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Abstract

Suicide from Internet directed hydrogen sulfide (H₂S) asphyxiation has been seen in the United States since August 2008, following a trend observed in Japan earlier that year. Instructions posted on the Internet include which cleaners and pesticides to buy, how to mix these commercially available chemicals to create the gas, and on some sites, a note to print out that cautions first responders to the presence of H₂S gas.

Hydrogen sulfide is poisonous primarily in the gaseous form, which is characterized by a "rotten egg smell" at low concentrations. Continued exposure to H₂S results in desensitization of the olfactory senses so that it is no longer detected. Normal healthy subjects have thiosulfate levels of less than 0.3 mg/L. Sulfide in the body is partially converted to sulfate and thiosulfate through oxidation. Baselt recommends that thiosulfate levels should be assessed to establish fatal intoxications. H₂S inhibits cellular respiration by binding with the iron of cytochrome oxidase, in the same fashion as hydrogen cyanide, thereby inhibiting binding of oxygen and stopping cellular respiration, resulting in death.

A 26 year old white male was found in his car with a note taped to the window reading "STAY AWAY! Poisonous Chemicals! Call 911" (sic). Also in the car were a bucket, bottles of toilet bowl cleaner and lime sulfur spray, and two other notes, both indicating that H₂S gas had been formed. A reading of 8 parts per million H₂S gas was taken by responding authorities. Hazmat removed a 5 gallon bucket with liquid that was located in the front passenger seat and quickly made it neutral. Suicide notes were found addressed to his family.

A complete forensic autopsy was performed at the Cuyahoga County Medical Examiner's Office (CCMEO), Cleveland, Ohio. It consisted of an external and internal examination of the body, microscopic examination, and toxicological examination. Samples of heart and femoral blood, vitreous humor, gastric contents, bile, urine, and liver were submitted for comprehensive toxicological examination.

The body was that of a normally developed 26-year-old adult white man with a length of 64 inches (5'4") and a weight of 157 pounds. External examination was significant for distinct gray/green discoloration of the face, lips, conjunctivae, abdomen, hands, and feet. Internal examination revealed mild, generalized brain edema with diffuse green discoloration of the cortex and deep gray structures. There was marked dark green discoloration of the substantia nigra, red nuclei, and cerebellar dentate nucleus. The cerebral and cerebellar white matter was unremarkable. Visceral organs appeared normal grossly. Microscopic examination revealed diffuse brain and visceral congestion with focal perivascular acute necrosis in the brain, evidence of acute microscopic cardiac ischemia, and hemorrhagic pulmonary edema.

Toxicological testing revealed ethanol 0.02 g/dL, caffeine and cotinine in the femoral blood. Heart blood was sent to AIT Laboratories (Indianapolis, IN) for a comprehensive drug screen and to National Medical Services (NMS) Labs (Willow Grove, PA) for thiosulfate analysis. AIT Laboratories found the femoral blood positive for alprazolam 14.3 ng/mL and caffeine. NMS Labs found 43 mg/L thiosulfate in the decedent's femoral blood, which is 143 times higher than the thiosulfate level of a healthy subject.

The autopsy findings in this case were consistent with the suspicion that death was due to acute exposure to H₂S. The cause of death was determined to be asphyxia due to hydrogen sulfide inhalation. The manner of death was ruled as suicide.

Keywords: Hydrogen Sulfide, Suicide, Internet

Objectives

- To provide a deeper knowledge of poisoning by hydrogen sulfide as a method of suicide.
- To inform forensic professionals about a novel suicide technique found on the Internet that can be used particularly by our youth.
- To bring to light the concerns first responders face at H₂S scenes.
- To discuss the unique Pathology/Toxicology findings resulting from H₂S intoxication.

