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High-Threat Chemical Agents: Characteristics, Effects, and Policy Implications

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High-Threat Chemical Agents: Characteristics, Effects, and Policy Implications

Summary

Terrorist use of chemical agents has been a noted concern, highlighted after the Tokyo Sarin gas attacks of 1995. The events of September 11, 2001, increased Congressional attention towards reducing the vulnerability of the United States to such attacks. High-threat chemical agents, which include chemical weapons and some toxic industrial chemicals, are normally organized by military planners into four groups: nerve agents, blister agents, choking agents, and blood agents. While the relative military threat posed by the various chemical types has varied over time, use of these chemicals against civilian targets is viewed as a low probability, high consequence event.

High-threat chemical agents, depending on the type of agent used, cause a variety of symptoms in their victims. Some cause death by interfering with the nervous system. Some inhibit breathing and lead to asphyxiation. Others have caustic effects on contact. As a result, chemical attack treatment may be complicated by the need to identify at least the type of chemical used. Differences in treatment protocols for the various high-threat agents may also strain the resources of the public health system, especially in the case of mass casualties. Additionally, chemical agents trapped on the body or clothes of victims may place first responders and medical professionals at risk.

Protection from and detection of chemical agents is an area of much concern. The range of protection and detection equipment available to first responders has led to questions regarding equipment standardization and state and local preparedness.

Whether terrorist groups are capable of using chemical agents as weapons of mass destruction is unclear. Some have asserted that the volumes of chemicals required to cause mass casualties would make that scenario unlikely. They claim that chemical terrorism is more likely to be small in scale. Others have suggested that there has been an increase in terrorist interest regarding chemical agents, and that this interest could lead to their use in terrorist attacks.

Current policies seek to reduce the proliferation of chemicals that could be transformed into chemical weapons, prevent unrestricted access to large amounts of toxic chemicals, provide federal assistance to locations that are affected by chemical terrorism, and support research and development activities. It is expected that the Department of Homeland Security will take a major role in federal policy efforts.

Additional measures suggested for addressing potential chemical terrorism vulnerabilities include further restricting domestic access to precursor chemicals and technologies required to manufacture high-threat chemical agents; directing continued research and development into selective, sensitive chemical agent detectors; implementing air monitoring equipment to detect chemical releases in, for example, public transportation or urban spaces; and overseeing further research into protective equipment, prophylaxis, and treatment against high-threat chemicals. This report will be updated as circumstances warrant.

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High-Threat Chemical Agents: Characteristics, Effects, and Policy Implications

Introduction

Since the terror attacks of September 11, 2001, policymakers have been attempting to decrease the vulnerability of the United States to the terrorist use of weapons of mass destruction. This report describes the different types of high-threat chemical agents. It also discusses their availability, treatment, and detection, and possible policy approaches to reducing the threat posed by them.

Terrorist use of chemical agents is widely believed to be an event that has low probability, but potentially high consequences. While there is still debate over whether terrorist groups have an increased interest in chemical acquisition and use, the domestic vulnerability of the United States to chemical attack remains high. Policy approaches to reducing chemical vulnerability have generally treated chemical agents as a group, rather than addressing specific agents. Additionally, military and civilian chemical agent detection have developed with little coordination, so that civilian toxic industrial chemical kits and military chemical weapons detectors having varying sensitivities and detection capabilities. Treatments for chemical exposure vary as well, depending on the type of chemical, and so must be addressed on a chemical by chemical basis. Because comparatively few individuals have been exposed to modern chemical weapons, practical experience in treatment of chemical casualties is limited, especially among civilian health care providers. While national efforts to reduce vulnerability to terrorist chemical agent use continue, it is not clear whether specific agents that pose the greatest danger are being adequately addressed as general vulnerabilities are being reduced.

What Are High-Threat Chemical Agents?

High-threat chemical agents are, for the purpose of this report, chemicals posing exceptional lethality and danger to humans.[1] Some may have been developed and used for commercial purposes. Others may have been used or developed by militaries as chemical weapons.

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[1] The determination of what chemical compounds pose the highest threat is open to interpretation. The discussion in this report is a synthesis of military and public health priorities and is not intended to represent a complete list of all potential threats.

Different chemical weapons cause different symptoms in and injuries to their victims. Because of this range of potential symptoms, it can be difficult to know what treatment will be most effective for a victim until the chemical or chemical type has been identified. Also, chemical weapons may produce their effects by different exposure routes, for example, by skin contact or by inhalation. As a consequence, depending on what chemical is encountered, different protective equipment must be employed; for example, a gas mask alone is not sufficient protection against chemicals which can damage through skin contact.

Types of Chemical Agents

Military planners categorize such agents into four classes: nerve, blister, choking, and blood agents.[2] This categorization groups chemicals by the effects they cause to those exposed to them. While the nerve and blister agents are predominantly only manufactured and used by militaries as weapons, both choking agents and blood agents include chemicals widely used in industrial processes.

Nerve Agents

Chemical weapons affecting the nervous system are called nerve agents. Nerve agents do not occur naturally. Rather, they are manmade compounds that require manufacture and isolation for high toxicity and purity. Most nerve agents belong to a group of chemicals called organophosphates. Organophosphates have a wide range of toxicity, and some are commercially employed as insecticides, though these are significantly less toxic than those developed as chemical weapons.[3] Nerve agents are mainly liquids.

Production. The first nerve agent developed for military use, called Tabun or GA, was made in Germany in the 1930s.[4] Following this discovery, a series of nerve agents similar to Tabun were developed. This series, known as the G-series, include the weapons Sarin (GB) and Soman (GD). In the late 1940s, another series of nerve agents, the V-series, was invented in England. Both the British and the United States chemical weapons programs investigated these compounds. The United States manufactured and stockpiled VX.[5] A related compound, V-gas, was manufactured and stockpiled by the Soviet Union. Military use of nerve agents has been rare.

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[2] *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, FM-8285, Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps, 1995.

[3] Nancy B. Munro, Kathleen R. Ambrose, and Annetta P. Watson, "Toxicity of the Organophosphate Chemical Warfare Agents GA, GB, and VX: Implications for Public Protection," *Environmental Health Perspectives*, Vol. 102, 1994, p. 38.

[4] U.S. Army Soldier and Biological Chemical Command, "Tabun - GA Nerve Agent (Dimethylphosphoramido-cyanidate)," Chemical Agent Fact Sheet, 2001.

[5] U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, (Washington, DC: Government Printing Office, December 1993).

Nerve agents were not used during World War I or World War II. During the 1980 — 1988 Iran-Iraq war, Iraq reportedly used nerve agents against Iranian troops and later against members of its Kurdish population in northern Iraq.[6]

National chemical weapons programs have produced nerve agents for decades. The technological barriers for a terrorist group to synthesize these agents might be overcome by using commercially available equipment, though there would be appreciable danger to the manufacturer due to the extreme toxicity of these compounds. Nerve agent production requires the use of toxic chemicals during synthesis and specialized equipment to contain the nerve agent produced. Of the nerve agents, VX has been identified as the most difficult to manufacture.[7]

Effects. Nerve agents are extremely dangerous and can enter the body through the lungs or by skin contact, though for the G-series nerve agents, the inhalation toxicity is significantly greater than the dermal toxicity. Of the nerve agents, VX is the most deadly and Tabun is the least deadly, though all are exceedingly toxic.

Nerve agents interfere with the nervous system, causing overstimulation of muscles. Victims may suffer nausea and weakness and possibly convulsions and spasms. At high concentration, loss of muscle control, nervous system irregularities, and death may occur. The action of nerve agents can be irreversible if victims are not quickly treated.

