden loss of consciousness with high concentrations
h. Asphyxia
i. Death

15. Nitrogen dioxide (also called Silo Filler's disease)
a. Heavier than air, displaces oxygen from low lying areas and closed spaces causing direct asphyxia
b. Low concentrations may cause
i. Ocular irritation
ii. Cough
iii. Dyspnea or tachypnea
iv. Fatigue
c. High concentrations:
i. Altered mental status including agitation
ii. Cyanosis
iii. Vomiting
iv. Dizziness
v. Loss of consciousness
vi. Cardiopulmonary arrest

16. Inhalants of abuse (e.g. felt tip markers, spray paint)
a. Physical presences of paint or residue on individual from the inhaled agent
b. Slurred speech
c. Altered mental status (excitation, drowsiness to unconsciousness)
d. Loss of consciousness
e. Cardiac dysrhythmias
f. Cardiopulmonary arrest

Patient Management

1. Don appropriate PPE; respiratory protection is critical.
2. Remove patient from the toxic environment; rescuers should be properly trained and equipped.
a. Remove the patient's clothing that may retain gases or decontaminate if liquid or solid contamination.
b. Flush effected or burned areas.
3. Rapidly assess the patient's respiratory status, mental status, and oxygenation**.**
4. Administer oxygen as appropriate for dyspnea or distress with a target of achieving greater than 93% saturation for most acutely ill patients.
5. Establish intravenous access ***[AEMT]*** (if possible).
6. Apply a ECG cardiac monitor
7. Conduct continuous and ongoing patient reassessment; this is critical.

Assessment

1. Make sure the scene is safe as many gases are heavier than air and will build up in low lying areas. This is especially true of hydrogen sulfide and it's "knock down" effect of the initial unprotected responder. Be aware that subsequent casualties can occur when unprotected rescuers attempt to save the first downed responder.
2. Consider BSI or appropriate PPE.
3. Remove patient from toxic environment by rescuers who are properly trained and equipped.
4. Decontaminate; rescuers should be properly trained and equipped.
5. Assess ABCD and if indicated, expose the patient and then cover the patient to assure retention of body heat.
6. Monitor vital signs, including temperature.
7. Place ECG cardiac monitor and examine rhythm strip for arrhythmia potentials (consider 12-lead ECG).
8. Check blood glucose level.
9. Monitor pulse oximetry and $ETCO_2$ for respiratory decompensation.
10. Perform carboxyhemoglobin and cyanide device assessment, if available.
11. Identify specific suspected agent if possible.
12. Obtain pertinent cardiovascular history or history of other prescribed medications for underlying disease.
13. Obtain pertinent patient history.
14. Conduct patient physical examination.

Treatment and Interventions

1. Assure a patent airway.
    a. Administer **oxygen** as appropriate for dyspnea or distress with a target of achieving 94-98**%** saturation for most acutely ill patients.
    b. Maintain the airway and assess for airway burns, stridor, or airway edema, and if indicated, perform intubation **[PARA]** early (recommendation to avoid non-visualized airways); cricothyroidotomy ***[PARA]*** may be required in severe cases.
    c. Apply non-invasive ventilation techniques.
        i. Use continuous **positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP)** ***[EMT]*** or High Flow Nasal Cannula (HFNC) ***[PARA]*** for severe respiratory distress or impending respiratory failure.
        ii. Use bag-valve-mask (BVM) ventilation in the setting of hypoventilation, respiratory failure or arrest.
2. Administer **Albuterol** to all patients in respiratory distress with signs of bronchospasm, either by basic life support BLS or ALS providers. This medication should be repeated at this dose with unlimited frequency for ongoing distress.
3. Administer **Ipratropium nebulized up to 3 doses *[EMT]*,** in conjunction with albuterol.
4. Consider isotonic IV/IO fluid bolus 20 ml/kg ***[AEMT]*** .
5. If the patient is experiencing significant pain, administer **IV/IO analgesics [PARA]:**
6. Administer early eye irrigation.
7. Treat topical chemical burns
8. In severe respiratory irritation, in particular hydrogen sulfide, with altered mental status and no improvement with removal from the toxic environment, administer oxygen as appropriate with a target of achieving 94-98% saturation

Patient Safety Considerations

1. Generally, in speaking to patients with exposure to highly soluble airway or respiratory irritants, you will find that they have self-extricated due to the warning properties such as the smell, rapidity of onset of irritation, and other symptoms,
2. The less soluble agents may generate only an odor (e.g. mowed hay smell for Phosgene) symptom and will have delayed serious symptoms such as acute pulmonary edema, hypoxia, and shortness of breath with minimal exertion.

Notes and Educational Pearls

Key Considerations

- Airway respiratory irritants can exacerbate underlying reactive airway diseases (e.g. asthma, COPD) and precipitate or exacerbate bronchospasm, respiratory distress, and hypoxia.
- As patients may be off gassing (particularly hydrogen sulfide and hydrogen cyanide) in the back of the transport vehicle, it is recommended to have adequate ventilation of the patient compartment.
- Removal from the toxic environment, oxygen, general supportive therapy, bronchodilators, respiratory support, and time are core elements of care as there are no specific antidotes for any of these inhaled agents (with the exception of heavy metals that may be chelated by physicians after agent identification).
- Hydrogen sulfide causes the cells responsible for the sense of smell to be stunned into inaction. Therefore, with a very short exposure they will shut down and the exposed victim will not perceive the smell, yet the victim will continue to absorb the gas as it is still present.
- Inhaled agents have become popular as a means of committing suicide. If there is some form of suicide signage—hoses, or buckets of substances—visible as you arrive at the vehicle or residence, immediately retreat to a well ventilated area and don SCBA before opening the vehicle or making entry. These gases may be highly concentrated and potentially lethal to EMS responders.
- Household bathroom, kitchen, and oven cleaners, when mixed, can generate a variety of airway respiratory irritants (ammonia, chloramine, and chlorine gas releases are particularly common). **A very common exposure is to chloramine, a gas liberated when bleach (hypochlorite) and ammonia are combined. Chloramine then hydrolyzes in the distal airways and alveoli to ammonia and hypochlorous acid.**
- Sudden sniffing death can result from a single use of inhalant of abuse.
- Some inhalants can cause the heart to beat rapidly and erratically and cause cardiac arrest.
- This syndrome most often is associated with abuse of butane, propane and effects of the chemicals in the aerosols.

Pertinent Assessment Findings

- Patient may describe a specific odor (chlorine swimming pool smell, ammonia smell, fresh mowed hay smell [phosgene]) which may be helpful but should not be relied upon as the human nose is a poor discriminator of scent.
- Respiratory distress (retractions, wheezing, stridor)
- Decreased oxygen saturation
- Skin color
- Neurologic status assessment
- Reduction in work of breathing after treatment
- Improved oxygenation after breathing

Quality Improvement

Associated NEMSIS Protocol(s) (eProtocol.01)

- 9914033—Exposure-Airway/Inhalation Irritants
- 9914139—Medical-Respiratory Distress/Asthma/COPD/Reactive Airway

Key Documentation Elements

Document key aspects of the exam to assess for a change after each intervention:

- Respiratory rate
- Oxygen saturation
- Use of accessory muscles or tracheal tugging
- Breath sounds

- Air entry or stridor
- Mental status
- Color
- Reduction of burning sensation in airway or pharynx

Performance Measures

- Clinical improvement in patient and response to therapy
- Survival rates of victims
- Long term sequelae of the victims
- No EMS providers injured while managing these incidents

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