The shelter-in-place decision – all things considered

Glotzer, Psoter, St. Jean and Weiserbs argue that community education can contribute to effective emergency management

Abstract

In the event of a serious accident, or intentional chemical, or radiological incident, the emergency management system must move in a quick and coordinated manner. Furthermore, emergency management must be prepared to advise the public on how to best protect themselves, and be able to manage large number of casualties among disaster victims and the worried well. The ability of emergency management to coordinate a response is based upon their ability in pre-incident planning and preparedness education, to quickly detect an incident, to determine its impact and spread rate, and to inform the public whether the best protective action is to evacuate or to shelter-in-place. Effectiveness of the response should be optimized through community education.

Introduction

On December 2nd and 3rd, 1984, a Union Carbide plant in Bhopal, India leaked 27 tons of the gas methyl isocyanate. None of the six safety systems designed to contain the leak were operational, allowing the gas to spread throughout the city of Bhopal (Broughton 2005). The Indian government reported that a half million people were exposed to the gas (Cassells 1996) and between 3,800 (Broughton 2005) and 10,000 (Sharma 2005) persons died in the first week after exposure to the toxic plume. In the subsequent two decades, an estimated 15,000 to 20,000 premature deaths were also attributed to methyl isocyanate exposure (Sharma 2005). While staggering, the epidemiological surveillance of respiratory, ocular, reproductive, genotoxicity and carcinogenicity, immunotoxicity, psychological and neurobehavioral, and nueromuscular toxicities (Dhara & Dhara 2002) does not portray the immense human suffering caused by this horrific industrial accident. The following anecdotal quote from the Bhopal Medical Appeal and Sambhavna Clinic, (Bhopal Medical Appeal and Sambahavna Trust 2007), a non-governmental organization whose mission is to raise awareness of the effects of the disaster and to provide free medical care for victims, addresses the human suffering caused by the disaster.

"The poison cloud was so dense and searing that people were reduced to near blindness. As they gasped for breath, its effects grew ever more suffocating. The gases burned the tissues of their eyes and lungs and attacked their nervous systems. People lost control of their bodies. Urine and feces ran down their legs. Women lost their unborn children as they ran, their wombs spontaneously opening in a bloody abortion."
(Bhopal Medical Appeal and Sambahavna Trust 2007, 9)

In reaction to the Bhopal disaster, in 1985 U.S. community leaders organized the National Institute for Chemical Studies (NICS) in Charleston, West Virginia to identify ways to reduce dangers posed by chemical plant operations and chemical transport. As a part of its mission, the NCIS provides training for those responsible for mitigating chemical risks. The Institute also provides a forum for the public and the chemical industry to identify safety, health and environmental dangers in order to modify and to improve current operational standards. In summary, the NCIS:

- fosters support for the continued growth and economic development of the chemical industry, while protecting public health, safety and the environment;
- serves as a national model for collaboration between the chemical industry and the American people;
- encourages chemical plants to make public their "worst-case scenarios" (based on this highly successful effort, the U.S. Clean Air Act now requires public disclosure of accident scenarios from all major industrial facilities);
- develops and promotes sheltering-in-place as an alternative to evacuation during chemical emergencies; and
- produces shelter-in-place videos to help publicize appropriate protective steps in a chemical emergency (NICS 2007).

This paper presents information regarding evacuation and sheltering-in-place decision parameters and argues that the effectiveness of these actions may be enhanced through appropriate community education.

Disasters, whether due to terrorist attacks, technology failures, or natural phenomena can happen anytime and anywhere, and without the forewarning necessary to consider all the available response options. Recent examples include the 2003 U.S. Northeast blackout, the 2005 London bombings, and severe weather events, such as hurricane Katrina in 2005 (Currier et al 2006). Although every emergency is different, the decision to evacuate or shelter-in-place is common to all disasters.

Evacuation, especially when the threat is a fire or a hurricane, is the established and instinctive method for protecting the public. Evacuation however, can be difficult, requiring the mobilization of public and private resources to undertake the enormous task of the physical movement of people (Astbury, Horsley, & Gent 1999; Southerworth 1991). Moreover, evacuation, under certain circumstances, may take excessive time and has inherent risks, such as the insurmountable problems plaguing the evacuation management of hurricane Katrina.

