Available at www.ijcasonline.com ISSN 2349 – 0594

International Journal of Modern Chemistry and Applied Science

International Journal of Modern Chemistry and Applied Science 2016, 3(1),323-325

Microbes as biological weapons-a review

Befekadu Teshome*

*Ethiopian Biodiversity Institute, Microbial Biodiversity Directorate, Addis Ababa, Ethiopia

E-mail: beftesh@gmail.com or beftesh@ibc.gov.et , Mobile No. 251932151668

Abstract: Infectious agents that could potentially be used as bioweapons include bacterial, fungal and viral pathogens and toxins produced by living organisms. Depending on the agents, a lethal or incapacitating outcome can occur. Many scientists and authors advised that, it must be done without impeding the necessary research for improving our scientific understanding of the environment and the world in which we live. The aim of this short review is to show the diferent thoughts concerning the study of microbes that could potentially be used as bioweapons and the importance of defining the boundary between defensive and offensive biological weapons research in a country.

Key words: Microbes, biological weapons

Introduction

A biological weapon is a weapons system that intentionally uses bacteria, viruses or toxins to cause death or disease in people, animals or plants. A biological weapon is a combination of a biological agent (the bacteria, virus or toxin) and the means of keeping the agent alive and virulent, transporting it to where it will be dispersed and a dissemination mechanism. For example one biological weapon could be anthrax spores, a plane and a pesticide sprayer. Another might be salmonella bacteria bred in a laboratory, transported in a vial and poured into some food. Some biological weapons are suited to large-scale production and dissemination for use in war, some are more likely to be considered for use in a smaller-scale terrorist attack, and others are only suitable as weapons of assassination[1].

The World Health Organization has defined biological weapons as 'those, whose intended target effects are due to the infectivity of disease-causing micro-organisms and other replicative entities, including viruses, infectious nucleic acids and prions[2]. This definition does not include toxins which are produced by microorganisms. As these toxins are produced and can be disseminated in similar ways to living microorganisms, they are often included in discussions of biological warfare. But, the 1972 Biological Weapons Convention and World Health Organization cover toxins as substances produced by any living organism, not only by micro-organisms, or by any other means, including synthesis and treated them under chemical weapons since they would be working, not through infectivity, but through toxicity[2].

Some defined Biological weapons, or bioweapons, as those containing replicating microorganisms (viruses, fungi, and bacteria, including chlamydia and rickettsia), prions, protozoa, or poisonous chemical toxins produced by living organisms (e.g., botulinum toxin, cobra venom, and the plant toxin, ricin). Depending on the pathogen being used, these weapons may be employed against humans, animals, or crops. In some instances, multiple species groups (e.g., animals and humans) may be affected. The use of such weapons by a nation against other nations and by insurgents within nations is generally referred to as biological warfare or biowarfare, while the use of these weapons for terrorist activities is generally referred to as bioterrorism. The distinction between these terms is not always clear and can be a subject for legal debate, when charges are pressed against those involved with using bioweapons. But, the recent definition of bioterrorism in the scientific literature is separated from biowarfare on the basis of the latter involving a declaration of war or the perception of war being waged between nations as evidenced by an appropriate level of hostile actions between nations. Keeping that distinction in mind, "Bioterrorism is the intentional use of microorganisms or toxins derived from living organisms to cause death or disease in humans, animals, or plants on which we depend."[3].

Biological weapons are often included with chemical and nuclear weapons in the term 'weapons of mass destruction'. Leeson (2000) and a number of writers have chosen to use the term 'weapons of mass casualties' instead, as biological agents do not cause any destruction to buildings or infrastructure. Even then, achieving mass casualties with biological weapons is a difficult task which depends on the agents used, the quantity of agents and the means of dissemination. Leeson (2000) even argued that biological weapons may be used as weapons of individual assassination or in small-scale targeted attacks, so it is misleading to speak of them as weapons of mass destruction or casualties, anyway. In the past, attempts to use biological weapons in individual assassinations or small-scale attacks have generally been more successful than attempts to cause mass casualties[1].