Treatment. Two drugs, atropine and pralidoxime chloride, are used as antidotes for nerve agents.[8] Atropine prevents muscle spasm and allows the body time to clear the nerve agent. Pralidoxime chloride limits the effects of nerve agent exposure by reversing the agent's action. Both of these drugs were issued to U.S. troops during the Persian Gulf War in the form of an antidote kit called the Mark I. Diazepam (Valium) may be used to reduce convulsions and seizures brought on by exposure to nerve agents.[9]

The treatment window for nerve agent exposure is agent-dependent. Some agents quickly and irreversibly react to enzymes within the body, while others require a much longer time to permanently bind to these enzymes. The most effective treatment occurs before such permanent binding has taken place. Soman, for example, is permanently bound within minutes, while Tabun is not and can be treated up to several hours after exposure. Prophylactic use of some compounds, such as

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[6] Colin Powell, U.S. Secretary of State, Presentation to the U.N. Security Council, February 5, 2003.

[7] U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, (Washington, DC: Government Printing Office, December 1993).

[8] *NATO Handbook on the Medical Aspects of NBC Defensive Operations*, AmedP-6(B), Department of the Army, the Navy, and the Air Force, February, 1996.

[9] Chemical Casualty Care Division, *Field Management of Chemical Casualties Handbook, Second Edition*, U.S. Army Medical Research Institute of Chemical Defense, July, 2000.

pyridostigmine bromide, may create a larger window for effective treatments for some nerve agents.[10]

Blister Agents

Blister agents, also known as vesicants, are chemicals that cause painful blistering of the skin. While such blistering is not generally lethal, the excruciating pain caused by blister agents requires full body protection against these chemicals. Militarily, blister agents produce casualties and reduce the combat effectiveness of opposing troops by requiring them to wear bulky protective equipment.[11] The most common blister agent is mustard agents, which includes nitrogen- and sulfur-based compounds. Mustard agents are oily liquids which range in color from very pale yellow to dark brown, depending on the type and purity, and have a faint odor of mustard, onion or garlic.[12] These liquids evaporate quickly, and their vapors are also injurious.

Blister agents are not naturally occurring compounds. Mustard agents, for example, were first developed in the late 1800s. During World War I, both sides in the conflict used these weapons against their enemies, and the mustard-type blister agent produced the greatest number of chemical casualties during World War I, though fewer than 5% of these casualties died. Many countries have stockpiled blister agents in their chemical weapon inventories. Mustard agent was also reportedly used in the Iran-Iraq war.[13] The United States is currently destroying its stockpile of blister agents.

Production. Production of blister agents is considered less complicated than that of nerve agents.[14] Like nerve agents, it requires the use of some toxic chemicals and specialized equipment to contain the agent produced. The most common blister agents have many different methods for their production published in the open literature.[15]

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[10] Chemical Casualty Care Division, *Medical Management of Chemical Casualties Handbook*, *Third Edition*, United States Army Medical Research Institute of Chemical Defense, August, 1999.

[11] *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, FM-8285, Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps, 1995.

[12] D. Hank Ellison, *Handbook of Chemical and Biological Warfare Agents*, (Boca Raton, FL: CRC Press) 2000.

[13] Chemical Casualty Care Division, *Medical Management of Chemical Casualties Handbook, Third Edition*,United States Army Medical Research Institute of Chemical Defense, August, 1999.

[14] U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, (Washington, DC: Government Printing Office, December 1993).

[15] For example, Jonathan B. Tucker, Director, Chemical & Biological Nonproliferation Program, Center for Nonproliferation Studies, Monterey Institute of International Studies,

(continued...)

Effects. Blister agents can enter the body through the lungs or by contact with the skin or eyes. Some can penetrate through normal clothing material, causing burns in areas that were covered by cloth. While blister agents react quickly upon skin contact, their symptoms may be delayed. In the case of mustard agent, damage occurs within 1-2 minutes of exposure, but symptoms do not manifest for several hours.[16] As even low concentration of vaporized blister agent quickly causes damage, it is unlikely that agents will be removed from the skin prior to injury.

The initial symptoms of blister agent exposure are a reddening of the skin, resembling sunburn, combined with pain in the effected area. Swelling, blisters, and lesions may then develop depending on the degree of exposure. Systemic symptoms such as malaise, vomiting, and fever may also develop in extreme cases.[17] Exposure to large amounts of liquid mustard agent may prove fatal.[18]

The eyes are also very sensitive to blister agents. At high vapor exposures, great pain, corneal damage, and scarring between the iris and lens may occur. The most severe eye damage is often caused by liquid agent, either from contact with airborne droplets or by self-contamination of the eyes from contaminated clothing or body parts.[19]

Victims inhaling blister agents may suffer damage to their lungs. While a single, low-level exposure will likely produce only temporary impairment, high concentrations or repeated exposures may cause permanent damage. Inhalation victims may have symptoms ranging from mild bronchitis to blistering of the lungs.[20]

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[15] (...continued)
testified that there are at least nine published methods to manufacture sulfur mustard agent. Testimony before the Senate Committee on Governmental Affairs, Subcommittee on International Security, Proliferation, and Federal Services, November 7, 2001.

[16] *Draft Toxicological Profile for Mustard Gas,* U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, September, 2001.

[17] *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, FM-8285, Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps, 1995.

[18] Daniel J. Dire, "CBRNE - Vesicants, Mustard: HD, HN1-3, H," *eMedicine Knowledge Base,* January 13, 2003 found online at [http://www.emedicine.com/EMERG/topic901.htm].

[19] During World War I, mild conjunctivitis accounted for 75% of eye injuries, with recovery in one to two weeks. Moderate conjunctivitis with complications accounted for 15% of the cases, with recovery in four to six weeks. Severe corneal damage accounted for 10% of the cases. Those with permanent corneal damage accounted for less than 1% of cases. About 0.1% of these severe casualties would meet the criteria for legal blindness today. Daniel J. Dire, "CBRNE - Vesicants, Mustard: HD, HN1-3, H," *eMedicine Knowledge Base,* January 13, 2003, found online at [http://www.emedicine.com/EMERG/topic901.htm].

[20] *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries,* FM-8285, Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps, 1995.

Treatment. Damage from blister agent exposure, lesions and other skin irritations, is symptomatically treated. Hospitalization may be required for respiratory tract injuries. Victims who suffer severe lung damage may require mechanical ventilation. An additional complication after exposure to large amounts of mustard agent is a general weakening of the whole immune system. Because of these systemic effects, special precautions must be taken against opportunistic infections in the case of exposure to high concentration of mustard agent.[21]

Choking Agents

Chemicals that act on the lungs, causing difficulty in breathing and, potentially, permanent lung damage are known as choking agents. Examples of choking agents include chlorine, ammonia, and phosgene. Choking agents have historically been used during wartime, and are sometimes encountered during industrial accidents.[22] Choking agents are generally gases that have marked odors and may color the surrounding air.

Production. Many choking agents are dual-use chemicals with both a civilian and a military purpose. Chlorine and ammonia are both used in large quantities for commercial applications, while phosgene is used within the chemical industry. Methods for producing choking agents are well known, but may be technically challenging. Choking agents require specialized equipment to produce, compress, and contain them. Choking agents were also manufactured for wartime use, and were extensively used during World War I. The first major, successful, chemical attack of the war used chlorine gas at Ypres in 1915.[23] Chlorine gas was later supplemented by phosgene use, which caused greater casualties.[24]

Effects. Choking agents injure their victims through inhalation, with a comparatively mild effect on the skin. Exposure to low chemical concentrations causes chest discomfort or shortness of breath, irritation of nose and throat, and tearing eyes. High agent concentrations may quickly cause swelling of the lungs, respiratory failure, and possibly death. Symptoms of lung damage can occur up to 48 hours after inhalation of moderate concentrations, and often do not manifest themselves until the lungs are aggravated by physical effort.[25]

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[21] Chemical Casualty Care Division, *Field Management of Chemical Casualties Handbook, Second Edition*, U.S. Army Medical Research Institute of Chemical Defense, July, 2000.