There are times when it is safer to stay indoors (sheltering-in-place), as the barrier of a building and the ambient building air may offer instant protection against a noxious agent until help arrives or the agent dissipates. Sheltering-in-place is a viable alternative to evacuation, an action by which exposure to the harmful effects of an agent, can be significantly reduced in both the dose and duration. There are three types of sheltering: normal, expedited, and enhanced sheltering (Sorensen 1988; Vogt et al 1999). Normal sheltering is taking refuge in an existing, unmodified building, closing all windows and doors, and turning off all heating, ventilation and air conditioning (HVAC) equipment. Expedited sheltering is taking shelter in a pre-planned site, where, in addition to normal sheltering, plastic sheeting and tape are applied to windows and doors to reduce infiltration. Enhanced sheltering further reduces infiltration by erecting permanent barriers, such as weather stripping and storm windows (Sorensen 1988; Vogt, Hardee, Sorenson, & Shumpert 1999).

One study (Prugh & Johnson 1988) demonstrated that in a modern, energy efficient building, exposure to a chemical plume was one-tenth the outside dose. The Army has also tested gas infiltration of housing structures by noxious agents such as mustard gas and sarin vapor (Blewett WK et al. 1999). Building protection varied with the air tightness of the building and the length of exposure to the hazardous plume or air movement. Studies on office buildings, especially those built after 1965 when stricter energy conservation standards were instituted, had lower air exchange rates than single story housing; understandably, the tighter the building, the lower the infiltration rate (Vogt, Hardee, Sorenson, & Shumpert 1999). Wind speed and direction, air temperature and inversion conditions contribute to the direction, speed and dispersion of the plume and effect infiltration rates (Vogt, Hardee, Sorenson, & Shumpert 1999). More importantly, for sheltering to be successful, people must have prepared, practiced and believe in the concept, they need to have faith in the recommendations of their local officials (Centers for Disease Control and Prevention 2005; Dombroski, Fischhoff, & Fischbeck 2006) and there must be adequate sheltering resources available (Sorensen, Shumpert, & Vogt 2004).

Frequently, evacuation is not even an option. Local governments may simply close all highways, major thoroughfares and public transportation during a catastrophe and people must shelter-in-place. Most U.S. federal agencies recommend an all hazards approach—planning for any type of disaster—rather than specific plans for each type of disaster, and maintaining provisions to shelter-in-place for 72 hours the average number of people involved in a facility (U.S. Department of Homeland Security 2004). This is especially true for any disaster involving hazardous chemicals or a radiological incident.

The decision to evacuate or to shelter does not occur in a vacuum. First, an official emergency plan is developed and then effectively communicated to the public. Most people even when advised by competent authority, will hesitate to shelter and with the image of the Twin Towers in their mind will instinctively want to "get the hell out". Consequently, with or without official guidance, individuals will still have to make their own decision (Fahy & Proux 1997).

The following is a summary of possible Protective Actions available to public emergency management officials in a disaster.

Evacuation - An order to leave a locale issued when a condition is so hazardous that sheltering-in-place would only place individuals within the area in greater danger. Evacuation instructions are usually issued by ZIP code (or postcode) area.

Shelter-in-place - An order issued for people to seal off a room in their business or dwelling and remain there until advised to leave. However, sheltering-in-place most likely cannot work for more than 3 days.

Note that "sufficiently downwind" is sometimes applied to orders for localities that are in the exposure path of an airborne agent, but are far enough away so that the concentration of the agent has dispersed enough to preclude serious injury. In a "sufficiently downwind" range, it is still advisable for individuals to shelter-in-place to avoid any risk of exposure to the diluted agent.

Community Shielding - Where a community or a government agency establishes and provides food, water and other supplies for community shelters.

Decontamination - The removal of contaminated clothing and showering to rinse contaminated agents from skin and hair (Edwards et al. 2006; NICS 2001).

The decision to shelter-in-place or to evacuate is complex and depends on many factors, including preplanning/preparation, the hazardous agent, the physical environment, and the social awareness of the population (Deci & Ryan 1991). As with all decision-making, one must assemble all available information, consider options, and weigh the pros and the cons of each scenario. A most effective emergency response model should recognize the public as participants in the response, rather than victims of the crisis. This fosters a culture of readiness, emphasizing the importance of good coordination and participation in pre-event drills. These activities give credibility to the agency or authority dispensing advice and helps the public realize that even the most horrendous disasters are manageable (Dombroski, Fischhoff, & Fischbeck 2006). Certainly the logistics of sheltering a population upon the release of a toxic agent becomes much more controllable with an "educated" community that understands the concept of identifying a shelter, providing emergency supplies and how to obtain sources of reliable information.

