Biological warfare and Bioterrorism

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Abstract—Biological warfare (BWs) is the deliberately use of toxins and microbes, generally of microbial, plant or animal origin to produce disease and death in humans, livestock and agriculture. The fact behind the use of bioweapons in war, and for use in terroristic attacks is attributed to easy access to a wide range of disease-producing biological agents, cost effectiveness, difficultly in sensing by routine security systems, and also to their transportation from one place to another. Furthermore, novel and accessible technologies give rise to proliferation of such weapons that have significances for regional and global security. In order to eliminate such threats, and in securing the culture and defense of peace, the need for leadership and in devising preventive and protective strategies has been emphasized through international consultation and cooperation. Current concerns regarding the use of BWs result from the increasing number of countries that are engaged in the proliferation of such weapons and their acquisition by terrorist organizations. Faithfully following to the Biological and Toxin Weapons Convention reinforced by confidence building measures sustained by use of monitoring and verification protocols, is indeed, an important and necessary step in abbreviating and devastating the threats of biological warfare and bioterrorism.

Index Terms— Biological Warfare, Bioterrorism, Microorganisms, Bacteria, Virus, Toxins, Anthrax, HIV/AIDS

1 INTRODUCTION

HUMANS, regrettably, have used all the available technologies for destruction of enemies as well as for beneficial purposes throughout history. Biological agents are one of them. Apart from the conventional weapons various countries have developed a variety of weapons of mass destruction e.g. Nuclear, chemical & biological weapons. Terrorists can get control of these weapons and can cause havoc. The concept of employing disease as a weapon has existed for centuries. Different factors have influenced a number of countries to pursue Biological Warfare (BW) throughout the 20th century. International agreements, such as Biological Weapons & Toxins Convention (BWC), have arguably done little to deter BW programs. [1]

Sometimes the purpose is causing panic rather than destruction like dirty bombs; Conventional bombs with nuclear waste which spread on detonation & people get panicky. Biological warfare & bioterrorism is a powerful tool in the hands of the states and terrorists.

History dates back to the eighteenth century (1754 – 1767) when British distributed blankets used by small pox patients to the Native Americans and the mortality in some tribes were as high as 50%. Japanese also used smallpox weapon against the Mongolians & Chinese during II world war. The preferred agents are bacillus anthracis, yersinia pestis, small pox virus or any genetically engineered organism that can survive, express or perpetuate in the natural environment. BWs are clubbed with the nuclear and chemical weapons.

However, bws are very different, while nuclear & chemical attacks cause their damage maximally immediately, biological attacks become manifest after sometime [2]. A bioterrorist can include any non-state actor who uses or threatens to use biological agents on behalf of a political, religious, ecological, or other ideological cause without reference to its moral or political justice. This includes non-state actors who operate in organized military units (as with guerillas) if biological agent use was undertaken with covert, improvised delivery means.

The attraction for bws is due to the following reasons; primarily, due to low production costs - called the "poor man's atomic bomb"[3] / "poor man's weapons of mass destruction". (5a). for atomic bombs, conventional weapons & nerve-gas weapons, the cost per causality would be approximately $2000, $800 & $600 however, for BW, the cost would be about $1 per causality. Secondly, Easy access to a wide range of disease producing biological agents.

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Thirdly-Non -detection by routine security system and easy transportation. Quarterly-High fatality: biological toxins are among the most toxic agents known e.g. the quantity of botox in the dot of an 'i' is enough to kill ~10 people. [4] BWs have the added advantage of destroying an enemy while leaving his infrastructure intact as booty for the winner.

2 TYPES OF AGENTS

Under current United States law, bio-agents (Table 1) 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 [5].

