ASSESSMENT OF CHEMICAL EXPOSURES

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This chapter is dedicated to Mary Anne Duncan

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INTRODUCTION

[contributed by Mary Anne Duncan]

Chemical releases can cause injuries to large numbers of workers and local residents. When this occurs public health officials may need epidemiologic data to best direct the public health response. Often, the responding local or state health agencies lack experience in chemical spill epidemiologic investigations and do not have sufficient staff to conduct one in a timely manner. In addition, the literature often lacks health outcomes from chemical releases in communities, so it can be difficult to communicate health information to the public.

In 2010, the Agency for Toxic Substances and Disease Registry developed the Assessment of Chemical Exposures (ACE) program to assist local/state health agencies to respond to acute chemical incidents. The program developed the ACE toolkit (https://www.atsdr.cdc.gov/ntsip/ace_toolkit.html)—surveys, consent forms, medical chart abstraction forms, and databases so that new materials do not need to be developed for each response. Instead, appropriate sections of the existing materials can quickly be adapted to the situation. ACE teams are available to deploy to the field to assist in an investigation or the program can provide technical assistance over the phone or through email. Reports are published after each ACE investigation describing the health effects identified after the chemical exposures.

ACE investigations may include: key informant interviews, surveying exposed persons, and reviewing medical charts. Data can also be collected about household pets to supplement the human data.

Data collected from ACE investigations has been used to:

- provide individual-level assistance to exposed persons
- report accurate descriptions of health impacts to reassure community members
- make recommendations to prevent a similar chemical release from occurring in the future
- make recommendations to improve response to future mass-casualty incidents
- make recommendations to protect the health of emergency responders
- change state-level policy for reporting chemical incidents to the health department
- identify exposed persons to be followed for longer term health effects of the acute exposure

The ACE program has also developed training materials, an on-line introductory course in performing assessments after acute chemical releases (https://cdc.train.org/DesktopModules/eLearning/CourseDetails/CourseDetailsForm.aspx?courseId=1060828), and a day-long in-person ACE course.

WEST VIRGINIA

[contributed by Erica Thomasson and Joy Hsu]

Incident

January 9, 2014

Approximately **10,000 gallons** of 4-methylcyclohexanemethanol (MCHM) and propylene glycol ethers (PPH) (~7% by weight) spilled from an aboveground chemical storage tank into the Elk River in Charleston, West Virginia, contaminating the potable water supply of approximately **300,000 residents**. The West Virginia Governor declared a State of Emergency, and the local water company issued a "Do Not Use" water order, except for flushing toilets, for nine counties. The West Virginia Poison Center (WVPC) received calls about exposure and symptoms that callers attributed to the contaminated water, such as vomiting and nausea and hospital emergency departments reported hundreds of visits by persons reporting exposure to contaminated water.

ACE implementation - *Emergency department medical record investigation*

The West Virginia Bureau for Public Health (WVBPH) requested assistance from ATSDR's Assessment of Chemical Exposures (ACE) Program. The ACE team deployed within two days of receiving the request for assistance and collaborated with epidemiologists at the WVBPH on an ACE investigation. The objectives of the investigation were to understand why people were seeking care at the emergency department following reported exposure to the contaminated water and to determine if the symptoms were serious.

Ten hospital emergency departments in the affected area were required to report daily to the WVBPH numbers of persons who visited their emergency departments reporting MCHM exposure. At the time of the chemical spill, toxicologic data on MCHM and PPH were limited and the human health effects of exposure were unknown. Therefore, **there was no standard clinical case** definition for exposure to either chemical. While all 10 emergency departments used case definitions that included patients reporting MCHM exposure, four emergency departments included alternative criteria. Among these four emergency departments, three case definitions included patients who reported certain symptoms but did not mention MCHM exposure, and one case definition included any patient who was in the affected area on the day of the chemical spill.

Medical records of persons reporting exposure were obtained and each record was reviewed. Exclusion criteria were created to eliminate medical records not related to the chemical spill. Records were excluded when a patient left without being seen by a physician, no exposure was recorded in the record, an alternate diagnosis was more likely to have caused a patient's symptoms, no symptoms were reported by the patient (i.e. emergency department visit was because of concern), and when a patient was already seen in the emergency department for this same event.

