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Case Report

Chlorobenzylidenemalonitrile Gas Exposure from A Novelty Personal-Protection Gun

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ABSTRACT

We present an unusual case of chlorobenzylidenemalonitrile (CS) tear-gas exposure from the unwitting discharge of a personal-protection handgun loaded with CS gas. The gun was in a bag of toys purchased from a local thrift store and was discharged by a child. The responding paramedic presumptively identified the substance as CS based solely on personal experience. This recognition led to suboptimal field management of the incident with the paramedic failing to follow the standard operating procedures for an unknown chemical exposure. As this was a benign agent, there were no serious consequences. This case highlights the pre-hospital and emergency department challenges associated with the management of an unknown chemical exposure and the potential consequences if the chemical is a toxic substance. A methodical approach following established protocols can reduce the potential for negative outcomes. Review of the literature found no other report of CS gas exposure from such a personal-protection weapon.

Case Description

A bag of assorted toys was purchased at a local thrift store for six children of a household. Upon arriving at their home, the children opened the toys and played with them. One item (Fig. 1, 2, 3) was a small, gun-like object. One of the boys pointed it at another child and pulled the trigger. They reported hearing a loud pop and seeing a red cloud of smoke shoot out of the gun and believed that this discharge hit the second child's rear thigh area. Occupants of the house immediately began to cough and choke. An adult

caretaker rushed the children out of the house and immediately called 911. A call identifying "four people burned by fireworks" was entered into the 911 system. This information was relayed to the private, contracted ambulance-service communications center, and a paramedic unit (EMT-P/EMT) was dispatched with only that information. The description of the event, the patients' signs and symptoms, and military experience with CS gas led the responding paramedic to believe that the patients had been exposed to CS. He decided that field decontamination of the patients was therefore unnecessary. Without making radio contact, paramedics transported the patients to the Emergency Department (ED) of Kern Medical Center, a 150-bed county teaching hospital and Level II trauma center. The first hospital notification regarding the patients was made when the paramedic field supervisor walked into the physicians' charting area of the ED and stated there was a paramedic unit outside the ED with seven patients who had been exposed to "CNS Gas."



Figure 1. CS emitting personal-protection weapon with barrel detached.



Figure 2. CS emitting personal-protection weapon assembled.

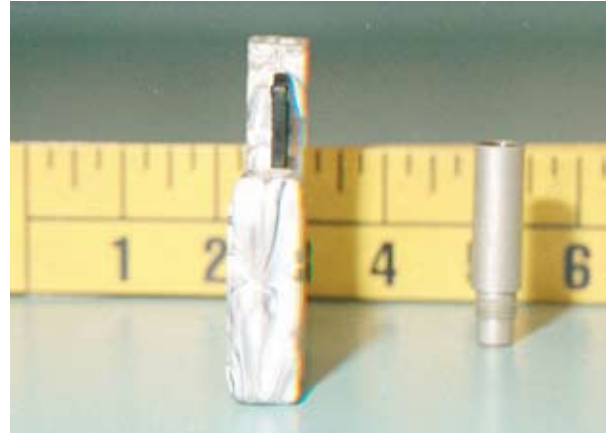


Figure 3. CS emitting personal-protection weapon bottom view.

Taking care to avoid contamination, an ED physician made a rapid visual assessment of the situation. Inside the ambulance were the transporting paramedic and seven patients (one adult and six children). Fifteen minutes after the initial exposure, the patients inside the ambulance appeared to be otherwise stable and asymptomatic, except for coughing and profuse tearing. The transporting paramedic said that based on prior military experience he believed the agent was CS gas. The patients and the paramedic were maintained in isolation in the ambulance for approximately 10 minutes while protective clothing was gathered and decontamination equipment was prepared. The patients and paramedic were directed into the ED decontamination area and decontaminated by ED staff wearing protective clothing consisting of fluid-resistant gowns, latex gloves, and surgical masks with face shields. Each patient was disrobed and copiously washed in the decontamination shower. The ED staff reported no symptoms.

The patients were observed in the ED for four hours and expressed no further symptoms. During that time, sheriff investigators inspected the device and found the stamped identifier "ACS-11." A sheriff firearms expert determined that this was likely an identifier of the active agent, CS gas. Because this identification was consistent with the observed symptoms, the patients were subsequently discharged in satisfactory condition with a diagnosis of acute CS gas exposure.