3 BIOLOGICAL/CHEMICAL WARFARE CHARACTERISTICS

Biological, chemical and nuclear weapons possess the common property of wreaking mass destruction. Though biological warfare is different from chemical warfare, there has always been the tendency to discuss one in terms of the other or both together. This wide practice probably arises from the fact that the victims of such warfare are biological in origin unlike that in the Kosovo War in which destruction of civic infrastructure, and large-scale disruption of routine facilities were the primary goals, e.g. the loss of electricity supplies through the use of graphite bombs. Another consideration is that several biological agents e.g., toxic metabolites produced by microorganisms, animals or plants are also produced through chemical synthesis. One of the main goals of biological warfare is the undermining and destruction of economic progress and stability. The emergence of bio-economic warfare as a weapon of mass destruction can be traced to the development and use of biological agents against economic targets such as crops, livestock and ecosystems. Furthermore, such warfare can always be carried out under the pretexts that such traumatic occurrences are the result of natural circumstances that lead to outbreaks of diseases and disasters of either endemic or epidemic proportions. Biological and chemical warfare share several common features. A rather comprehensive study of the characteristics of chemical and biological weapons, the types of agents, their acquisition and delivery has been made [6].

TABLE 1

SOME POTENTIAL BACTERIAL, VIRAL & TOXIC BWS

Category	Bacteria	Viruses	Toxins
Agents pose a risk to national security	Tularemia or rabbit fever	Smallpox	Botulinum toxin
	Anthrax		
	Botulinum toxin		
Moderately easy to disseminate	*Brucella* species	alphaviruses	----------
	Clostridium perfringens	*Vibrio cholerae*	----------
	Salmonella species	*Cryptosporidium parvum*	C. Perfringens toxin
	E coli O157		Cholera toxin
	Shigella		Shiga toxin
	Staphylococcus aureus		Trichothecenes
	Burkholderia mallei		Volkensin
	Burkholderia pseudomallei		Modescin
	Chlamydia psittaci		Ricin, abrin
	Coxiella burnetii		Cholera toxin
	Rickettsia prowazekii		
Emerging Pathogens		Nipah virus	
		Hantavirus	
		SARS	
		H1N1 a strain of influenza (flu)	
		HIV/AIDS	

Formulae and recipes for experimenting and fabricating both types of weapons result from increasing academic proficiency in biology, chemistry, engineering and genetic manipulations.

Both types of weapons, to date, have been used in bio- and chemoterroristic attacks against small groups of individuals. Again, defense measures, such as emergency responses to these types of terrorism, are unfamiliar and unknown. A general state of helplessness resulting from a total lack of preparedness and absence of decontaminating strategies further complicates the issue.

The widespread ability and interest of non-military personnel to engage in developing chemical and biologically based weapons is linked directly to easy access to academic excellence world-wide. Another factor is the tempting misuse of freely available electronic data and knowledge concerning the production of antibiotics and vaccines, and of conventional weapons with their varying details of sophistication.

Several other factors make biological agents more attractive for weaponization, and use by terrorists in comparison to chemical agents. Production of biological weapons has a higher cost efficiency index since financial investments are not as massive as those required for the manufacture of chemical and nuclear weapons. Again, lower casualty numbers are encountered with bigger payloads of chemical and nuclear weapons in contrast to the much higher numbers of the dead that result from the use of invisible and microgram payloads of biological agents.

To a great extent, application or delivery systems for biological agents differ with those employed for chemical and nuclear weapons. With humans and animals, systems range from the use of live vectors such as insects, pests and rodents to aerosol sprays of dried spores and infective powders. In the case of plants, proliferation of plant disease is carried out through delivery systems that use propagative material such as contaminated seeds, plant and root tissue culture materials, organic carriers such as soil and compost dressing, and use of water from contaminated garden reservoirs.

In terms of lethality, the most lethal chemical warfare agents cannot compare with the killing power of the most lethal biological agents [7]. Amongst all lethal weapons of mass destruction — chemical, biological and nuclear, the ones most feared are bioweapons [8]. Biological agents listed for use in weaponization and war are many. Those commonly identified for prohibition by monitoring authorities are the causative agents of the bacterial diseases anthrax and brucellosis; the rickettsial disease Q fever; the viral disease Venezuela equine encephalitis (VEE), and several toxins such as enterotoxin and botulinum toxin.