The **medical records abstraction form found in the ACE toolkit was customized** to create a standardized data abstraction form that would be appropriate for a large-scale water contamination incident. The following information was abstracted from the medical records: patient demographics, prior medical history, routes of exposure, reported symptoms, test outcomes, diagnoses, and treatment. Data were managed in Microsoft Excel and a descriptive analysis was conducted using Epi Info 7.

The medical chart analysis showed that the majority of patients presented to the emergency department with mild symptoms that required minimal or no treatment. The most common symptoms were nausea, rash, vomiting, abdominal pain, and diarrhea. The complete results of this investigation were published in *Public Health Reports* (http://dx.doi.org/10.1177/0033354917691257).

ACE Implementation - *Hospital survey*

Environmental health emergencies involving contaminated water supplies can **present unique challenges for hospital emergency preparedness**. For example, decisions about resource allocation can affect hospitals' provision of health care. This part of the investigation sought to understand the chemical spill's impact on hospital operations.

The survey included **questions from the ACE toolkit's Hospital Survey** and was conducted approximately two weeks after the chemical spill, involving all ten hospitals providing daily updates to WVBPH (as described above). At each hospital, the infection control specialist participated in the survey and sometimes volunteered additional survey respondents from the same hospital

(e.g., hospital quality improvement or disaster response staff). Because of winter weather, surveys were administered either in person or by phone, depending on the road conditions for each day. Survey data were analyzed using Microsoft Excel.

Results revealed that the spill-related loss of potable water affected many aspects of hospital operations, including hemodialysis, sterilization of surgical or endoscopic equipment, hospital cleaning, and infection control for *Clostridium difficile*, a health care-associated infection (because alcohol does not kill *Clostridium difficile* spores, the use of soap and water is more efficacious than alcohol-based hand sanitizer [REF https://www.cdc.gov/hai/organisms/cdiff/cdiff_faqs_hcp.html]). The complete results of this investigation were published in *Disaster Medicine and Public Health Preparedness* (https://doi.org/10.1017/dmp.2016.193).

Lessons learned

Emergency department medical record investigation

Clear case definition help narrow the scope of the review and enable timely investigation.

Using multiple data collection methods help better understanding of the incident and its effects.

Prior to this incident, ACE investigations involved direct releases of common hazardous materials, including chlorine, ammonia, and vinyl chloride for which chemical-specific data on toxicity and exposure limits is readily available. This large scale contamination of a municipal water supply by a mixture of chemicals with limited toxicity data presented many unique challenges, including the lack of a standard clinical case definition as described above. The use of varying case definitions by hospital emergency departments exaggerated the number of medical records; over one-third (215 of 584) of the medical records were eliminated after exclusion criteria were applied. Medical chart reviews are time and labor intensive and a clear case definition would help narrow the scope of the review and enable the investigation to be conducted in a timely manner, especially in cases of acute chemical exposures. Moreover, frequently reported symptoms such as nausea and vomiting were nonspecific, making it difficult to distinguish health effects attributable to MCHM exposure from symptoms attributable to other causes. A standardized clinical case definition should be utilized to identify exposed persons when toxicological data for a chemical are available.

Jurisdictions should consider utilizing multiple data collection methods, such as key informant interviews and surveying exposed persons. Incident responders and hospital staff can be interviewed to gain a better understanding of what happened, who was exposed, steps taken to protect health, and communication during the response. More detailed information on exposure history, symptoms experienced, medical history, health services used, how people received information about the chemical spill/release, and resulting needs can be collected by interviewing exposed persons. Because this ACE investigation did not include key informant interviews and interviews of exposed persons, findings were limited to information documented in the medical records.

Hospital survey

Hospitals ought to have plans for alternate source of potable water.

This ACE investigation found that hospitals could enhance emergency preparedness plans for a compromise in water supply by specifying alternative sources of potable water sufficient for hemodialysis, sterilization of surgical or endoscopic equipment, hospital cleaning, infection control of *Clostridium difficile*, and other relevant hospital operations. These results complement existing guidance on emergency water supply planning for hospitals. [REF https://www.cdc.gov/healthywater/pdf/emergency/emergency-water-supply-planning-guide.pdf].

Additional data sources

Using additional data sources to complement ACE, complements and enhances incident understanding.

Jurisdictions should consider utilizing additional sources of data and disaster epidemiology methods to complement ACE investigations during a disaster response. Since the medical record review provided information only for those who sought medical care at emergency departments, we analyzed two additional data sources to provide a more multifaceted picture of the acute health effects associated with this chemical spill. First, we reviewed poison center caller records to capture data on acute health effects in people who contacted the poison center but did not visit the emergency department. Second, to identify acute health effects among members of households in the affected communities, we included household questions on health effects in the Community Assessment for Public Health Emergency Response (CASPER) conducted three months after the spill (Results are available in Public Health Reports, http://dx.doi.org/10.1177/0033354916689606).

