R7DHRE Hazardous Materials Guideline: Hydrogen Sulfide

Region VII Disaster Health Response Ecosystem

REGION VII DISASTER HEALTH RESPONSE ECOSYSTEM (R7DHRE)

CHEMICAL SPECIALTY TEAM

Call Your Poison Center for Immediate Assistance: 1-800-222-1222

Hazardous Materials Guideline: Hydrogen Sulfide

This document is intended as a supplement for discussion with your local poison center or toxicologist.

1.0 BACKGROUND

1.1 Description: **Hydrogen sulfide (also known as H_2S or "sewer gas") is an irritating, colorless, highly flammable, and explosive gas with a characteristic rotten-egg odor**. H_2S is released during oil and gas drilling, wood pulp and paper production/recycling, decomposition of manure, and other proteinaceous organic material. Hydrogen sulfide is considered to be a "knock down" gas in that a single breath of a high enough concentration of hydrogen sulfide can be rapidly lethal. However, **olfactory fatigue and desensitization may occur and consequently its odor does not provide adequate warning of hazardous concentrations**. Hydrogen sulfide is well absorbed through the lungs; cutaneous absorption is minimal. Hydrogen sulfide is frequently transported in cylinders as a liquefied compressed gas; contact with liquid hydrogen sulfide may result in frostbite injury.

1.2 Mechanism of Injury: Hydrogen sulfide is a chemical asphyxiant, which blocks cytochrome oxidase and prevents cells from using oxygen. After a large exposure to hydrogen sulfide, ATP and energy production with the cells rapidly shuts down. It is slightly heavier than air and may accumulate in enclosed, poorly ventilated, and low-lying areas.

1.3 Routes of Exposure: **Inhalation**, **Ocular**, Dermal.

2.0 PROVIDER SAFETY

2.1 Personal Protective Equipment (PPE) – Decontamination Team: Personnel decontaminating patients must wear **full-body chemical-resistant clothing and respiratory protection**. Respiratory protection may consist of either:

2.1.1 A positive pressure air or oxygen source, such as an air-line respirator or a Self-Contained Breathing Apparatus (SCBA) or

2.1.2 A filtered air respirator (including Powered Air Purifying Respirators (PAPRs)) with filters capable of adsorbing hydrogen sulfide.

2.1.3 A positive pressure air or oxygen source is preferred if there is doubt as to the identity of the chemical in question or if there may be exposure to a level of hydrogen sulfide which would overwhelm the filter.

2.2 Personal Protective Equipment (PPE) – Treatment Team: Personnel treating patients who have been adequately decontaminated need no additional PPE other than **universal precautions** since there is no serious risk of secondary contamination.

2.3 Patient Decontamination:

2.3.1 Persons exposed to only **hydrogen sulfide gas** and have **no skin irritation, no eye irritation, dry skin, AND dry clothes generally do not need decontamination**. These patients do not pose a significant risk of secondary contamination.

2.3.2 Persons contaminated with **liquid hydrogen sulfide** solutions do **pose a risk of secondary contamination** from off-gassing of hydrogen sulfide vapors and direct contact with the chemical.

2.3.3 Remove contact lenses if it can be done without additional trauma to the eye. **Irrigate eyes for a minimum of 15 minutes.** Continue irrigation until eye pH is neutral (7 to 8). An ophthalmic anesthetic may be necessary to alleviate blepharospasm.

2.3.4 Remove ALL clothing and jewelry. Double bag clothing and jewelry to prevent off-gassing.

2.3.5 Decontamination is best **accomplished by irrigation with copious amounts of water**. Wash skin and hair with plain water for a minimum of 5 minutes and then wash twice with soap & water after washing with plain water. Washing with water alone (for a longer period of time) is acceptable if soap is not available.

2.3.6 Watch for hypothermia (1) in children and the elderly, (2) when decontamination is done with un-heated water, or (3) during cold weather.

2.3.7 *Frostbite Considerations*: Handle frostbitten skin and eyes with caution. Re-warm the affected area in the same manner as for environmentally-induced frostbite. For eyes, use lukewarm water or saline to irrigate & re-warm eyes, as appropriate.

3.0 SIGNS & SYMPTOMS

3.1 Severity of symptoms will depend upon the concentration of the hydrogen sulfide to which the person is exposed and the duration of exposure.

3.2 Inhalation: **Irritation or burning of the eyes, nose, throat, moist mucous membranes and lower respiratory tract**. Cough, shortness of breath, and bronchial or lung hemorrhage. High concentrations can cause bronchitis and pulmonary edema. Pulmonary effects may be immediate or delayed for up to 72 hours after exposure.

3.3 Dermal: Prolonged low-level exposure, or a short-term high-level exposure, may cause burning, itching, redness, and painful inflammation of the skin. Exposure to the liquefied gas can cause frostbite injury.

3.4 Ocular: Eye irritation (i.e., “gas eye”), inflammation, clouding of the eye surface, blurred vision, sensitivity to light, and spasmodic blinking or involuntary closing of the eyelid may occur.

3.5 *Systemic*: Inhibition of oxidative phosphorylation and decreased energy production leads to metabolic acidosis, lactic acidosis, hypotension, myocardial depression, arrhythmias, shock and death. Nausea and vomiting may also occur.

