INDUSTRIAL CHEMICALS AND TERRORISM: HUMAN HEALTH THREAT ANALYSIS, MITIGATION AND PREVENTION

Abstract

Terrorists, warring factions, and saboteurs use chemicals commonly found in communities in industrialized nations to create improvised explosives, incendiaries, and chemical agents. Common chemicals may be used because standard military chemical agents may be difficult or dangerous to manufacture, access, or disperse.

The Agency for Toxic Substances and Disease Registry (ATSDR) developed a 10-step procedure to analyze, mitigate, and prevent public health hazards resulting from terrorism involving industrial chemicals. The procedure includes identifying key information such as potential threats, local sources of chemicals of potential use to terrorists, exposure pathways, impacts on human health and infrastructure, health risk communication needs, and mitigation and prevention methods. The information identified during these steps is then incorporated into emergency response plans and training exercises. Results of applying the 10-step procedure to two communities are discussed.

Introduction

Terrorists sponsored by states, and those with substantial financial resources and technical expertise, may purchase or develop explosives, incendiaries and chemical agents similar to those used by military services. However, several factors limit the use of these weapons by many terrorists, including controlled access to precursor chemicals, difficulty and danger in producing the agents, problems with dispersion of liquid droplets without military munitions, security surrounding government chemical agent stockpiles, and binary chemical agent storage. Industrial chemicals have been used by terrorists as improvised explosives, incendiaries and poisons in several recent

incidents[2,3,4]. While the improvised chemical agents may be less toxic than military agents, many are perceived by the public to be highly dangerous; they have rapid, highly visible impacts on health; they are accessible; and they can be dispersed by smoke, gas clouds, or food and medicine distribution networks.

In response to increasing concerns about chemical terrorism in the United States, the Agency for Toxic Substances and Disease Registry developed a 10-step procedure to assist local public health and safety officials in analyzing, mitigating and preventing such hazards[5,6]. Although the procedure was used to address terrorism in the United States, it may be adapted to conflict zones where industries become targets.

The purposes of this paper are to briefly describe the procedure, and to describe some of the major findings when it was applied to two communities in the United States: a large city in a desert with chemical and entertainment industries, and a county containing several major chemical manufacturing facilities located along a river valley.

Ten-Step Procedure

The procedures consists of the following steps:

1. Identify, assess and prioritize threats
2. Identify local sources of chemicals that may be used in improvised weapons
3. Evaluate potential exposure pathways
4. Identify potential acute and chronic health impacts
5. Estimate potential impacts on infrastructure and the environment
6. Identify health risk communication needs
7. Identify methods to mitigate potential hazards
8. Identify specific steps to prevent the use of industrial chemicals as improvised weapons
9. Incorporate the threat assessment, mitigation, and prevention information into emergency response plans
10. Conduct training exercises to prepare to prevent and mitigate the health threats.

***Step 1**: Identify, Assess and Prioritize Threats*

As a starting point for the first step, national statistics on domestic terrorism were reviewed to identify trends that may have some relevance at the State and local levels[7]. Those statistics indicated that:

- 93% of the incidents involved the use of explosives or incendiaries
- 75% of the incidents occurred in two regions of the country
- 86% of the groups focused on narrowly defined political issues with potential targets that could be identified in advance of an incident, and
- 43% of the targets were businesses or industries, and another 50% involved government staff or property.

The information on national trends dispelled misconceptions about the nature of the threat, and provided strong guidance for identifying and prioritizing threats at the local level. After reviewing the statistics, potential threat groups were assessed based on several characteristics, including potential targets and potential use of industrial chemicals as improvised weapons. In both communities, terrorist groups in the immediate State or region were identified as posing the greatest threats. These groups primarily targeted Federal government infrastructure. However, some of the same groups also espoused a conservative religious agenda, and might

target abortion clinics, gambling casinos, and nightclubs that they find offensive. One of the multi-national corporations located in the river valley community had experienced a chemical disaster at a plant in a foreign nation, resulting in thousands of deaths and injuries. Potential retribution attacks by foreign terrorist groups were considered a significant threat for that industrial facility and the surrounding community.