ACE investigations are descriptive in nature and oftentimes cannot quantify exposure to a chemical. Although this method may be inexact and unable to ascertain causality, it was useful for describing the acute health effects associated with the chemical

spill. Results were used to formulate risk communications in an effort to help alleviate the public's concerns about spill-related health effects and to determine whether long-term health monitoring was warranted.

Collaboration infrastructure

At the time of this incident, there was limited infrastructure in place to conduct investigations such as ACE and minimal awareness of disaster epidemiology utility in emergency response. Establishing collaboration across multiple disciplines and across multiple levels of government and securing buy-in from stakeholder leadership (first response organizations, healthcare, public health, etc) is crucial for effective response to emergencies such as MCHM spill.

Establishing collaboration across multiple disciplines and levels of government enhances incident response.

State or local jurisdictions should consider conducting training in disaster epidemiology methods to build capacity and raise awareness and utilization of these tools among epidemiologists and personnel involved in emergency response, including hospital emergency response coordinators. Since the investigation, the WVBPH coordinated with CDC/ATSDR and NIOSH to host a 3-day disaster epidemiology training, with participation of about 70 responder, healthcare, and public health staff from across the state.

References

Acute Health Effects After the Elk River Chemical Spill, West Virginia, January 2014 (http://dx.doi.org/10.1177/0033354917691257)

Assessment of Impact and Recovery Needs in Communities Affected by the Elk River Chemical Spill, West Virginia, April 2014 (http://dx.doi.org/10.1177/0033354916689606)

Hospital Impact After a Chemical Spill That Compromised the Potable Water Supply: West Virginia, January 2014 (https://doi.org/10.1017/dmp.2016.193)

CALIFORNIA *[contributed by Svetlana Smorodinsky, Jason Wilken, Tracy Barreau]*

Incident

June 2010

Chlorine gas, which can cause severe respiratory symptoms with long term consequences, was unintentionally released from a ruptured 1-ton low-pressure tank at a recycling facility in Tulare County, CA. The tank was unlabeled, reportedly empty, and sold to the facility as scrap metal.

ACE implementation

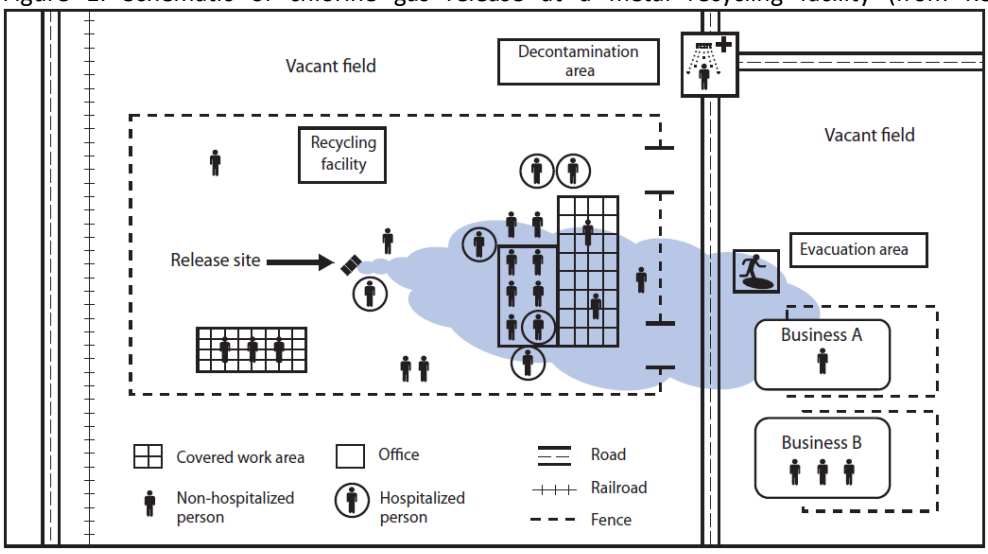
Following the incident, ATSDR and CDC collaborated with the California Department of Public Health (CDPH) and Tulare County agencies to determine the causes and extent of chlorine gas exposures and their associated health effects, and to develop recommendations for preventing similar incidents in the future. This investigation was a pilot implementation of the newly-developed Assessment of Chemical Exposures (ACE) toolkit.

