

Danger behind the Door: Challenges of Field Rescue and Medical Management in a Hydrogen Sulfide Suicide Attempt

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Abstract

Background: Hydrogen Sulfide (H₂S) has become a method of suicide that has gained popularity across the world in the recent years. The traditional means included a well-sealed car in a remote location. The completion rate of suicide was very high and living patient contact is rarely made.

Case Discussion: A 35 year old female was discovered in her apartment after a suicide attempt in an apartment room, utilizing H₂S. A multiple tiered response included Emergency Physicians from the onset of the case both on scene and at the receiving facility advising on scene safety, toxicological issues and management. The patient required intubation in the field and supportive care, but ultimately was discharged from the hospital neurologically intact. No first responders or bystanders were seriously affected.

Discussion: With rapid on scene care and early and aggressive critical care this patient survived without deficit. First responders and emergency physicians need to be aware of this novel method of self-harm and the implications for patients, emergency personnel and bystanders.

Introduction

The events surrounding a patient's care before they arrive at the emergency department (ED) are often forgotten by hospital-based emergency medicine providers. The pre-hospital care paradigm involves transporting patients from an unstable, difficult, or even unsafe environment and bringing them to the ED. EMS providers often render care in such environments. Environmental threats can include everything from utility hazards to violence from patients and bystanders.

Acids		Sulfide		
Toilet Bowl Cleaners:	Tile and Tub Cleaners:	Dandruff Shampoo		Spackle
The Works	Kaboom	Paints: Oil and Latex		Pesticides/Fungicides
Sno Bol				
Lysol	CLR (Calcium Lime Rust)			

Table 1: Commonly cited household used in intentional H₂S production

While scene safety is the first teaching of pre hospital care, it is less of an issue when responding to overdose cases, as these most frequently involve ingestion or injection of illicit drugs and medications. However, in some circumstances, individuals may attempt suicide using poisonous gases such as carbon monoxide, helium and chlorine gas. In recent years hydrogen sulfide (H₂S), generated from a mixture of common household chemicals, has arisen as a suicide method [1] (Table 1). This method has taken hold in Japan

as well, and has spread across the world via the Internet and news reports [2]. While H₂S is widely recognized as an occupational or environmental hazard [3], significant exposure is unusual in residential settings. Scene response to a case of intentional H₂S exposure can pose unexpected hazards and challenges for pre hospital providers. In this report, we describe the detailed on-scene response and clinical course of case of intentional H₂S poisoning which occurred in a multi-unit residential building.

Case Report

After the patient did not arrive for a regularly scheduled medical appointment, a concerned physician called 911 to perform a patient "well-being check." EMS was dispatched to a multi-unit apartment building along with local fire and police department personnel. The initial dispatch information provided to the responding units was "Unknown Medical". Upon arrival to the scene, approximately 10 yards from the outside entrance, providers noted the smell of rotten eggs. Police, fire and EMS personnel entered the building together and found printed warning signs on the door to the patient's apartment reading, "Stay Away, Hydrogen Sulfide". EMS and Police immediately evacuated the building's other occupants. The fire department's detectors registered 40 ppm of hydrogen sulfide, measured just inside the hallway leading up to the apartment's bedroom entrance.

On-scene fire resources declared the area a hazardous materials situation. Police, fire and EMS staged at the fire chief's discretion, approximately 100 yards away from the building, with variable winds noted. This location was chosen based on road access, limiting traffic to a single roadway entry point. Incident command was established, with the deputy fire chief assuming the role of commander, and region-wide HAZMAT resources were requested. As plans were being

formalized, an EMS Physician on scene relayed information to the anticipated receiving facility and contacted that facility's medical toxicology consultation service. Discussions included: potential threats to providers from the patient's exposure, as well as public health concerns. Other occupants in the building were asymptomatic at the time of evacuation, and it was deemed unnecessary to transport them for medical evaluation. A second EMS physician on scene pre-screened rescuers who were preparing to make entry wearing full HAZMAT protection, as the ambient temperature exceeded 90°F.