As a rule, microbiologists have pioneered research in the development of a bioarmoury comprised of powerful antibiotics, antisera, toxoids and vaccines to neutralize and eliminate a wide range of diseases. However, despite the use of biological agents in military campaigns and wars [9], it is only since the mid- 1980s that the attention of the military intelligence has been attracted by the spectacular breakthroughs in the life sciences [10]. Military interest, in harnessing genetic engineering and DNA recombinant technology for updating and devising effective lethal bioweapons is spurred on by the easy availability of funding, even in times of economic regression, for contractual research leading to the development of:

- vaccines against a wide variety of bacteria and viruses identified in core control and warning lists of biological agents used in biowarfare.
- rapid detection, identification and neutralisation of biological and chemical warfare agents
- antidotes and antitoxins for use against venoms, microbial toxins, and aerosol sprays of toxic biological agents
- development of genetically-modified organisms
- development of bioweapons with either incapacitating or lethal characteristics
- development of poisons e.g. ricin, and contagious elements e.g. viruses, bacteria
- development of antianimal agents e.g. rabbit calcivirus disease (RCD) to curb overpopulation growth of rabbits in Australia and New Zealand
- development of antiplant contagious agents e.g. causative agents of rust, smut, etc.

4 BIOTERRORISM

Popular scenarios of bioterrorism, that may have some mythical origins and cinematic Hollywoodian links, include the use of psychotic substances to contaminate food; the use of toxins and poisons in political assassinations; raids with crude biological cloud bombs; use of dried viral preparations in spray powders; and low flying cruise missiles adding destruction and havoc with genetically-engineered microorganisms.

Public awareness of the growing threat of bioterrorism in the USA is gathering momentum [11]. Development of national preparedness and an emergency response focus in essence, on the co-ordination of on-site treatment of the incapacitated and wounded, on-spot decontamination of the affected environment, and detection of the type and character of the biological agent, and its immediate isolation and neutralization. The rise of bioterrorism as a priority item on the agendas of international concern and co-operation is now being reflected in the establishment of verification procedures to guard against contravention of the Biological and Toxin

Weapons Convention, and in efforts in institutionalizing a desirable and much needed state of preparedness. In the USA, there has been a boost in funding for such research and defensive measures [12]. International workshops and seminars focus on the peaceful use of biotechnology and the Convention on Biological Weapons. In addition several other measures are in force to monitor the development and use of bioweapons [13]. Data generated by the Human Genome Project helps in the use of genomic information

- to develop novel antibiotics and vaccines,
- to enhance national and civil defence systems to contain and counteract the use of biological agents in the manufacture of bioweapons,
- to minimise and eliminate susceptibilities of different peoples, cultural and ethnic groups to hitherto unfamiliar or unknown diseases such genomic research could fuel the production of ethnic or peoples' specific weapons.

Curators and conservationists of biological diversity, public health officials, and biosecurity personnel, developing emergency preparedness provide convincing arguments to continue to maintain live viral stocks for the preparation of new vaccines in guarding against the reemergence of small-pox as a result of either accidental release or planned use in bioterrorism. The microbiological community and especially culture collections have an important role to play in educating the public to contain unexpected and sudden outbreaks of diseases through minimizing the easy acquisition of microbial cultures for use in bioterrorist threats. To offset the illegitimate use of microbial cultures, obtained through either fraudulent or genuine means, the microbiological community naturally occupies a central role in answering the challenges posed in the production of bioweapons Biological agents may be obtained from culture collections providing microbial species for academic and research purposes; supply depots of commercial biologics; field samples and specimens; and application of genetic engineering protocols to enhance virulence [14]. An example is the acquisition by a laboratory technician, of the causative agent of bubonic plague through the routine mailing system. In addition to expanding and safeguarding the planet's microbial genetic heritage, certified microbiologists can contribute to the building up of the defenses of peace through the development of educational and public health training programs and surveillance protocols in counteracting bioterrorism.

A recent survey of over 1400 research institutions, universities, medical colleges, and health science centres in the USA focused on research activities, production capabilities and containment facilities that may necessitate compliance declarations with the protocols of the Biological and Toxin Weapons Convention [15]. However, in the absence of a systematized infrastructure, the administrative, educational, economic and legal costs are burdensome and considerable.

Compliance declarations and regimes are of direct consequence with institutions that are engaged in routine and genetically–engineered research with specialized groups of microbial pathogens and toxins; that possess high-level containment facilities and laboratories; that are engaged in the design and engineering of high-production capacity bioreactors with fermentation volumes of 100- litres and above; and that do contract research for government and industry with biological agents that could serve as potential triggers of biological warfare and bioterrorism [15].

