CASE REPORT

John D. Howard,[1] M.D.; Kristen J. Skogerboe,[2] Ph.D.; Glenn A. Case,[3] B.S.; Vidmantas A. Raisys,[4] Ph.D.; and Emmanuel Q. Lacsina,[1] M.D.

Death Following Accidental Sodium Azide Ingestion

REFERENCE: Howard, J. D., Skogerboe, K. J., Case, G. A., Raisys, V. A., and Lacsina, E. Q.,**"Death Following Accidental Sodium Azide Ingestion,"** *Journal of Forensic Sciences*, JFSCA, Vol. 35, No. 1, Jan. 1990, pp. 193–196.

ABSTRACT: Two college students developed symptoms of poisoning following ingestion of a salt solution during a college physiology laboratory exercise. Symptoms included nausea, vomiting, diarrhea, and altered consciousness. The ingested solution was identified as isotonic buffered saline containing sodium azide in a concentration of 1.0 g/L. The solution was commercially prepared for instrumentation use only and was used inadvertently for the exercise instead of freshly preparing sodium chloride in water. One student drank three sips of the solution and survived. The other student drank 700 to 800 mL and over several days became progressively ill, suffering myocardial damage and cardiac dysrhythmias, and, finally, died. Toxicologic studies confirmed the presence of azide in an antemortem urine sample from the deceased. Sodium azide is an uncommon but potent poison which can cause serious illness and death.

KEYWORDS: toxicology, poisoning, sodium azide

Sodium azide is used as a preservative in many laboratory settings. Azide compounds are also used in the explosives industry. A small number of cases of nonfatal accidental sodium azide poisoning have been reported [*1*,*2*]. These cases involved inadvertent ingestions of estimated 5 to 80 mg of sodium azide. The clinical symptoms and findings in these patients variably included loss of consciousness, chest pain, lowered blood pressure, myocardial ischemia, diarrhea, sweating, incontinence of urine, and headache. Cases of fatal self-administration of sodium azide have been reported [*3*,*4*]. One man who ingested an estimated 10 to 20 g of sodium azide was observed to have metabolic acidosis, cardiac dysrhythmias, decreased cardiac output, hypotension, and pulmonary edema [*5*].

Case Report

A 29-year-old college student and her laboratory partner participated in a physiology laboratory exercise designed to show how the kidney regulates fluid and electrolytes.

Received for publication 4 Nov. 1988; revised manuscript received 21 Feb. 1989; accepted for publication 28 Feb. 1989.

[1] Associate medical examiner and chief medical examiner, respectively, Pierce County, Tacoma, WA.

[2] Senior fellow, Department of Laboratory Medicine, University of Washington, Seattle, WA.

[3] Toxicologist, Washington State Toxicology Laboratory, Seattle, WA.

[4] State toxicologist and Professor, Department of Laboratory Medicine, University of Washington, Seattle, WA.

Working in groups of two, students were to ingest different fluids. The laboratory manual designates the following fluids to be ingested; tap water, "normal saline" (0.9% sodium chloride solution), hypertonic saline, and a bicarbonate solution. Urine samples were to be examined before and after ingestion of the various fluids.

The two women students were to ingest the "normal saline." One student took 3 sips of the fluid and declined to continue, complaining of a bad taste. The 29-year-old student drank 4 containers of the fluid, totaling 700 to 800 mL. Within 5 min of the ingestion, both students developed nausea and altered consciousness with confusion, followed by vomiting and diarrhea. The 29-year-old student remained in the laboratory with continuing symptoms. The other student left the laboratory and was found collapsed in a nearby restroom. Her symptoms diminished with time, and she has survived the incident without apparent sequelae.

The 29-year-old woman's symptoms persisted. She was initially observed at the school, later seen at an urgent-care medical clinic, and then referred to a nearby hospital. She was admitted for observation approximately 3½ h following the ingestion. Sodium azide exposure was apparently not known by the hospital at the time of admission. Routine laboratory test results were within normal limits. She was later discharged to home.

Her generalized symptoms continued and worsened over two days, and she presented to a second hospital near her home with chest pain. Medical evaluation revealed evidence of heart failure, and she was transferred emergently to a third hospital in a nearby city. During the hours before death she had sporadically changing cardiac dysrhythmias, including premature ventricular and atrial contractions, sinus tachycardia, and runs of ventricular tachycardia. Electrocardiographs revealed elevated ST segments. Cardiac catheterization and angiography were performed, revealing normal coronary artery studies and marked hypokinesis of the left ventricle, most prominent in the anterior wall. Seizure activity, hypotension, and respiratory distress were observed. Despite medical efforts, her condition deteriorated and she died approximately 3½ days following the ingestion.

Case Investigation

Investigation into the circumstances surrounding the ingestion and the death revealed that the ingested solution was not "normal saline" but a commercially prepared solution intended for instrumentation use only. The solution contained sodium azide. It was determined that the solution used was contained in a 20-L box in the chemical stock room of the college. It was also determined that the laboratory technician preparing the solutions for the laboratory exercise used the stock commercial product instead of freshly preparing sodium chloride in water to the correct concentration as directed. It appears that the technician was unaware of the danger of using this solution and thought that it would be appropriate for substitution of the "normal saline." The stock box is labeled "isotonic buffered saline, for in-vitro diagnostic use, diluent for blood cell counting and sizing." The reactive ingredients are listed as sodium chloride (8 g/L), potassium chloride (0.38 g/L), and sodium azide (1.0 g/L). A warning is present on the label regarding the possibility of formation of explosive compounds with plumbing. There is no warning against ingestion.