***Step 2**: Identify Local Sources of Chemicals Used in Improvised Weapons*

"Soft target" sources of chemicals in the two communities mentioned above included:

- chemical manufacturing plants (chlorine, peroxides, other industrial gases, plastics, and pesticides)
- food processing and storage facilities with large ammonia tanks
- chemical transportation assets (rail tank cars, tank trucks, pipelines, and river barges)
- gasoline and jet fuel storage tanks at distribution centers, airports, and barge terminals
- compressed gases in tanks, pipelines, and pumping stations
- gold mines where cyanide and mercury compounds are used
- pesticide manufacturing and supply distributors, and
- educational, medical and research laboratories.

Figure 1 Acids are common industrial chemicals that can be misused as irritants or as ingredients in improvised explosives and incendiaries. Photo by authors.

Some of the more common types of chemicals that could be used in improvised weapons in the communities included:

- eye, skin and respiratory irritants (acids, ammonia, acrylates, aldehydes, and isocyanates)
- choking agents (chlorine, hydrogen sulfide, and phosgene)
- flammable chemical industry gases (acetone, alkenes, alkyl halides, amines)
- aromatic hydrocarbons that could be used as water supply contaminants (benzene, etc.)
- oxidizers for improvised explosives (oxygen, butadiene, and peroxides)
- aniline, nitrile, and cyanide compounds that could be used as chemical asphyxiants
- compressed hydrocarbon fuel gases that could be used as incendiaries or simple asphyxiants (liquified natural gas, propane, isobutane)
- liquid hydrocarbon fuels that could be used as incendiaries or water supply contaminants (gasoline, jet fuel)
- industrial compounds that could be used as blister agents (dimethyl sulfate), and
- organophosphate pesticides that could be used as low-grade nerve agents.

***Step 3**: Evaluate Exposure Pathways*

Five components were evaluated for each potential exposure pathway:

- the source of the chemical (type, duration and magnitude of release)
- delivery methods (transportation routes; fate and transport in air and water; food and drug distribution networks)
- potential targets (businesses and industries, government buildings, animal research

laboratories, abortion clinics, etc.) and adjacent affected areas
- exposure routes (ingestion, inhalation, dermal, and ocular), and
- receptor populations, including sensitive sub-populations such as children, patients in health care facilities, etc.

Figure 2: Chemical transportation assets can be delivered to a wide range of targets. Photo by authors.

Communities with completed exposure pathways (i.e., all five components were potentially present) were identified as high priorities for mitigation and prevention efforts. Three important points were revealed during the pathways analyses. First, unlike military chemical warfare, ingestion is a major exposure route in chemical terrorism, particularly with cyanides, heavy metals, and liquid aromatic hydrocarbons. Second, in both communities, chemical transportation assets posed greater hazards than fixed facilities because substantial quantities of chemicals could be moved closer to potential targets. Finally, it is critically important to identify sensitive sub-populations within each potential receptor population, if possible. For example, in the river valley community, several schools were located adjacent to a facility containing acrylonitrile. Concentrations of acrylonitrile in air that are irritating to adults can be lethal to children.

***Step 4**: Identify Potential Acute and Chronic Health Hazards*

Acute hazards are listed explicitly or can be inferred from the information presented in Step 2. Detailed information can be obtained from a number of government, academic, and commercial sources. References used during the evaluations of the two communities in this paper included :

- the North American Emergency Response Guide Book (http://hazmat.dot.gov/gydebook.htm)
- toxicological profiles, chemical fact sheets, Case Studies in Environmental Medicine, and Medical Management Guidelines published by ATSDR (1-888-422-8737, http://www.atsdr.cdc.gov/)
- fact sheets from the U.S. Environmental Protection Agency (http://www.epa.gov/)
- material safety data sheets from academia http://www.chem.utah.edu/MSDS)
- commercial hazardous substances databases such as TOMES by Micromedix.