The Hazardous Materials Team obtained a measurement of 15 ppm of H₂S just outside of a window air conditioning unit suspected to be in the same room as the patient. An initial HAZMAT recon team, using level A precautions, was tasked with making entry into the apartment and identifying immediate threats. An unconscious adult female was found in the bedroom where a brief primary medical survey noted spontaneous respirations. A deceased dog was found on the floor next to her. The patient had mixed a household cleaner "The Works" with an additional sulfur-containing detergent. This mixture was found in a bucket next to her bed.

The initial HAZMAT team removed the patient in an expedient fashion. Initial decontamination, consisting of clothing removal, was performed in the apartment. Washing with detergent, copious water, and scrubbing was performed as the patient exited the building into the decontamination area. EMS was waiting at the end of the decon area and immediately received and assessed her when she was transferred. Of note, significant challenges were noted as a result of wearing HAZMAT suits.

Such protective gear reduced mobility, as well as increasing the difficulty to perform a rigorous medical exam. The extreme temperatures limited the time the HAZMAT technicians were able to spend in the suits. The distance from the warm zone to the building entrance added additional time in an already challenging physical environment. Plans and priorities needed to be well established prior to sealing the suits, in order to maximize the time in the hot zone.

Immediate evaluation by EMS physicians demonstrated diminished respiratory effort, weak central pulses, and ashen skin color. The patient's best neurological response was to intermittently withdraw to pain, resulting in a GCS of 7, E1 V2 M4. Blood pressure obtained was 50/p mmHg with a heart rate of 54. Continuous wave form capnography demonstrated an ETCO₂ of 34. An intraosseous catheter was placed and rapid-sequence intubation was performed using succinylcholine, etomidate and fentanyl. She received a two-liter bolus of normal saline en route to the hospital. Vital signs obtained pre-hospital and on ED arrival are shown in Table 2.

	BP	HR	O ₂ sat	Temp	EtCO ₂	GCS
On Scene	50/p	54	UTO	UTO	34	7
ED Arrival	126/95	60	98%	36.3		7

Table 2: Pre-hospital and ED vital sign parameters

On arrival to the ED, the patient remained intubated with the following vital signs: BP126/95, HR 60, RR 16, oral temperature 36.3, oxygen saturation 98% on the ventilator. Physical exam (without sedation) was notable for 5 mm reactive pupils bilaterally, no conjunctival injection, no mucosal irritation, clear lungs, and normal skin temperature and moisture. The best neurologic response was

withdrawal of all four extremities to painful stimuli with 2-3 beats of clonus in bilateral lower extremities.

Review of previous medical records indicated that the patient had a past medical history of bipolar disorder, borderline personality disorder, hypertension, GERD, hypothyroidism and migraines. She had over ten documented suicide attempts in the past including attempts involving prescription medication overdose and intentional carbon monoxide exposure. Her home medications included ibuprofen, levothyroxine, omeprazole, citalopram, lamotrigine, clonazepam, bupropion, and risperidone.

An initial arterial blood gas showed a pH of 7.32, pCO₂ of 43 mmHg, pO₂ of 242 mmHg and HCO₃ of 23 mEq/L. Serum lactic acid was 1.4 mmol/L. Serum ethanol and toxic alcohol concentrations were undetectable. Comprehensive urine toxicology screening detected the presence of bupropion, caffeine, doxylamine, chlorpheniramine, fluconazole and citalopram. A chest x-ray showed clear lungs. Initial ECG demonstrated normal sinus rhythm with no conduction abnormalities or ST-segment changes. The two liters of normal saline were continued and a sedation protocol with midazolam and fentanyl was initiated.

The patient was admitted to the ICU, and over the next two days the patient remained intubated but hemodynamically stable with minimal oxygen requirements. As her sedation was weaned, the patient exhibited alternating periods of extreme agitation and somnolence, preventing a trial of extubation. The patient self-extubated on hospital day 4, was quickly weaned to room air and had no further respiratory issues. On hospital day 6 she was deemed medically stable for psychiatric evaluation. On her initial psychiatric interview she denied any recollection of the events surrounding this suicide attempt, although she admitted she may have attempted a "test run" with hydrogen sulfide several weeks prior. She specifically denied any intentional ingestion of her medications or other drugs. She remained in the hospital awaiting a psychiatric unit bed, and on hospital day 7 began to complain of auditory disturbances and a sense that sounds were muffled and echoing. The patient was transferred for long-term psychiatric care.