Table 1: Factors that Lead to a Positive Shelter Decision vs. Evacuation

Pre-event Planning/ Preparation	Agent/Event	Physical Environmental Considerations	Social, Situational Awareness
Building known to be solid;	Chemical (solid, liquid, gas), or radiological;	Night time, visibility limited;	Population density high, urban area;
Designated shelter area available;	Mode of transmission unknown;	Weather dangerous;	Special needs population present (handicapped, kids, elderly);
Necessary supplies on hand;	Potential ability to detect presence poor;	Roads closed; Public transportation inhibited Traffic clogged;	Little advanced warning of event;
Practice drills held;	Persistence and volatility of agent unknown;	Fatalities, but no injuries seen;	No panic, population concurs to shelter;
Employees/public perception positive.	Toxic load of agent high, duration short.	Unusual odor or droplets in the air; Dead animals, birds present; Persons are geographically removed from center of event.	Family members reported safe elsewhere; Information and communication available.

Table 1 enumerates the primary factors involved in the decision whether to shelter or to evacuate in a disaster. The table is not a dichotomous checklist, but an educational tool for identifying, many of the factors involved in the decision to shelter or to evacuate. The table also provides a framework for discussing family emergency actions, "family go-packs" (emergency supplies), and other preparatory actions of importance. It can also be used as guidance as part of developing authoritative public educational information by local and regional entities.

The decision to shelter-in-place or to evacuate primarily depends on the physical structure of the building, evaluation of the outside environment and situational factors; such as, has adequate pre-planning for an incident been conducted? Even with detailed guidelines, optimal decisions will depend on the specificity and the severity of the particular event. For example, if a chemical disaster occurs, will there be high/low levels of noxious vapors that cover a large/limited geographical area? Is the agent extremely harmful to the skin, eyes and respiratory system?

Disseminating appropriate information to emergency managers and various responsible entities beforehand, so that communities are at least minimally prepared and have an understanding of shelter-in-place and evacuation will help to ensure that the decisions of emergency managers will be acted upon and followed through with as little resistance as possible.

In the United States the Department of Homeland Security (DHS) in conjunction with other federal agencies has produced fifteen all hazards scenarios to develop national preparedness standards and the National Response Plan (NRP), which integrates all Federal government level actions into a single all hazards plan. The focus of these scenarios is on the response capabilities and the resources required in each type of incident (DHS 2004). The scenarios include a wide range of natural and man-made disasters. In each, the emergency management system must move in a quick and coordinated manner to advise the public how to best protects themselves. Interestingly to the theme of this discussion, one-third (five) of these scenarios involve a hazardous chemical release or radiation: (1) agent Yellow, a mixture of blister agents Mustard and Lewisite, (2) exploding toxic industrial chemicals (TIC), (3) a Sarin vapour nerve gas release, (4) an industrial Chlorine gas release, and (5) a 'dirty' bomb radiation exposure event.

Using these scenarios, modified for local conditions, responding agencies can explore their response tactics and identify areas in which pre-event education and support to the community would aid their reaction effectiveness. They can be used as well by individual community members to plan to take action to minimize morbidity and mortality independent of the official responder's activities.

An event involving any one of these chemical or radiological agents will strain or inhibit emergency services at all levels of government. Limited or complete cessation of transportation, communication and medical systems would further undermine response efforts and intensify the importance of the media to inform and to protect citizens. Information from emergency management officials will be vital in keeping the public informed of optimal protective and healthcare actions. Effective communication systems must exist to support the management of an incident. Pre-event communication to the community of the basic sheltering versus evacuation parameters, information/communication sources during an emergency and solid advice on basic individual needs for evacuation and sheltering-in-place should enhance the responding agencies efficacy.

It is important for emergency response agencies and media to be familiar with the different ways that people may react in an emergency. Each crisis will carry its own psychological baggage. The community officials must anticipate the mental stresses that the population will be experiencing and apply appropriate risk communication strategies. Effective communication needs a reasoned and mature approach in the selection of the message for the intended audiences. The response agencies must build the perception of competence and expertise in advance of the emergency so that the public will follow their advice. Use of effective communication techniques also allows for managing requests for information from the media, and confronting rumors and misinformation (Reynolds 2006). Along with the information presented here regarding shelter-in-place, using the scenarios may prove a more practical way for emergency planners to present information regarding shelter-in-place versus evacuation decision-making to the public in their community awareness programs.

Conclusion

Disaster preparedness and evaluation of strategies to minimize casualties and death is complex. In order to optimize emergency management and public health outcomes, factors that help lead to a decision to evacuate or shelter-in-place, such as building type, availability of a designated shelter area and supplies, and prior disaster preparedness, are necessary. These factors should be fully assessed and prepared for prior to an actual disaster by responsible agencies and individuals educated by those agencies. This partnership between government, the private sector and individual community members should optimize the effectiveness of a disaster response. The level of education and appropriate dissemination of educational material has to be assessed for its understanding by the general population, in order to assure effective and efficient emergency responses.

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