History and use of biological weapons

The intentional use of living organisms or infected materials derived from them has occurred over centuries during war and "peace" time by armies, states, groups and individuals. One of the first recorded uses of a biological agent in the war was in 184 B.C. The Carthaginian soldiers led by Hannibal used snakes in the battle against King Eumenes of Perganium and achieved a victory. As early as 300 B.C., the Greeks polluted the

wells and drinking water supplies of their enemies with animal corpses[4]. There were also many other occasions of using microbes or toxins produced by living organisms in the history of human being on planet earth after the birth of Christ. The 1346 Siege of Caffa (also spelled Kaffa, which is now Feodosija, Ukraine) involved the most gruesome and crudest example of biological warfare when the Mongol army catapulted plague-infected cadavers into the besieged city. "Mountains of dead were thrown into the city," infecting the inhabitants and resulting in many deaths from the Black Death (plague).

The use of catapults and siege machines introduced new technology to biological warfare. More recent events of chemical and biological weapons are broadly categorised into four phases. World War I saw the introduction of the first phase, in which gaseous chemicals like chlorine and phosgene were used in Ypres. The second phase ushered in the era of the use of nerve agents e.g. *tabun*, a cholinesterase inhibitor, and the beginnings of the anthrax and the plague bombs in World War II[5]. This time was the beggining of the modern era of biological weapons development. The Japanese released fleas infected with plague in Chinese cities in the 1930's and 1940's. Water supplies and food items were contaminated with *Bacillus anthracis, Vibro cholerae*, Shigella spp., Salmonella and *Yersinia pestis*[4]. The Vietnam War in 1970 constituted the third phase which was characterised by the use of lethal chemical agents e.g. Agent Orange, a mix of herbicides stimulating hormonal function resulting in defoliation and crop destruction. This phase included also the use of the new group of *Novichok* and mid-spectrum agents that possess the characteristics of chemical and biological agents such as auxins, bio-regulators, and physiologically active compounds. Concern has been expressed in regard to the handling and disposal of these mid-spectrum agents by "chemobio "experts rather than by biologists[5].

The fourth phase coincides with the era of the biotechnological revolution and the use of genetic engineering. One of the major use of bioweapons during this present period by unknown individual/group in 2001 is the iintentional dissemination of anthrax spores through the US Postal System leading to the death of five people, infection of 22 others and contamination of several government buildings[5]. Gene-designed organisms can be used to produce a wide variety of potential bioweapons such as organisms:

- functioning as microscopic factories producing a toxin, venom or bio-regulator
- with enhanced aerosol and environmental stability resistant to antibiotics, routine vaccines, and therapeutics
- with altered immunologic profiles that do not match known identification and diagnostic indices
- that escape detection by antibody-based sensor systems

Categories and features of microbes used as bioweapons

Infectious agents that could potentially be used as bioweapons include bacterial, fungal and viral pathogens and toxins produced by living organisms. Depending on the agents, a lethal or incapacitating outcome can occur.

Features of microbes used as bioweapons

The key features that make biological agents particularly effective as weapons are high morbidity and mortality, potential for person-to-person spread, low infective dose and highly infectious by aerosol, lack of rapid diagnostic capability, lack of universally available effective vaccine, potential to cause anxiety, availability of pathogen and feasibility of production, environmental stability, presence of adequate database of prior research and development, and potential to be "weaponized"[4, 6]. Agents of bioterrorism may be used in their naturally occurring forms, or they can be deliberately modified to provide maximal impact. Among the approaches to maximizing the deleterious effects of biologic agents are the genetic modification of microbes for the purposes of antimicrobial resistance or evasion by the immune system, creation of fine-particle aerosols, chemical treatment to stabilize and prolong infectivity, and alteration of host range through changes in surface proteins. Certain of these approaches fall under the category of weaponization, which is a term generally used to describe the processing of microbes or toxins in a manner that would ensure a devastating effect of a release[6].

Categories of microbes used as bioweapons

Based on the ease of transmission, severity of morbidity, mortality, and likelihood of use, biological agents can be classified into 3 categories: A, B, C.

