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Research article

CLASSIFICATION, CAUSES, CONTROL MEASURES AND ACTS OF BIOTERRORISM

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ABSTRACT: Bioterrorism poses a unique and serious danger to all nations' security, endangers public health and disrupts economies. During the past century, rapid advancements made in life sciences have simplified the development and production of bioweapons. With the discovery of ricin toxin, the concern over bioterror has heightened and resulted in the declaration of war against bioterrorism. The foremost strategy to control bioterrorism is to minimize the easy access to the biological materials. Strengthening of forensic techniques is another most essential step to spot and disable biological weapons. Project BioShield, a government-funded initiative has started funding for the procurement of medical countermeasures during emergencies. Other such initiatives and necessary measures must be taken by all nations to maintain laboratory biosecurity, including physical protection, border controls and law enforcement efforts. For implementing security at the laboratory working level, biorisk policies should be created and updated by the policy-makers. The governments around the globe should increase surveillance, awareness and preparedness in order to identify as well as disarm biological agents. Various such multimodal and multiagency approaches are required to combat bioterrorism and many of these approaches are relatively straightforward.

Keywords: Bioterror agents, biosecurity, surveillance centers, vigilance tools, bioterrorism acts

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INTRODUCTION

The international terrorist attacks are changing over the past 25 years towards the use of more deadly weapons for massive civil disruption (fas.org). Most terrorists use explosive and guns but some groups now show interest in using chemical, biological, radiological, or nuclear (CBRN) materials in order to cause mass casualties. Many countries including Algeria, Bulgaria, China, Cuba, Egypt, France, India, Israel, Iran, Iraq, Libya, Laos, North Korea, South Korea, Syria, South Africa, Taiwan, Vietnam, Russia *etc.* are possessed, pursued or capable of acquiring weapons (fas.org). In contrast of accessing functional chemical, radiological or nuclear materials, biological materials are produced easily. The deliberate release of such materials including toxin, disease causing microorganisms (pathogens) as well as their products to inflict harm on a wider population is termed as bioterrorism (Ackerman and Moran, 2004; Rasco and Bledsoe, 2005). Although, it needs trained aggressor and have unpredictable mortality to the civilian, terrorist can use them as their trump card in the emergency situations.

Origin of these weapons is contemporary biotechnology research that made great advances in agriculture and industrial processes along with revolution in the practice of drugs as well as therapeutics formulation. The very technologies that fueled these benefits to society, also pose a potential risk as well. According to Gerald Fink Report, "Biotechnology research in an age of terrorism: Confronting the dual-use dilemma" (National Research Council of the National Academies, 2003). The dual-use research concept came in early 2001, when an experiment was conducted for the development of viral contraceptive to control rodent populations by Australian scientists group.

They inserted an immune-system protein gene into the mousepox virus that converts the benign virus into highly lethal form in mice, even when animals were vaccinated against it. However, this finding was not published as they may provide a 'roadmap' for terrorists to develop more lethal human infecting viruses (Atlas and Dando, 2006). Furthermore, to check the mutation pressure, 'superbug' *Escherichia coli* O104 strain was discovered which has entire drug immunity. Much more alarming are the possibilities of developing completely novel biological weapons by using these practices.

