Bioterrorism

United States Airman wearing an M-17 nuclear, biological, and chemical warfare mask and hood

Terrorism

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Bioterrorism is terrorism involving the intentional release or dissemination of biological agents. These agents are bacteria, viruses, or toxins, and may be in a naturally occurring or a human-modified form. For the use of this method in warfare, see biological warfare.

Definition

According to the U.S. Centers for Disease Control and Prevention (CDC):

> A *bioterrorism attack*
>
> is the deliberate release of viruses, bacteria, toxins or other harmful agents used to cause illness or death in people, animals, or plants. These agents are typically found in nature, but it is possible that they could be mutated or altered to increase their ability to cause disease, make them resistant to current medicines, or to increase their ability to be spread into the environment. Biological agents can be spread through the air, water, or in food. Terrorists tend to use biological agents because they are extremely difficult to detect and do not cause illness for several hours to several days. Some bioterrorism agents, like the smallpox virus, can be spread from person to person and some, like anthrax, cannot.[]

Bioterrorism is an attractive weapon because biological agents are relatively easy and inexpensive to obtain, can be easily disseminated, and can cause widespread fear and panic beyond the actual physical damage they can cause.[1] Military leaders, however, have learned that, as a military asset, bioterrorism has some important limitations; it is difficult to employ a bioweapon in a way that only the enemy is affected and not friendly forces. A biological weapon is useful to terrorists mainly as a method of creating mass panic and disruption to a state or a country.

However, technologists such as Bill Joy have warned of the potential power which genetic engineering might place in the hands of future bio-terrorists.[2]

The use of agents that do not cause harm to humans but disrupt the economy have been discussed.[*citation needed*] A highly relevant pathogen in this context is the foot-and-mouth disease (FMD) virus, which is capable of causing widespread economic damage and public concern (as witnessed in the 2001 and 2007 FMD outbreaks in the UK), whilst having almost no capacity to infect humans.

History

Early use

Biological terrorism dates as far back as Ancient Rome, when faeces were thrown into faces of enemies.[3] This early version of biological terrorism continued on into the 14th century where the bubonic plague was used to infiltrate enemy cities, both by instilling the fear of infection in residences, in hopes that they would evacuate, and also to destroy defending forces that would not yield to the attack. The use of disease as a weapon in this stage of history exhibited a lack of control aggressors had over their own biological weapons. Primitive medical technology provided limited means of protection for the aggressor and a battle's surrounding geographical regions. After the battle was won, the inability to contain enemies who escaped death led to widespread epidemics affecting not only the enemy forces, but also surrounding regions' inhabitants. Due to the use of these biological weapons, and the apparent lack of medical advancement necessary to defend surrounding regions from them, widespread epidemics such as the bubonic plague quickly moved across all of Europe, destroying a large portion of its population. The victims of biological terrorism in fact became weapons themselves. This was noted in the Middle Ages, but medical advancements had not progressed far enough to prevent the consequences of a weapons use.[4]

Over time, biological warfare became more complex. Countries began to develop weapons which were much more effective, and much less likely to cause infection to the wrong party. One significant enhancement in biological weapon development was the first use of anthrax. Anthrax effectiveness was initially limited to victims of large dosages. This became a weapon of choice because it is easily transferred, has a high mortality rate, and could be easily obtained. Also, variants of the anthrax bacterium can be found all around the world making it the biological weapon of choice in the early 19th century. Another property of anthrax that helped fuel its use as a biological weapon is its poor ability to spread far beyond the targeted population. Anthrax could not be spread from person to person.

20th century

By the time World War I began, attempts to use anthrax were directed at animal populations. This generally proved to be ineffective. Shortly after the start of World War I, Germany launched a biological sabotage campaign in the United States, Russia, Romania, and France.[] At that time, Anton Dilger lived in Germany, but in 1915 he was sent to the United States carrying cultures of glanders, a virulent disease of horses and mules. Dilger set up a laboratory in his home in Chevy Chase, Maryland. He used stevedores working the docks in Baltimore to infect horses with glanders while they were waiting to be shipped to Britain. Dilger was under suspicion as being a German agent, but was never arrested. Dilger eventually fled to Madrid, Spain, where he died during the Influenza Pandemic of 1918.[5] In 1916, the Russians arrested a German agent with similar intentions. Germany and its allies infected French cavalry horses and many of Russia's mules and horses on the Eastern Front. These actions hindered artillery and troop movements, as well as supply convoys.[]

American biological weapon development began in 1942. President Franklin D. Roosevelt placed George W. Merck in charge of the effort to create a development program.[6] These programs continued until 1969, when by executive order President Richard Nixon shut down all programs related to American offensive use of biological weapons.[]

US President Richard M. Nixon announced his new policy on biological warfare at a press conference in the Roosevelt Room of the White House on November 25, 1969. “Biological weapons have massive, unpredictable, and potentially uncontrollable consequences,” he declared. “They may produce global epidemics and impair the health of future generations.” He then stated that, in recognition of these dangers, the United States had decided to destroy its entire stockpile of biological agents and confine its future biological research program to defensive measures, such as vaccines and field detectors.[7] As the 1970s passed, global efforts to prevent the development of biological weapons and their use were widespread.

