Int J Pharm Bio Sci 2013 July; 4(3): (B) 647 - 653

**Review Article** **Microbiology**

**International Journal of Pharma and Bio Sciences** **ISSN 0975-6299**

# OVERVIEW OF BIOTERRORISM AND ITS AGENTS

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## ABSTRACT

Bioterrorism is the deliberate release of bacteria, toxins and viruses, or other microbes used to cause illness or death in people, animals, or plants. The Center for Disease Control and Prevention (CDC) has classified the biological agents into three categories based on the potential of use and risk factors as weapons. The biological agent should have the following characteristics in order to be effective for use in biological warfare: highly virulent, highly contagious, short incubation period, easy production, easy dispersion, easy handling, and susceptibility to target population. Usually found in nature, these agents are chemically changed to amplify their ability to cause disease, make them resistant to current medicines, or to increase their ability to be spread into the environment. These agents can be spread through the food, water or air. Since these biological agents are extremely difficult to detect, terrorists may use it. In this brief review we have reiterated the overview of bioterrorism and its agents.

**KEYWORDS: Bioterrorism, Center for Disease Control and Prevention (CDC), categories, biological agents.**

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# INTRODUCTION

***Bioterrorism***

is terrorism involving the intentional release or dissemination of biological agents. Biological agents include plague, smallpox, anthrax, Q fever, melioidosis, Severe Acute Respiratory Syndrome (SARS), and Acquired Immunodeficiency Syndrome **(**AIDS) which can potentially be used for bioterrorism. Bioterrorism is different from chemical, nuclear, or radiation warfare or attacks, designed to cause immediate damage through the release of dangerous substances. Biological weapons are relatively inexpensive to create and also easy to transport unlike the chemical, and nuclear technologies which are expensive. Since a biological attack is not usually signaled by an explosion or other obvious cause it may not be recognized immediately, it may take time to discover that a disease is spreading in a particular area by local public authorities and the public alike. In worldwide the methods for predicting the use of biological agents as well as assessing the hazards associated with a biological attack are being established and many medical disciplines, such as emergency medicine, trauma surgeons, psychiatry, dentistry and dermatology have documented attempts at assessing the bioterrorism preparedness in their communities. Bioterrorist acts can be due to political, religious, ideological, or criminal motivation and could be conceivably planned by groups or a single individual or may be part of state sponsored terrorist activities.[1] However, there are some ways to protect against bioterrorism agents and to identify an attack when it occurs.

***HISTORY***

The origin of bioterrorism can be related to history of bio-warfare from 6$^{th}$ Century B.C.

*6th Century B.C*: Assyrians employed rye ergot, an element of fungus which contains mycotoxins to poison the wells of their enemies. [2, 3]

*6th Century B.C*: Greeks during their siege of the city of Krissa used hellebore (skunk cabbage), a plant with powerful purgative and cardiac glycoside effects to poison the water supply. [2, 3]

*1346*: During the siege of Kaffa (a port on the black sea), Tatars spread bubonic plague by catapulting diseased corpses into towns. [4]

*1422*: At the battle of Carolstein, bodies of plague-stricken dead soldiers were catapulted in to the ranks of the enemy.

*15$^{th}$ C*: Pizarro's conquest of South America, improved his chances of victory by presenting Variola-contaminated clothing as gifts to the natives. [5, 6]

*1710*: During Russia's war with Sweden, Russian troops hurl the corpses of plague victims over the city walls. [7, 8]

*1767*: During the French and Indian war, seeking to gain an advantage over the France the English general, Sir Jeffrey Amherst, gives blankets and handkerchiefs laced with smallpox to Indians loyal to the French. [7, 8, 2]

*1914-1917*: Allegations are made against the Germans that during World War I they attempted to spread cholera in Italy and plague in St. Petersburg in Russia. Germany denied all these allegations, including biological bombs dropped over Britain. [9, 10]

*1915*: During World War I, a German-American, Dr. Anton Dilger, grew cultures of *Bacillus anthracis* (anthrax) and *Pseudomonas mallei* (Glanders), which was supplied by the German government to him in his Washington D.C. home. This program allegedly featured covert operations. In Baltimore for sympathetic dockworkers the Disease producing agents and an inoculation device were given in order to infect 3000 ship horses and cattle. It is also suspected that several hundred troops were additionally affected. [9, 10]