Only the two students who were to ingest the "normal saline" and were therefore exposed to the sodium azide developed symptoms. A drug screen performed on the solution gave negative results. Chemical analysis of the solution confirmed the presence of sodium azide in an amount as labeled. The solution was also analyzed for the presence of cyanide, with negative results.

Autopsy Findings

Autopsy revealed a normally developed adult female with evidences of medical therapy. The deceased was 5 ft 4 in. (162.5 cm) in height and weighed 115 lbs (52 kg). The internal organs were all normally formed and showed vascular congestion diffusely. Other than the heart there were no specific anatomic alterations.

The heart weighed 325 g. The coronary arteries pursued normal courses and were widely patent. There were no thrombi. No developmental anomalies were identified. The myocardium was diffusely pale and soft, predominantly in the anterior and lateral left ventricular wall. Some congestion was visible in the posterior wall of the left ventricle. Microscopic examination of the myocardium revealed areas of nonspecific interstitial edema and foci of myocardial necrosis.

Toxicological Findings

Antemortem urine and blood samples from the initial hospitalization were retrieved by the Medical Examiner's Office and were submitted to the State Toxicology Laboratory for further studies. A drug screen of the blood yielded negative results. Urine glucose (250 mg/dL) and ketones (50 mg/dL) were detected. The corresponding blood glucose was 147 mg/dL.

The urine was tested for the presence of azide. The high-performance liquid chromatographic (HPLC) method of Swarin and Waloo [*6*] was adopted for confirmation due to a reported sensitivity for sodium azide in the nanogram range. A linear calibration curve was constructed by injecting aqueous sodium azide standards and using linear regression analysis. Two separate aliquots of the victim's urine were analyzed, and azide was detected at a calculated mean concentration of 135 ng/mL. Six other urine samples which had been submitted to the toxicology laboratory for drug screens were also analyzed and found to contain no detectable azide, or interferents. The detection limit of sodium azide from this analysis was estimated to be 10 ng/mL. The recovery of a 120 ng/mL azide standard prepared in blank urine was found to be 104%.

Discussion

Sodium azide is a poison with both accidental and apparent intentional ingestions being previously reported. The toxic mechanisms of sodium azide are similar to that of cyanide with impairment of cellular oxidative phosphorylation by interference with cytochrome oxidase [*7,8*]. As with cyanide, other cellular enzyme systems appear also to be inhibited [*9*]. While a systemic poison, sodium azide appears to have particularly adverse effects on the myocardium. In the case reported, death was attributed to toxic cardiomyopathy as a result of sodium azide poisoning and the manner of death was classified as accident.

Sodium azide continues to be used by many laboratories. Other laboratories have discontinued the use of sodium azide containing solutions because of the hazard of explosive compound formation when disposed of through metal plumbing. Outdated solutions may still be stored by laboratories due to the problems with disposal. The toxicity of sodium azide solutions particularly in the described concentration may not be fully appreciated, and specific warnings against ingestion may not be present. Sodium azide should be considered and handled as a toxic compound which is potentially lethal. An HPLC method for sodium azide analysis in body fluids can be used with instrumentation available to most toxicology laboratories. The possibility of sodium azide poisoning should be considered when investigating illness or death related to a laboratory setting.

Acknowledgments

The authors wish to thank the Seattle Laboratory of the Food and Drug Administration for their cooperation and expertise in the analysis of the solution and Dr. Corinne Fligner and Marty Jones for their assistance with the preparation of the manuscript.

References

[1] Richardson, S. C. N., Giles, C., and Swan, C. H. J., "Two Cases of Sodium Azide Poisoning by Accidental Ingestion of Isoton," *Journal of Clinical Pathology*, Vol. 28, No. 5, May 1975, pp. 350–351.

[2] Pedmons, O. and Bourne, M. S., "Sodium Azide Poisoning in Five Laboratory Technicians," *British Journal of Industrial Medicine*, Vol. 39, 1982, pp. 308–309.

[3] Kozlicka-Gasdzinska, H. and Brizyski, J., "A Case of Fatal Intoxication with Sodium Azide," *Archives for Toxikologie*, Vol. 22, 1966, pp. 160–163.

[4] Emmett, E. A. and Ricking, J. A., "Fatal Self Administration of Sodium Azide," *Annals of Internal Medicine*, Vol. 83, 1975, pp. 224–321.

[5] Albertson, T. E., Reed, S., and Siefkin, A., "A Case of Fatal Sodium Azide Ingestion," *Clinical Toxicology*, Vol. 24, No. 4, 1986, pp. 339–351.

[6] Swarin, S. J. and Waldo, R. A., "Liquid Chromatographic Determination of Azide as the 3-5-Dinitrobenzoyl Derivative," *Journal of Liquid Chromatography*, Vol. 5, No. 4, 1982, pp. 597–604.

[7] Graham, J. D. P., "Actions of Sodium Azide," *British Journal of Pharmacology*, Vol. 4, 1949, pp. 1–6.

[8] Foulkes, E. C. and Lemberg, R., "The Azide Inhibition of Catalase," *Enzymologia*, Vol. 13, 1949, pp. 302–312.

[9] Robertson, H. E. and Boyer, P. D., "The Effect of Azide on Phosphorylation Accompanying Electron Transport and Glycolysis," *Journal of Biological Chemistry*, Vol. 214, 1955, pp. 295–305.

Address requests for reprints or additional information to
John D. Howard, M.D.
Associate Medical Examiner
3629 South D St.
Tacoma, WA 98408