[22] For examples of small toxic gas leaks, see Charles Shumaker and Ken Ward Jr, "Chlorine Leak Closes South Charleston," *The Charleston Gazette*, January 29, 2002 and "Ammonia Leak Forces Evacuation," *The Clarion-Ledger*, February 24, 2003.

[23] A. Boserup, *The Problem of Chemical and Biological Warfare — Volume I — The Rise of CB Weapons*, (Stockholm: Almqvist & Wiskell), 1973.

[24] Scott R. Burnell, "Be Prepared: Act Fast in a Chem Attack," *The Washington Times*, February 12, 2003.

[25] Chemical Casualty Care Division, *Medical Management of Chemical Casualties Handbook, Third Edition*, United States Army Medical Research Institute of Chemical Defense, August, 1999.

Treatment. Victims of choking agents are generally treated symptomatically. Because lung damage may be exacerbated by exercise, victims are kept at rest until the danger of fluid in the lungs is past. Symptoms such as tightness of the chest and coughing are treated with immediate rest and comfort. Shallow breathing and insufficient oxygen may require supplemental oxygen.[26]

Swelling and accumulation of fluids in the lungs are likely after exposure to a high dose of choking agent. Administration of corticosteroids has been recommended in cases of fluid accumulation, but their beneficial effects have not been proven.[27] Rest, warmth, sedation, and oxygen are still the primary treatments, even in the case of marked edema.

Blood Agents

Blood agents are chemicals that interfere with oxygen utilization at the cellular level. Hydrogen cyanide and cyanide salts are agents in this group. Hydrogen cyanide is a very volatile gas, smelling of almonds, while cyanide salts are odorless solids.

Hydrogen cyanide was considered for use as a chemical warfare agent, but was rarely used in military situations because its effectiveness was limited by its quick dispersion. The French manufactured hydrogen cyanide as a military agent during World War I.[28] Hydrogen cyanide was used in other situations though; the principle agent used to kill individuals in German World War II concentration camps, Zyklon B, used hydrogen cyanide as its active agent.[29] Hydrogen cyanide use has been attributed to both sides during the Iran-Iraq war.[30]

Production. Hydrogen cyanide and cyanide salts are now used as industrial chemicals, having application in the chemical, electroplating, and mining industries. As with choking agents, methods for producing blood agents are relatively well-known. However, the gaseous nature of hydrogen cyanide complicates production and storage.

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[26] Chemical Casualty Care Division, *Field Management of Chemical Casualties Handbook, Second Edition*, U.S. Army Medical Research Institute of Chemical Defense, July, 2000.

[27] *NATO Handbook on the Medical Aspects of NBC Defensive Operations*, AmedP-6(B), Department of the Army, the Navy, and the Air Force, February, 1996.

[28] Chemical Casualty Care Division, *Medical Management of Chemical Casualties Handbook, Third Edition*, United States Army Medical Research Institute of Chemical Defense, August, 1999.

[29] J. H. Barrington, Ed., *The Zyklon B Trial: Trial of Bruno Tesch and Two Others*, (London) 1948.

[30] Stephanie Nolen, "Kurds Dread Another Yellow Sky of Death," *The Globe and Mail*, February 15, 2003

Effects. Blood agents act through inhalation or ingestion and impair cellular oxygen use.[31] The central nervous system is especially susceptible to this effect, and blood agents usually cause death through oxygen starvation of brain cells. The symptoms of blood agent exposure depend upon the agent concentration and the duration of exposure. In mild cases, there may be headache, dizziness, and nausea for several hours, followed by complete spontaneous recovery. Higher concentration or longer exposure may additionally cause convulsions and coma. Very high concentrations may lead to powerful gasping for breath, violent convulsions, and cardiac failure within a few minutes.[32]

Treatment. The effects of blood agents are reversed through treatment with specific antidotes: either amyl or sodium nitrite combined with sodium thiosulfate. The combination of these two chemicals removes cyanide, the active compound in blood agents, from the body. When symptoms such as convulsion or depressed breathing are present, ventilation with oxygen and administration of anticonvulsants are used. Cyanide is metabolized more readily than most chemical weapons; with prompt treatment, victims may recover from otherwise-fatal doses.[33]

Protection Against Chemical Agents

Protection against chemical agents is predominantly achieved through physical, rather than medicinal, means. Physical protections limit exposure by protecting the eyes, lungs, and/or skin from chemical contact.

Physical

Physical protection against chemical agents includes gas masks and special protective clothing. Gas mask filters equipped with chemical filters are effective against inhaled chemical agents, but may not provide sufficient protection against chemical agents active on skin contact, such as VX or mustard agents, or high concentrations of other nerve agents.

Gas mask filters are normally constructed from layers of activated charcoal and fine porous material to remove particles and chemicals from the airstream. The activated charcoal binds chemicals, preventing them from being inhaled. Each gas

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[31] *Draft Toxicological Profile for Cyanide*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, September, 1997.

[32] *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, FM-8285, Departments of the Army, the Navy, and the Air Force, and Commandant, Marine Corps, 1995.

[33] Chemical Casualty Care Division, *Medical Management of Chemical Casualties Handbook, Third Edition*, United States Army Medical Research Institute of Chemical Defense, August, 1999.

mask filter has a finite capacity, proportional to the amount of unbound activated charcoal remaining, and so has a limited lifetime once put into operation.[34]

For those chemical weapons that cause effect upon skin contact, a protective garment is required. These garments range in complexity and protective ability. Hazardous materials suits are typically suits made of layered rubber with activated charcoal. In comparison, military battle dress overgarments designed to protect against chemical weapons in the battlefield are generally cloth, sometimes treated to resist absorbing liquids, containing a layer of charcoal-impregnated foam.[35] The rubber in protective equipment is impermeable to most chemical agents, while the activated charcoal acts in a manner similar to a gas mask filter. The combination of mask and suit provides full protection against most chemical exposures.

Medical

There are few examples of medical prophylaxis against chemical weapons. Unlike some biological pathogens, there are no vaccines to provide immunity from the effects of these weapons. However, some protection against the nerve agent Soman can be achieved by the pre-exposure use of pyridostigmine bromide. Pyridostigmine bromide acts to supplement post-exposure administration of the nerve agent antidotes atropine and pralidoxime chloride. Use of pyridostigmine bromide prevents permanent binding of nerve agents within the nervous system. Pyridostigmine bromide use is recommended only when there is a high imminent threat of chemical weapon use, as it has noticeable side effects.[36]

As an added protection against chemical weapons which cause their effects through skin contact, the U.S. Army Medical Research Institute of Chemical Defense has developed a chemical resistant topical skin cream. The Skin Exposure Reduction Paste Against Chemical Warfare Agents, also known as SERPACWA, is designed to complement chemical protective equipment provided to soldiers in the field.[37]

Decontamination

Decontamination, where chemicals are removed from the victims, usually through washing the eyes and skin with water and (against some chemical agents) a

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[34] "Chemical Defense Equipment" by Michael R. O'Hern, Thomas R. Dashiell, and Mary Frances Tracy, *Medical Aspects of Chemical and Biological Warfare*, Chapter 16, pp. 361-396.

[35] *Information Paper: Mission Oriented Protective Posture (MOPP) and Chemical Protection*, Department of Defense, October 30, 1997.

