WHAT ARE THE LONG-TERM CONSEQUENCES?

Late Health Effects of Chemical Agent Exposure
Most health effects from a chemical attack would occur quickly. Some injuries from acute exposure to toxic chemicals, such as eye damage and chemical burns, can persist for a lifetime. Detailed information on the possibility of developing other types of health effects later in life would be made available once a specific exposure is known. Of the military chemical weapons, only mustard gas is a known carcinogen. Although some industrial chemicals are carcinogenic, the risk of developing cancer later in life is not likely to increase significantly following a one-time exposure.

Monitoring and Clean-up of Affected Areas
In the days and weeks following the use of a chemical agent, officials might be expected to:
- Evacuate the limited area near the release site.
- Ensure proper ventilation of the area.
- Establish a plan for careful monitoring and assessment of affected areas.
- Decontaminate areas where liquid agent was present.
- Assure the public that the threat has passed after thorough testing of the affected area.

Economic Impact
Such impacts might involve disruption to lives and livelihoods as the contaminated area is being cleaned up. An attack on a food or agricultural crop could result in long-lasting economic impact for suppliers and their communities as well as consumers.

Chemical Attack

CHEMICAL ATTACK
WARFARE AGENTS, INDUSTRIAL CHEMICALS, AND TOXINS

WHAT IS IT?
A chemical attack is the spreading of toxic chemicals with the intent to do harm. A wide variety of chemicals could be made, stolen, or otherwise acquired for use in an attack. Industrial chemical plants or the vehicles used to transport chemicals could also be sabotaged. Harmful chemicals that could be used in an attack include:
- Chemical weapons (warfare agents) developed for military use.
- Toxic industrial and commercial chemicals that are produced, transported, and stored in the making of petroleum, textiles, plastics, fertilizers, paper, foods, pesticides, household cleaners, and other products.
- Chemical toxins of biological origin such as ricin.

The toxicity of chemicals varies greatly. Some are acutely toxic (cause immediate symptoms); others are not very toxic at all. Chemicals in liquid or vapor form generally lead to greater exposures than chemicals in solid form.

How Toxic Chemicals Could be Used
The severity of an attack is related to the toxicity of the chemical and its concentration when it reaches people. Many variables affect the concentration of a chemical including wind and the volatility of the chemical. The release of toxic chemicals in closed spaces (e.g., in subways, airports, and financial centers) could deliver doses high enough to injure or kill a large number of people. In an open area, a toxic chemical cloud (plume) would become less concentrated as it spreads and would have to be released in large quantities to produce a lot of casualties. Potential delivery methods of toxic chemicals include:
- Ventilation systems of a building.
- Misting, aerosolizing devices, or sprayers.
- Passive release (container of chemical left open).
- Bombs, mines, or other explosive devices that contain chemicals other than those used to create the explosion.
- Improvised chemical devices that combine readily available chemicals to produce a dangerous chemical.
- Sabotage of plants or vehicles containing chemicals.
- Introduction of toxins in the food and water supply.

Detection
Many chemicals at high concentrations can be readily detected with hand-held detection equipment carried by many emergency responders.

Symptoms of Exposure
Visual signs of exposure could include people grouped together who have similar symptoms such as choking or eye irritation. Symptoms in the animal population (birds, wildlife, pets) can be important first indicators, often at concentrations much lower than detected by hand-held devices.
WHAT IS THE DANGER?

Immediate Impact to Human Health

Acute toxic chemicals can cause injury or fatalities if they are inhaled or absorbed by the skin. The harm that chemicals can cause depends on: 1) their degree of toxicity; 2) the concentration of the chemical, 3) the route of exposure, and 4) the duration of the exposure. The symptoms of exposure to most toxic chemicals would appear in minutes to hours. Different chemicals have different effects on the body. Table 1 shows the health effects for some chemical weapons. Some of the most toxic industrial chemicals can produce similar types of health effects at high concentrations. Table 2 shows lethal concentrations for some chemical weapons and industrial chemicals.

