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Challenges During a Chlorine Gas Emergency Response

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Abstract

Objective: A chlorine gas release occurred at a poultry processing plant as a result of an accidental mixing of sodium hypochlorite and an acidic antimicrobial treatment. We evaluated the public health and emergency medical services response and developed and disseminated public health recommendations to limit the impact of future incidents.

Methods: We conducted key informant interviews with the state health department; local fire, emergency medical services, and police departments; county emergency management; and representatives from area hospitals to understand the response mechanisms employed for this incident.

Results: After being exposed to an estimated 40-pound chlorine gas release, 170 workers were triaged on the scene and sent to 5 area hospitals. Each hospital redistributed staff or called in extra staff (eg, physicians, nurses, and respiratory therapists) in response to the event. Interviews with hospital staff emphasized the need for improved communication with responders at the scene of a chemical incident.

Conclusions: While responding, hospitals handled the patient surge without outside assistance because of effective planning, training, and drilling. The investigation highlighted that greater interagency communication can play an important role in ensuring that chemical incident patients are managed and treated in a timely manner.

Keywords

chlorine; chemical release; emergency response; hospital response

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In June 2011 at approximately 0900 in the southern United States, an estimated 40 pounds of chlorine gas was released inside a poultry processing plant. The release resulted from an accidental mixing of sodium hypochlorite and FreshFX (SteriFX, Shreveport, LA), a US Department of Agriculture–approved antimicrobial treatment comprising a combination of acids. At the time of the incident, approximately 600 workers, who primarily spoke Spanish or Marshallese, were present in the plant. The release resulted in a complete evacuation of the plant.

Chlorine (Cl_2) is a greenish-yellow gas that is heavier than air and has a pungent, irritating odor.¹ Given that it is moderately water-soluble, chlorine gas produces hypochlorous and hypochloric acids when it contacts moist tissues, such as the eyes, throat, and lungs, and can damage these tissues. The health effects include acute inflammation of the conjunctiva, nasal mucosa, pharynx, larynx, trachea, and bronchi, in addition to wheezing and dyspnea. Chlorine's effects depend on its concentration, as well as other factors affecting the exposure dose such as the duration of exposure and the water content of the tissue involved.^{2,3}

After the chlorine release occurred, the state health department worked with the Assessment of Chemical Exposures (ACE) program⁴ at the Centers for Disease Control and Prevention Agency for Toxic Substances and Disease Registry to evaluate the incident. The ACE program is a component of the National Toxic Substance Incidents Program,⁵ which includes state-based and national surveillance of toxic substance incidents, in addition to the ACE investigations after large-scale toxic releases.

The objectives of this investigation were to (1) evaluate the public health and emergency medical services (EMS) response and (2) develop and disseminate public health recommendations to improve preparedness to limit the impact of future incidents. Concurrently, colleagues at the National Institute for Occupational Safety and Health conducted an investigation at the plant.⁶

METHODS

Key informant interviews were conducted with staff from the state health department, fire/EMS, county emergency management, and local police to understand all response-related activities. The interviews were designed to provide an in-depth description of the incident, roles during the response efforts, and event-related issues. Structured interviews were also conducted with representatives from the 5 local hospitals that received patients exposed to the chlorine gas. These representatives included incident commanders, chief operating officers, chief nursing officers, and emergency department (ED) staff working during the event. The interviewees provided feedback on their hospital's response, focusing on communication, surge, methods of decontamination, and the Hospital Preparedness Program.

In addition to the interviews, medical chart data were abstracted for all patients from the incident who presented to the EDs. Data were collected on patient demographics, arrival and discharge times, symptomatology during the ED visit, medical testing completed, and whether patients were admitted to the hospital or treated and released from the ED.

RESULTS

Incident Description

The structured interviews led to a more detailed understanding of the incident. Fire department personnel were called to the scene for a pregnant woman in distress and were not immediately aware that there was a mass casualty hazardous materials (hazmat) incident. When they arrived and saw multiple people experiencing respiratory symptoms, they realized there was a toxic gas release. They did not initially recognize the gas as chlorine because the US Environmental Protection Agency Tier 2 Chemical Inventory Reports from the facility did not indicate that chlorine was used at the plant. They predicted the gas to be chlorine because of the description of the green cloud and the chemistry of the mixed chemicals and confirmed this prediction with a positive Draeger tube air sampling test. Because chlorine gas is heavier than air, the chlorine gas fell to the floor, and the negative pressure of the plant carried the chlorine gas through a major hallway that was used as a primary evacuation route. Prior to identifying the chemical, the fire department/EMS notified the nearest hospital about the mass casualty hazmat incident and asked them to notify other local hospitals and to assess their capacity. There was a delay in activation of the emergency operations center (EOC), and the health department was not informed until at least 2 hours after the incident. As a result, they were unable to take advantage of hospital preparedness preparations at the state health department, such as a radio system to assist in communication and translators.

Surge Capacity

At the scene, fire/EMS distributed triage tags to help to prioritize 170 workers; giving out 85 minor, 53 delayed, and 34 immediate tags before running short of tags. (Triage categories were as follows: red (1) = immediate—critical patient; yellow (2) = delayed—serious patient that could wait until all reds have been transported; green (3) = ambulatory/hold—minor injuries; black = deceased [expectant]). Additionally, fire/EMS also did not have sufficient oxygen distribution devices for all patients needing them. The triage tags helped EMS route injured workers to 5 area hospitals based on severity of health effects and travel time. The hospitals ranged from 1.3 miles from the plant, with a travel time of approximately 5 minutes, to 25.9 miles and approximately 30 minutes away. The hospital bed capacity varied greatly, ranging from 73 to 233 beds.

