CASE REPORT

Valerie J. Rao,[1] *M.D. and William Lee Hearn,*[2] *Ph.D.*

Death from Pool Chlorine—An Unusual Case

REFERENCE: Rao, V. J. and Hearn, W. L., **"Death from Pool Chlorine—An Unusual Case,"** *Journal of Forensic Sciences,* JFSCA, Vol. 33, No. 3, May 1988, pp. 812-815.

ABSTRACT: A tank truck containing bulk pool chlorinating solution overturned. A man was trapped beneath the truck, and a ruptured seam in the tank released a continuous flow of sodium hypochlorite over him. He survived for 10 min as the caustic solution extensively eroded soft tissue exposed to the chemical flow.

KEYWORDS: pathology and biology, sodium hypochlorite, death, sodium hydroxide, chlorine, corrosive

The lay public is for the most part unaware of the hazardous properties of products containing sodium hypochlorite, or household bleach. Although bleach is widely recognized as toxic by oral ingestion, injury or death may also result from inhaling the fumes (chlorine, hypochlorous acid, or chloramine) released upon mixing household bleach with other cleaning agents [*1-3*]. The material safety data sheet on sodium hypochlorite lists the toxic effects on skin as causing reddening with skin damage and severe irritation to the eyes and mucous membranes [*4*]. Recently, the Dade County Medical Examiner Department investigated a death resulting from cutaneous exposure to a high concentration of sodium hypochlorite sold as "pool chlorine." The effects seen in this particular case are extreme because of the concentration of the chemical involved, and the extended period of chemical exposure.

Case Report

The victim was a 29-year-old white male who had a dispute with a pool chlorine delivery truck driver. During the altercation, he jumped onto the driver's side of the truck and smashed out the window in an attempt to get at the driver. The driver, fearing for his life, drove the vehicle at top speed down the street in an effort to get the assailant off the vehicle. While making a sharp right turn at a major intersection, the truck overturned. The victim either jumped or was thrown off the vehicle. He fell to the street and was partially pinned under the tank in a prone position (Figs. 1 and 2). A seam in the tank above the victim ruptured. According to eyewitness estimates, the sodium hypochlorite solution poured onto the victim at the rate of 5 gal/min, dousing his lower extremities and pooling on either side of

Received for publication 29 June 1987; accepted for publication 14 July 1987.

[1]Associate medical examiner, Dade County Medical Examiner Department, and clinical assistant professor of pathology, Department of Pathology, University of Miami School of Medicine, Miami, FL.

[2]Laboratory director, Dade County Medical Examiner Department, Miami, FL.

FIG. 1—*Deceased pinned under tank carrying "pool chlorine."*

FIG. 2—*Close up of deceased pinned under tank.*

his torso. He was heard to cry out for help stating that his skin was burning. Rescue personnel could not extricate him from beneath the tank, and so they attempted to dilute the chemical with water. He nonetheless died about 10 min after the tanker overturned.

The chlorine fumes were so irritating to the eyes that an adequate examination of the deceased could not be carried out at the scene. Gas masks, however, afforded protection to the rescue personnel who ultimately maneuvered the deceased person from where he was pinned.

Rescue personnel who responded to the scene at the time the deceased was still alive stated that they observed the soft tissue of the left leg was continuously eroded, exposing the left femoral shaft. The eroded area gradually enlarged while the victim was still alive. This

chemical erosion of the soft tissue continued after death, and at the time of autopsy, the soft tissue damage was extensive (Fig. 3).

The left femoral shaft and tibia were totally denuded of soft tissue and bleached. The soft tissue margins were finely scalloped at the continually eroding edges. Areas of skin that were minimally exposed to the chemical spill had tiny pits (Fig. 4). More exposure resulted in skin splitting and subcutaneous fat and skeletal muscle erosion. Finally, the long bones were exposed and bleached.

The esophageal, tracheal, and laryngeal mucosa were hyperemic but not eroded. Microscopically, these tissues had mucosal denudation but no acute inflammatory response. Microscopic examination of the involved skin and soft tissue disclosed no vital reaction. The