The Area Affected

In an open-air environment, the area affected would depend upon such factors as the type and amount of the chemical agent, the means of dispersal, the local topography, and the local weather conditions. For highly toxic chemicals, lethal or immediately life-threatening results could be seen close to where the agent is released where the concentration is highest, while severe to moderate symptoms could be seen at some distance from the event. A toxic cloud would spread roughly with the speed and direction of the wind, but the concentration of the chemical would be greatly diminished at distances far from the source. For a release in a closed space, a volatile chemical will disperse to fill the space. The smaller the space, the greater the concentration of the chemical.

Exposure Through Contaminated Food

Chemical agents can make foods highly toxic, sometimes without changing the appearance or taste of the foods. Butter, oils, fatty meats, and fish absorb nerve agents so readily that removal of contaminated food is virtually impossible. Foods in bottles, cans, or wrappings are not affected by agent vapor and can be salvaged following decontamination. The food supply is vulnerable to intentional contamination by toxins such as botulinum toxin.

Exposure Through Contaminated Water

Water sources in the area of a chemical release could become contaminated, but drinking fish or aquatic life might warn of the release before human use. Deep groundwater reserves and protected water storage tanks are regarded as safe sources of drinking water following a vapor release of chemical agents. There are methods of treating large volumes of potentially contaminated water for emergency drinking.

WHAT SHOULD PEOPLE DO TO PROTECT THEMSELVES?

Practical Steps

If the release is inside a building or a closed space, people should:

1. Do whatever it takes to find clean air quickly: exit the building if they do so with out passing through the contaminated area or break a window to access clean air.
2. Remove outer clothing and place it in a sealed plastic bag.
3. Wash with soap (preferably liquid) and water. Flush skin with lots of water; flush eyes with water if they are irritated.
4. Put on clean clothes.
5. Seek medical attention if they have been exposed, even if they have no immediate symptoms.

If they are near an outdoor chemical release, people should:

1. Avoid any obvious plume or vapor cloud.
2. Walk away from the site and into a building in order to shelter-in-place.
4. Lock doors, close windows, air vents, and fireplace dampers.
5. Turn off fans, air conditioning, and forced air heating systems.
6. Go into a room with as few windows as possible. Seal the room to create a temporary barrier between people and the contaminated air outside.
7. Seal all windows, doors, and air vents with plastic sheeting and duct tape.
8. Improve with what is on hand to seal gaps to create a barrier from any contamination.
9. Watch TV, listen to the radio, or check the Internet often for official news and instructions as they become available.

Decisions Regarding Evacuation

Evacuation as a toxic cloud is passing could result in greater exposures than staying inside. The best course of action will be provided by emergency officials who may use computations from models to calculate the path and potential health effects of the toxic cloud.

Medical Treatment

Immediate medical treatment is required for those exhibiting signs and symptoms of exposure to toxic chemicals. (See Table 1)

Antidotes

There are reliable antidotes for nerve agent exposure, which may be available from medical professionals. Some antidotes, such as atropine, pralidoxime chloride (2-PAM chloride), and diazepam, are contained in the medical kits of first responders, but larger quantities of these antidotes may be found at hospitals and treatment facilities. A specific antidote kit is available for cyanide, but it may have to be administered in a hospital. Supportive medical care and hospital therapy is required for large exposures to phosgene and chlorine vapor.