On August 10, 1972, President Richard M. Nixon formally transmitted the Biological Weapons Convention to the United States Senate for ratification. In his transmittal, he states: "I am transmitting herewith, for the advice and consent of the Senate to ratification, the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons, and on their Destruction, opened for signature at Washington, London and Moscow on April 10, 1972. The text of this Convention is the result of some three years of intensive debate and negotiation at the Conference of the Committee on Disarmament at Geneva and at the United Nations. It provides that the Parties undertake not to develop, produce, stockpile, acquire or retain biological agents or toxins, of types and in quantities that have no justification for peaceful purposes, as well as weapons, equipment and means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."[8]

In 1972 police in Chicago arrested two college students, Allen Schwander and Stephen Pera, who had planned to poison the city's water supply with typhoid and other bacteria. Schwander had founded a terrorist group, "R.I.S.E.", while Pera collected and grew cultures from the hospital where he worked. The two men fled to Cuba after being released on bail. Schwander died of natural causes in 1974, while Pera returned to the U.S. in 1975 and was put on probation.[9]

Since that time, efforts to use biological warfare has been more apparent in small radical organizations attempting to create fear in the eyes of large groups. Some efforts have been partially effective in creating fear, due to the lack of visibility associated with modern biological weapon use by small organizations.

1984 - USA - Rajneeshee bioterror attack

In Oregon in 1984, followers of the Bhagwan Shree Rajneesh attempted to control a local election by incapacitating the local population. This was done by infecting salad bars in 11 restaurants, produce in grocery stores, doorknobs, and other public domains with *Salmonella typhimurium* bacteria in the city of The Dalles, Oregon. The attack infected 751 people with severe food poisoning. However, there were no fatalities. This incident was the first known bioterrorist attack in the United States in the 20th century.[10]

1993 - Japan - Aum Shinrikyo anthrax release in Kameido

In June 1993 the religious group Aum Shinrikyo released anthrax in Tokyo. Eyewitnesses reported a foul odor. The attack was a total failure, infecting not a single person. The reason for this, ironically, is that the group used the vaccine strain of the bacterium. The spores recovered from the attack showed that they were identical to an anthrax vaccine strain given to animals at the time. These vaccine strains are missing the genes that cause a symptomatic response.[11]

21st century

2001 - USA - Anthrax Attacks

In September and October 2001, several cases of anthrax broke out in the United States in the 2001 anthrax attacks, caused deliberately. Letters laced with infectious anthrax were delivered to news media offices and the U.S Congress. The letters killed 5. CNN [12] Tests on the anthrax strain used in the attack pointed to a domestic source, possibly from the biological weapons program. Still the attacks provoked efforts to define biodefense and biosecurity, where more limited definitions of biosafety had focused on unintentional or accidental impacts of agricultural and medical technologies.

Types of agents

Under current United States law, bio-agents which have been declared by the U.S. Department of Health and Human Services or the U.S. Department of Agriculture to have the "potential to pose a severe threat to public health and safety" are officially defined as "select agents". The CDC categorizes these agents (A, B or C) and administers the Select Agent Program, which regulates the laboratories which may possess, use, or transfer select agents within the United States. As with US attempts to categorize harmful recreational drugs, designer viruses are not yet categorized and avian H5N1 has been shown to achieve high mortality and human-communication in a laboratory setting.

Category A

These high-priority agents pose a risk to national security, can be easily transmitted and disseminated, result in high mortality, have potential major public health impact, may cause public panic, or require special action for public health preparedness.

Tularemia

Tularemia, or rabbit fever,[13] has a very low fatality rate if treated, but can severely incapacitate. The disease is caused by the *Francisella tularensis* bacterium, and can be contracted through contact with the fur, inhalation, ingestion of contaminated water or insect bites. *Francisella tularensis* is very infectious. A small number (10–50 or so organisms) can cause disease. If *F. tularensis* were used as a weapon, the bacteria would likely be made airborne for exposure by inhalation. People who inhale an infectious aerosol would generally experience severe respiratory illness, including life-threatening pneumonia and systemic infection, if they are not treated. The bacteria that cause tularemia occur widely in nature and could be isolated and grown in quantity in a laboratory, although manufacturing an effective aerosol weapon would require considerable sophistication.[14]