[36] The Food and Drug Administration has approved this compound for military treatment of Soman exposure. Pyridostigmine bromide has limited treatment effectiveness against other nerve agents. FDA News, "FDA Approves Pyridostigmine Bromide as Pretreatment Against Nerve Gas," US Department of Health and Human Services, February 5, 2003.

[37] For more information regarding SERPACWA, see Cindy Kronman, "Army Grants Commercial License for Topical Skin Protectant Technology," *Chemical and Biological Defense Information Analysts Center Newsletter*, Spring, 2003.

dilute bleach solution, is an essential protection against secondary chemical exposure.[38] In addition to stopping the victim's exposure to the chemical agent, this procedure prevents those treating the victim from becoming victims themselves, and avoids contamination of treatment facilities.[39] Decontamination is especially important in those cases where victims have encountered liquid chemical agents, and may have significant amounts of chemical agent trapped in their garments. In events with gaseous agents, decontamination may be less critical. After decontamination is completed, treatment of the victims occurs, in some cases with agent-specific antidotes while in others, symptomatic treatment is performed.

Detection of Chemical Agents

Chemical weapons detection has been predominantly an area of concern for military planners, although the manufacture of some of these agents for commercial use requires detection capabilities at manufacturing plants and by hazardous-materials first responders. While some military units have equipment designated for chemical weapon detection, civilian first responders use a variety of commercial equipment to detect and identify a wide range of chemicals.

Because of the wide spectrum of chemical agents, the development of a portable, integrated instrument which quickly detects all chemical agents remains an area of research and development. The Department of Defense currently employs a series of technologies to detect and identify chemical agents, including personal sensors, automated atmospheric sampling, and field-adapted laboratory methods for battlefield use.

Detection of chemical agents can serve many purposes. One is to provide warning of a chemical attack, allowing additional time to react to a terror event. Another is to identify the chemical agent used in an attack. This might provide for better treatment and more effective response. Finally, determining when an area is clear of chemical agents after a terror attack requires sensitive post-event detection.

There are techniques for detecting chemical agents that are based on sampling the local environment. Detection paper, tickets, and tubes are examples of such techniques. Detection paper is absorbent paper impregnated with special dyes. When a drop of chemical agent is absorbed by the paper, it dissolves one of the pigments, causing the paper to change color. Detection tickets are used in a manner similar to detection paper. The ticket is waved in the air or used with a hand pump to determine if chemical agents are present. Detection tubes use a similar

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[38] Liudvikas Jagminas and Dennis P. Erdman, "CBRNE-Chemical Decontamination," *eMedicine Knowledge Base,* October 15, 2001.

[39] Following the 1995 Sarin attack in the Tokyo subway, it was determined that 10% of the emergency medical technicians who transported victims to the hospital and 23% of the hospital staff workers who treated those victims developed symptoms of Sarin exposure. Jonathan B. Tucker, "Chemical Terrorism: Assessing Threats and Responses," in *High-Impact Terrorism: Proceedings of a Russian American Workshop*, (Washington, DC: National Academy Press) 2002.

technology, but rely on a hand pump to draw air samples through the tube, which discolors in the presence of an agent. A disadvantage to these techniques is that other substances can also dissolve these pigments, causing false positives.[40] The pigments involved can be specific to a type of agent, so an array of papers, tickets, or tubes may be required to identify the exact agent encountered.

Handheld detectors, such as the Chemical Agent Monitor (CAM), are able to detect some chemical agents, namely mustard agents and nerve agents, at levels that are below the lethal threshold, but above the acceptable daily exposure limit for civilians.[41] Automatic sampling devices, such as the Automatic Chemical Agent Detector/Alarm (ACADA), are also employed to provide automated, constant atmospheric sampling.[42] These devices sometimes use a technique called ion mobility spectroscopy to detect the presence of chemical agents.

Much of the above equipment is commercially available, and could be used by hazardous material response teams to assess potential terrorist activity. Typically, hazardous material response teams are equipped with detection paper, tickets, or tubes, but these teams have differing requirements regarding equipment standardization.[43] The President has requested FY2004 funding for the Department of Homeland Security for research on standards for first responder detection equipment.[44] To aid first responders in choosing the best or most appropriate system for their use, the National Institute of Justice has provided guidelines to assess various types of detectors.[45] Supplementing first responders is the Metropolitan Medical Response System, a federal program to enhance local capabilities in the event of a terrorist incident.[46] Ninety-seven metropolitan areas are involved in this system and maintain additional chemical detection, treatment, and decontamination equipment.[47]

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[40] Griffin Davis and Gabor Kelen, "CBRNE - Chemical Detection Equipment," *eMedicine Knowledge Base*, October 15, 2001, found online at [http://www.emedicine.com/emerg/topic924.htm].

[41] Institute of Medicine, *Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response*, (Washington, DC: National Academy Press) 1999.

[42] Daniel M. Nowak, *Chemical Detection on Mobile and Armored Vehicles*, US Army Ground Vehicle Survivability Symposium , 1999.

[43] For more on this topic see CRS Report RL31680 *Homeland Security: Standards for State and Local Preparedness* by Ben Canada.

[44] Department of Homeland Security, *Budget in Brief (FY2004)*, found online at [http://www.dhs.gov/dhspublic/interweb/assetlibrary/FY_2004_BUDGET_IN_BRIEF.pdf]

[45] National Institute of Justice, *Guide for the Selection of Chemical Agent and Toxic Industrial Material Detection Equipment for Emergency First Responders*, US Department of Justice, June, 2000.

[46] This program was moved to the Department of Homeland Security. For more information regarding the Metropolitan Medical Response System, see online at [http://www.mmrs.hhs.gov].

[47] The Department of Health and Human Services has set as a goal the inclusion of 200
(continued...)

Public Health Monitoring

Another way of detecting a chemical terrorism event would be through the public health system. The sudden arrival of chemical casualties in local hospitals will quickly alert health care professionals. Since September 11, 2001 increases in public health networking has improved information sharing between localities.[48] This may increase the likelihood of identifying, for example, a covert release of blister agent through identification of symptoms. Public health monitoring also may aid in forensic investigations following a covert event, especially if symptoms are delayed. Such public health monitoring may also provide opportunities to identify terrorists who may have self-inflicted chemical weapon injuries. Additionally, the Laboratory Response Network has been established, which links together diagnostic laboratories for the identification of chemical agents, as well as disease outbreaks.[49]

Chemical Agents as Weapons of Terror Rather Than as Weapons of Mass Destruction

Many experts believe that it would be difficult for terrorist groups to use chemical agents as weapons of mass destruction. Even VX, the most lethal of nerve agents, would require tons, spread uniformly and efficiently, to kill 50% of the people in a 100 km^2 area.[50] On the other hand, chemical agents might be effectively used as weapons of terror in situations where limited or enclosed space might decrease the required amounts of chemical. That is, the use of the weapon itself, even if casualties are few, could cause fear that would magnify the attack's effect beyond what would be expected based solely on the number of casualties.

There have been few examples of successful chemical terror attacks. In 1995, Aum Shinrikyo, a Japanese apocalyptic cult, used Sarin on the Tokyo subway. The attack killed 12 people and sent more than 5,000 to the hospital with some degree of injury.[51] This same cult reportedly carried out an attack in Matsumoto as well, where

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[47] (...continued)
metropolitan areas in the MMRS by FY 2006. US Department of Health and Human Services Fact Sheet, *Medical Response in Emergencies: HHS Role*, January 25, 2001.

[48] For example, the Centers for Disease Control and Prevention have established the National Electronic Disease Surveillance System to more quickly identify and respond to public health threats. For more information on the National Electronic Disease Surveillance System, see [http://www.cdc.gov/nedss/].

