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Conducting Descriptive Epidemiology Following A Disaster: A Case Study of the West, Texas Fertilizer Plant Explosion

David Zane, Kahler Stone, Hammad Akram, Stephanie Alvey, Bonnie Morehead, Sandi Arnold, and Tracy Haywood

I. Background of the Fertilizer Plant Explosion

On April 17, 2013, a fire and subsequent explosion occurred at the West Fertilizer Company plant in West, Texas. This plant is located in central Texas, in McLennan County. The explosion caused extensive damage to the homes, businesses, and schools near the plant. Because explosions of this magnitude are rare, an epidemiologic investigation was initiated to describe the fatal and nonfatal injuries caused by the explosion. The investigation found that the explosion killed 15 individuals and directly injured an additional 252 individuals.

This investigation serves as a case study on how descriptive epidemiology can be used after a disaster.

Below is an overview of the investigation, the challenges, and promising best practices.

II. Collaboration among Multiple Governmental Partners

The investigation was implemented by the following agencies:

- Local – Waco/McLennan County Public Health District (WMCPHD)
- Regional – Texas Department of State Health Services, Health Service Region 7 (Temple)
- State – Texas Department of State Health Services, Central Office (Austin)

This multi-organization collaboration among local, regional, and state agencies was amongst the main strength of this investigation and had a direct impact on planning, logistics, implementation, data management and dissemination phases of the study. During the planning phase, the Texas Department of State Health Services (DSHS) facilitated protocol development through consultation with the Oklahoma State Department of Health and Center for Disease Control and Prevention. DSHS also assisted with the Institutional Review Board (IRB) process. To identify the acutely injured, WMCPHD and DSHS coordinated with health care facilities and hospitals most likely to have received acutely injured patients to review medical records and facilitate the data collection process.

The local health department knew the community and had existing relationships with local hospitals and healthcare organizations, which expedited the data collection process and enabled the entire team to review medical records. WMCPHD maintains a database of all healthcare facilities in the county along with schools, nursing homes, and daycare facilities routinely as part of their disease surveillance-related activities. In addition, DSHS was able to obtain contacts from the Federal Emergency Management Agency (FEMA) a list of applicants for assistance, death certificates, medical examiner reports, and mobile medical unit list. Collaboration with regional and state DSHS offices provided the team the authority to obtain data from the facilities that were outside of McLennan County boundaries. All organizations collaborated in medical record review and conducting phone interviews with injured

survivors which accelerated the investigation process. After completing the data collection and survivor interviews phases, DSHS provided data analysis, GIS, and related technical support to interpret the findings.

III. Skills of the Investigative Team

The team consisted of five epidemiologists, one preparedness coordinator, two public health nurses, one public health planner, and one health geographer. This allowed an integrated team environment that facilitated reciprocal transfer of knowledge, expertise, and capacity.

- **Epidemiologists:** Epidemiological skills were essential in protocol/survey development, client interviews, and data management, including analysis and interpretation.
- **Preparedness Coordinator and Public Health Planner:** Coordination, planning, and logistical support; the staff was also trained in client interviews as a part of WMCPHD Epi-teams program.
- **Public Health Nurses:** Client interviews, medical records review, understanding of International Classification of Diseases (ICD) coding system, and counseling skills.
- **Health Geographer:** Analytical support, geocoding of addresses, development of map books, and mapping of individual's approximate location at the time of the explosion.

Overall this multidisciplinary team allowed for better and more efficient use of resources, minimization of costs, and led to an improvement in project-related performance and work quality. Experts with diverse skill-set provided different perspectives and solutions to problems; the team worked collaboratively and in a professional manner to complete the investigation. The team held weekly conference calls with prepared agendas and discussed team activities and goals.

IV. Objectives of the Investigation

To understand the types and characteristics of injuries and healthcare resources that were used during and after the explosion, the investigation team sought to:

- Describe the characteristics of fatal injuries caused by the explosion
- Describe the physical injuries of survivors of the explosion
- Describe risk factors associated with injuries caused by the explosion, including the location at the time of the blast, timing of injury, and demographic characteristics.
- Quantify the number of acutely injured persons who sought medical care
- Describe the medical care received by the injured

V. Methods

A multi-pronged approach was used to identify and collect data on injuries.

Case definition:

Fatal injuries due to the incident were recorded through the review of medical examiner records and death certificates of individuals who died within 1 week of post-explosion time period in the county.

Non-fatal injuries that occurred within 5 days of the explosion and related to the blast in terms of location, timing, and cause were recorded through the review of medical records from hospitals and urgent care facilities located in the county and an adjacent county.

