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Methemoglobinemia Following Unintentional Ingestion of Sodium Nitrite --- New York, 2002

Methemoglobinemia is an unusual and potentially fatal condition in which hemoglobin is oxidized to methemoglobin and loses its ability to bind and transport oxygen. The most common cause of methemoglobinemia is the ingestion or inhalation of oxidizing agents such as nitrates or nitrites (e.g., sodium nitrite, which is used commonly as a preservative in curing meats and fish). This report summarizes the investigation of an incident of methemoglobinemia in five members of a household in New York who became ill after eating a meal seasoned with a white crystalline substance from a plastic bag labeled "Refined Iodized Table Salt" (Figure). The findings underscore the need for proper storage of hazardous materials to avoid unintentional ingestion and the importance of collaboration by multiple agencies to address a potential public health emergency.

On May 16, 2002, Yonkers, New York, emergency personnel were called to a household in which five adults of Middle Eastern descent (three men aged 40, 43, and 44 years and two women aged 60 and 29 years) reported symptoms of dizziness, lightheadedness, and cyanosis almost immediately after sharing a meal. Two of the men also reported vomiting. A sixth person, a man aged 21 years, who did not eat the meal, was asymptomatic.

Case Report

On arrival, the first responders found the younger woman unresponsive; all others were awake and alert. En route to the hospital, both women had progressive respiratory distress and loss of consciousness and were intubated; the older woman began having seizures. On arrival at the emergency department (ED), the five persons were markedly cyanotic and had oxygen saturation levels by pulse oximetry of 72%--96% (normal: ≥92%) (Table). Blood drawn for routine testing was described as "black colored." Empiric therapy with methylene blue was initiated for suspected methemoglobinemia after consultation with a poison control center. Subsequently, the patients were found to have extremely high methemoglobin levels (range: 21.1%--87.0%) (normal: 1%--3%) (Table).

Within 10--15 minutes after administration of methylene blue, cyanosis resolved and oxygenation improved. After therapy, the three men became asymptomatic, and the two women continued to require ventilatory support; the younger woman did not regain consciousness immediately. After overnight observation, the three men were discharged. The older woman was extubated on May 18, and the younger woman was extubated on May 20; all patients recovered completely.

Epidemiologic Investigation

Initial reports indicated that first responders and ED personnel had developed a rash following contact with the patients. Although these reports were found later to be erroneous, emergency hazardous materials procedures were implemented at both the apartment building and the ED until ambient testing of the building confirmed the absence of chemical or biologic agents and clinical laboratory testing confirmed the diagnosis of methemoglobinemia. Because of heightened awareness for potential terrorist events and intelligence information about the disappearance of a shipment of cyanide in Mexico (sodium nitrite is used as an antidote by persons handling sodium cyanide), local and federal law enforcement organizations also investigated the incident for potential criminal activity. Both health department and law enforcement staff interviewed the patients during the investigation.

The implicated meal consisted of meat, rice, and vegetables. The meat was purchased on May 15, 2002, from a national discount food warehouse. It was boiled in water to which was added a white crystalline substance from a plastic bag labeled "Refined Iodized Table Salt" in both English and Arabic. Herbs were added to the water, which was subsequently used to make the rice and vegetables. Samples of all residual food items from the implicated meal were obtained for analysis, including all herbs, the product labeled as salt, and spices found in the kitchen and samples of the remaining uncooked meat, which had been frozen. Samples of meat from the same lot number from the store at which it was purchased also were obtained. Finally, prescription drugs found in the home were collected for testing. All samples were sent to the Food and Drug Administration (FDA) for testing, including specific tests for nitrites, cyanide, arsenic, and select hydrocarbons.

Sale of the meat was suspended voluntarily during the investigation, and the store cooperated with the health department in determining the origin of the meat and identifying other customers who had purchased the same lot number of meat. Those customers were contacted; none reported any symptoms following consumption.

Within 48 hours of onset of illness, FDA laboratory testing confirmed the presence of sodium nitrite in all three foods eaten by the group. The meat contained 3,134 parts per million (ppm), the rice 18,792 ppm, and the vegetables 7,440 ppm (upper limits of normal: 1,000--2,000 ppm; acceptable levels in smoked fish: 200 ppm). The substance in the plastic bag labeled "Refined Iodized Table Salt" contained 100% sodium nitrite. Remaining uncooked meat from the household and from the same lot number from the store had negligible levels of sodium nitrite.