*1925*: The Geneva Protocol was signed by thirty eight countries. It is the first mutual agreement that extends the ban of chemical agents and biological agents. [8]

*1932*: Japan conducted biological warfare experiments and research from 1932 to until the end of World War II. The program was under the direction of Shiro Ishii, a physician and army officer and Kitano Misaji. [5, 11]

*1936*: Unit 731 the center of the Japanese bio-warfare program is formed. The program consisted of more than one hundred and fifty building complex, five satellite camps, and a team of more than 3000 scientists. Organisms and diseases of interest were *B. anthracis, Neisseria meningitidis, Vibrio cholerae, Shigella* spp., and *Yersinia pestis*. More than 10,000 prisoners died there as test cases. It is said that at least 3000 of these victims were prisoners of war, including Korean, Chinese, Mongolian, Soviet, American, British, and Australian soldiers.[5, 12]

*1941-1943*: US launch an offensive biological warfare program under the direction of a civilian agency, the War Reserve Service. The program included a research and development facility at Camp Detrick, Fort Detrick, testing sites in Mississippi and Utah, and a production facility in Terra Haute, Indiana. [5]

*1949*: In December, a Soviet military tribunal tried twelve Japanese prisoners of wars for preparing and using bacteriological weapons. [13]

1970: On February 14, the USA President Nixon terminated the offensive biological weapons program by executive orders and limits its research to defensive purposes only. [11]

*1972*: Broader efforts followed with biological weapons convention (convention on the prohibition of the development, production, and stockpiling of bacteriological and toxin weapons and on their destruction). It is eventually signed by 103 nations to prohibit "the development, production, and stockpiling of chemical and bacteriological weapons". [14, 15]

*1975-1983*: The inhabitants of Laos and Kampuchea have been attacked by planes and helicopter delivering multi-colored aerosols ("Yellow Rain"). [5, 11] Both man and animal were affected and some died. There is no definitive evidence that these aerosol attacks truly represented biological warfare agents, but there is a belief among many that it may comprise Trichothecene toxins (e.g., T-2 mycotoxin). The controversy over the yellow rain incidents remains uncertain. [5, 11]

*1978*: On September 7, a Bulgarian exile named Georgi Markov was attacked and killed in London. This assassination later known as "umbrella killing," because the weapon used was a device disguised as an umbrella. This weapon discharged a tiny platinum-iridium pellet into the subcutaneous tissue of Markov's leg. The following day, he became severely ill, and he died within three days after the attack. Before 10 days of the assassination of Markov, an attempt made in Paris to kill another Bulgarian exile, Vladimir Kostov. Kostov said that one day when he was leaving a metro stop in Paris; he had felt a sharp pain in his back. When he turned around, he saw a man with an umbrella running away. Two weeks later, after he came to know about Markov's death, Kostov was examined by French doctors. They removed a similar pellet, which was made from an exotic alloy of iridium and platinum and contained the toxin ricin. [5, 16]

1984: In September, the followers of Bagwan shree Rajneesh, an Indian religious cult, contaminated salad bars in Oregon with *Salmonella* Typhimurium. Over 751 were poisoned and 40 hospitalized. The purpose was to influence the outcome of a local election and the perpetrators were eventually caught and prosecuted. [7, 8]

*1980*: There was the reported discovery in a laboratory in a safe house of the Red Army Faction in Paris, France having contained a bathtub filled with large amounts of *Clostridium botulinum* toxins. The report was later repudiated by the German government. However, they say, the toxin was never used.[17]

*1991*: Representatives of the Iraqi government announced that it had conducted research into a number of bio-warfare agents such as *B. anthracis*, botulinum toxins, and *Clostridium perfringens*. Only some of these R&D facilities were destroyed during the Persian Gulf war.[5, 18]

*1995*: It was reported that on at least 10 occasions, the fatalist cult Aum Shinrikyo attempted to disperse anthrax, botulinum toxin, Q fever, & Ebola causative agents against the mass population in Japan. But no reported infections occurred. Nevertheless, in later times Cult members released sarin, a neurotoxin, in the Tokyo subway system. This resulted in thousands of injured civilians and eight deaths.[8]

*2001*: Letters containing anthrax spores were mailed to a television news anchor Tom Brokaw,

democratic US senators, and others, leading to the death of a few people and hospitalization of 17 others.[19]

## *BIOLOGICAL AGENTS*

CDC has classified the biological agents into three categories based on the potential of use and risk factors as weapons.[20] The effective bio-weapon has characteristics such as high virulence, higher transmissibility, short incubation period, easy production, easy dispersion, easy handling, and susceptibility to target population.