History of bioterrorism

Biological weapons including filth and cadavers, animal carcasses, and contagion have been used to wage war and promote terror throughout history (Robertson and Robertson, 1995). The very first recorded incident of bioterrorism was in city-state Assyria of Mesopotamia in 600 BC. They employed rye ergot from fungus *Claviceps purpurea*, which contains mycotoxins in the wells of their enemies (Rega, 2004). After then, bioweapons have been employed repeatedly by nations, groups and individuals. In 1346, the siege of Caffa controlling seaport in a well-fortified Genoese (now Feodosia, Ukraine), attack the Tartar force and experienced an epidemic of plague (Wheelis, 2002). This plague (also known as Black Death) appeared as the most devastating public health disaster that spread to Europe and North Africa in the 14^{th} and 15^{th} centuries, killing more than 25 million Europeans. Furthermore, during the battle between Russian troops and Swedish forces, plague cadavars were used in Reval in 1710. In addition, the deliberate use of smallpox by Sir Jeffrey Amherst, the commander of the British forces in North America was suggested to diminish the native Indian population during the French-Indian War in 1754-1767 (Christopher *et al.*, 1997; Henderson *et al.*, 1999). Furthermore, ricin (*Ricinus communis*) toxin was used as bioweapon in World War I for bullets and shrapnel coating or as powder form to be inhaled into the lungs (Smart, 1997). In 1984, United States (US) faced the first identified attack of bioterrorism, when the followers of Bhagwan Shree Rajneesh contaminated salad bars in Oregon with *Salmonella typhimurium* bacteria which attack 751 people with severe food poisoning (Christopher *et al*., 1997; Caudle, 1997). Another attack by the fatalist cult Aum Shinrikyo in Japan caused concern worldwide. Cult members released sarin, a neurotoxin, in the Tokyo subway system in March 18, 1995. This resulted in thousands of injured civilians, but only eight deaths. In 1996, laboratory workers at a large medical center in Dallas, Texas, received an email for partake of muffins and donuts in break room. Twelve individuals later developed severe diarrhea, 8 of whom tested positive for *Shigella dysenteriae* type 2. Anthrax has been used as both a threat and a weapon in the US in October 2001, utilizing the postal service for delivery. A total of 18 cases were identified in New York, New Jersey, Florida, and Washington DC. Eleven of which were inhalational and seven of which were cutaneous (Salem, 2003). These events had heightened the concern over terror, and resulted in declaration of war against bioterrorism.

Biological Agents of Bioterrorism

The US 'Centre for Disease Control and Prevention' (CDC) has classified potential bioterrorism agents into three priority categories, labeled A, B, and C on the basis of their ability to be disseminated, mortality rates, capability of causing public panic and actions required for public health preparedness (**Fig 1**) (www.bt.cdc.gov).

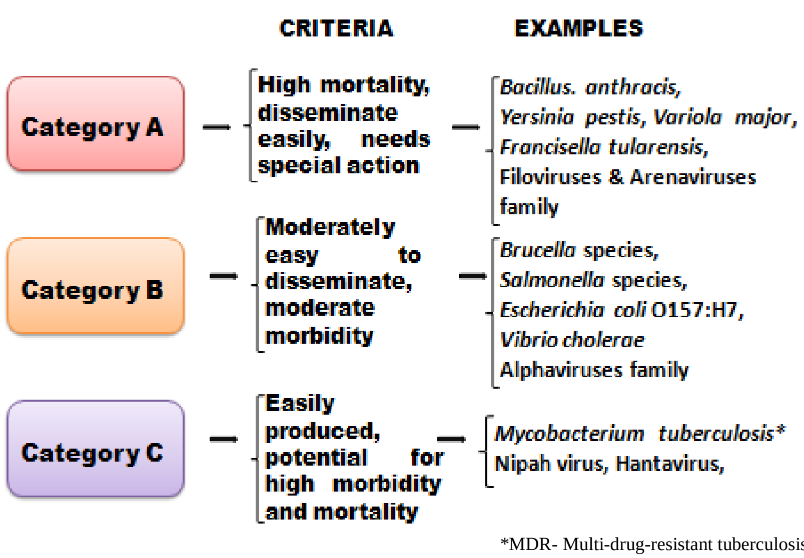

Fig 1: Classification of biological weapons (www.bt.cdc.gov).

Although there are several human biological pathogens, only handful of them has the potential to be used as effective bioweapons. For mass casualties and civil disruption, bioweapons should have infectivity and toxicity, environmental stability, ease of large-scale production, large geographical area coverage and disease severity properties. In addition, the aerosol route provides a large-scale attack therefore pathogens should be stable in aerosol and capable to be dispersed (5-17µm particle size). They should have the ability of being communicable from person to person and having no treatment or vaccine (Kortepeter and Parker, 1999) and can be improved by genetic engineering as well as other weaponization processes (Jansen *et al.,* 2014). Factors like weather, season and growth stage also play an important role in the effectiveness of the agent employed (Kaufmann *et al.,* 1997). Fulfilling these criteria, *Variola major* (smallpox) could be a potential bioweapon as no vaccine is available against it. Furthermore, no antiviral drug is effective, although cidofovir have *in vitro* activity (Whitley, 2003).