DISCUSSION

Evaluation of this case illustrates some educational points regarding management of toxic exposures. Although some procedures were performed well, including the prevention of ED contamination and secondary contamination

of ED personnel, other elements of care and evaluation could be improved. We believe there was insufficient initial field identification of the agent, failure to request a hazardous materials (HAZMAT) response, failure to decontaminate patients before transport, secondary contamination of ambulance and paramedic, and inadequate hospital notification regarding the incident and patients.

This case also provides an opportunity to review the physical properties and biological effects of CS, as well as highlighting an uncommon device for its release. CS is commonly known as tear gas and is classified as a lacrimator agent. Developed in 1928, it is more potent and less toxic than chloracetophenone (CN). It was used in World War I (WWI) by the U.S. military and still available on the civilian market as "mace." In 1958, CS began to be used as the primary riot-control agent by the U.S. military and civilian law enforcement agencies.

Chemically, CS is a flammable white crystalline solid with a melting point of 93 degrees Celsius. It has a low vapor pressure and is heavier than air when in its gaseous state. CS is poorly water soluble but readily soluble on organic solvents. It is a SN_2 alkylator that acts at nucleophilic sites via unclear mechanisms, but may involve the inactivation of enzymes such as lactic dehydrogenase and the pyruvate decarboxylase system.

CS is noted to have a pepper-like aroma. Direct skin contact with CS causes irritation with complications that include contact dermatitis, bronchospasm, and direct pulmonary damage. Treatment of acute exposure consists of removal from further contamination and copious irrigation with water. Although noxious, most exposures to CS are relatively benign. Symptoms rapidly resolve once exposure stops.^{1,2,3}

Early and accurate identification of the offending agent is key to the optimal management of a HAZMAT incident. In traditional HAZMAT response, one operational tenet is to use

multiple sources of identification and reference, if possible, before developing a definitive action plan. References could include the U.S. Department of Transportation Emergency Response Guidebook, commercial packaging, manufacturer safety data sheets (MSDS), shipping invoices, vehicle placards, and computerized databases. As in this case, a chemical release without a readily marked container is not well suited to identification by these sources and the use of past personal experience can be valuable; however, it should not be the only resource used to make definitive management decisions. In retrospect, the field paramedic was correct in the identification of the offending agent. However, it was this confidence in the identification of CS that resulted in some of the poor decontamination decisions made.

While waiting for a fire department HAZMAT response to arrive, it would have been appropriate to make initial management decisions based on the paramedic's past experience-based presumptive identification of CS by directing patients into a well-ventilated area, initiating gross self-decontamination, and establishing communications with the receiving ED to prepare for multiple symptomatic patients from chemical exposure. Upon arrival of police, fire or HAZMAT, more detailed situation assessment and substance identification could have been performed. If this was determined to be a more toxic agent, then appropriate decontamination activities in accordance with U.S. Federal HAZMAT guidelines and response recommendations could have been undertaken.^{4,5} If the paramedic's identification of CS was indeed correct, the HAZMAT response could then have been downgraded to an appropriate level. As this was a relatively benign exposure, time was available for adequate field decontamination of the patients prior to placing them into an ambulance, thereby avoiding secondary contamination of the ambulance and paramedic.

Regardless of whether the paramedic's identification of the chemical agent was correct or not, multiple symptomatic patients contaminated by a noxious and potentially toxic agent were placed in a clean ambulance without being decontaminated first, and transported. The result was a now-contaminated ambulance and further off-gassing of the noxious agent into the enclosed environment of the ambulance, prolonging symptoms and increasing the likelihood of an adverse outcome. The paramedic violated an important rule of HAZMAT response: not to become another victim. Fortunately, time and ventilation of the ambulance and the paramedic were enough to decontaminate both.

