K23 Thiosulfate Antemortem and Postmortem Blood Concentrations Following Suspected Hydrogen Sulfide Exposures - An Evaluation of Ten Positive Cases

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After attending this presentation, attendees will learn about hydrogen sulfide as a toxic agent, the recommended specimen types that should be collected for toxicological analysis following a possible exposure and the application of thiosulfate as a biomarker of exposure.

This presentation will impact the forensic community by providing additional information that may be of benefit when evaluating cases of hydrogen sulfide gas exposure.

Situations involving hydrogen sulfide gas exposures are frequently encountered in the practice of forensic toxicology and the interpretation of analytical findings is directly dependent upon selecting the appropriate marker of exposure. Hydrogen sulfide is a colorless, flammable gas that is highly toxic. It is a natural gas that can be produced by decaying organic matter or as a by-product of various industrial processes including petroleum refining and mining. Hydrogen sulfide is insidious in that even though the gas has a distinctive rotten- egg odor that may be detectable at concentrations as low as 0.5 ppb, olfactory fatigue, depending upon concentration and length of exposure, may also occur. At room temperature hydrogen sulfide is a gas and, since it is heavier than oxygen, it tends to accumulate in poorly ventilated low-lying areas. Inhalation is the major route of exposure, and its mechanism of action is such that it causes disruption of the mitochondrial electron transport system. In the body hydrogen sulfide is rapidly metabolized to its major oxidation product thiosulfate and it is mostly for this reason that this metabolite has often been used as a biomarker in the evaluation of non-fatal and fatal hydrogen sulfide exposure cases. Also, even though sulfide may also be used as an indicator of exposure, the detection of sulfide is difficult especially in non-fatal cases since it undergoes rapid metabolism in the body. Another potential complexity involving the interpretation of a postmortem sulfide level is that sulfide may be formed during the decomposition process.

Over the course of a 5-year period several blood specimens collected for investigative purposes where hydrogen sulfide exposure was suspected, were submitted to NMS Labs for thiosulfate analysis. The analytical technique utilized for this work is ion chromatography (IC) and the test, as it specifically relates to the analysis of a blood specimen, is briefly described as follows: specimens first undergo a two- fold dilution using deionized water followed by vortexing and centrifugation. Specimens are passed through an ultrafiltration device and the filtrates transferred to autosampler vials that are crimped with Teflon-lined caps. Identification is based upon retention time (RT) and peak shape (e.g., area to height ratio) as compared to that of calibrators and quality control samples. All analytical work is performed using the technique of standard addition and the final analytical result is reported based upon this calculation. The lower limit of quantification (LLOQ) is 2 mcg/mL.

A review of our testing results revealed ten positive cases where thiosulfate was detected in antemortem and/or postmortem blood specimens. Out of these ten cases, postmortem blood was tested in eight cases while antemortem blood was tested in three cases. It should be noted that one case had both antemortem and postmortem blood submitted for testing. The thiosulfate postmortem blood concentrations in the eight death cases ranged from 2.3 to 100 mcg/mL (average 25 ± 37 mcg/mL, median 7.0 mcg/mL). The three antemortem specimens were positive at a concentration slightly less than the reporting limit of the assay (approximately 1.6 mcg/mL), 5.8 mcg/mL and 17 mcg/mL. The specimen reported at 5.8 mcg/mL was collected from an individual believed to have been chronically exposed to hydrogen sulfide gas in the workplace. The 17 mcg/mL specimen involved the death of an individual where the sample was collected antemortem. As a point of reference, whole blood thiosulfate concentrations in healthy persons are normally less than 0.3 mcg/mL.

Although the majority of the above cases involved suspected occupational exposures to hydrogen sulfide, there was one distinctive case where two commonly used household cleaning products were purposefully mixed together so that hydrogen sulfide gas was generated in an apparent suicide. It was this case where the highest concentration (100 mcg/mL) of thiosulfate was detected.

Even though thiosulfate is not a unique marker of hydrogen sulfide exposure its detection and measurement may aid in the verification of a hydrogen sulfide exposure especially when case history supports the analytical finding.

Thiosulfate, Hydrogen Sulfide, Gas Exposures

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