Causes/Targets of Bioterrorism

The main cause of bioterrorism is the globalization and the population growth that ultimately increases mass migration thereby accelerating commerce and travel. Approximately 1.8 million airline passengers cross international borders daily, that lead to a free route of radiating infectious biological materials around the world within hours (Drexler, 2010). Poverty is also intimately connected to bioterrorism which is increasing continuously with the climate change, population growth as well as agricultural ill policies (Reuveny, 2007). Growth of slums at the outskirts of developed cities is the origin of infectious diseases as these habitats lack clean water, proper sanitation and education. Some of these diseases are due to dangerous pathogens that are the subject of legitimate study in government, academic, and industry labs thereby easily accessible for the terrorist. Other climatic changes such as water scarcity, land degradation, droughts, deforestation, floods, storms and famines also hamper agriculture and trigger more migrations which lead to the hostile atmosphere (Meinhart, 2005). Some anti-social elements use this atmosphere for malevolent bioweapons production as pathogens genomic data is easily available either on the internet and open scientific literature or through legitimate research laboratories and pharmaceutical manufacturing sites.

Bioterrorism have devastating effect on the environment. Most of the bioweapons are relatively easy to generate, inexpensive and capable of mass destruction while using small quantities by simple means. Potential targets for bioweapons are water supplies and water distribution systems as it is the critical need of every ecosystem health and also to the smooth functioning of a commercial and economy sector of our industrialized society (Dembek *et al.*, 2007). Agriculture is another perfect target for bioterrorism which uses highly contagious, virulent and resistant agents that result in economic hardship on countries. In addition, animals, plants and birds could also be targeted for biological threat generation (**Fig 2**).

According to World Organization for Animal Health (OIE), 80% of pathogens used for biowarfare are of animal origin and 60% of human pathogens are zoonotic (www.oie.int). Furthermore, there are many animal foreign agents (foot and mouth disease virus, *Bacillus anthracis* and African swine fever virus) that are readily available in the nature and also from commercial sources, which require little effort in handling and dispersing these pathogens (www.oie.int). For the year 2016, OIE-listed 118 animal diseases, infections and infestations that could be developed as bioweapons (www.oie.int). For plants, agents such as wheat smut fungus *Tilletia laevis (T. foetida)* and/or *T. tritici (T. caries)* or rice blast fungus (*Magnaporthe grisea*), appear more harmful than others.

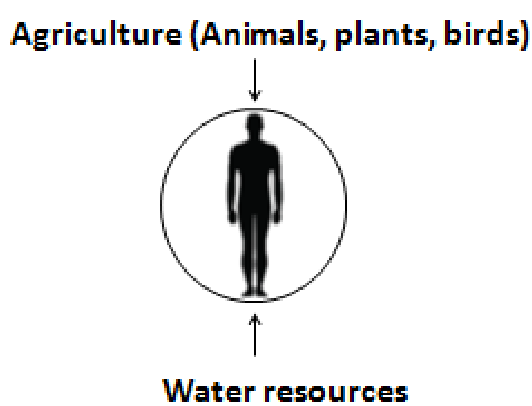

Fig 2: Potential targets for effective biowar fare.

Effective Control Measures

Public health is an important pillar for any national security framework and therefore an effective response is required against bioterrorism. This can be achieved through multimodal and multiagency approach and many of these approaches are relatively straightforward. Effective control measures against bioterrorism include:

i). Biosecurity
ii). Vigilance tools
iii). Research programs by NIAID
iv). Planning for risk management
v). Bioterrorism act

i). **Biosecurity**

Biosecurity is the method to protect and control the unauthorized access, loss, theft, intentional release thereby risk of transmission of infectious diseases in crops and livestock, quarantined pests, invasive alien species and living modified organisms (Koblentz, 2010). The revolutionary discoveries in life sciences lead to the unexpected paradoxes and dilemmas. Genomic information on one hand has opened the possibilities of better drugs and therapeutic formulation whereas on the other hand, malicious combinatorial bioweapons have been generated using this information. Therefore, it is necessary to have effective biosecurity that requires promotion of a set of attitudes, behaviors and systems by people which should be easy to comply with and hard to avoid (www.daf.qld.gov.au).

Biosecurity term is used in various context including food and agriculture biosecurity, industry biosecurity, laboratory biosecurity, farming biosecurity *etc.* The key elements and the implementation of biosecurity risk management in any of these fields can be targeted by the stepwise analysis, evaluation and monitoring of the system designed (**Fig 3)**.