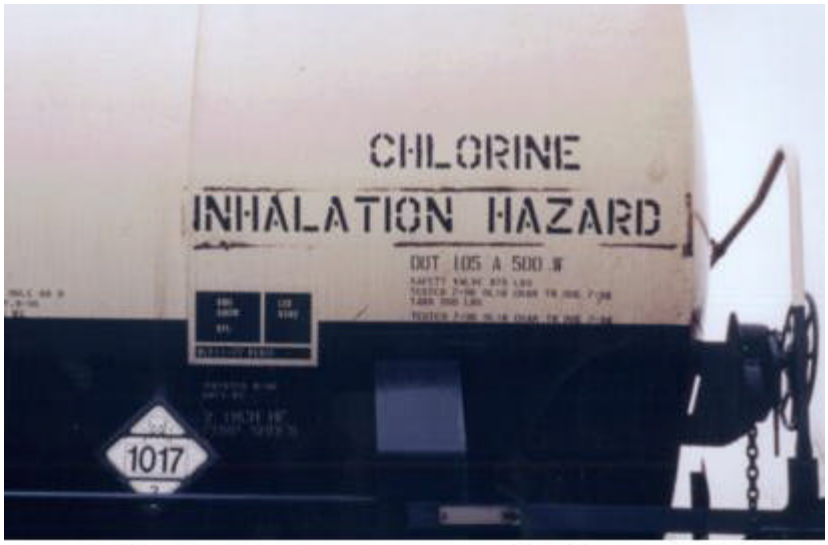

Figure 3: Industrial chemicals can cause acute and chronic health hazards. Photo by authors.

Potential chronic health effects from weapons that could be improvised from sources in the two communities include:

- infections of skin and lung burns, mental depression, and disabilities from incendiaries and explosives
- chronic conjunctivitis and permanent corneal damage from eye irritants
- respiratory diseases (bronchitis, pneumonitis, chronic reduced airway flow) from choking agents
- permanent nerve damage, visual problems, muscle necrosis, psychiatric problems, and memory loss from exposure to organophosphates
- heart, kidney and liver damage from heavy metals, and
- increased risks of birth defects from exposure to nitriles.

Cancer incidence would not be expected to increase in either of the two communities evaluated in response to an acute exposure, although communities are frequently concerned about relationships between chemical exposures and cancers. Long-term medical monitoring would be needed for several of the adverse health effects mentioned above in both communities.

***Step 5**: Identify Potential Infrastructure and Environmental Impacts*

Potential infrastructure impacts identified for the two communities included:

- the need for police, fire and ambulance crews to operate in contaminated environments
- contamination of hospital emergency rooms and staff
- traffic jams and damage to transportation infrastructure (roads, bridges, etc.)
- increased risks of infectious diseases from lack of clean water, disruption of solid waste disposal services, and contact with sewage from broken pipes
- damage to or contamination of government emergency operations centers
- potential need to divert law enforcement personnel to evacuate jail and prison inmates
- disruption of electrical power, telephone, and computer services, and
- destruction, damage, or contamination of houses, schools, and offices.

***Step 6**: Identify Health Risk Communication Needs*

During a major incident, elected officials, the news media, and the public will demand credible information on health risks from exposure to chemical agents, as well as information about casualties, traffic, school children, etc. Health risk communication needs include fact sheets for high-priority chemicals, a formal communications plan, risk communication training, and coordination with law enforcement officials to protect sensitive information.