Data collection:

Standardized data collection tools based on the questionnaires from the 1995 Oklahoma City bombing, 2012 Alabama tornado outbreak, and the blast injury forms developed by the Centers for Disease Control and Prevention and the American College of Emergency Physicians were referenced during the development of our data collection tools. The tools were comprised of a fatal injury abstraction form, a non-fatal injury abstraction form, and a telephone survey for survivors.

Eligible injured patients identified through medical records were contacted to participate in a survivor survey. Contact information, including residential address and telephone number, was obtained from medical records when possible. Patient records were linked with the demographic data obtained from the FEMA data on West residents whose homes were damaged or destroyed and subsequently applied for emergency assistance from the federal government. In addition, investigators conducted phone interviews with survivors to obtain additional information about their locations and whether they were indoors or outdoors at the time of the explosion. The investigation protocol and participant consent process were reviewed and approved by the state health department's IRB.

Data analyses:

Descriptive statistics, chi-square tests and Satterthwaite t-tests, and logistic regression models were used to analyze the data. In addition, geographical information systems were used to geocode and then map the known approximate location, at the time of the explosion, of all chart-abstracted and interviewed cases. The distance proximity of cases to the explosion's epicenter was then calculated.

VI. Selected Recommendations from the Investigation Findings

Hospitals should review the results of this investigation and similar studies to better predict and plan for the types of injuries that might occur in similar emergency incidents and when and how those patients might be arriving at the medical facility, which may improve medical recognition and management of those injured. While examining apparent physical injuries, medical providers should also screen for ear and brain injuries that may result from similar emergency incidents.

Long-term care facilities (e.g., nursing homes, assisted-living facilities) should review their procedures for gathering patient medical records when evacuating or moving patients in a similar emergency and also exercise their evacuation plans regularly.

Public health entities are encouraged to use this investigation as a model for collaboration between local, regional, state, and federal agencies. A tabletop exercise using these specific incidence data and challenges would help epidemiologists improve their capacity to conduct these types of investigations in the future.

VIII. Challenges

- Submission of study protocol to the IRB

WMCPHD and Texas DSHS staff sought IRB approval to ensure the study protocol would be appropriate and uphold the highest level of ethics through the process. Despite the investigation team already having public health authority in the state to investigate this incident, IRB approval was thought to be the best approach in light of this high-profile incident. The IRB process took approximately three months to complete. The team spent over two months developing the study protocol including the data abstraction tools, survivor interview forms, and detailed plans for data analysis and retention. Perhaps the most time-consuming element for the investigation team was deciding on the appropriate case definitions. The expedited review process by the IRB took one month before approval was granted. The time-consuming nature of submitting an IRB application should be noted for future investigations, though this IRB process helped the team carefully craft the study protocols.

- Communication of the case definitions to data sources

Several case definitions (described above) were crafted by the team, with varying complexity. Case definitions were developed to clearly and easily identify which persons were considered a case and associated with the explosion and which were not. The team contacted and provided acute care facilities with case definitions to aid in querying medical records for abstraction. Unfortunately, the case definitions often confused the health facility personnel, which necessitated further communication with them to clarify issues. This resulted in delays receiving relevant medical records and subsequent quality checks from the investigation team to ensure the appropriate records were being abstracted and that no additional records were missed. Having points of contacts and relationships with medical records departments at acute care facilities sped the process up.

- Intense media interest

Naturally, with a disaster of this magnitude, there was a great deal of sustained interest from local and state media on the investigation. The media was interested in learning more about the methodology of the investigation (e.g., counting acute physical injuries versus mental health conditions, hospital-based focus versus physician offices surveillance, future plans for long term tracking of survivors), costs, status, and timeline. The public information officers from the local and state health department worked closely with the epidemiology team on these inquiries; there was an excellent collaboration among the public information officers from the local and state health department themselves, to timely, consistently, and accurately respond to these media inquiries.

- Timeliness issue of the completed report

Perhaps one of the greatest challenges the investigation team encountered was the time required to fully complete the study, write, and publish the final report. It took one year to publish the first public health report from the initial investigation meeting and almost three years to publish the study as a manuscript in a peer-reviewed journal. Each phase of the study (i.e., medical record abstraction, survivor interviews, analysis) was underestimated for the time required, pushing the completion of the study back. By the time the study reached the report-writing phase (almost one year later), other workplace duties competed for time and priority. Once all data were collected and analyzed, the team spent two months writing the final report, passing drafts back and forth frequently. Knowing there was intense media interest, the report was carefully crafted to ensure ultimate clarity with little room for misunderstanding or misinterpretation from the results. The final report can be accessed at: <http://www.waco-texas.com/userfiles/cms-healthdepartment/file/pdf/West-Texas-Report-6-2014.pdf>. In addition, the investigation was published in a peer-reviewed journal.¹

IX. Promising Best Practices

- Designated coordinator for investigation

This investigation, as already noted, took significant time to complete. To keep the investigation moving forward, one member of the team served as coordinator to facilitate weekly calls to discuss progress, issues, and task assignments. Having a designated coordinator to keep the multidisciplinary team focused was critical to the completion of this investigation and highly recommended for similar future investigations.