Anthrax

Anthrax is a non-contagious disease caused by the spore-forming bacterium *Bacillus anthracis*. An anthrax vaccine does exist but requires many injections for stable use. When discovered early anthrax can be cured by administering antibiotics (such as ciprofloxacin).[15] Its first modern incidence in biological warfare were when Scandinavian "freedom fighters" supplied by the German General Staff used anthrax with unknown results against the Imperial Russian Army in Finland in 1916.[16] In 1993, the Aum Shinrikyo used anthrax in an unsuccessful attempt in Tokyo with zero fatalities.[11] Anthrax was used in a series of attacks on the offices of several United States Senators in late 2001. The anthrax was in a powder form and it was delivered by the mail.[17] Anthrax is one of the few biological agents that federal employees have been vaccinated for. The strain used in the 2001 anthrax attack was identical to the strain used by the USAMRIID.[]

Smallpox

[18] Smallpox is a highly contagious virus. It is transmitted easily through the atmosphere and has a high mortality rate (20–40%). Smallpox was eradicated in the world in the 1970s, thanks to a worldwide vaccination program.[19] However, some virus samples are still available in Russian and American laboratories. Some believe that after the collapse of the Soviet Union, cultures of smallpox have become available in other countries. Although people born pre-1970 will have been vaccinated for smallpox under the WHO program, the effectiveness of vaccination is limited since the vaccine provides high level of immunity for only 3 to 5 years. Revaccination's protection lasts longer.[20] As a biological weapon smallpox is dangerous because of the highly contagious nature of both the infected and their pox. Also, the infrequency with which vaccines are administered among the general population since the eradication of the disease would leave most people unprotected in the event of an outbreak. Smallpox occurs only in humans, and has no external hosts or vectors.

Botulinum toxin

[21] Botulinum toxin is one of the deadliest toxins known, and is produced by the bacterium *Clostridium botulinum*. Botulism causes death by respiratory failure and paralysis.[22] Furthermore, the toxin is readily available worldwide due to its cosmetic applications in injections.

Bubonic plague

[23] Plague is a disease caused by the *Yersinia pestis* bacterium. Rodents are the normal host of plague, and the disease is transmitted to humans by flea bites and occasionally by aerosol in the form of pneumonic plague.[24] The disease has a history of use in biological warfare dating back many centuries, and is considered a threat due to its ease of culture and ability to remain in circulation among local rodents for a long period of time. The weaponized threat comes mainly in the form of pneumonic plague (infection by inhalation)[25] It was the disease that caused the Black Death in Medieval Europe.

Viral hemorrhagic fevers

[26] This includes hemorrhagic fevers caused by members of the family *Filoviridae* (Marburg virus and Ebola virus), and by the family *Arenaviridae* (for example Lassa virus and Machupo virus). Ebola virus disease has fatality rates ranging from 50–90%. No cure currently exists, although vaccines are in development. The Soviet Union investigated the use of filoviruses for biological warfare, and the Aum Shinrikyo group unsuccessfully attempted to obtain cultures of Ebola virus.[*citation needed*] Death from Ebola virus disease is commonly due to multiple organ failure and hypovolemic shock. Marburg virus was first discovered in Marburg, Germany. No treatments currently exist aside from supportive care. The arenaviruses have a somewhat reduced case-fatality rate compared to disease caused by filoviruses, but are more widely distributed, chiefly in central Africa and South America.

Category B

Category B agents are moderately easy to disseminate and have low mortality rates.

- Brucellosis (*Brucella* species)[27]
- Epsilon toxin of *Clostridium perfringens*
- Food safety threats (for example, *Salmonella species*, *E coli* O157:H7, *Shigella*, Staphylococcus aureus*)*
- Glanders[28] (*Burkholderia mallei*)
- Melioidosis (*Burkholderia pseudomallei*)[29][30]
- Psittacosis (*Chlamydia psittaci*)
- Q fever (*Coxiella burnetii*)[31]
- Ricin[32] toxin from *Ricinus communis* (castor beans)
- Abrin toxin from *Abrus precatorius* (Rosary peas)
- Staphylococcal enterotoxin B
- Typhus (*Rickettsia prowazekii*)
- Viral encephalitis (alphaviruses, for example,: Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis)
- Water supply threats (for example,, *Vibrio cholerae*,[33] *Cryptosporidium parvum*)

Category C

Category C agents are emerging pathogens that might be engineered for mass dissemination because of their availability, ease of production and dissemination, high mortality rate, or ability to cause a major health impact.