The ACE team conducted key informant interviews with various parties, including local health and environmental health officials, fire and hazmat responders, and facility owners. Using the ACE exposure and health effects questionnaire, the team interviewed the affected individuals; with the help of county public health nurses, most interviews were completed in one day. In addition, CDPH created a supplementary assessment form for employees to evaluate safety practices at the recycling facility. An ATSDR industrial hygienist conducted a facility walkthrough and assessment, and provided a comprehensive report with recommendations to the facility. Finally, medical records of the exposed individuals were abstracted. The results are available in an MMWR publication, https://stacks.cdc.gov/view/cdc/29040.

The release occurred outdoors in an open work area when the chlorine tank was torn open by heavy equipment. The chlorine gas plume traveled at least a mile from the explosion site in the direction of the facility exit gate, reaching a field across the street. That field was designated in the facility's plan as the emergency evacuation area (see Figure 1; information obtained from the surveillance video and employee interviews). Most workers followed the designated route, inadvertently evacuating into the plume. One worker described holding his breath until he was across the street, therefore unwittingly inhaling chlorine gas in the evacuation area. Three hours after the incident, a hazmat team measured the tank off gassing at 328 ppm (life-threatening effects such as pulmonary edema and respiratory failure can occur within 2-4 hours from chlorine exposure at 40-60 ppm; exposure to 430 ppm lasting over 30 minutes is lethal). [*REF: Agency for Toxic Substances and Disease Registry. Toxicological profile for chlorine. Atlanta: U.S. Department of Health and Human Services; 2010 Nov. Accessible online at: https://www.atsdr.cdc.gov/toxprofiles/tp172.pdf*]

The incident affected 29 people, of whom 23 (including employees, customers, and workers at nearby businesses) reported respiratory symptoms within 24 hours of exposure; six were hospitalized for 1–11 days; one required mechanical ventilation for two days. Those hospitalized were not necessarily the closest to the release (Figure 1).

Figure 1. Schematic of chlorine gas release at a metal recycling facility (from Kelsey et al., MMWR, 60(28):951–4).



At the conclusion of the investigation, CDPH created and distributed a Chemical Release Alert (https://www.cdph.ca.gov/programs/ept/Documents/ChlorineReleaseAlert.pdf *URL TO BE UPDATED once ADA-compliant doc is posted*) to >1,200 recycling facilities in California to educate them on how to prevent future releases of chlorine gas and other hazardous materials. The alert encouraged facilities to only accept containers that are cut open, dry, and without a valve or plug; to treat closed containers as potential hazardous waste; and to develop and practice an evacuation plan and train workers to stay upwind when evacuating for a chemical release.

CDPH conducted further follow up interviews with the affected individuals six months after the event, assessing continuing symptoms (including a post-traumatic stress disorder checklist) and the quality of received medical care. The purpose of the follow up was to understand the long-term consequences of the exposure, facilitate access to adequate healthcare, and evaluate feasibility and utility of such follow up after other incidents. The follow up showed that several individuals continued to have ongoing symptoms not present before the incident; many were not satisfied with the medical care they received; and several screened positive for PTSD. CDPH made an attempt to connect these individuals with the necessary providers.

Lessons learned

The ACE team was initially not aware that multiple fire departments were involved in the immediate response, and therefore did not conduct interviews with the correct personnel at the beginning. Thus, quickly obtaining information about all responding agencies, understanding the complexity of local response, and forming partnerships with key players is of utmost importance.

Developing prevention materials following an ACE is valuable. CDPH developed the content of the Chemical Release Alert in collaboration with ATSDR and CDC staff. CDPH also sent a draft of the alert to the affected employer and to the safety director of a scrap recycling trade association for their input. The Alert was widely distributed and well-received.

The six-month follow up illustrated that a hazardous material incident like this could result in lasting physical and mental health effects. It may be helpful to plan for a follow up at the outset of an ACE. For instance, it might be useful to obtain patient consent for further contact at the initial interview or to adapt ATSDR's Rapid Response Registry tool (https://www.atsdr.cdc.gov/rapidresponse/) for a smaller scale event.