Each of the 5 hospitals initiated its disaster response plan. To assist with surge management, each hospital redistributed or called in extra staff, including physicians, nurses, and respiratory therapists. The hospitals also borrowed supplies from other departments to allocate to the ED. Three of the 5 hospitals were under the same parent operating organization, allowing them to share patient information and coordinate patient tracking. According to the hospital staff interviewed, despite the lack of external communication, internal hospital communication functioned as planned, which they attributed to internal hospital drills, trainings, and exercises.

Patient Demographics and Level of Care Provided

Nearly three-quarters (122/170) of the patients were female. The mean patient age was 40 years (range, 22–64 years). Additionally, most (127, 75%) patients were of Hispanic ethnicity. The number of Marshall Islanders was difficult to determine because of various hospital race/ethnicity reporting systems. Many of the patients did not speak fluent English but rather spoke Spanish or Marshallese. Ninety-one patients were seen in the ED and were discharged on the day of the incident; duration of stay ranged from 25 minutes to approximately 10 hours for those patients. Sixty-four patients were either held in the ED overnight or admitted and then released the next day. Six patients were held for 2 days, and 9 patients were released 3 days after the incident. Three patients returned to the ED after they were discharged, with additional symptoms that may have been attributable to the incident. One patient was seen at 2 hospitals on the day of the incident.

No decontamination was performed at the scene. Owing to the lack of communication from responders at the scene and in established guidance procedures for this type of release, the hospitals varied in their decontamination procedures, with 2 performing a full water decontamination, 1 a removal and bagging of clothing, and the other 2 no decontamination.

Hospital Feedback

Based on feedback from the hospital survey, the fire/EMS notification process did not adequately alert the responding hospitals despite hospital preparedness radios for such situations. Hospitals received little information about the chemical involved, as well as related appropriate decontamination and treatment protocols. Each hospital had to find their own sources of treatment and decontamination guidance. Had the state health department been notified at the time of the incident, they could have immediately provided unified guidance to all hospitals. They also noted an inability to communicate with patients because many of them were non-English-speaking and they were unaware of the translation services the health department could offer. Family members of the injured showed up at the nearest hospital, many of them to find out that their family member was not there. It was difficult to help family members locate where relatives were sent because hospitals did not get patient distribution logs from fire/EMS. Hospitals identified specific information that responders at the scene (eg, fire/EMS or emergency management) and the health department could provide that may help increase their effectiveness in responding to future mass casualty incidents. This information included (1) the total number of patients and their severity (to help to determine how many they could accept); (2) an estimated time of arrival; (3) information on the substance and concentration, if known; (4) level of decontamination required at the hospital if not performed at the scene; and (5) discharge instructions for patients in their native languages.

DISCUSSION

As is typical with mass casualty emergency responses, the responders involved in the response—fire/EMS and hospitals—experienced challenges with information management, resource allocation, and risk communication. These challenges can lead to coordination and communication breakdowns between these groups. The dynamic and complex nature of a

crisis often makes it difficult for fire/EMS and ED teams to coordinate their activities. To lessen potential future breakdowns in information management, response mechanisms including the Incident Command System, EOCs, and communication channels have been developed by the county and state to aid the public health response.

The lack of timely and informative communication to the hospitals added to their frustration during the response. However, preplanning and drilling enabled them to overcome these issues. In an ideal situation, the flow of communication effectively links Incident Command with the EOC and responding partners. Based on the information learned from this response, communication between all of the stakeholders can be improved by implementing the full Incident Command System and activating an EOC. This process can be enhanced through drills, training, and exercises among all responding agencies. Additionally, the health department should be notified immediately when mass casualty incidents occur because they have developed many resources to assist in these situations. In this case, they had a hospital emergency radio system in place and translators for Marshallese and were prepared to give guidance on the treatment protocols for chlorine exposures.

If there are large or unique local non-English-speaking populations in their area, hospitals can work jointly with the state and local health departments to be prepared to communicate with them through translators or a telephone/Internet translation service. Hospitals can also develop a plan for the creation and dissemination of informational materials.

After the investigation highlighted issues associated with the notification procedures, the state health department and state department of emergency management developed new criteria for notification of the health department, facilitating immediate notification of all chemical, biological, radiologic, nuclear, and explosive incidents. The health department personnel also discussed the importance of health department notification in an Improvement Plan Workshop for all regional hospitals.

The region held a post-incident after-action review meeting with all of the involved parties to evaluate the response and communication and to determine how to improve coordination during future incidents. During this after-action review, the responding parties discussed (1) improving communication between the scene of an incident and responding hospitals, (2) determining a standard protocol for which incidents require decontamination at the scene, and (3) notification procedures.

From the after-action review, additional suggested actions were (1) integrating hospitals into regional and state disaster exercises; (2) inviting federal, state, and local emergency planning committee members to key hospital meetings and events; (3) implementing methods to better track patients from mass casualty incidents when they are sent to multiple health care facilities; and (4) evaluating and updating communication and notification procedures as needed.

The investigation and after-action reviews also pointed to the necessary involvement of the Local Emergency Planning Committee, which is a key component of emergency preparedness and is required to have, among others, first responders, industry representatives, hospital officials, and public health professionals. Part of the Local

Emergency Planning Committee's role is to be aware of and communicate to the public the toxic chemicals that are manufactured and used in the local community and region. On the basis of these chemicals, emergency patient management plans can be developed and reviewed by all stakeholders to ensure the plans are sufficient to address community needs. Regular disaster drills and exercises of the plan involving all responding parties including the community, first responders, industry, local and state health departments, poison control centers, and hospitals that serve the community would make proper implementation of an emergency patient management plan more likely in a real emergency. Because of this, hospitals in the region are continuing to strengthen relationships through coordinated exercises with the local emergency management offices.

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