Discussion

Historically, toxic exposures to hydrogen sulfide (H₂S) have been from occupational or environmental sources such as sewage facilities, petroleum refineries, manure pits, and volcanoes. In recent years a number of exposures in the setting of suicide attempts have been reported [1,4]. First recognized in Japan, information on this suicide method has disseminated via the internet and has now been reported in both the United States and Canada. As illustrated by this case, H₂S can be generated by the mixture of common, easily obtained household chemicals (Table 1).

H₂S exists as a highly flammable, colorless gas at room temperature, which is heavier than air and tends to accumulate in lower lying areas. Once generated, it can persist in the local atmosphere for up to 18 hours, particularly in enclosed and poorly ventilated areas. At H₂S concentrations of 0.025 ppm, a characteristic rotten egg odor is perceptible, however induction of olfactory paralysis at concentrations as low as 100 ppm makes odor an unreliable predictor of exposure. Systemic toxicity mainly occurs via inhalation. Local irritation may occur from dermal or ocular exposure, but systemic absorption through these routes is minimal [5,6]. H₂S's concentration-dependent toxicity occurs due to both irritant gas and cellular asphyxiant

properties [7]. Contact with mucous membranes can result in local irritation, manifested as keratoconjunctivitis, dermatitis and pneumonitis. At higher concentrations, systemic toxicity develops. H₂S binds to the ferric group of cytochrome oxidase, inhibiting electron transport and ATP generation via aerobic metabolism, similar to cyanide [8]. Clinical findings include progressive CNS dysfunction (dizziness, lethargy, seizure and coma), pulmonary injury (non-cardiogenic pulmonary edema), myocardial dysfunction and ultimately cardiovascular collapse. At Proposed treatment for H₂S exposure is based on theoretical benefit and case reports as a paucity of literature or evidence based recommendations exist. The use of nitrates to induce methemoglobinemia has been proposed as a treatment; however potential complications of hypotension and worsening hypoxia make this less likely to be beneficial [8,9]. Hydroxycobalamin, which is postulated to bind hydrogen sulfide, has been shown to decrease mortality in animal models of H₂S toxicity [10,11]. Successful treatment of H₂S toxicity using hyperbaric oxygen has been described in multiple case studies [12,13].

Why should an emergency physician be aware of this?

This case illustrates several challenges associated with intentional H₂S exposure that are not seen in cases of drug related poisoning. A self-contained breathing apparatus (SCBA) is required to limit inhalational exposure when entering an area potentially contaminated with H₂S. In this case, the initial entry team utilized Level A HAZMAT suits; however, since dermal absorption is felt to be minimal, SCBA is probably sufficient protective equipment. As noted above, the use of Level A suits significantly impaired the movements of first responders. Given the method of creating H₂S in this scenario, any liquid soaked clothing could serve as a potential source for continued H₂S release and should be removed and contained. Although low levels of H₂S can be detected in expired air for up to 2 hours post-exposure, the victim themselves should not be considered a significant off-gassing risk once externally decontaminated [5]. The location of the case also appears to be unique; prior cases encountered in the United States occurred inside of closed automobiles or other isolated conditions. The setting of a multi-unit residential building raised the possibility of exposure to other building residents, necessitating evacuation. While local fire and EMS experiences with previous H₂S exposures in a sealed motor vehicle have demonstrated a high case fatality rate, this patient was found alive and eventually made a full recovery. Hence, first responders can be faced with balancing personal safety with expeditious retrieval of a patient. In addition, EMS personnel in this case benefitted from the participation by on-scene emergency physicians as well as direct consultation with medical toxicologists at the receiving hospital. In many other jurisdictions, such resources will be unavailable and EMS will need to consult with local medical control and poison control centers.

In conclusion, this case serves to alert EMS personnel and emergency physicians of H₂S poisoning in non-occupational settings. Compared to most other types of deliberate self-poisoning, these cases present unique challenges to EMS personnel. Personal safety must be considered in balance with rapid patient retrieval. Depending on the setting, additional resources (e.g. HAZMAT) may be required to ensure public safety. Consultation with expert resources, such as poison control centers or local health departments, is recommended to help guide on-scene management.

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