Conducting further follow up on chemical exposure incidents which result in mass casualties, such as this one, offer multiple public health and healthcare opportunities, such as:

- Bringing attention to long-term consequences of such exposures
- Educating and training healthcare providers
- Improving standards of care for chemical exposures
- Creating more robust literature on the topic
- Improving workplace health and safety
- Improving emergency planning at the facilities and among first responders

This ACE investigation was a successful collaboration of federal, state, and local agencies and allowed CDPH to understand the circumstances of the incident, health effects associated with exposures, and to make recommendations for preventing recurrences.

NEW JERSEY *[contributed by Alice Schumate, Jason Wilken]*

Incident

November 30 2012

A freight train derailed while crossing a railroad bridge over a creek on the outskirts of a town of ~6,000 residents in New Jersey. Four tanker cars fell into the creek and one tanker car was ruptured, releasing ~20,000 gallons of pressurized vinyl chloride. Vinyl chloride is a colorless, sweet-smelling gas, the inhalation of which can cause respiratory and neurological symptoms, and, at high concentrations, can cause cardiac dysrhythmia, loss of consciousness, and death.

Authorities issued a shelter-in-place (SIP) order, the street adjacent to the creek was evacuated, and later in the day the evacuation order was extended. Over the next four days, SIP orders were issued and lifted as ambient vinyl chloride concentrations fluctuated. Four days after the derailment, more residents were evacuated when ambient vinyl chloride concentrations rose.

The New Jersey Department of Health (NJDOH) collaborated with ATSDR and CDC to characterize exposure and health effects of the community affected by the vinyl chloride release, examine the medical response to the release, evaluate the occupational safety and health of emergency personnel who responded to the incident, and to describe the response to the incident and develop recommendations for public health preparedness and response to mass-casualty chemical releases.

ACE implementation – Community survey

In response to widespread public concern about the health impact on the local community, the NJDOH initiated an ACE household survey of affected residents stratified into four areas by proximity, time, and evacuation status (Figure 1). **Household surveys** were designed to capture information on exposure, health effects, communication during the incident, and preferred methods of communication.

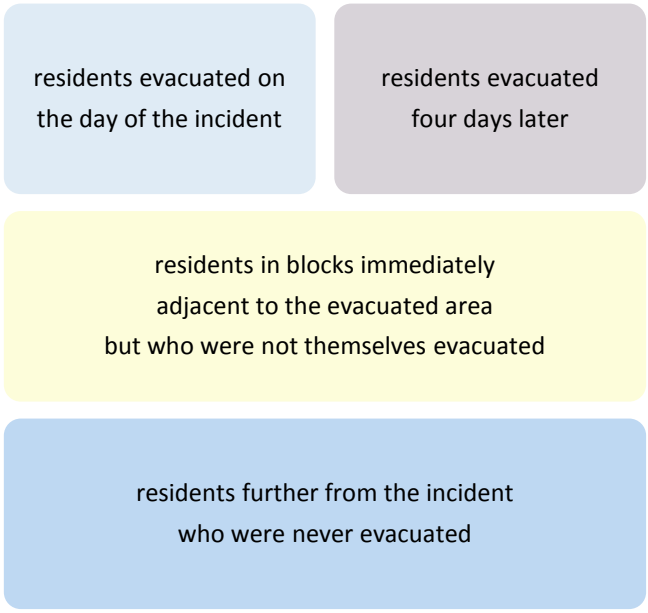


Figure 1: Geographic and temporal stratification of households sampled for interviews.

Two survey types were used. **In-person household surveys** were conducted during a one week period beginning 14 days after the incident, after evacuated residents had been allowed to return. These in-person household interviews were conducted door-to-door in randomly selected census blocks from within each of the four designated areas, and employed a household member information sheet, the ACE General (Adult) Survey, and the ACE Child Survey, as well as ACE Consent Forms. Surveys captured information on all household members who were at home for any amount of time in the seven days immediately following the incident and who were willing to participate. Surveyors were trained using the ACE Interviewer Training Manual, and included employees of NJDOH, ATSDR, CDC, and volunteers from the local Medical Reserve Corps as well as US Public Health Service officers stationed nearby. To ensure that all residents had an opportunity to participate, a **self-administered mail-in questionnaire** was sent to all postal addresses in the town; this mailed survey was a simplified version of the in-person survey.

Fifty-eight percent of town residents surveyed in-person experienced at least one new or worsened symptom consistent with exposure to vinyl chloride. In general, those living closer to the derailment site reported symptoms at higher frequencies than those living further away, however, those immediately adjacent to the derailment, who were evacuated the same day, reported lower frequencies of symptoms than did those in adjacent area who sheltered in place during the first several days (Figure 2). Respondents to the mail-in questionnaire reported symptoms at slightly higher rates, but with otherwise consistent results. An average of 9% of surveyed individuals sought medical care; this frequency was higher closer to the derailment site and lower further away.