3.6 Central Nervous System:

3.6.1 Low-level exposure (less than 50 ppm) does not typically cause neurologic effects.

3.6.2 Intermediate- to high- level exposure (50 to 250 ppm) can produce drowsiness, fatigue, weakness, headache, and dizziness with much faster onset the higher the concentration. Patients with this degree of exposure may exhibit syncope with respirations intact. Immediate removal of the patient to fresh air may result in spontaneous recovery.

3.6.3 Very high-level exposure (250 to 500 ppm) may also produce tremors, anxiety and agitation, weakness of extremities, ataxia, and opisthotonus. Delirium, seizures, collapse, and coma may occur with prolonged or higher concentration exposure. Death is possible.

3.6.4 Extreme exposure (500 ppm or higher) produces "knockdown," rapid loss of consciousness, respiratory arrest, seizures, and coma. Concentrations higher than 1,000 to 2,000 ppm may be immediately fatal because of instantaneous central respiratory paralysis.

3.6.5 There is also a risk of neurologic sequelae not predictable by initial symptoms or severity of exposure. Some patients who are initially markedly symptomatic may recover completely, while others have long-term neurologic and neuropsychiatric sequelae.

4.0 DIAGNOSTICS

4.1 Hydrogen sulfide poisoning is a clinical diagnosis and there is no specific diagnostic testing. Any diagnostic evaluation should be based on signs and symptoms of cellular asphyxiant or irritative effects. It can be detected in ambient air through specialized monitoring devices, which may assist with a diagnosis if the history is otherwise consistent with hydrogen sulfide.

4.2 Pulse oximetry should be used in symptomatic patients to evaluate the need for supplemental oxygen and additional monitoring.

4.3 Monitor serum lactate in addition to standard baseline labs as a measure of impairment of aerobic metabolism.

4.4 Obtain arterial blood gas analysis with MEASURED (not just calculated) percentage oxyhemoglobin saturation co-oximetry. Calculated values may not be accurate because they do not take into account abnormal hemoglobins (e.g., sulfhemoglobin, sulfmethemoglobin, carboxyhemoglobin, methemoglobin).

4.5 Consider a chest x-ray in patients with persistent symptoms and hypoxia.

5.0 TREATMENT

5.1 General: **Treatment is mainly decontamination and supportive care** including basic and advanced life support. There is no specific antidote for hydrogen sulfide poisoning, which is known to be effective.

5.1.1 Due to the "knock down" effects of hydrogen sulfide, a thorough examination should be performed to rule out occult trauma in any patient that experienced a loss of consciousness.

5.2 Inhalation: **Maintain the patient's airway as necessary. Support oxygenation and ventilation as necessary**. Use standard treatments for pulmonary edema and bronchospasm.

5.3 Dermal: **Treatment is the same as that for thermal burns**. If frostbite is present, rewarm the affected area in the same manner as for environmentally induced frostbite.

5.4 Ocular: **Irrigate eyes to a neutral pH**. Perform a thorough eye exam: test visual acuity and perform fluorescein and slit lamp examinations. Ophthalmology consultation may be necessary. Immediately consult an ophthalmologist for patients who have corneal injuries.

5.5 Systemic: Nitrite therapy has been suggested as a therapy for hydrogen sulfide exposure, but there is **only anecdotal evidence that nitrite therapy is effective**. If the decision is made to use nitrite therapy, it should be given within the first few minutes after exposure; however, victims of hydrogen sulfide poisoning have survived without sequelae after supportive care alone.

5.5.1 *If nitrite therapy is chosen, sodium nitrite is preferred*:

5.5.1.1 The goal of nitrite therapy is to achieve a methemoglobin level of 20-30%. This represents a level that an *otherwise healthy* individual can tolerate without significant adverse symptoms.

5.5.1.2 Nitrites should not be used in patients with mild symptoms or with concomitant carbon monoxide toxicity.

5.5.1.3 Methemoglobin levels should be monitored when nitrite therapy is used, with the goal of a methemoglobin level < 30%.

5.5.1.4 The use of methylene blue to decrease the amount of residual methemoglobin has the potential to cause a re-release of sulfide. The use of methylene blue should be considered *only* when severe and life-threatening excessive methemoglobin is present.

5.5.2 Sodium Nitrite Dosing

5.5.2.1 *Sodium nitrite* ($NaNO_2$) is administered as soon as vascular access is established. $NaNO_2$ should be administered intravenously over 5-10 minutes; rapid IV administration causes hypotension.

5.5.2.2 The following dosing (from the FDA-approved package insert for cyanide treatment) is for patients with normal hemoglobin levels. Patients with anemia should have the dose of sodium nitrite decreased in proportion to the decrease in their hemoglobin.

- Adults: 300 mg (10 mL of 3% solution)
- Pediatrics: 6 mg/kg (0.2 mL/kg of a 3% solution), up to a maximum of 300 mg.

Disclaimer: This guideline is intended to be an informational reference only and should not be used as a substitute for consultation with a poison center or toxicologist, and/or the clinical judgement of the bedside team.

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