Table 1. Effects and treatment of some chemical weapons developed for military use

<table>
<thead>
<tr>
<th>Nerve Agents</th>
<th>Blister Agents (injure skin, eyes, and airways)</th>
<th>Blood Agents (cause blood changes and heart problems)</th>
<th>Choking Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>Hydrogen Cyanide</td>
<td>Cyanogen Chloride</td>
<td>Chlorine</td>
</tr>
<tr>
<td>Odor</td>
<td>Odorless</td>
<td>Garlic or Mustard</td>
<td>Garlic or Mustard</td>
</tr>
<tr>
<td>Persistence</td>
<td>Persistent (&gt;12 hrs)</td>
<td>Persistent</td>
<td>Non-persistent</td>
</tr>
<tr>
<td>Rate of Action</td>
<td>Rapid for vapors; liquid effects may be delayed</td>
<td>Delayed</td>
<td>Rapid</td>
</tr>
<tr>
<td>Signs and Symptoms</td>
<td>Headache, runny nose, salivation, pinpointing of pupils, difficulty in breathing, tight chest, sweating, convulsions, nausea, and vomiting</td>
<td>Red, burning skin, blisters, sore throat, dry cough, pulmonary edema, eye damage, nausea, vomiting, diarrhea</td>
<td>Cherry red skin/lips, rapid breathing, dryness, nausea, vomiting, convulsions, diluted pupils, excessive salivation, gastrointestinal hemorrhage, pulmonary edema, respiratory arrest</td>
</tr>
<tr>
<td>First Aid</td>
<td>Remove from area, treat symptomatically</td>
<td>Remove from area, assist ventilations, treat symptomatically, administer cyanide kit</td>
<td>Remove from area, remove contaminated clothing, assist ventilations, rest</td>
</tr>
<tr>
<td>Decontamination</td>
<td>Remove from area, remove clothing, flush with soap and water, anise</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Volatiles, their effects, approximate lethal concentrations, and signs of exposure to toxic chemicals

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Effects</th>
<th>Approx. lethal concentrations (ppm)</th>
<th>Signs of exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarin</td>
<td>Nerve, VC, symptoms of exposure to nerve agents</td>
<td>30</td>
<td>Headache, symptoms of exposure to nerve agents</td>
</tr>
<tr>
<td>Mustard</td>
<td>Mustard, symptoms of exposure to mustard gas</td>
<td>29</td>
<td>Headache, symptoms of exposure to mustard gas</td>
</tr>
<tr>
<td>Leesolate</td>
<td>Leesolate, symptoms of exposure to leesolate</td>
<td>29</td>
<td>Headache, symptoms of exposure to leesolate</td>
</tr>
<tr>
<td>Hydrogen Cyanide</td>
<td>Cyanogen Chloride</td>
<td>Chlorine</td>
<td>Phosgene</td>
</tr>
</tbody>
</table>
Exposure Through Contaminated Water
Toxic chemicals could be used to contaminate the drinking water distribution system. Surface water sources in the area of a chemical release could become contaminated, but drying fish or aquatic life might warn of the release before human use. Deep ground water reservoirs and protected water storage tanks are regarded as safe sources of drinking water following a vapor release of chemical agents. There are methods of treating large volumes of potentially contaminated water for emergency drinking.

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Practical Steps
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<tr>
<th>Chemical agent</th>
<th>Approx. lethal concentration* (in ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarin (GB)</td>
<td>36</td>
</tr>
<tr>
<td>Hydrogen cyanide**</td>
<td>120</td>
</tr>
</tbody>
</table>

Table 2. Varying toxicity of chemicals.

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Some Industrial Chemicals

<table>
<thead>
<tr>
<th>Chemical agent</th>
<th>Approx. lethal concentration* (in ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine**</td>
<td>293</td>
</tr>
<tr>
<td>Hydrogen chloride</td>
<td>3,000</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>4,000</td>
</tr>
<tr>
<td>Ammonia</td>
<td>16,000</td>
</tr>
<tr>
<td>Chloroform</td>
<td>20,000</td>
</tr>
<tr>
<td>Nitric chloride</td>
<td>100,000</td>
</tr>
</tbody>
</table>

*Based on LD50 values in laboratory rats: exposure concentration for 60 minutes at which 50% of rats would die. Rates are used for toxicology tests in part because of similarity to humans, but they are likely to be more susceptible because they have higher metabolisms.

**Used both as chemical weapons and as industrial chemicals Source: NRC, EPA, and ATSDR
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