- Existing epidemiology capacity at local, regional, state levels

Existing epidemiology capacity at the local, regional, and state levels was critical for the successful completion of this investigation. As noted above, the epidemiology capacity consisted of protocol/survey development, client interviews, and data management, including analysis and interpretation. But it also included a willingness to apply these capabilities in response to a disaster to describe what happened and to provide subsequent recommendations for hospitals, long-term care facilities, and public health agencies. This capacity was supported by local, state, and federal funding.

- Consultation with blast and disaster experts

Because explosions of this magnitude are rare, the epidemiologic team reached out for advice to state and federal public health colleagues that had conducted similar investigations. As noted above, conference calls were held with epidemiologists that responded to the 1995 Oklahoma City bombing and the 2012 Alabama tornado outbreak. These conversations yielded valuable insights which contributed to the development of the epidemiologic investigation approach to this disaster. Talking with colleagues with similar experience was extremely valuable and built confidence that this investigation would be successful.

- Established working relationships with hospitals and urgent care facilities

The investigation team reviewed 654 patient records at 14 facilities, including 11 hospitals and 3 urgent care facilities. Access to hospital medical records is key to this type of investigation; therefore, it was very valuable for DSHS and WMCPHD to have established relationships with those hospitals and urgent care facilities. Due to the complexity of the case definitions, extensive communication with the facility staff was necessary to ensure all records that pertained to the investigation were included. WMCPHD clinic staff and epidemiologists work with hospital staff in a variety of different capacities daily. Existing contacts from these staff were able to direct the investigative team to the appropriate department contacts who could release the needed records. Medical facilities must take every effort to protect the health information of their patients, and existing confidentiality and privacy laws can create a barrier to accessing the medical record data. Being a trusted partner agency with existing information sharing mechanisms makes the process quicker.

- Mental health training/awareness provided to medical abstraction and interview teams

The epidemiologic plan was for team members to review medical charts and interview survivors of the explosion. It was anticipated that reading graphic descriptions of injuries, listening to survivors' vivid stories of their experiences, and acknowledging the enormous grief in the community may impact the mental health of the epidemiology team. As such, early on, a psychiatrist colleague provided mental health training to the team so that they would better equip them in to recognizing, processing, coping, and seeking professional assistance with emotions and feelings that might be experienced during the investigation.

- Access to FEMA data

The local health department contacted state FEMA representatives and requested permanent and temporary residential address and alternate telephone numbers on West residents whose homes were damaged or destroyed and subsequently applied for emergency assistance from the federal government. The goal was to obtain this information as part of the epidemiologic plan to conduct survivor interviews. A Centers for Disease Control and Prevention colleague had informed us that a request of this nature to FEMA was allowed, as announced in the Federal Registry, incidentally published just two weeks after the explosion.² The request for FEMA individual assistance files is allowed "for the purpose of contacting FEMA applicants to seek their voluntary participation in surveys or studies concerning effects of disasters, program effectiveness, and to identify possible ways to improve community preparedness and resiliency for future disasters." FEMA representatives provided the requested information quickly.

- Use of GIS in injury mapping

Mapping was an invaluable tool in this epidemiologic investigation. Geocoding the approximate location, at the time of the explosion, of all chart-abstracted and interviewed individuals allowed for the calculation of their distance proximity to the explosion's epicenter. This led to the conclusion that patients located closer to the explosion were more likely to be admitted to the hospital for treatment of injuries than were those who were located further away.

Prepared by David Zane, Kahler Stone, Hammad Akram, Stephanie Alvey, Bonnie Morehead, Sandi Arnold, and Tracy Haywood (8/4/2017)

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¹ Metzger K, Akram H, Feldt B, Stone K, Alvey S, Henley S, Hernandez A, Melville S, Haywood T, Zane D. Epidemiologic Investigation of Injuries Associated with the 2013 Fertilizer Plant Explosion in West, Texas. *Disaster Med Public Health Prep.* 2016 Aug;10(4):583-90.

² Disaster Assistance Recovery Files, Notice of Privacy Act System of Records, 78 Federal Register 25282, 48765-6, April 30, 2013.