Suicide With Hydrogen Sulfide

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Abstract: This presentation will address the recent rise of suicide deaths resulting from the asphyxiation by hydrogen sulfide (H_2S) gas.

Hydrogen sulfide poisoning has been an infrequently encountered cause of death in medical examiner practice. Most H_2S deaths that have been reported occurred in association with industrial exposure.

More recently, H_2S has been seen in the commission of suicide, particularly in Japan. Scattered reports of this phenomenon have also appeared in the United States.

We have recently observed 2 intentional asphyxial deaths in association with H_2S. In both cases, the decedents committed suicide in their automobiles. They generated H_2S by combining a sulfide-containing tree spray with toilet bowl cleaner (with an active ingredient of hydrogen chloride acid). Both death scenes prompted hazardous materials team responses because of notes attached to the victims' car windows indicating the presence of toxic gas. Autopsy findings included discoloration of lividity and an accentuation of the gray matter of the brain. Toxicology testing confirmed H_2S exposure with the demonstration of high levels of thiosulfate in blood.

In summary, suicide with H_2S appears to be increasing in the United States.

Key Words: suicide, hydrogen sulfide, asphyxia

(*Am J Forensic Med Pathol* 2013;34: 81–82)

Hydrogen sulfide (H_2S) is a colorless gas that has a pungent odor likened to the smell of rotten eggs. It is flammable and can be explosive. It is produced by the decomposition of sulfur-containing organic matter and is used in some manufacturing processes.[1] At low levels, H_2S acts primarily as a severe local irritant especially affecting the conjunctivae, sclerae, and the upper respiratory tract.[2] At higher concentrations (1000–2000 ppm), it produces rapid death with systemic toxicity, which is thought to be related to inhibition of cytochrome oxidase.[3]

Hydrogen sulfide poisoning is infrequently encountered in medical examiner practice. Most H_2S deaths that have been reported occurred in association with exposure to sewer gas, which contains H_2S. More rarely, industrial exposures have been described.[1,2,4,5]

Hydrogen sulfide asphyxiation as a suicide modality has become increasingly prevalent in Japan. *USA Today* reported that Japan had 517 self-inflicted deaths with H_2S in 2008.[6] There are many Japanese Web sites that give instructions using readily available household products, and some sites even offer templates for warning signs that can be downloaded and printed to alert family and emergency responders to the hazard.[7] This modality is starting to be observed in the United States as this information becomes disseminated through the Internet. However, this information is not just being discussed on Web sites dedicated to suicide. Medical examiners and emergency personnel need to be aware of this suicide modality for both safety and diagnostic reasons.

We recently observed 2 intentional asphyxial deaths in association with H_2S. In both cases, the decedents committed suicide in their automobiles.

CASE REPORT 1

A 44-year-old white woman, who had previously been reported as missing, was found dead in her car. Signs were posted in the windows of the car that stated that a poison was present in the car and warned not to open the car. A hazardous materials team was called in and a bucket containing lime sulfur tree spray (containing 30% calcium polysulfide) and toilet bowl cleaner (containing 20 % hydrogen chloride) was found in the car along with the decedent. The decedent and the car both underwent decontamination. The decedent's medical history was significant for depression. No medications were found in the car.

Upon external examination, a pink discoloration of lividity was noted. The gray matter of the brain had a green discoloration consistent with H_2S exposure. The rest of the postmortem examination was unremarkable. Cardiac blood, gastric contents, brain, liver, and vitreous were all sent for toxicologic analysis. Toxicologic analysis was notable for thiosulfate (12 μg/mL in blood—normal up to 1 μg/mL). Lamotrigine, nortriptyline, and amitriptyline in therapeutic concentrations were also detected. The cause of death was certified as H_2S poisoning with manner of death as suicide.

CASE REPORT 2

A 31-year-old white man was found unresponsive in a motor vehicle. When police arrived at the scene, notes were found on the vehicle stating "Toxic H_2S Gas." Hazardous materials personnel responded and confirmed the presence of H_2S gas. The vehicle was not running, and the ignition was in the off position. The windows were all closed, and the vents had been taped over. On the passenger side floor mat, a pool of what appeared to be household cleaners was found. The decedent had a medical history significant for major depressive disorder, and the police had also found a note, written by the decedent, which detailed his being unhappy with his life. The postmortem examination was unremarkable except for slight green discoloration of the gray matter, which was identified retrospectively. Toxicologic testing was positive only for thiosulfate at 16 μg/mL. The cause of death was certified as H_2S poisoning with manner of death as suicide.

DISCUSSION

Death by H_2S is not a new phenomenon. However, these deaths have traditionally involved accidents from workplace

Manuscript received September 1, 2011; accepted October 20, 2011.

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This article was presented at the 2010 National Association of Medical Examiners Annual Meeting and was awarded the 2010 John Smialek Best Resident Paper Award.

The authors report no conflicts of interest.