On determining that a product available commercially and labeled as table salt might have contained sodium nitrite, the local health department, police, and FDA canvassed area stores to find and remove similar bags marked as iodized table salt, and an education campaign was initiated to alert the public and prevent the use of this product. FDA investigators also searched national and international records to determine the origin of the product labeled as salt and whether it had been imported into the United States. Although the original source of this product was traced to a foreign country, no records of importation into the United States were identified by FDA.

Further interviews with the patients found that they had moved recently from another residence to the apartment in which they ate the meal. During the move, two of the patients packed food items from the previous residence to use in the new apartment, including the bag labeled as iodized table salt. None could remember purchasing the bag. However, several recalled that another tenant of the initial residence had been involved in curing meats and returned to his country of origin several months earlier. Law enforcement personnel contacted this person and ascertained that he had used sodium nitrite in preserving meat and transferred a portion to the bag labeled as table salt for storage.

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Editorial Note:

Methemoglobin is produced when ferrous iron is oxidized to ferric iron within a hemoglobin molecule, an effect that inhibits the binding and delivery of oxygen by a red blood cell (*1*). Methemoglobinemia occurs when excessive oxidative stress produces methemoglobin at a rate that overwhelms the body's capacity to reduce it through enzyme systems (e.g., nicotinamide adenine dinucleotide [NADH] methemoglobin reductase). Methemoglobinemia is acquired most commonly after ingestion or inhalation of an oxidizing agent, such as nitrates or nitrites.

Sodium nitrate and sodium nitrite are used for their antimicrobial effects to preserve and cure meat, fish, and certain cheeses. They also are used commercially to prevent corrosion of pipes. Epidemics of methemoglobinemia have been associated with drinking water from sodium nitrite--contaminated tanks and pipes (*2*). Well water contaminated by nitrogenous fertilizer run-off is an important cause of nitrate-induced methemoglobinemia (*3*--*6*).

Methemoglobinemia should be suspected in patients presenting with cyanosis that does not improve with supplemental oxygen. Oxygen saturation is not measured accurately by conventional pulse oximetry in the presence of methemoglobinemia and appears relatively normal even when PaO_2 is decreased markedly. The blood of victims is described as "chocolate brown" or otherwise atypical in color and does not redden with exposure to air. Although cyanide and carbon monoxide poisoning are included in the differential diagnosis of agents causing respiratory distress and altered mental status, they do not cause cyanosis. Cyanosis and chocolate-brown blood develop when methemoglobin concentrations reach approximately 15%--20%. Symptoms typical of hypoxia (e.g., dyspnea, weakness, headache, metabolic acidosis, seizures, and coma) occur with progressively rising levels of methemoglobin.

Because of the acute and dramatic nature of illness onset, early reports of potential contamination of first responders, and law enforcement intelligence reports of the disappearance of a shipment of sodium cyanide, local and federal agencies were mobilized to address a possible biologic/ chemical incident. Although environmental testing ruled out ambient chemical exposure and medical evaluation and epidemiologic evidence excluded a biologic agent, the cause of the poisoning remained unknown. Further collaboration between local and federal agencies and the store in which the meat was purchased allowed investigators to rule out a widely distributed commercial product and to allay public fears. Within 48 hours of the onset of illness, widespread and rapid testing of food and products indicated that the contamination and exposure were limited to a single household. Further investigation indicated that this incident was associated not with criminal activity but rather with improper storage and inadvertent ingestion of sodium nitrite.

This incident highlights the need to store and label potentially hazardous materials properly to avoid unintentional ingestion and the importance of an ongoing working relation among multiple agencies and organizations in the effective and timely response to a potential public health threat.

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Table

TABLE. Admission laboratory values for five patients with methemoglobinemia — New York, 2002

Patient	Methemoglobin (% total hemoglobin)	PO_2 (mmHg)	FiO_2	O_2 Saturation (%)
Male, aged 43 yrs	21.1	NA*	100% (nonrebreather mask)	NA
Male, aged 40 yrs	62.0	389	100% (nonrebreather mask)	82
Male, aged 44 yrs	49.5	133	100% (nonrebreather mask)	96
Female, aged 60 yrs	72.7	136	100% (ventilator)	72
Female, aged 29 yrs	87.0	86	50% (ventilator)	NA

* Not available

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Figure

FIGURE. Bag containing sodium nitrite (labeled "Refined Iodized Table Salt")

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