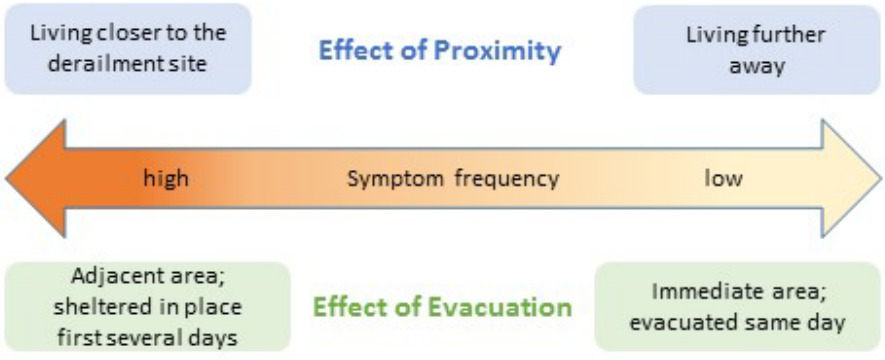


Figure 2: Comparison of the effects of proximity and evacuation on frequency of reporting symptoms among persons participating in household survey.

The community survey was extremely informative regarding **communication during this incident**. Most area residents first learned of the chemical leak, and about what actions they should take, from a relative, friend, neighbor, co-worker, or from television, rather than from a person in a position of authority. Residents who learned that they were supposed to shelter in place often didn't understand what actions were needed in order to do so safely. Survey participants expressed a preference to receive more information directly from a person in authority.

ACE implementation – Hospital study

Every incident is unique, requiring a different type and scale of medical response, and making medical response planning challenging. The ACE toolkit includes a **Hospital Survey designed to help capture the medical response and lessons learned**. Approximately two weeks after the incident, key informant interviews at area hospitals were used to better understand available resources and their usage, communication during the response, the number of patients treated and types of care required, and lessons learned. In addition, at the request of the State Epidemiologist, follow-up medical chart reviews were conducted for patients who sought care at area hospitals in the month following the chemical release, using the ACE Medical Chart Abstraction Form.

Hospital approaches to the response varied across facilities, but all reported effective internal communication and functioning. All hospital key informants expressed a desire for more complete and timely information regarding the incident, including initial notification of the event and the imminent arrival of individuals needing emergency care, the chemical released, and whether or not patient decontamination would be necessary upon patient arrival. Resources available through the poison center and a designated medical coordination center, including information about patient decontamination as well as chemical plume modeling, were underutilized. Finally, nearly all patient visits were concentrated at the single closest facility, and better response communication might facilitate a more even distribution of the patient surge.

No fatalities were associated with the vinyl chloride release, and 98% of patients were treated in the emergency department and then released. Most patients self-identified as having been exposed to the released chemical, and hospitals used different wording, but consistently identified the chemical exposure in the chief complaint field. While signs and symptoms were rarely severe enough to warrant hospital admission, they were often persistent: patients continued to seek care for signs and symptoms related to vinyl chloride exposure for four weeks after the incident. Five of six admitted patients had preexisting medical conditions and 93% of asymptomatic emergency department patients were children.

ACE implementation – First responder survey

To understand the **emergency response, exposures, occupational health factors**, and symptoms of responders who worked at the incident site at any time between November 30 and December 7, 2012, approximately 100 responders representing fire, police, emergency medical services, and hazardous materials disciplines were surveyed**. A self-administered survey adapted from the ACE General Survey** (and sharing some questions with the community survey) assessed health effects, the use of personal protective equipment, and preparedness training among emergency responders. The investigation team met with Unified Command, emergency response leaders, and local responders during the period December 11–21. Respondents completed surveys during the meetings, and those who did not attend any meetings had the option of mailing in the survey.

The survey included questions addressing demographics, emergency response roles, activities, and experiences. Because a typical work shift lasted 12 hours, participants were categorized by duration of exposure: those who worked a total of $\leq$12 hours and those who worked >12 hours in the evacuation zone throughout the entire eight-day period. Utilization of medical care and personal protective equipment (PPE), including respiratory protection, was assessed. In addition, respondents were asked questions to evaluate preparedness training and their perceptions of the response. Questions pertaining to medical history prior to the event and mental health status after the response were examined as well. Finally, the emergency responders' perceptions of the response and interagency communication were assessed.

