Acute Occupational Exposure to Hydrogen Sulfide

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Occupational exposures to hydrogen sulfide occur in a wide variety of sectors.

Hydrogen sulfide (H_2S), also known as sewer gas, swamp gas, or sour gas, is a colorless, flammable, explosive, irritant gas that acts as a systemic asphyxiant. H_2S has a strong warning odor of rotten eggs, with an odor threshold at 5 ppm. However, at high concentrations (> 100 ppm), exposed workers may be unable to smell the gas due to olfactory adaptation and toxic inactivation of the first cranial nerve.

Occupational exposures occur in a wide variety of sectors, including agriculture (e.g., animal waste disposal systems and manure containment areas), human sewage treatment facilities, natural gas and petroleum extraction, underground coal mining and processing, production using animal products (e.g., tanneries), sugar-beet processing, wood-pulp processing, hot-asphalt paving, on commercial fishing vessels, in fish product processing, and in the synthesis of heavy water (Sood, 2005).

H_2S has both irritant and asphyxiant properties. Prolonged exposure to H_2S, even at relatively low levels, may result in painful dermatitis and burning eyes. Dermal exposure to the liquefied gas can cause frostbite injury. Prolonged or massive exposure may cause burning, itching, redness, and painful inflammation of the skin.

Inhalation is the major route of H_2S exposure. The gas is rapidly absorbed by the lungs. Acting as an asphyxiant at the cellular level, H_2S binds to and inactivates cytochrome c oxidase in the mitochondria, impairing cell respiration. Pulmonary edema, which may be immediate or delayed, can occur after exposure to high concentrations. Inhalation of high concentrations of H_2S rapidly leads to life-threatening clinical manifestations that result from the inability of metabolizing cells to use oxygen.

Immediate asphyxiant effects may result in syncope, rapid loss of consciousness, and respiratory paralysis in a single worker or a group of workers. This is known in the oil and gas industry as "knockdown." If two or more workers are found unconscious, H_2S exposure should be considered immediately, even if it has not previously been suspected as a hazard in that workplace.

Other presenting signs and symptoms attributable to H_2S asphyxiant properties include central nervous system (CNS) depression, tachycardia, and hyperpnea. Direct toxic effects of the gas may result in hypoxemia, tachypnea, and chest infiltrates of delayed noncardiogenic pulmonary edema. Prolonged exposures to H_2S at high concentrations may lead to severe CNS depression, cardiovascular instability, respiratory paralysis, coma, and even death. Both minor and severe H_2S poisoning have been described as resulting in acute and delayed neuropsychiatric and neurologic deficits (Beckett, 2007).

Although H_2S does not accumulate in the body, repeated or prolonged exposure has been reported to cause low blood pressure, headache, nausea, loss of appetite, weight loss, ataxia, conjunctival irritation, corneal ulceration, and chronic cough. Chronic exposure may also cause lowered odor-detection threshold or even complete anosmia, leaving the exposed worker unable to detect subsequent exposures. The cumulative effects of repeated knockdowns may be alterations in cognition, affect, and personality (Sood, 2005).

Treatment for acute H_2S exposure begins with emergency supportive measures including immediate administration of 100% oxygen for workers who are experiencing impaired pulmonary gas exchange. However, oxygen administration will not remedy the inactivation of cytochrome c oxidase by H_2S in metabolizing cells. Amyl nitrite is given by inhalation followed by intravenous sodium nitrite to generate methemoglobin. The methemoglobin competes for H_2S by forming sulfhemoglobin, thereby freeing cytochrome c oxidase for cellular metabolism (Agency for Toxic Substances and Disease Registry, 2007).

The potential for irreversible and nearly immediate lethal outcomes of H_2S exposure requires extremely rigorous air monitoring, gas-sensing alarms, and control technology in any workplace using industrial processes associated with H_2S. Workers must be educated about potential risk, evacuation procedures, and clean air supplying respiratory protective equipment to be used as escape equipment during gas leaks and for worker rescue.

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