[49] Centers for Disease Control and Prevention, *Summary on the Laboratory Response Network*, April 17, 2002.

[50] U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, (Washington, DC: Government Printing Office, December 1993).

[51] For an overview of the Aum Shinrikyo use of sarin in the Tokyo subway system, see David E. Kaplan, "Aum Shinrikyo (1995)" in *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker, Ed. (Cambridge, MA: MIT Press) (continued...)

7 people were killed and over 200 injured.[52] Both of these attacks used G-series nerve agents, which are more toxic through inhalation than by contact. V-series agents employed in a similar manner might have caused greater fatalities.

In comparison, blister agents would likely be less lethal, but more injurious, if used in a similar manner. Blister agents are dermally active, so inhalation of the agent would not be necessary to cause injury. Additionally, since mustard agent vapor penetrates most fabrics, victims near the point of release might suffer grievously. Blister agents, while not likely to cause mass destruction, might cause mass terror and injury.

Choking agents are no longer considered to be useful military weapons, as chemical suits and masks provide high protection. As a weapon of mass destruction used against civilians, the comparatively low lethality of choking agents complicates their use as a weapon of mass destruction, since very large volumes would be needed.[53] On the other hand, the industrial availability of some choking agents provides opportunities for acquisition and subsequent use of potentially very large volumes of such agents. For example, the United States produces approximately 1 billion pounds of chlorine a year for use in water treatment facilities. The potential vulnerability of chlorine-filled rail tank cars, by which chlorine is primarily transported, has been noted.[54] Terrorist attack on industrial stores at chemical or water treatment facilities or during shipment has been raised as another potential source of concern.[55]

Blood agents may be difficult to employ as weapons of mass destruction for many of the same reasons as choking agents. The quick dispersal of blood agents, combined with the large amounts necessary to cause mass casualties, make such agents difficult to use on a mass scale. Even those blood agents which are industrially manufactured are often used on-site without being shipped. However, terrorist groups seem to be increasingly interested in these agents, perhaps because of criminal use of them.[56]

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[51] (...continued)
2000.

[52] A fact sheet regarding the Matsumoto incident can be found at the Chemical and Biological Arms Control Institute, online at [http://www.cbaci.org/matsumot.htm].

[53] The first use of chlorine, at Ypres in 1915, was a release of 168 tons of chlorine gas. It is estimated to have killed 5,000 unprotected Allied troops.

[54] For example, the deliberate explosion on a rail-car of liquified chlorine is used as an example in the Metropolitan Washington Council of Governments, Regional Emergency Coordination Plan, found online at [http://www.mwcog.org/homeland_plan/RESF_download.htm].

[55] For a representative example, see Fred Reed, "Modern Realities Do Favor Terrorists," *The Washington Times*, February 13, 2003.

[56] Cyanide salts have been used to poison over-the-counter medications. A number of people, seven in 1982, one in 1987, and two in 1993, have died from cyanide poisoning following the use of over-the-counter medications which had been tampered with. See (continued...)

Ramzi Yousef, convicted of the 1993 World Trade Center bombing, stated he had intended to include sodium cyanide in that bomb, in order to create a cloud of cyanide gas.[57] While a small amount of cyanide was found in the supplies of the bombers, there was no evidence that this had been done. In 1995, following the Sarin attack, members of Aum Shinrikyo attempted an attack in Tokyo by setting fire to a plastic bag of sodium cyanide positioned next to a bag of an acid. A similar combination of chemicals was discovered the following month in another station. Both devices were successfully disarmed.[58] In 2002, Italian police arrested four Moroccan men possessing potassium ferrocyanide. It was reported that the men arrested planned to poison the water supply using the potassium ferrocyanide. It is questionable how effective this would have been, considering the volume of the water supply and the amount of potassium ferrocyanide found in their possession.[59] A group calling itself September 11 threatened the use of cyanide to disrupt the America's Cup boat race in New Zealand.[60]

It is believed that the al Qaeda terrorist group has produced and developed plans for the employment of chemical weapons, including hydrogen cyanide. Osama bin Laden has stated that al Qaeda has a chemical capability.[61] Ahmed Ressam, convicted in a plot to bomb the Los Angeles airport, testified he had received training in the use of hydrogen cyanide in Afghanistan at an al Qaeda training camp.[62] The training described included the production of hydrogen cyanide using cyanide salts and acids, demonstrations of the effectiveness of the agent by exposing dogs to it, and introducing the agent into building ventilation systems by placing a source near the air intakes.[63] CNN also located and retrieved videotapes from Afghanistan which portray the results of testing of unknown chemical agents on dogs. It has been

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[56] (...continued)
"Sudafed Tamperer Gets Life With No Parole," *United Press International*, June 8, 1993.

[57] For an overview of the World Trade Center bombing of 1993, see John V. Parachini, "The World Trade Center Bombers (1993)," in *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Jonathan B. Tucker, Ed. (Cambridge, MA: MIT Press) 2000.

[58] "Key Cultist Sentenced to Die for Role in Two Sarin Attacks: Court Rejects Defendant's Claim He Feared Asahara," *The Japan Times*, June 30, 2000.

[59] An overview of this event is provided in Eric Croddy, Matthew Osborne, and Kimberly McCloud, "Chemical Terrorist Plot in Rome?" Research Story of the Week, Center for Nonproliferation Studies, Monterey Institute of International Studies, March 11, 2002.

[60] "NZ Newspaper Receives Second Cyanide Threat Letter," *Reuters*, March 4, 2003.

[61] "Bin Laden Claims to Have Nuclear Weapons in Interview with Pakistani Newspaper," *Associated Press*, November 10, 2001.

[62] Sharon Theimer, "Chemical Weapons Training Revealed," *Associated Press*, September 25, 2001.

[63] Stephen Grey, Dipesh Gadher and Joe Lauria, "What Bin Laden Taught Ressam: from Gruesome Experiments with Poison Gas to the Art of Bomb-Making," *The Ottawa Citizen*, October 7, 2001.

suggested that the chemical agent used in those videotapes was a blood agent, most likely hydrogen cyanide.[64]

Current Policy

Export Control

Treaties and multinational agreements are used to control international proliferation of chemical weapons. These multinational programs inhibit proliferation by increasing the technical barriers to weapon production and the difficulties of obtaining required precursor chemicals. Examples of such multilateral controls include the Wassenaar Arrangement, the Chemical Weapons Convention,[65] and the Australia Group.[66] The Chemical Weapons Convention provides lists of chemicals which are to be controlled through national export regulation. These chemicals include chemical weapons themselves and select precursor chemicals which might be used to develop chemical weapons. In conjunction with these lists for export controls are criteria and a mechanism for inspection visits of facilities suspected of being used to develop chemical weapons.[67] U.S. export controls aimed at creating proliferation barriers include Export Administration Regulations and International Traffic in Arms Regulations.[68]

Industry Self-regulation

Other mechanisms, including voluntary governmental programs, increased contacts between suppliers and purchasers, and industrial best practices, are currently used to monitor sale of dual-use chemicals. The Department of Treasury developed a program called "Operation Shield America," where Customs agents visit U.S. firms manufacturing or distributing technologies and materials which may interest terrorist groups.[69] These agents provide firms with information about U.S. export controls

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[64] Nic Robertson, "Disturbing Scenes of Death Show Capability with Chemical Gas," *CNN*, August 19, 2002.

[65] The Chemical Weapons Convention is the short title of Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction.

[66] Information on the Wassenaar Arrangement, the Australia Group and the Chemical Weapons Convention is found online at [http://www.wassenaar.org/], [http://www.opcw.org/], and [http://www.australiagroup.net]. The United States agreed to the Wassenaar Arrangement in 1996, ratified the Chemical Weapons Convention in 1997, and is a charter member of the Australia Group.