Acute symptoms of vinyl chloride exposure were common, but only 23% of respondents sought medical care. The majority of respondents did not use respiratory protection, but most reported receiving some emergency responder training and felt they had sufficient instruction, indicating a possible gap in perception of risk.

While the first responder survey captured invaluable information about experiences and exposures of first responders, coordinating the investigation among the large number of involved agencies and identifying core questions applicable to each responding agency was challenging. The vast majority of surveys were completed in-person, and only a handful were returned by mail, underscoring the importance of direct contact between investigators and survey respondents. Scheduling meetings with responders (and providing opportunities to complete the survey) at different times of the day improved capture across work shifts.

ACE implementation – Refinery survey

While conducting the First Responder Surveys described above, the investigation team was approached by a responder who was concerned about vinyl chloride exposures at a **refinery near the derailment site**. The investigation team arranged a meeting with ~20 refinery workers, the refinery health and safety officer, and the environmental officer, and learned that the train derailment occurred near the time of shift change and had blocked the only access road to the refinery. Workers unable to exit the refinery

and workers trying to reach the refinery were potentially exposed. Workers on the refinery grounds identified elevated levels of an unknown volatile organic compound shortly after the derailment. The refinery environmental officer learned of the residential SIP order near the derailment site, and the refinery ordered an SIP for its workers. Approximately 4 hours after the derailment, the train was cleared from the access road and the refinery released all non-essential workers. The refinery safety officer raised concerns about difficulties in obtaining timely information about the incident from incident command at the derailment site.

The team **partnered with the refinery health and safety officer, environmental officer, and an employee union representative** to develop and distribute a voluntary survey for the refinery workers and contractors using a questionnaire adapted from the community survey including questions specific to refinery workers (e.g. worker experiences during the incident including if/where they sheltered and how they received communications about the incident). Most workers completing the survey reported experiencing at least one symptom, but none sought medical evaluation after the incident. Some reported moving from one shelter to another during the incident either in response to rising volatile organic compound concentrations or to reach shelters designated by existing emergency plans. Workers who moved from one shelter to another were more likely to have been symptomatic, possibly because of increased vinyl chloride exposure while outdoors although also possibly because of greater concentrations inside a shelter than outside. Workers completing the survey echoed concerns of the refinery environmental officer about lack of effective communication with outside agencies.

Lessons learned

Community Survey

Risk communication was a clear need, including direct communication from authorities about the incident and steps for the residents to take in order to protect themselves and their families. Public concern and frustration were high at the time of the community survey. Residents were concerned about exposure and potential health effects, confused about decisions that were made regarding evacuation, and frustrated regarding what they perceived as a lack of communication and guidance from responders as well as local health agencies. Interviewers often spent a great deal of time capturing respondents' thoughts, and the community survey provided an important opportunity to distribute key health information and answer community questions and concerns. Residents were thankful that their views were being captured.

Jurisdictions should develop, test and follow emergency communication plans.

Public health agencies should be engaged with the incident command system.

Community survey results led to several recommendations. First, it is important that jurisdictions develop, test, and follow emergency communication plans, so that residents efficiently receive instructions from persons in authority during emergency events. Second, local officials should prepare community-specific emergency planning educational materials tailored to the relevant hazards, and make those available to the residents. Finally, public health agencies should be engaged within the incident command system, to provide guidance to and address the health concerns of the affected population. After this incident, the local jurisdiction began working to implement these recommendations, starting with improvements to the reverse 911 system and emergency communication plans.

Hospital Study

Communication in emergency responses is always a challenge, and this vinyl chloride release was no different. While hospital key informants reported effective communication within their facility, they reported a need for better external communication, including notification about the release, the identity of the chemical, the need for patient decontamination upon arrival, and the number and acuity of patients en route.

Notifying hospitals of a release and identity of the chemical allows facilities to anticipate patient needs.

Emergency planning should incorporate strategies for patient surge.

Continuous emergency response planning on a regional level can better familiarize all partners with the available resources as well as with important counterparts at other organizations, and can establish important communication channels in advance. Emergency response planning might incorporate strategies to distribute the patient surge among area hospitals based on symptom acuity and resource availability. For emergencies in which many patients transport themselves to the hospital, public communication strategies could be used to help distribute the patient surge. Additionally, risk communication might target individuals with existing medical conditions and caretakers of children, to offer pediatric-specific guidance on signs and symptoms.