In brief, the very skills and technologies that are used by industry to screen process and manufacture drugs and vaccines could be used to develop bioweapons. Given the increasing risks to pertaining to the threats of bioterrorism and bioweapons, and the dilemma of dual-use technologies, site-verification of existing facilities and data assemblage and monitoring activities seem to be necessary. Nevertheless, despite bio-industrial concerns based on potential risks pertaining to loss of confidential biotechnological data and proprietary genetic holdings, compliance with the Biological and Toxin Weapons Convention is a must. The role of industry in designing apt verification measures is a crucial element in the strengthening of the convention [16]. Doing so, as a fundamental and primary step, provides recognition of the utility of the convention, and at the same time strengthens its importance and authority in the outright banning of the production, stockpiling and manufacture of undesirable bioweapons [17]. The practice of such investigations emphasises the growing need for the development of a verification protocol that deters and discourages violation of the Convention [18].

5 CONTROL, MONITORING AND REPORTING SYSTEMS

Reporting of outbreaks of disease, often attributed to natural causes, should always be taken seriously since such outbreaks often result from non-compliance with the prohibitions embodied in international conventions in force. Potential nosocomial transmission of biological warfare agents occurs through blood or body fluids (e.g. haemorrhagic fever and hepatitis viruses); drainags and secretions (e.g. anthrax, plague, smallpox); and respiratory droplets (e.g. influenza plague, smallpox).

The obligatory notification and reporting of outbreaks of diseases in humans, animals and plants helps to contain and neutralise the threats of biological warfare and bioterrorism. Such practice, in accordance with existing health codes and complementary reporting systems, helps to develop a reservoir of pre The development of a response strategy and technology in monitoring the control of weapons is at the core of a state of preparedness in the USA [19]. Current anti-bioterrorism measures involve the devising of unconventional effective countermeasures to combat misuse of pathogens encountered either naturally or in a genetically modified state. Such a strategic response involves:

- the use of bacterial RNA-based signatures and corresponding structural templates through which all pathogens can be potentially identified through appropriate trial and error testing, and verification;
- development of a data base of virtual pathogenic molecules responding to the bacterial signature templates;
- development, evaluation and use of effective antibacterial molecules that eliminate pathogens but do not harm humans nor animals [20].

6 CONCLUSION

Biological warfare can be used with impunity under the camouflage of natural outbreaks of disease to decimate human populations, and to destroy livestock and crops of economic significance. Attempts to regulate the conduction of warfare and the development of weaponry using harmful substances such as poisons and poisoned weapons are enshrined in conventions drawn up with respect to the laws and customs on land. These early instruments of war –prevention measures, and eventual confidence building and peace-building measures, have evolved from normal practices and characteristic usages established amongst, civilized peoples; from the basic laws of humanity; the tenets of long established and widely accepted faiths, and the dictates of public conscience.

In that context, the conventions outline steps and measures to safeguard buildings and historic monuments dedicated to art, religion and science, and to clinics and hospitals housing the sick and wounded, provided they are not engaged in combat. Use of such personnel in experiments designed to enhance the lethality of weaponry containing harmful substances such as poisons, disabling chemicals and ethical pharmaceuticals is implicitly and strictly prohibited. In the history of the interactions between science, culture and peace, the term Unit 731 is associated with the demeaning of science and humanity, their values and ethics. The activities carried out by Unit 731 in World War II were prohibited as far back as 1907.

New threats from weapons of mass destruction continue to emerge as a result of the availability of technology and capacity to produce, world-wide, such weapons for use in terrorism and organized crime [21]. Novel and accessible technologies give rise to proliferation of weapons that have implications for regional and global security and stability. In counteraction of such threats, and in securing the defense of peace, the need for leadership and example in devising preventive and protective responses has been emphasized through the need for training of civilian and non-civilian personnel, and their engagement in international cooperation. These responses emphasize the need for the reduction and elimination of bioterrorism threats through consultation, monitoring and verification procedures; and deterrence, through the constant availability and maintenance of a conventional law and order force that is well-versed in counter proliferation controls and preparedness protocols [22].

Adherence to the Biological and Toxin Weapons Convention, reinforced by confidence-building measures [23] is indeed, an important and necessary step in reducing and eliminating the threats of biological warfare and bioterrorism [24].

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