[67] For more information on the Chemical Weapons Convention, see CRS Issue Brief IB94029 *Chemical Weapons Convention: Issues for Congress* by Steven R. Bowman.

[68] Export Administration Regulations can be found at 15 CFR Parts 730-774. International Traffic in Arms Regulations can be found at 22 CFR Parts 120-130.

[69] This program, renamed Project Shield America, was transferred to the Department of
(continued...)

and request that vendors notify the Customs Service if they are approached by customers looking to acquire and export their products illegally.[70] Some industries, such as parts of the chemical and pharmaceutical industries, are developing best practices programs to limit potential misuse of dual-use equipment, equipment with both a civilian and military use. These practices include higher physical security of laboratory and production facilities.[71]

Members of some industries have also developed security plans and self-regulatory mechanisms. For example, the American Chemistry Council, a chemical industrial group, requires its members to adhere to its Responsible Care Security Code. This code has multiple phases including: prioritizing facilities; assessing the physical security procedures at each facility; developing and implementing any identified flaws or risks; and conducting external and internal audits of facility security programs.[72] The General Accounting Office has stated that the extent of security preparedness at chemical facilities is unknown and that such voluntary efforts only reach a fraction of the total number of chemical facilities.[73]

Research and Development

Federal agencies currently involved in research and development related to chemical weapons countermeasures include the Department of Health and Human Services, the Environmental Protection Agency, the Department of Energy, and the Department of Defense. Research being performed in areas related to chemical weapons includes: biomedical research; increasing detector sensitivity; and obtaining better scientific understanding of the behavior of chemical releases.

The Department of Homeland Security's Science and Technology Directorate will fund research and development activities against chemical terrorism. The FY2004 budget request contains $65 million for Chemical/High Explosives Countermeasures, which includes developing better technologies for chemical detection in air and water, chemical weapons forensics, and civilian chemical defense

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[69] (...continued)
Homeland Security and is now operated by the Bureau of Customs and Border Protection within the Border and Transportation Directorate.

[70] For more information on Project Shield America, see [http://www.cbp.gov/xp/cgov/enforcement/ice/investigative_priorities/ecee/].

[71] Members of the American Chemistry Council have adopted a Responsible Care Security Code to limit the effects of terrorist attacks or infiltration at their facilities. See *Protecting a Nation: Homeland Defense and the Business of Chemistry*, American Chemistry Council, 2002. Other industry groups have developed similar plans. See *Biosafety and Biosecurity — Industry Best Practices to Prevent Misuse of Biohazardous Material*, Interpharma, May, 2002.

[72] For more information on chemical plant security, see CRS Report RL31530 *Chemical Plant Security* by Linda-Jo Schierow.

[73] U.S. General Accounting Office, *Security of Chemical Facilities*, GAO-03-439, March, 2003.

systems; and $25 million for a Standards Program, part of which will develop test and evaluation criteria for first responder detection equipment.[74]

Biomedical Research. The United States government continues defensive research into chemical weapons. This research includes enhancing and improving medical treatments for victims of chemical weapon exposure and increasing understanding of the fundamental mechanisms of chemical weapon action. Some of this research is carried out by the Department of Defense, coordinated by the Defense Threat Reduction Agency.[75] The U.S. Army Medical Research Institute of Chemical Defense and U.S. Army Soldier and Biological Chemical Command perform research and development activities, while other research aspects are performed through outside contracts.[76]

Increasing Detector Sensitivity. There are a range of programs engaged in developing new or improved detectors for chemical weapons. Improvements are sought in sensitivity, speed, applicability, and other factors. These programs are located in the Department of Defense, the Department of Energy, and the Environmental Protection Agency.

The Department of Defense is developing the next generation of chemical agent detectors. It has funded the development and testing of the Joint Chemical Agent Detector, a sensitive, multi-agent detection system intended for individual use or networked as perimeter detection.[77] Other research, performed at Department of Energy laboratories, has resulted in the µChemLab system, a portable, hand-held device incorporating "lab on a chip" analysis systems.[78] These devices are in the development and production stages.

Better Understanding of Chemical Releases. Chemical releases may be modeled using powerful computer programs. This ability may aid in determining the potential extent of contamination, areas of likely effect, and the need for evacuation. Additionally, the science of particle/droplet formation, diffusion and dispersal, and technologies for cloud-monitoring and identification are areas where research continues to be funded.[79]

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[74] Department of Homeland Security, *Budget in Brief (FY2004)*, found online at [http://www.dhs.gov/dhspublic/interweb/assetlibrary/FY_2004_BUDGET_IN_BRIEF.pdf].

[75] For more information on the Defense Threat Reduction Agency's Chem-Bio Defense, see [http://www.dtra.mil/cb/cb_index.html].

[76] For more information on the U.S. Army Medical Research Institute of Chemical Defense, see [http://chemdef.apgea.army.mil/]. For more information on the U.S. Army Soldier and Biological Chemical Command, see [http://www.sbccom.army.mil/].

[77] BAE Systems is developing the Joint Chemical Agent Detector. For more information on the Joint Chemical Agent Detector, see [http://www.jcad.baesystems.com/jcad_1.htm].

[78] The µChemLab system is under development at Sandia National Laboratories. For more information on the µChemLab system, see [http://www.ca.sandia.gov/microchem/McCmLab.pdf].

[79] For an example of such research, see "Containing the Effects of Chemical and Biological

(continued...)

Federal Response Teams

There are numerous federal response teams which could be deployed in the event of chemical terrorism. In general, these teams would support local responders in detection, decontamination, or treatment roles. A selection of these teams will be described below.

One response team is the DOD's Chemical/Biological Incident Response Force (CBIRF).[80] CBIRF can be deployed to aid in consequence management after a chemical or biological terror attack. It possesses both decontamination and treatment facilities and can be deployed domestically or internationally at short notice. This rapid response force was deployed at the Atlanta Olympics and is equipped with state of the art equipment for chemical and biological threats. It is located at Indian Head, Maryland, and could be deployed in the case of chemical terrorism.[81]

The Federal Bureau of Investigation maintains a Hazardous Materials Response Unit which, in response to crimes involving chemical weapons, would be available to analyze and identify chemicals and threats present. This unit provided site-safety assessments during the September 11, 2001 attacks.[82]

The U.S. Army Technical Escort Unit conducts chemical detection, decontamination, and remediation of chemical devices or hazards worldwide. While typically deployed to handle and secure discovered chemical munitions, they also have been used to provide support to other large national events.[83]

As part of the National Disaster Medical System, Disaster Mortuary Operational Response Teams, Disaster Medical Assistance Teams, and four National Medical Response Teams are available to be deployed to the scene of a national emergency. This program was transferred to the Department of Homeland Security and is now located within the Emergency Preparedness and Response Directorate.[84]

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[79] (...continued)
Agents in Buildings," *EETD Newsletter*, Spring, 2002. For more information on modeling airborne toxic releases, see the Urban Security Project at Los Alamos National Laboratory, found online at [http://www.lanl.gov/orgs/d/d4/aquality/urban.html].

[80] More information on the Chemical/Biological Incident Response Force can be found online at [http://www.lejeune.usmc.mil/4thmeb/cbirf.htm].

[81] Steve Vogel, "Specialized Marine Unit Readies To Respond to the Unthinkable: Force Trains for Chemical, Biological or Radiological Attacks," *The Washington Post*, February 17, 2003.

[82] *FBI Laboratory 2001 Report*, Federal Bureau of Investigation, 2001.

[83] More information can be found online at [http://teu.sbccom.army.mil/].