***Step 7**: Identify Methods to Mitigate Hazards*

Specific steps to mitigate potential hazards and impacts identified during the evaluations of the two communities in this paper included stocking antidotes for cyanide, nitrile, aniline, and organophosphate compounds; specifying alternate emergency operations centers, transportation routes, and medical treatment facilities; preparing paper copies of critical documents in case computer systems fail; and interagency coordination and training exercises. In the river community, emergency response agencies had already distributed "shelter-in-place" instructions to each household in the event of an accidental release. Large electronic billboards in the entertainment section of the desert city could be used for the same purpose. Hazardous materials control infrastructure currently in place at the major chemical plants in the river valley included trained and equipped hazardous materials response crews, a state-of-the-art geographic information system containing detailed industrial chemical information, redundant automated control systems, vapor cloud suppression equipment, expanded highways along evacuation routes in neighborhoods adjacent to the plants, and earth barriers around chemical storage tanks. This infrastructure would be effective in mitigating intentional as well as accidental chemical releases.

Figure 4: Sheltering in place may be preferred over evacuation if danger is close. Photo by authors.

***Step 8**: Identify Specific Steps to Prevent the Use of Industrial Chemicals as Weapons*

Standard industrial security measures were reviewed with security staff from facilities and potential targets in the river community. These included routine searches for suspect devices, anti-blast curtains or film over windows, high-quality locks and alarms, bomb blankets to cover suspect devices, video surveillance, metal detectors, separate entrance and exit points, bag check-in and searches, security fencing, prohibiting unattended package deliveries, employee identification badges, and decals for vehicles. Although routine security measures at government buildings and abortion

clinics were excellent, security at chemical plants ranged from fair to very poor. Most security gaps were the result of complacency and lack of awareness of the threat (i.e., that almost half of the targets were businesses and industries). Chemical plant security managers were very pessimistic about their ability to deter sabotage by employees, yet none of them had implemented simple background checks for key employees such as chemical process operators. None of the corporate security staff had been trained to identify combinations of common chemicals at their facilities that could be used as improvised explosives and incendiaries, although most were aware of individual chemicals that posed significant fire, explosion or poison hazards. Security around chemical transportation assets ranged from poor to non-existent. Chemical barge terminals were located along the banks of the chemical plants, and were freely accessible along the river side of the facility. Rail and truck assets had no security beyond staging areas. Rail cars containing cyanide compounds, flammable liquid pesticides, liquified petroleum gases, chlorine, acids and butadiene were parked alongside residential areas.

***Step 9**: Incorporate Threat, Mitigation, and Prevention Information into Response Plans*

In the United States, chemical emergency response plans are required by Federal law at the Federal, State and local government levels. Most of the State and local plans currently do not address chemical terrorism, and many of those that do focus on terrorist use of military nerve and blister agents, rather than on the more accessible industrial chemicals. Information obtained during the threat, mitigation, and prevention evaluations is being incorporated into emergency response plans in the two communities.

***Step 10**: Train to Mitigate and Prevent Hazards*

The final step is to train to respond to high-priority, realistic threats. Training should include chemical protective equipment for industrial as well as military chemical agents, victim decontamination and transportation, hospital emergency room operations in a chemical environment, medical management of chemical casualties from admission to discharge, victim registration procedures, industrial security measures related to chemical terrorism, and hazardous materials spill assessment and cleanup procedures in areas that are crime scenes and require preservation of evidence. People generally respond to emergencies in the manner in which they are trained. Failing to train to address the specific aspects of industrial terrorism increases the vulnerabilities of industries and adjacent communities.

Conclusion

Industrial chemicals provide terrorists with effective and readily accessible materials to develop improvised explosives, incendiaries, and poisons. Many public and corporate emergency responders are unaware of the magnitude of the threat of terrorism to businesses and industries. The procedure described in this paper is one way to begin to address that threat. It is also adaptable to industries that may become targets in conflict zones. Vigorous efforts are needed by government personnel and corporate security experts to insure that these threats are identified, and that attacks are mitigated, or better yet, prevented from occurring.

Authors

CDR Joseph L. Hughart
Mark M. Bashor
Agency for Toxic Substances and Disease Registry, U.S. Public Health Service

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Dana Abouelnasr dxa0@cdc.gov
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