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Blue Ridge Poison Center's

Tox Talks

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TOXIC GASES: METHANE AND HYDROGEN SULFIDE

DOES YOUR FACILITY HAVE TELEMEDICINE?

The Blue Ridge Poison Control Center offers CME-accredited toxicology lectures through telemedicine. Planning for the Fall 2007 schedule is still underway. To suggest a topic, or for more information, contact Heather Collier: 434-924-5185 or HLC8E@virginia.edu.

THE UVA CENTER OF CLINICAL TOXICOLOGY associated with the Blue Ridge Poison Center manages over 500 patients each year on site in the University of Virginia Health System - from outpatient clinic visits to critically ill inpatients managed in our pediatric and adult intensive care units. In addition, over 2,000 requests are made each year for consultation with our physicians from other healthcare facilities by phone or telemedicine. Our Boarded Medical Toxicologists are internationally known for the expertise in the care of poisoned patients. Call 1-800-222-1222 24 hours a day, every day.

[Cell users: 1-800-451-1428]

IN CHARLOTTESVILLE

Reminder: At University of Virginia Hospital, the first Wednesday of every month features toxicology Grand Rounds. For more information, contact Heather Collier: 434-924-5185 or HLC8E@virginia.edu

In July, five people died in a manure pit accident. A farmer climbed into the pit to unclog a pipe. He rapidly collapsed unconscious. Frantic rescue efforts by three of his family members and a coworker left all five dead. Toxic gases, such as methane and hydrogen sulfide, are created in enclosed manure pits. One of these gases was likely the culprit of this unfortunate accident.

Methane

Methane is a simple asphyxiant that displaces oxygen from the environment. If oxygen levels in the enclosed space atmosphere drop below 16%, symptoms begin. If levels drop below 6%, rapid loss of consciousness, gasping respirations and death occur. Methane does not have any pharmacologic activity but simply suffocates a person when levels are extremely high in an enclosed environment.

Hydrogen Sulfide

On the other hand, hydrogen sulfide is a systemic asphyxiant that is a close relative to hydrogen cyanide gas. Hydrogen sulfide's rapid and deadly onset of clinical effects have been termed the "slaughterhouse sledgehammer effect." Poisoned workers are "knocked-down," most frequently in an agricultural or industrial event. Numerous case reports describe multiple victims in these events. Would-be rescuers often themselves become victims when they attempt a rescue in an environment with high concentrations of hydrogen sulfide. OSHA reports that 25% of fatalities involved rescuers.

Hydrogen sulfide is produced naturally by bacterial decomposition of proteins and is used or produced in many industrial activities. Decay of sulfur-containing products,

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such as fish, sewage, and manure also produces hydrogen sulfide. Several farm workers and rescuers have died from exposure to hydrogen sulfide generated in liquid manure pits. Industrial sources of hydrogen sulfide include pulp paper mills, heavy-water production, the leather industry, petroleum - distillation and refining, roofing asphalt tanks, vulcanizing of rubber, viscose rayon production, and coke manufacturing from coal. It is a major industrial hazard in oil and gas production, particularly in sour gas fields (natural gas containing sulfur).

Hydrogen sulfide is a colorless gas, more dense than air, with an irritating odor of "rotten eggs." An interesting but unfortunate phenomenon is the ability to perceive the odor at low levels, but at higher levels it is rapidly extinguished because of olfactory nerve paralysis. Prolonged exposure can occur when the extinction of odor recognition is misinterpreted as dissipation of the gas. Systemic absorption usually occurs through inhalation, and it is rapidly distributed to tissues. The heart and brain are most sensitive to hydrogen sulfide because of their high oxygen demands. Similar to hydrogen cyanide, hydrogen sulfide causes its toxicity by disrupting cellular respiration and stopping aerobic metabolism. Essential the cells suffocate.

Clinical Effects

Hydrogen sulfide is highly toxic and leads to rapid unconsciousness and cardiopulmonary arrest at concentrations greater than 700 ppm. Neurologic manifestations are common and many victims of acute exposures have a rapid loss of consciousness ("knockdown"). If the patient is removed from the exposure rapidly, recovery may be prompt and complete. Secondary neurologic effects can result from hypoxia secondary to respiratory compromise. Neurologic outcome can be quite variable, ranging from no neurologic impairment to permanent sequelae.

Acute exposures affect other organ systems. Myocardial hypoxia or direct toxic effects on cardiac tissue may cause cardiac dysrhythmias, myocardial ischemia, or myocardial infarction. Because unresponsiveness is rapid, trauma from falls should not be overlooked. In one report, 7% of patients experiencing a "knock-down" had associated traumatic injuries.

In addition to systemic effects, hydrogen sulfide produces intense irritation of the skin, eyes and upper respiratory tract.

Diagnostic Clues

Because there is no rapid method of detection that is of clinical diagnostic use, management decisions must be made based on history, clinical presentation, and diagnostic tests that infer hydrogen sulfide's presence. Circumstances surrounding the patient's illness will often be the best evidence for suspecting hydrogen sulfide poisoning. At the bedside, the smell of rotten eggs on clothing or emanating from exhaled air suggests hydrogen sulfide exposure. In addition, darkening of jewelry or coins is a clue to exposure. Specific tests for laboratory confirmation of hydrogen sulfide exposure are not readily available in clinical laboratories. Therefore, the presence of hydrogen sulfide is best confirmed by directly measuring the gas in the environment. In acute poisoning, readily available diagnostic tests that are biomarkers of hydrogen sulfide poisoning may be useful but nonspecific. An arterial blood gas analysis demonstrates metabolic acidosis with an associated elevated serum lactate concentration is expected and normal oxygen saturation should be noted unless acute lung injury is present.

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Treatment

Treatment of patients with hydrogen sulfide poisoning requires optimal supportive care. The initial treatment is immediate removal of the victim from the contaminated area into a fresh-air environment. Administer high-flow oxygen as soon as possible. Optimal supportive care has the greatest influence on the patient's outcome. Because death is rapid from inhalation of hydrogen sulfide, limited human cases reaching the hospital for treatment are reported in the literature. Most patients have significant delays before receiving treatment. Therefore, treatments and antidotes beyond supportive care are not of proven clinical benefit.

Because hydrogen sulfide toxicity is severe, and case reports suggest the occurrence of delayed sequelae, the potential benefits of nitrite therapy should be considered for seriously ill patients exposed to hydrogen sulfide. Use of this therapy occurs after optimum supportive care has been ensured.

The similarities in the toxic mechanism between hydrogen sulfide and cyanide created an interest in the use of nitrite-induced methemoglobin as an antidote. Nitrite-generated methemoglobin acts as a scavenger of sulfide. Animal studies suggest that nitrite must be given within minutes of exposure to ensure effectiveness. Because hydrogen sulfide poisoning is rare, no studies exist to evaluate the clinical outcomes of patients treated with sodium nitrite but several human case reports showed rapid return to normal when nitrites were administered soon after exposure. Patients with suspected hydrogen sulfide poisoning with altered mental status, coma, hypotension, or dysrhythmias should probably receive sodium nitrite by slow infusion at the same dose as cyanide poisoning. Sodium thiosulfate or hydroxocobalamin are of no benefit in the treatment of hydrogen sulfide.

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FEEDBACK

If you have any topics you would like to see covered in an upcoming newsletter, or if you have any suggestions on how to improve the newsletter, please contact us at ch2xf@virginia.edu.

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