[84] For more information see CRS Report RL31791, *Emergency Management Funding for the Department of Homeland Security: Information and Issues for FY2004* by Keith Bea, Coordinator, Rob Buschmann, Ben Canada, Wayne Morrissey, C. Stephen Redhead, and Shawn Reese.

The National Guard supports several Weapons of Mass Destruction Civil Support Teams. They were established to support local resources in determining the nature and extent of an attack or incident. These teams are able to deploy within four hours of a given alert.

Policy Implications

There are several areas where policymakers may wish to further address the danger posed by terrorist acquisition and use of high-threat chemical agents: the availability of such chemical agents; the availability of chemical detectors, their sensitivity, and their use; the ability of first responders and diagnostic laboratories to detect, respond to, and resolve a chemical attack; the development of new treatments and prophylaxis; and determining whether an appropriate amount of funds and federal attention is being given to this topic.

Chemical Availability

Chemical agent availability varies greatly. Some chemicals, notably those with commercial or industrial use, are available for over-the-counter purchase from chemical suppliers. Because these chemicals have a legitimate civilian use, there is little oversight of such sales. Consequently, these chemicals may be available for purchase or theft in large quantities.[85]

Regulatory mechanisms designed to increase the barriers to illicit acquisition of dual-use chemical agents, such as mandatory identity or use verification for domestic purchases, might reduce the relative threat. Such a proposal might add a significant burden to chemical manufacturers and distributers, as well as end-users of these chemicals, since verification paperwork and procedures could increase manufacturing and overhead costs. Additionally, increasing acquisition barriers via purchase of such agents would not address the threat posed by theft of these agents.

Dual-use chemical agents are transported, and occasionally stored, in large quantities, and it is possible that they might be stolen, or even intentionally damaged while in transit, as part of a terror attack. Some have advocated that the transport and storage of these chemicals be regulated with greater strictness, with their transport limited to less populated areas and the amounts transported or stored limited,[86] and that such facilities be made more secure.[87] Others have pointed to efforts taken by

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[85] Theft of some high-threat agents has been reported. For example, ten tons of sodium cyanide were stolen by hijacking a cargo truck in Mexico. Laurence Iliff, "Stolen Truck with Cyanide Cargo Found in Mexico," *The Dallas Morning News*, May 17, 2002. There have also been reports of anhydrous ammonia stolen from user facilities. "1,500 Evacuated After Theft Causes Ammonia Leak in Washington State," *Associated Press*, May 13, 2002.

[86] See, for example, Steve Dunham, "Securing Rail Freight," *Journal of Homeland Security*, February, 2003.

[87] For example, the city of Baltimore is currently developing an ordinance designed to lower

(continued...)

water officials to reduce on-site stockpiles of chemicals and to use alternate purification methods as a model for reducing vulnerability.[88]

Such proposals raise the question of what an acceptable threshold for stored or transported chemical agents might be. Railcars may contain up to ninety tons of chemical, while other storage facilities may contain comparable amounts. Anhydrous ammonia used for refrigerant purposes is sometimes stored in fifty to one hundred ton amounts. Proposals involving increasing security or limiting the size of allowed transfer or storage of chemicals might have significant economic costs. Additional security at manufacturing and transport facilities may increase the cost of these chemicals, while requiring end-user security improvement may prove impractical. Assessing the success of such plans may also be complicated. Legislation has been introduced in the 108th Congress to address some of these issues.[89]

The availability of actual chemical weapons is severely limited. Facilities where they are kept have high security, and access to chemical weapons is strictly controlled.[90] Chemical weapons in the United States are controlled in military facilities.[91] On the other hand, some chemical weapon precursors, such as thiodiglycol, can be domestically purchased from chemical companies in limited quantities. Some companies have instituted a greater degree of identity and use verification for these purchases. There are many potential manufacturing methods for chemical weapons, and so it is possible to make them from simpler, unregulated compounds. However, this process would increase the manufacturing complexity and time required for production. Legislation has been introduced in the 108th Congress to address some of these issues.[92]

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[87] (...continued)
the risk of terrorism at industrial plants. Marina Sarris, "Baltimore Security Ordinance Being Put Into Place," *Pesticide and Toxic Chemical News*, February 3, 2003.

[88] Carol D. Leonnig and Spencer S. Hsu, "Fearing Attack, Blue Plains Ceases Toxic Chemical Use," *The Washington Post*, November 10, 2001.

[89] For information about 108th Congress legislation regarding chemical plant security, see CRS Report RL31530, *Chemical Plant Security*, by Linda-Jo Schierow..

[90] An intruder spotted at the Deseret Chemical Depot caused a quick mobilization of security forces. "Intruder Spotted at Army Chemical Depot," *CNN*, September 5, 2002.

[91] Chemical demilitarization facilities dispose of chemical weapons on their sites. Deseret Chemical Depot is currently engaged in incineration of chemical weapons, and seven other facilities are to be constructed. U.S. Army Corps of Engineers, *Chemical Demilitarization Fact Sheet*, September, 2001.

[92] Representative Engel introduced H.R. 726, the Chemical Attack Prevention Act, on February 26, 2003. It would require licenses for the domestic sale, purchase, and distribution of certain chemicals that are precursors to chemical weapons. It has been referred to the Committee on Energy and Commerce, Subcommittee on Commerce, Trade and Consumer Protection, where no further action has been taken as of this writing.

Chemical Detector Research

Policymakers may wish to direct or increase research efforts in developing reliable, sensitive chemical agent detectors. Detection of chemical agents at low levels is a challenging task which has not yet been uniformly achieved. The current generation of Chemical Agent Monitors is not capable of detecting chemical weapons at the acceptable exposure threshold limit.[93] This greatly complicates the efforts of hazardous materials first responders in assessing safety.

One of the trade-offs in developing sensitive chemical detectors is the risk of detecting a chemical similar to a chemical agent and incorrectly registering it as an agent. In a civilian system, such false positives may lead to great disruption and uncertainty.[94] In contrast, false negatives, where the detector signals the absence of a chemical agent when one is actually present, might endanger civilians.

Environmental Detection of Chemical Weapon Release

How chemical weapon detectors are to be employed in civilian society is open to question. Currently detectors are used on a case-by-case basis, generally in response to an emergency. Chemical weapon detectors are used to determine the extent of a hazardous release and the degree of contamination of the air and surrounding materials. (The atmosphere is not generally monitored for chemical weapons.) This prevailing approach is being assessed to determine if it is the most appropriate use of such equipment.

At least one real-time chemical detection system has been installed in public transit in Washington, DC, to detect potential chemical attacks in the Washington Metropolitan Transit System. Information about the extent of the system and its sensitivity is not publically available, but such a prototype system might be further expanded to provide greater detection coverage within the Washington Metropolitan Transit System or installed in other public transit systems to provide chemical detection ability.[95] Expansion of such a system might prove costly, both in initial costs and in maintenance. An assessment of how effective the current prototype system has been, including whether it has an appreciable number of false signals or the degree of testing the system has undergone in identifying compounds at appropriately low concentrations, is not publicly available.

The Environmental Protection Agency has a nationwide system of air quality detectors which it uses to monitor certain compounds, such as ozone and common

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[93] Eugene L. Berger, "Sensitivities of Selected Chemical Detectors," MITRE Technical Report, February, 2000.

[94] False positives are of concern for military units as well. As a partial remedy to excessive false positives in current military equipment, troops in the Persian Gulf were issued chickens, which are considered especially sensitive to chemical agents, as chemical weapon detectors. Ron Claiborne, "Chicken Warnings Aren't for the Birds: U.S. Army Units Say Chickens Are Reliable Gas Attack Detectors," *ABC News*, February 25, 2003.