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ISSN: 0195-7910/13/3402–0081
DOI: 10.1097/PAF.0b013e3182886d35

exposure to "sewer gas" or fatal exposures in commercial manufacturing.[1] The Occupational Health and Safety Administration reported 13 work-related H_2S asphyxiation deaths in 2007.[8] Suicide by H_2S poisoning is an unusual technique that has historically been more prevalent in Japan. *USA TODAY* reported "a suicide fad is sweeping Japan" because 517 Japanese used the technique to kill themselves in 2008.[6] They attributed the spike in this technique to information and instructions being widely disseminated over the Internet. This readily available information allowed young depressed Japanese to obtain procedures and enter into suicide pacts with other depressed individuals.

Although this technique has been popular in Japan, it has not been seen with any frequency in the United States; however, this may be changing. Increasing awareness of the general public, coupled with the ease of obtaining information, necessitates that forensic and rescue personnel become aware of its existence and potential for increased prevalence.

The use of H_2S to commit suicide presents important considerations for safe practices by first responders and death scene investigators. In both of our cases, the decedents warned responders that toxic gas was present. Hazardous materials response teams, and a bomb squad in the first case, responded to the scenes to minimize the risk of collateral damage. A real concern is that not all decedents will leave a warning. Civilians present at the scene and rescuers responding to the scene all risk becoming casualties if exposed to residual gas. In 2008, *The Japan Times* reported that a 14-year-old girl's use of H_2S to commit suicide had forced an evacuation of her building, and 80 other occupants were sickened from exposure.[9] That H_2S in high concentrations is rapidly fatal and may have few warning signs should be kept in mind by rescue and forensic personnel.

In Japan, H_2S is commonly produced by mixing bath sulfur with toilet cleaner. In the United States, sulfur tree spray is substituted in Internet instructional materials, as bath sulfur is unavailable. Both decedents reported here used sulfur tree spray and toilet bowl cleaner. These chemicals are easily obtained, and instructions for mixing the chemicals for suicide are readily available on the Internet.

Hydrogen sulfide is thought to lead to death by inhibiting cytochrome oxidase, similar to cyanide.[3] Deaths caused by H_2S are traditionally related to accidental exposure.[1] They are often associated with exposure to "sewer gas," which is made up of H_2S, methane, and carbon dioxide.[2] Hydrogen sulfide is most well known for its characteristic "rotten eggs" smell, which is detectable in concentrations as low as 0.3 ppm.[10] These low levels that give an olfactory warning are generally not fatal. The Occupational Safety and Health Administration limits exposure to 20 ppm with a 50-ppm 10-minute peak permitted once during an 8-hour period.[8] Levels high enough to cause harm may not give the "rotten eggs" olfactory warning because olfactory nerve paralysis occurs around 150 ppm.[10] Levels of 700 to 900 ppm lead to central respiratory paralysis, and beyond 1000 ppm, H_2S causes nearly instantaneous respiratory paralysis and coma.[10]

Common autopsy findings are nonspecific and include conjunctivitis and scleritis along with evidence of respiratory irritation.[2] Pulmonary edema occurs at levels of 300 ppm and may be the only clue in cases of substantial exposure (>1000 ppm).[2] Hydrogen sulfide poisoning may present with nonspecific findings such as greenish discoloration of the cerebral gray matter and "cherry-red" or pink lividity. Both of these findings were observed in our first case, but brain findings were subtle and only appreciated retrospectively. Less common autopsy findings may be exhibited such as hemorrhagic pulmonary edema, visceral congestion, bronchial secretions, and scattered petechiae.[8] Because none of these findings are specific, the diagnosis of H_2S poisoning may be difficult and the importance of death scene investigation in such cases cannot be overestimated. Death scene investigators should be of aware of sources of H_2S such as toilet cleaner and sulfur tree spray.

Toxicologic analysis for thiosulfate confirms the diagnosis. Exogenous sulfide is partially oxidized by both hemoglobin and liver enzymes to thiosulfate.[3] In our cases, both decedents had significantly elevated thiosulfate levels (12 and 16 μg/mL) consistent with the acute massive exposure expected from death scenes. Poli et al[11] found that, in their case of 5 workers who died from H_2S exposure, the thiosulfate blood concentrations were an average of 8 mg/kg. Blood and tissue thiosulfate levels were stable when tested 6 months after the autopsies were performed.

In summary, suicide with H_2S appears to be increasing in the United States. Its use may further increase as it gains more national media attention. Rescue and forensic personnel should use appropriate safety measures when dealing with suspected H_2S death scenes because it is toxic, flammable, and potentially explosive. Dissemination of information regarding this relatively new suicide modality to these individuals and others (eg, suicide prevention agencies) is strongly encouraged. Because autopsy findings of H_2S poisoning are nonspecific, scene investigation may be critical to the diagnosis. Elevated levels of thiosulfate establish the diagnosis.

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