Category A

Category A includes the highest priority agents that pose a risk to national security because they:
i. can be easily disseminated or transmitted person-to-person causing secondary and tertiary cases.
ii. Cause high mortality with potential for major public health impact including the impact on health care facilities.
iii. Cause public panic and social disruption.
iv. Require special action for public health preparedness.
Anthrax (*Bacillus anthracis*), Botulism (*Clostridium botulinum* toxin), Tularemia (*Francisella tularensis*), small pox (*Variola major*) and viral hemorrhagic fevers (Arenaviruses, Bunyaviridae and Filoviridae) are classified under category A.

Category B

This category contains the second highest priority agents because they:
i. Are moderately easy to disseminate
ii. Cause moderate morbidity and low mortality
iii. Require specific enhancement of diagnostic capacity and enhanced disease surveillance
The following microorganisms and toxins are classified under category B.

Bacteria:

Coxiella burnetti (Q fever), *Brucella species* (Brucellosis), *Burkholderia mallei* (Glanders)
Burkholderia pseudomallei (Melioidosis), *Rickettsia prowazekii* (Typhus fever) and
Chlamydia psittaci (Psittacosis)

Viruses (Alpha viruses):

Venezuelan encephalomyelitis, Eastern equine encephalomyelitis and Western equine encephalomyelitis.

Toxins:

Ricin toxin from *Ricinus communis* (Castor beans), Epsilon toxin (*Clostridium perfringens*), and Enterotoxin B (*Staphylococccus aureus*)

Food or Water Borne Pathogens:

Salmonella species, Shigella dysenteriae, Escherichia coli 0157:H7, Vibrio cholerae and *Cryptosporidum parvuus*

Category C

Category C agents are the third highest priority. These include certain emerging pathogens, to which the general population lacks immunity, that could be engineered for mass dissemination in the future because of availability, ease of production, ease of dissemination, potential for high morbidity and mortality, and major public health impact. A potential pandemic strain of influenza, such as avian influenza, is one such example. Nipah, Hantavirus, SARS coronavirus are also included here.

Biological weapons convention

National and international law is an essential component of the array of measures that should be taken to protect against the hostile release of biological agents. Biological weapons convention were made to effect this purpose. Biological weapons convention provide for international cooperation in order to prevent the use of biological weapons, and for assistance and cooperation where breaches of these treaties are suspected, especially when such weapons have been used.

The 1972 Biological Weapons Convention which was based on the 1925 Geneva Protocol encouraged the international community to adopt *Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction.*

Conclusions

Many scientists and authors advised to strengthen the Biological Weapons Convention to ensure compliance with the edicts – never, under any circumstances, to develop, produce, stockpile, or otherwise acquire or retain microbial or other biological agents, or toxins in quantities that have no justification for peaceful purposes; not to transfer agents, toxins, weapons, equipment, or means of delivery of biological weapons to others; and to take necessary measures to prohibit and prevent the development or acquisition of biological weapons by a nation's military or citizens. They also advised that, it must be done without impeding the necessary research for improving our scientific understanding of the environment and the world in which we live. Thus, defining the boundary between defensive and offensive biological weapons research is very mandatory.

References

1. Leeson K. (2000). Biological Weapons: Bioterrorism and the Public Health. Medical Association for Prevention of War. www.mapw.org.au
2. World Health Organization. (2004). Public health response to biological and chemical weapons: WHO guidance-2nd ed. World Health Organization, Geneva.
3. Milton Friend. (2006). Disease Emergence and Resurgence: The Wildlife–Human Connection Chapter 6 Biowarfare, Bioterrorism, and Animal Diseases as Bioweapons, Page 234-272. www.nwhc.usgs.gov/publications/disease_emergence/Chapter6.pdf
4. Southern Illinois University School of Medicine. (2012). Overview of Potential Agents of Biological Terrorism. www.my.siumed.edu
5. DaSilva E..*Electronic Journal of Biotechnology.* **2**: 3, 1999
6. Lane H., Fauci A. (2010). Introduction to Infectious Diseases: Chapter 6 Microbial bioterrorism. Harrison's Infectious Diseases, McGraw-Hill Global Education Holdings, LLC Page 66-80.