[95] "Subway Defense Effort Picks Up Steam," *CBS News*, September 27, 2001.

pollutants. A prototype system for detecting biological agents has been added to selected detectors, with the goal of identifying covert biological weapon release.[96] Whether a similar system could be developed to detect covert chemical weapon release may be of interest to policymakers. Any such system would need to be sensitive and provide timely data, while also providing detector coverage for an appreciable outdoor area. In the prototype biological detection system being implemented, samples are taken back to a laboratory and there tested for biological material. This may be an effective method for testing for biological weapons, as there is usually a multi-day incubation period for infection. In contrast to biological weapons, chemical weapons cause their effects quickly. Any detector system designed to monitor ambient air would need to respond immediately, a key criterion in a "detect-to-warn" system. A chemical weapon's effects would be detected through the arrival of victims in hospitals before a laboratory test of detector samples could be performed.

Additionally, the utility of such a detection grid might be in question if the system is unable to detect small, but effective, amounts or releases which occur within enclosed spaces. Development and maintenance of such a system may prove costly, both in initial capital and in maintenance costs. Determining the density and location of such monitors may also pose a difficult policy issue. The criteria used for locating air quality monitors may not be equally appropriate for chemical agent detection.

First Responder Equipment and Diagnostic Laboratories

First responder equipment is currently not standardized, with each jurisdiction purchasing its own equipment. Whether all first responders should have standardized equipment may be a topic of Congressional interest.[97] Some first responder teams feel well-equipped and prepared for a potential chemical attack, while others do not yet have necessary equipment.[98] While the National Institute of Justice has provided a manual outlining the criteria by which chemical equipment might be assessed,[99] some first responders have claimed that the federal government has not provided enough oversight and direction regarding such esoteric purchases.[100] Advocates of allowing each community to choose what equipment to provide to first responders point out that the needs of one community may not be the same as the next, and, because of location, population, or previous expenditures, mandating specific

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[96] "U.S. Launching Bioterror Detectors: Nationwide System Uses Existing Air Pollution Filters," *MSNBC*, January 22, 2003.

[97] Greg Seigle, "'First Responders' to Terrorism Seek Federal Strategy, Equipment," *Global Security Newswire,* March 6, 2002.

[98] Kevin Flynn, "New York City Officials Defend Counterterror Training," *The New York Times*, February 14, 2003.

[99] *Guide for the Selection of Personal Protection Equipment for Emergency First Responders,* NIJ Guide 102 — 00 (Volumes I, IIa, IIb, and IIc), National Institute of Justice, November, 2002.

[100] Greg Seigle, "'First Responders' to Terrorism Seek Federal Strategy, Equipment," *Global Security Newswire,* March 6, 2002.

equipment purchases may not meet locality needs.[101] The Department of Homeland Security's Standards Program will develop test and evaluation criteria and conduct analyses for first responder detection equipment to help provide more guidance.[102] The adequacy of current first responder equipment and its availability, whether proper guidance has been given by the federal government to state and local authorities regarding this equipment, and what steps may be required, through oversight or legislation, to properly equip first responders, are also topics of potential interest to policymakers.

Another area where equipment and methodologies are not standardized is the testing of environmental samples. State public health laboratories, which might be reasonably expected to handle analysis of samples from potentially contaminated sites or perform confirmatory tests as to the identity of a chemical used in an attack, have reported a lack of funding and planning regarding this topic.[103] The Chemical Terrorism Project of the Association of Public Health Laboratories has developed a series of recommendations for improving the ability of public health laboratories to respond to chemical terrorism.[104] Thus, there may be interest in determining whether federal agencies are fulfilling their role in providing validated testing methods for diagnostic laboratories, whether appropriate support is available for testing equipment for state laboratories, and what role the federal government should play with respect to state laboratories.

Treatments and Prophylaxis

Because of the rarity of chemical weapon exposure, there has been little civilian market for new treatments and prophylactics against them. Development and identification of medications against chemical weapons is thus an area of limited private sector research. Some have argued that without federal sponsorship of such research, advances in this area will be very slow, and new treatments will not be sufficiently developed. They assert that the federal government should commit to purchasing fixed quantities of a successful new treatment in order to boost private-sector funding of this research.[105] They point out that without an assured market, the private sector will not be willing to spend research and development money on products. Others believe that committing to the purchase of unproven treatments will not yield the best treatments and prophylaxis possible. Finally, some assert that

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[101] For more information on this topic, see CRS Report RL31475 *First Responder Initiative: Policy Issues and Options*, by Ben Canada.

[102] For more information on this topic, see CRS Report RL31680, *Homeland Security: Standards for State and Local Preparedness*, by Ben Canada.

[103] "Study Finds Public Health Laboratories Not Ready for Chemical Terrorism," Association of Public Health Laboratories, February 5, 2003.

[104] See Chemical Terrorism Project, *Ready or Not...*, Association of Public Health Laboratories, July, 2003.

[105] For example, in the 2003 State of the Union address, President Bush announced Project BioShield, which would invest $900 million for development and storage of weapon of mass destruction countermeasures. There has been extensive action in Congress on this proposal. For detailed information, see CRS Report RS21507 *Project BioShield*, by Frank Gottron.

improvements should be made to the general public health system, rather than targeting low probability events.

Federal Emergency Response Teams

The possible use of federal response teams to augment local first responder capabilities provokes differing responses. An investigation by the General Accounting Office in 2000 found that "Federal response teams do not duplicate one another."[106] On the other hand, the varied teams established by these agencies have been called redundant.[107] Also, the general structure of establishing regional teams has been questioned, since there would be a delay in response due to required travel time for a team.[108] Others have advocated that parallel civilian and military response teams may be necessary, since military teams might not be available to civilians during wartime.

Related CRS Products

CRS Report RL31332, *Weapons of Mass Destruction: The Terrorist Threat*, by Steve Bowman.

CRS Report RL31831, *Terrorist Motivations for Chemical and Biological Weapons Use: Placing the Threat in Context*, by Audrey Kurth Cronin.

CRS Report RL31669, *Terrorism: Background on Chemical, Biological, and Toxin Weapons and Options for Lessening Their Impact*, by Dana A. Shea.

CRS Report RL31475, *First Responder Initiative: Policy Issues and Options*, by Ben Canada.

CRS Report RL31853, *Food Safety Issues in the 108th Congress*, by Donna U. Vogt.

CRS Report RL31791, *Emergency Management Funding for the Department of Homeland Security: Information and Issues for FY2004*, by Keith Bea, Coordinator, Rob Buschmann, Ben Canada, Wayne Morrissey, C. Stephen Redhead, and Shawn Reese.

CRS Report RL31530, *Chemical Plant Security*, by Linda-Jo Schierow.

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[106] General Accounting Office, *Combating Terrorism: Federal Response Teams Provide Varied Capabilities; Opportunities Remain to Improve Coordination*, GAO-01-14, November 2000.

[107] Jonathan B. Tucker, "Chemical Terrorism: Assessing Threats and Responses," in *High-Impact Terrorism: Proceedings of a Russian American Workshop*, (Washington, DC: National Academy Press) 2002.

[108] Joshua Green, "Weapons of Mass Confusion," *The Washington Monthly*, May 2001.

CRS Report RL30169, *Export Administration Act of 1979 Reauthorization*, coordinated by Ian F. Fergusson.

CRS Issue Brief IB94029, *Chemical Weapons Convention: Issues for Congress*, by Steven R. Bowman.

CRS Report RL31559, *Proliferation Control Regimes: Background and Status*, by Sharon A. Squassoni, Coordinator, Steven R. Bowman, and, Carl E. Behrens.