*Category A*: Category A- agents can be easily transmitted and disseminated from person to person which may result in high mortality rates or may cause public panic and social disruption therefore these high priority agents' poses a risk to national security and it requires special action for public health preparedness.

**Table 1**
***Some common category A bio-warfare agents***

| Disease | Agent | Agent type | Lethality ( death) | Possible release | Effective dose | Route of infection | Environmental stability |
|---|---|---|---|---|---|---|---|
| Anthrax | *Bacillus anthracis* | Bacterium | High | Spores | 10,000-50,000 spores | Aerosol | Very stable for years |
| Botulism | *Clostridium botulinum* | Bacterial toxin | High | Toxins | 0.001 mcg/Kg weight | Ingestion food/water | Relatively stable |
| Plague | *Yersinia pestis* | Bacterium | High | Vegetative cells | 100-500 organisms | Aerosol | Stable for 1 year |
| Smallpox | Variola major | Virus | High | Virus particles | 10-100 organisms | Aerosol | Very stable |
| Tularemia | *Francisella tularensis* & Arenaviruses *(Lassa, Machupo)* | Bacterium | Low | Aerosol release | 10-50 organisms | Insects or ticks | Stable for months |
| Ebola Hemorrhagic Fever | Ebolavirus | Virus | High | Virus particles | 10-100 organisms | Aerosol | Unstable |

***Category B: Category B agents are second highest priority agents that are moderately easy to disseminate and which will have low mortality and moderate morbidity rates; and require specific enhanced disease surveillance.***

**Table 2**
***Some common category B bio-warfare agents***

| Disease | Agent | Agent type | Lethality ( death) | Possible release | Effective dose | Route of infection | Environmental stability |
|---|---|---|---|---|---|---|---|
| Brucellosis | *Brucella* spp. | Bacteria | Low | Vegetative cells | 10-100 organisms | Aerosol | Very stable |
| Q-Fever | *Coxiella burnetii* | Bacteria | Low | Spores | 1-10 organisms | Aerosol | Stable for months |
| Ricin Toxin | From *Ricinus communis* | Toxin from Castor Beans | High | Toxin | 3-5 mcg/Kg weight | Food/water | Stable |
| Cholera | *Vibrio cholerae* | Bacteria | High | Contaminating food and water | 10-500 organisms | Water/ Food | Unstable |
| Typhus | *Rickettsia prowazekii* | Bacteria | Low | Aerosol | Unknown | Arthropod vectors | Stable |
| Glanders | *Burkholderia mallei* | Bacteria | High | Aerosol | Very few organisms | Infected animals | Very stable |

***Category C: Category C agents are third highest priority agents which include emerging pathogens. In future these could be engineered for mass dissemination because of availability, dissemination and ease of production, ability to cause high morbidity and mortality rates and major health impact.***

**Table 3**
***Some common category C bio-warfare agents***

| Disease | Agent | Agent type | Lethality ( death) | Possible release | Route of infection | Environmental stability |
|---|---|---|---|---|---|---|
| SARS | Coronavirus | Virus | High | Aerosol | Contact with Infected human | Stable |
| HIV/AIDS | Human Immunodeficiency Virus | Virus | High | Injecting the victims with HIV-contaminated blood | Sexual Transmission, Through Infected Blood, Perinatal | very fragile, Not survive outside the human body. very stable at low temperatures |
| Yellow fever | *Flaviviridae* | Virus | High | Aerosol | Infected *Aedes* mosquitoes | Stable |
| Hantavirus | *Bunyaviridae* | Virus | High | Aerosol | Rodents | Uncertain |
| Nipah virus | Paramyxovirus | Virus | High | Aerosol | Infected pigs | Stable |
| Drug-Resistant Tuberculosis | *Mycobacterium tuberculosis* | Bacteria | High | Aerosol | Airborne | Stable |