- Nipah virus
- Hantavirus
- SARS
- H1N1 a strain of influenza (flu)
- HIV/AIDS

Planning and response

Planning may involve the development of biological identification systems.Until recently in the United States, most biological defense strategies have been geared to protecting soldiers on the battlefield rather than ordinary people in cities. Financial cutbacks have limited the tracking of disease outbreaks. Some outbreaks, such as food poisoning due to *E. coli* or *Salmonella*, could be of either natural or deliberate origin.

Preparedness

Biological agents are relatively easy to obtain by terrorists and are becoming more threatening in the U.S., and laboratories are working on advanced detection systems to provide early warning, identify contaminated areas and populations at risk, and to facilitate prompt treatment. Methods for predicting the use of biological agents in urban areas as well as assessing the area for the hazards associated with a biological attack are being established in major cities. In addition, forensic technologies are working on identifying biological agents, their geographical origins and/or their initial son. Efforts include decontamination technologies to restore facilities without causing additional environmental concerns.

Early detection and rapid response to bioterrorism depend on close cooperation between public health authorities and law enforcement; however, such cooperation is currently lacking. National detection assets and vaccine stockpiles are not useful if local and state officials do not have access to them.[34]

Biosurveillance

In 1999, the University of Pittsburgh's Center for Biomedical Informatics deployed the first automated bioterrorism detection system, called RODS (Real-Time Outbreak Disease Surveillance). RODS is designed to draw collect data from many data sources and use them to perform signal detection, that is, to detect a possible bioterrorism event at the earliest possible moment. RODS, and other systems like it, collect data from sources including clinic data, laboratory data, and data from over-the-counter drug sales.[][] In 2000, Michael Wagner, the codirector of the RODS laboratory, and Ron Aryel, a subcontractor, conceived the idea of obtaining live data feeds from "non-traditional" (non-health-care) data sources. The RODS laboratory's first efforts eventually led to the establishment of the National Retail Data Monitor, a system which collects data from 20,000 retail locations nation-wide.[]

On February 5, 2002, George W. Bush visited the RODS laboratory and used it as a model for a $300 million spending proposal to equip all 50 states with biosurveillance systems. In a speech delivered at the nearby Masonic temple, Bush compared the RODS system to a modern "DEW" line (referring to the Cold War ballistic missile early warning system).[35]

The principles and practices of biosurveillance, a new interdisciplinary science, were defined and described in the *Handbook of Biosurveillance*, edited by Michael Wagner, Andrew Moore and Ron Aryel, and published in 2006. Biosurveillance is the science of real-time disease outbreak detection. Its principles apply to both natural and man-made epidemics (bioterrorism).

Data which potentially could assist in early detection of a bioterrorism event include many categories of information. Health-related data such as that from hospital computer systems, clinical laboratories, electronic health record systems, medical examiner record-keeping systems, 911 call center computers, and veterinary medical record systems could be of help; researchers are also considering the utility of data generated by ranching and feedlot operations, food processors, drinking water systems, school attendance recording, and physiologic monitors, among others.[] Intuitively, one would expect systems which collect more than one type of data to be more useful than systems which collect only one type of information (such as single-purpose laboratory or 911 call-center based systems), and be less prone to false alarms, and this appears to be the case.

In Europe, disease surveillance is beginning to be organized on the continent-wide scale needed to track a biological emergency. The system not only monitors infected persons, but attempts to discern the origin of the outbreak.

Researchers are experimenting with devices to detect the existence of a threat:

- Tiny electronic chips that would contain living nerve cells to warn of the presence of bacterial toxins (identification of broad range toxins)
- Fiber-optic tubes lined with antibodies coupled to light-emitting molecules (identification of specific pathogens, such as anthrax, botulinum, ricin)

New research shows that ultraviolet avalanche photodiodes offer the high gain, reliability and robustness needed to detect anthrax and other bioterrorism agents in the air. The fabrication methods and device characteristics were described at the 50th Electronic Materials Conference in Santa Barbara on June 25, 2008. Details of the photodiodes were also published in the February 14, 2008 issue of the journal Electronics Letters and the November 2007 issue of the journal IEEE Photonics Technology Letters.[36]

The United States Department of Defense conducts global biosurveillance through several programs, including the Global Emerging Infections Surveillance and Response System.[37]

Response to bioterrorism incident or threat

Government agencies which would be called on to respond to a bioterrorism incident would include law enforcement, hazardous materials/decontamination units and emergency medical units, if they exist.

The US military has specialized units, which can respond to a bioterrorism event; among them are the United States Marine Corps' Chemical Biological Incident Response Force and the U.S. Army's 20th Support Command (CBRNE), which can detect, identify, and neutralize threats, and decontaminate victims exposed to bioterror agents. US response would include the Center for Disease Control.

Historically, governments and authorities have relied on quarantines to protect their populations. International bodies such as the World Health Organization already devote some of their resources to monitoring epidemics and have served clearing-house roles in historical epidemics.

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