Introduction

- Hydrogen sulfide (H₂S) is the product of a metal ligand sulfur compound mixed with a hydrogen source, such as water or ammonium.
- Hydrogen sulfide gas occurs naturally in abundance in natural gas wells or as a result of sulfur-reducing bacteria.
- Industrial accidents (sewer gas, commercial manufacturing) were the main source of hydrogen sulfide deaths¹.
 - 13 work related deaths due to H₂S in 2007¹.
- A characteristic "rotten egg" smell results from even small quantities of hydrogen sulfide gas.
- Hydrogen sulfide gas kills similar to hydrogen cyanide gas. The central nervous system and respiratory system are most effected; death results quickly with exposure to high enough concentrations².
 - The gas is absorbed through the respiratory and gastrointestinal systems and expelled through exhalation, in feces or as metabolites in urine².
- Thiosulfate is a naturally occurring sulfuric compound in the body, and is also a metabolite of hydrogen sulfide gas. When testing for postmortem hydrogen sulfide levels, thiosulfate levels should exceed 0.3 mg/L, to account for the natural level³.
- This particular method of suicide began in Japan in 2008 and spread through the use of internet forums⁴.
- The first instance of hydrogen sulfide suicide in America was in 2008 in California⁵.
 - Based on comments in internet forums, it appears this delay resulted from the need to translate the instructions from Japanese to English.
- A quick internet search on suicide yielded many web sites devoted to discussing ways and reasons to kill oneself.
 - A forum⁶ discussed this method, including its origin in Japan, and a list of suitable over the counter chemicals arranged by availability per country.
 - This forum and another site⁷ discussed methods of suicide, the statistics regarding success rate and the user's need to be cognizant of methods that do not harm bystanders or first responders.
- A number of first responder websites^{5,8} also posted bulletins, at roughly the same time the suicide forums began mentioning hydrogen sulfide suicide, offering precautions for dealing with this method.
 - While the trend has been towards leaving warning messages during this type of suicide, it is possible that some may not. These professional bulletins help avoid secondary casualties¹.
- The main metabolic pathway of hydrogen sulfide is through oxidation: sulfide → thiosulfate → sulfite → sulfate².
 - Alkylation and reaction with metallo- or disulfide-containing products are additional metabolic paths².
- In fatal cases, blood thiosulfate levels are used for diagnosing poisonings².

Case History

- A 26 year old white male was found deceased in his car by a passerby.
- He had broken up with his girlfriend three weeks prior and had a history of depression.
- Last seen alive at approximately 7:30 pm the night before by his sister.

Materials and Methods

- Toxicology was performed at the Cuyahoga County Medical Examiner's Office and consisted of a volatile analysis, basic and acidic neutral screens, a 13-panel ELISA, and salicylate and acetaminophen screening by colorimetry. Confirmations were performed using gas chromatography/mass spectrometry (GC/MS).
- Specimens were also sent to AIT Laboratories in Indianapolis, IN for a general toxicology screen and NMS Labs in Willow Grove, PA for a thiosulfate analysis. The thiosulfate analysis was done by ion chromatography at NMS.
- NMS Labs analyzed for thiosulfate by the following procedure⁹:
 - Femoral blood was diluted with deionized water and injected into an ion chromatograph. Separation was done based on conductivity detection. The analytical range was 1.0 to 20 mcg/mL. The lower limit of quantification (LLOQ) was 2.0 mcg/mL. The standard addition method was followed for quantification calculations.

Results

Scene:

- The doors and windows of the car were closed when first responders arrived on scene.
- Three warnings were taped to the inside of the windows (Figure 1). The messages were "STAY AWAY! Poisonous Chemicals! Call 911", "CALL 911 HAZMAT Don't be a hero", and "H₂S highly toxic one breath may kill do not open call 911 and Hazmat."
- Hazmat was brought in to process the scene. They broke the windows of the car to ventilate the fumes, and neutralized the source of the hydrogen sulfide gas.
- In the car, an open pack of markers, a notebook, a five gallon plastic bucket, and two bottles each of bleach based toilet bowl cleaner and lime sulfur pesticide were found.
- The cleaner and the pesticide were mixed in the bucket, and were the source of the hydrogen sulfide gas. A reading of 8 ppm of H₂S was taken near the source of the gas.
- The markers and notebook were consistent with what was used to write the warning notes that were found on the windows and an apparent suicide note addressed to his family.

Results

Figure 1: Decedent's car with warning note



Autopsy:

- A full autopsy was performed at the Cuyahoga County Medical Examiner's Office (CCMEO) in Cleveland, Ohio.
- In addition to the internal and external examinations, microscopic and toxicological examinations were performed.
- During the external examination, green/gray discolorations were noted on the face, lips, conjunctivae, abdomen, hands, and feet. A similar discoloration was also noted in the brain along with swelling shown in Figure 2B.
- The microscopic examination of the brain showed acute necrosis and swelling, and the microscopic examination of the heart and lungs showed cardiac ischemia and pulmonary edema.

Figure 2 A-B: Brain color comparison between a healthy brain (2A) and a brain after hydrogen sulfide intoxication (2B)

2A. Healthy brain



2B. Brain after H₂S intoxication



Results

Toxicology:

- Femoral blood tested at the Cuyahoga County Regional Forensic Science Laboratory, Toxicology Department and at AIT Laboratories, was positive for ethanol, caffeine, cotinine, and alprazolam.
 - Ethanol 0.02 g/dL
 - Alprazolam 14.3 ng/mL
- Femoral blood was also sent out to NMS Labs for thiosulfate testing, with a result of 43 mg/L.

Conclusions

- Despite the lower H₂S concentration (8 ppm) detected in the car, the thiosulfate level in the decedent's blood was 143 times greater than what would be expected in a healthy individual¹. Based on the thiosulfate level in the blood, the physical observations of the deceased and what was noted at the scene, it was determined that the cause of death was asphyxia due to hydrogen sulfide by manner of suicide.

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