First Responder Survey

Having an accurate account of emergency responders who worked at the scene and the periods over which work shifts occurred is imperative. Because complete rosters of emergency responders who worked in the evacuation zone were unavailable, it is possible that a number of first responders never completed the survey. As a result of the first responder survey, the investigation team recommended that various agencies implementing the Emergency Responder Health Monitoring and Surveillance (ERHMS; http://www.cdc.gov/niosh/topics/erhms) system in order to roster and monitor responders in incidents like this one.

It is imperative to have accurate account of first responders who work the scene.

Despite the limitation that not all responders were captured, the first responder survey allowed the investigation team: 1) to describe those who arrived at the evacuation zone and assess their acute health effects, medical evaluations, and use of PPE; and 2) to capture respondents' perceptions, attitudes, and beliefs about training and safety prior to, during, and after the response. On the basis of those findings, the team recommended to evaluate training needs for all emergency response roles and to promote proper PPE and other work practices to reduce first responder exposures.

Refinery Survey.

Though the investigation team was not aware of the events at the refinery when developing their initial goals and priorities for the ACE implementation, the refinery assessment offered an opportunity to capture experiences of a unique population impacted by the vinyl chloride release and highlights the importance of flexibility and capacity to add new components during an ACE investigation. Interviews with key refinery staff allowed the interview team to refine and develop questions specific to the refinery workers, thereby capturing data pertinent to the refinery's emergency response; based on these findings, the team was able to develop guidelines for responses to chemical releases at similar facilities including both internal and external communication strategies, emergency egress plans, and the judicious use of sheltering in place and air handlers to minimize exposure to a chemical plume.

Being aware of the incident's impact on nearby employers and employees is critical.

Conclusion

This investigation highlights the multiple populations that can be exposed by a chemical release and underscores the scalable and modular design of the ACE toolkit. The ACE toolkit includes hospital as well as general and household survey modules and, as shown in this investigation, surveys can be rapidly tailored based on the specific exposures and characteristics of each population; e.g., surveys informed by interviews with representatives of response agencies, can be tailored to capture the exposures and experiences of first responders.

The investigation team used the ACE toolkit general, household, and hospital surveys, tailored as described above, as part of a holistic approach to describing the exposures of multiple populations impacted by a large chemical release. Existing templates enabled development of these different survey instruments on the fly, allowing the investigation team to rapidly capture a large amount of data for different populations. A common theme amongst these population surveys results was a perceived lack of adequate risk communication, and by documenting these communication gaps an ACE investigation can strengthen inter-agency and community emergency planning and response, thereby reducing the morbidity and mortality associated with chemical releases.

References

The separate components of the investigation were conducted using different modules of the ATSDR ACE toolkit. The results are available in the following publications:

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SUMMARY

In addition to human-related causes, natural disasters can be important mechanisms of direct and indirect hazardous material releases; therefore, integrating public health investigations of environmental and occupational emergencies into all-hazards plans is of utmost importance.

ACE is a scalable and modular set of tools for large-scale chemical release incidents. Jurisdictions can use a variety of approaches and epidemiological sampling techniques to achieve incident-specific ACE objectives. An ACE investigation may fit in either the response or recovery phases of emergency cycle. A trained team (whether local/State or from ATSDR) can deploy to the affected area within just a few days and seamlessly integrate within the Incident Command System (for more discussion on ICS, please see the CASPER chapter). Finally, receiving an ACE training or conducting an ACE fulfills all four functions of PHEP Capability 13 (Public Health Surveillance and Epidemiological Investigation).

Overall, an ACE may have many potential benefits for agencies, community members, and other stakeholders.

- Describe acute health effects of chemical exposures and understand the impact on the community
- Assess shelter-in-place or evacuation efficacy
- Identify population cohorts that may be followed for persistent health effects of acute exposures
- Better direct aid to the affected community
- Identify issues to address in emergency and mass casualty plans, such as training or communication gaps
- Identify issues to address with established stakeholder partnerships
- Identify occupational safety and health issues
- Identify best methods of communication with the public

Resources

ACE Website

https://www.atsdr.cdc.gov/ntsip/ace.html

ATSDR ACE workbook

https://www.atsdr.cdc.gov/ntsip/ACE_ToolKit/docs/ACE%20Workbook.pdf

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