Initiation of a HAZMAT response also would have prevented the lapse in communication with the ED regarding the ongoing incident and transport of chemically exposed patients by activating the Kern County Med-Alert System. During a Med-Alert, a Kern County EMS Department

EMS coordinator would provide oversight of Medical/EMS operations for the incident, notify and communicate with affected hospitals, assess resource needs, and coordinate transport of patients from the scene. Even if a Med-Alert was not activated as in this case, transport of seven patients in one ambulance alone would be sufficient cause for hospital notification prior to ambulance arrival. Adding a chemical exposure to the scenario should make this communication mandatory. If there are concerns about making the notification via radio because transmitted information can be intercepted by radio scanners, then communicating by telephone should be considered. Regardless of field decontamination, early hospital notification is essential to allow the ED staff time to prepare to receive contaminated and/or symptomatic patients and set up for initial or secondary decontamination, if necessary.

This emergency department is typical of any medium-sized community ED. Our capacity for dealing with contaminated HAZMAT patients, whether criminal or accidental, is limited. At the time of this case the only available personal protective equipment (PPE) was Level D: fluid-resistant gowns, surgical masks with splash shield, and shoe covers. The decontamination equipment consisted of a decon shower room located adjacent to the ambulance entrance of the ED capable of decontaminating two ambulatory patients or one non-ambulatory patient at a time. The need for additional equipment would have to be met by requests for assistance from the fire department. After the initial physician assessment in the ED ambulance bay, it was clear that the paramedic supervisor had misspoken when he stated that the patients were exposed to "CNS Gas" and that CS or a similar agent was more likely based on signs, symptoms, and time frame. Therefore, it was believed that the Level D PPE would be acceptable for assisted decon activities. Since this incident, a limited number of Level C PPE suits and portable decon showers have been procured through Homeland Security-related grants.

While advance notification provides time for the receiving ED physician to assess the level of protection appropriate for the situation, as in this case, such advanced warning is not always provided. Neither would it be expected if chemically contaminated patients bypassed the EMS system and arrived by private vehicles. Therefore, EDs must be able to effectively and efficiently respond to such events with minimal advanced notification. One of the benefits of the attention being paid to chemical terrorism with equipment and training for hospitals is that it can improve preparedness for non-terrorism related chemical incidents, as in this case, for Kern Medical Center.

The consequence of inadequate advance ED notification and lack of proper protective equipment can be severe. Although an extreme case, the Tokyo subway sarin attack provides an illustration of the risk.⁶ According to Nozaki et al., of the 15 doctors treating patients exposed to

sarin in Tokyo, 13 (86.6%) reported symptoms as a result of the resuscitation of just two victims. Of those treating physicians, six (40%) required treatment. Initial treatment was rendered without any advance warning about sarin being the causative agent, and no special protective clothing and equipment were used.⁷

Another unusual aspect of this case is the delivery vehicle of the CS. Although no malicious intent was ever proven in this case, it appears that a personal-protective device was somehow inadvertently mixed with donated children's toys. After lengthy discussions with officials investigating this case it was learned that this particular type of weapon was commonly marketed more than 20 years ago as a personal-protection device (unpublished personal communication, Kern County Sheriff's Department; Kern County, California). According to these investigators, special interest magazines in the "detective," "soldier-of-fortune," and "spy" genre commonly carried advertisements for such weapons. After extensive internet searches (keywords: gun, CS, teargas, personal protection) and inquiries to federal firearms experts (unpublished correspondence, Federal Law Enforcement Training Center, U.S. Treasury Department), no current sources of such weapons (excluding standard police and military riot control devices) could be found.

CONCLUSIONS

A multitude of chemical agents, such as household chemicals, industrial materials, agricultural pesticides, law enforcement chemical agents (such as CS and pepper spray), and chemical terrorism may result in toxic exposures. The case presented here illustrates how a seemingly innocuous item can cause a toxic exposure with multiple symptomatic patients. It is important to maintain a high index of suspicion when evaluating any potential toxic exposure. In cases of known or suspected toxic exposures, existing guidelines recommend identification of the toxic agent, early notification to the receiving ED, use of personal protective

equipment and adequate decontamination. While in this case several pre-hospital system failures allowed for the transportation of chemically contaminated patients to an ED without notification prior to their arrival, it is functionally similar to the unannounced arrival of contaminated patients arriving by private transportation, a scenario every ED must be able to handle. It is in everyone's best interest to adhere to strict isolation, decontamination, and protective clothing/equipment procedures. Failure to do so can place us all at risk: emergency responders, emergency department and hospital personnel, and the community at large.

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