## *PREPAREDNESS*

The most terrible time to set up the proper actions in response to an emergency situation is during the emergency. Thus, it is significant that the health department officials elucidate the preparedness roles and responsibilities of their departments and identify liable response activities before they are needed. Preparedness accomplishes the various activities that can be taken before an emergency. Such activities describe and improve the response system and range from expanding existing surveillance systems to developing and maintaining a possible emergency operations plan.[21] In the terrorism event**,** the public health community will have a special role in preventing destruction. The public health system at the local, state, and federal levels may be first to monitor and report emerging infectious diseases that cause unusual illnesses or injuries. To respond to terrorism event public health department must be capable of carrying out some of the key elements preparedness program such as identifying the types of events that may take place in their communities; setting up emergency activities in advance to make sure a coordinated response to the consequences of probable events; building capabilities is essential to take action efficiently to the consequences of those events; identifying the nature of an event when it happens; implementing the intended response quickly and efficiently; and recovering from the event. To meet all the above mentioned capabilities, the health department should develop various key preparedness elements for instance, hazard analysis; emergency response planning; health surveillance & epidemiologic investigation; laboratory diagnosis & characterization; and consequence management.[21]

## *MANAGEMENT*

Biological weapons are, conceivably, somewhat unique in their ability to cause confusion, disruption and fear compared to conventional, chemical, and nuclear weapon threats. Hence, understanding the pathogenesis, modes of transmission, behavior, diagnostic modalities and available treatment options for each of the potential agents becomes necessary. Appropriate and thorough evaluation and management of a potential biological attack is likely to be complex and problematic before a causative agent is recognized. For this reason, a ten-step process to guide medical personnel in such evaluation and management is recommended.[16]

1. *Maintain an index of suspicion*: A few associations in an otherwise healthy population are extremely suggestive, especially when they are seen in clusters or in high numbers. A. Plague: hemoptysis**.** B. Anthrax: wide mediastinum**.** C. Smallpox: centripetal rash (rash more abundant on face and extremities).
2. *Protect yourself*: Appropriate Personal Protection Equipment (PPE) must be used. For instance in case of smallpox triage and evaluate patient in an isolated room and also wear appropriate respirator such as N-95.

3. *Evaluate the patient*: Assess patient's history. Carry out a physical examination with special attention to the respiratory system, nervous system, hematologic and skin condition.
4. *Decontaminate as appropriate*: For all biological and most chemical agents water, soap and shampoo are perfectly adequate. Bleach should not be used on exposed people. Biologically contaminated clothes can be laundered with soap and water. Chemically contaminated clothes should be removed and discarded safely.
5. *Establish a diagnosis*: Assume clinically and epidemiologically and always culture the specimens. For instance, possible diagnosis for pulmonary symptom is anthrax, plague & tularemia and for neuromuscular symptom is botulism & Venezuelan equine encephalitis.
6. *Provide prompt therapy*: Except viral infections to treat, for almost everything Doxycycline can be used. Doxycycline or ciprofloxacin plus, one or more other antibiotics are used to treat inhalational anthrax. According to public health recommendations antibiotics and vaccines should be administered.
7. *Follow good infection control*: Some recommended isolation precautions include: Contact precautions for cutaneous anthrax; airborne and contact precautions for smallpox; and contact precautions if lesions present for tularemia.
8. *Alert the proper authorities*; such as- FBI, municipal office, local emergency medical services unit, local hospitals, and CDC.
9. *Assist in the epidemiologic investigation*: Count cases, relate to the at-risk population, make comparisons, develop hypotheses, test hypotheses, make inferences, conduct studies, interpret and evaluate.
10. *Maintain skill and spread the gospel*: This can be carried out by availing any one of the resources. The OTSG (www.nbc-med.org) and USAMRIID (www.usamriid.army.mil) Web Sites provide a wealth of information. Annual satellite television broadcasts, sponsored by USAMRIID, provide in-depth discussion and training in medical biodefense as well. A new field manual (Army FM 8-284) summarizes biological warfare disease management recommendations. Finally, medical personnel who were aware of the risk and trained to deal with it must make sure that other personnel in their units receive training as well.

## CONCLUSION

The threat of bioterrorism to national and global security has become major and real. To eliminate and prevent the future bioterrorism threats, we need greater preparedness, we need to support research efforts, and we must educate our health care team. Preparedness should be incorporated into disaster plans. Further, in the event of biological or radiological weapons used all the medical personnel must be prepared with the knowledge and ability to perform their role as front-line respondents. Nevertheless, we will survive even in the midst of possible future bioterrorist catastrophe.

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