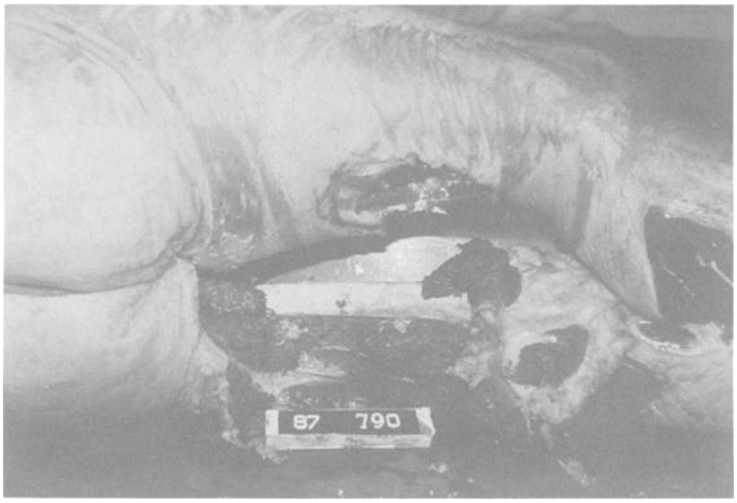

FIG. 3—*Extensive exposure of left femoral shaft, secondary to chemical injury.*

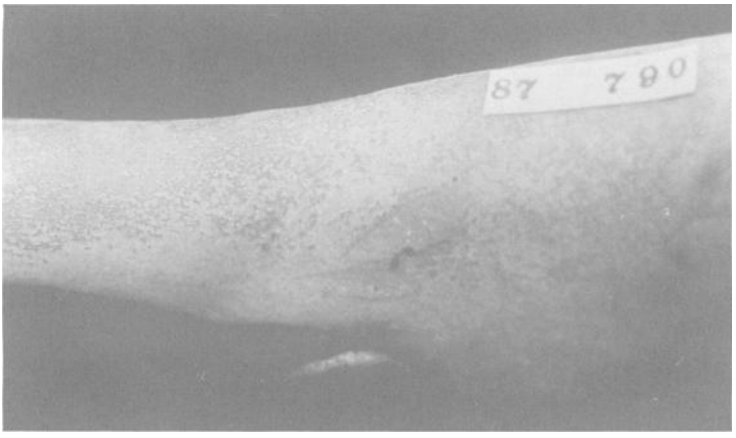

FIG. 4—*Pitted areas of skin subsequent to chemical injury.*

deceased also suffered a hairline skull fracture sustained as he fell to the street. The cause of death was listed as blunt head trauma associated with chemical injury.

The bizarre behavior of the victim before the tanker overturning was attributed to his intoxicated state. His blood alcohol concentration was 0.11 g/dL and his blood cocaine concentration was 0.12 mg/L. Swabs and gas samples from the trachea were tested for oxidizing substances (namely, chlorine) by potassium iodide—starch spot test with negative results. The pH of the bronchial mucosa was physiologically normal.

Discussion

Pool chlorinating solution is a concentrated concoction of sodium hypochlorite prepared by adding chlorine to a 14% (3.5*M*) solution of sodium hydroxide. The resulting solution contains approximately 10% by weight sodium hypochlorite and excess sodium hydroxide to maintain its stability. According to the manufacturer, the solution has a pH between 13.2 and 13.5. Thus, it combines the hydrolytic activity of sodium hydroxide toward fats and proteins with the strong oxidizing potential of the hypochlorite. Mack [5] states that a pH in excess of 12.5 is required to produce esophageal ulceration; a similar relationship of pH to corrosive effect appears to exist for skin and other soft tissues. Household liquid bleach, which has negligible corrosive effect on soft tissues, is also composed of sodium hypochlorite and sodium hydroxide but its concentration is 3 to 6% and its pH is approximately 11. Therefore, it is to be expected that pool chlorinating solution is considerably more corrosive to soft tissues than bleach. In spite of this corrosive potential, its widespread use in pool maintenance rarely occasions serious injury, probably because skin exposure is limited both in contact area and in duration. The extensive soft tissue injury which occurred in this case can be attributed to the victim's inability to escape the continuous flow of the toxic solution over his body.

Bleach has been used by forensic pathologists as a method to denude partially skeletonized postmortem remains of adherent soft tissue. A search through the forensic science literature has not revealed any published data as to the preferred concentration of sodium hypochlorite, nor time exposure, required to achieve complete skeletonization of the remains. The above case history demonstrates the same strong corrosive action of pool chlorinating solution on living soft tissue.

References

[1] Reisz, G. R. and Gammon, R. S., "Toxic Pneumonitis from Mixing Household Cleaners," *Chest*, Vol. 89, No. 1, Jan. 1986, pp. 49-52.

[2] Dreisbach, R. H., *Handbook of Poisoning*, 8th ed., Lang Medical Publications, Los Altos, CA, 1974, p. 251.

[3] Arena, J. M. and Drew, R. H., *Poisoning: Toxicology, Symptoms, Treatments*, 5th ed., Charles C Thomas, Springfield, IL, 1986, pp. 298-299, 692.

[4] "Material Safety Data Sheet: Sodium Hypochlorite," The Chlorine Institute, New York, May 1982.

[5] Mack, R. B., "Some Non-Caustic Remarks About Bleach," *North Carolina Medical Journal*, Vol. 44, No. 4, April 1983, p. 221.

Address requests for reprints or additional information to
Valerie J. Rao, M.D.
Metropolitan Dade County Medical Examiner Department
1050 N.W. 19th St.
Miami, FL 33136