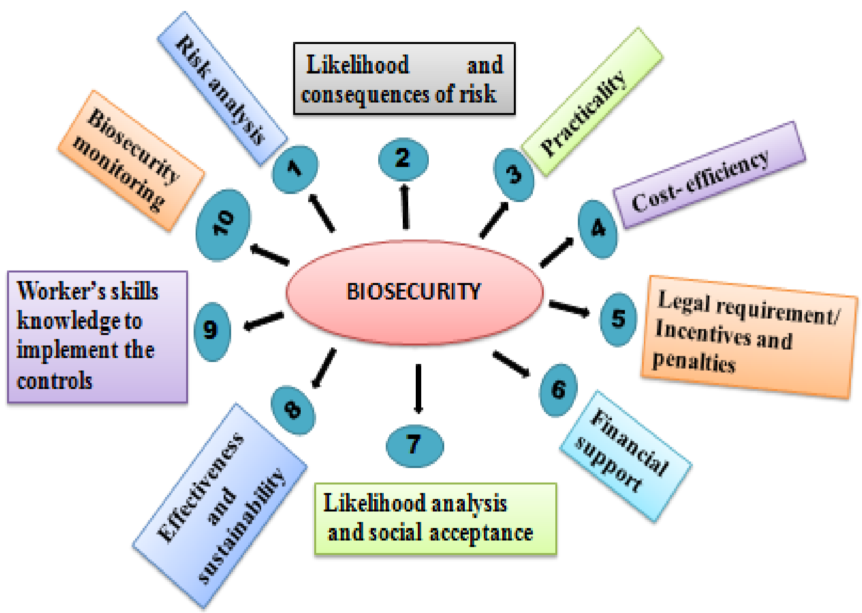

Fig 3: Analysis, designing and the steps of implementation of biosecurity (www.daf.qld.gov.au).

To prevent bioterrorism, national strategies have now been focusing mainly on the way of limiting access to the pathogenic microorganisms and laboratory biosecurity play immense role in this. The main components of laboratory biosecurity are physical security (restrict access to authorized individuals), personnel security (individual screening), material control & accountability (provide awareness regarding material and the responsible person), transport security (packaging and reliable carrier information), information security (sensitive information protection from public release) (www.biosecurity.sandia.gov). Apart from this, a competent scientific manager should be there to check all the rules and the records. Participation of all the individuals including scientific directors, principal investigators, biosafety officers, laboratory scientific staff, maintenance staff, administrators, information technology staff, law-enforcement agencies and security staff are required to form effective biosecurity and vigilance in protecting society (www.who.int). Biosecurity measures have been also extended to the regulation of dual-use research in the life sciences.

ii) Vigilance tools

Various past outbreaks have led to the understanding that a regional and even global response is needed. The early recognition of a bioterror agent is essential in ensuring effective containment and reduction of casualties. Once agent is detected, appropriate response and mitigation of events is required for epidemiological capability and population risk. With greater speed and precision of detection we can better prepare a functional response against biological attacks. Some of the vigilance tools are:

- **a) Epidemic information exchange** (Epi-X) is web-based communications network that serves as a powerful communications exchange between CDC, state and local health departments, poison control centers, and other public health professionals (www.cdc.gov).
- **b) Early aberration reporting system** (EARS) is a web-based communication method for monitoring bioterrorism during large-scale events. This network connects various cities, country and state public health officials in the US and abroad to CDC (Hutwagner et al., 2003).
- **c) Biowatch** is a US federal government program to detect the release of pathogens into the air as part of a terrorist attack on major American cities. The air samples typically are monitored daily for signs of the particular biological agents (Goldstein, 2010).
- **d) Joint biological point detection system** (JBPDS) consists of a biological suite that has a biological aerosol warning sensor (or trigger), collector, fluid transfer system and identifier and used to limit the effects of biological agent attacks that have the potential for catastrophic effects on US forces (www.dote.osd.mil).
- **e) Organic light-emitting devices** (OLEDs) have been developed to detect agents of bioterrorism (e.g. lethal factor produced by Bacillus anthracis). It is based on luminescent (bio) chemical sensors, where the photoluminescence excitation source is an OLED (Tabatabai, 2005).
- **f) Real time public health surveillance system** (RODS) provides an early alert to larger exposure or outbreaks and bioterrorism. A key component of the RODS system is the HL7 (Health Level Seven) message protocol which is an effective method of transferring health information electronically and it can be easily integrated into the mainstream (Tsui et al., 2003).
- **g) Microarray technology** is the most effective technique to detect bioterror agents from blood with the help of blood-screening microarrays using rRNA. It is a miniature device with oligonucleotide probes; these probes are able to differentiate the PCR products from pathogens using small amounts of sample (Ramachandran, 2008). Real-time PCR assays also provide higher specificity and shorter assay times than classical PCR techniques. One exciting report describes the development of real-time PCR protocols using reagents that are stable at ambient temperatures (Qu et al., 2010). Biofilms containing species can be detected using peptide nucleic acid fluorescence in situ hybridization (PNA FISH) through confocal laser scanning microscopy (CLSM) (Aune et al., 2011).
- **h) Raman microspectroscopy** is capable of identifying anthrax endospores inside a sealed paper envelope through a turbid medium (Arora et al., 2012).

- **i) Bioinformatics tools** (**Table-1**).

iii). Research programs by National Institute of Allergy and Infectious Diseases (NIAID)

For better understanding of the biological threats, the US Department of Health and Human Services established the 'National Science Advisory Board for Biosecurity' (NSABB) in 2006 which provide advice and guidance to the federal government regarding biological research (*i.e.* dual use research) (Nordmann, 2010). US Health and Human Services also form NIAID which is one of the 27 institutes and Centers of the National Institutes of Health (NIH) that conducts and supports basic and applied research in US and around the world.

Developing medical tools to counter bioweapons threats requires thorough knowledge of these microbes and the human immune system's response to them. In this field, the NIAID has placed a major emphasis on generating information on the genetic make-up of agents coupled with knowledge in biochemistry, microbiology and immunology. Genomic information also used to make rapid diagnostic tests, antimicrobial therapies, and new vaccines. In 2004, for category A biological agents procurement, BioShield was established which is a government-funded initiative that provide funds and spur private sector research (Cohen, 2011).

Table 1: Bioinformatics tools for vigilance.

TOOLS	DETECTION	REFERENCES
Bioterrorism and Epidemic Outbreak Response Model (BERM)	Program for estimating healthcare staffing needs for response to a bioterrorism attack or large-scale natural disease outbreak, based on number of current staff and number of patients expected to require rapid treatment	www.ahrq.gov
Desktop cDNA Annotation System (dCAS)	Allows users to import raw cDNA sequences, build sequence contigs, perform SignalP analysis, and compare BLAST contigs against numerous BLAST databases.	www.niaid.nih.gov
GPS-Prot	Allows facile integration of different HIV interaction data types as well as inclusion of interactions between human proteins derived from publicly-available databases, including MINT, BioGRID and HPRD.	Fahey *et al.*, 2011
JoinSolver	Performs IgE nucleotide and amino acid alignment as well as extensive mutation and CDR3 analysis, human V(D)J recombination analysis.	joinsolver.niaid.nih.gov
'open-target' approach to Biosensing	A relatively small, non-specifically designed, DNA microarray is capable of identifying the presence of multiple organisms in mixed samples coupled with a mathematical model and laboratory generated data.	Mohtashemi *et al.*, 2011
Papillomavirus Episteme (PaVE)	Graphic visualization of sequence features using a novel "locus view", precise BLAST results against the papillomavirus-specific PaVE databases,	www.niaid.nih.gov
PhyloMap	Combines ordination, vector quantization, and phylogenetic tree construction of influenza A virus genome sequences.	Zhang *et al.*, 2011
SNP Explorer	Visualizes and analyses SNPs from custom Affymetrix resequencing Hyper-IgM/CVID microarrays.	www.niaid.nih.gov

In 2014, the 'Centers of Excellence for Translational Research' (CETR) program was established by NIAID that focus and promote the translational research for the development of next generation therapeutics, vaccines and diagnostics against emerging and re-emerging infectious diseases. Two 'National Biocontainment Laboratories' (NBLs) having biosafety level-4 (BSL-4) **(Table-2)** and 12 'Regional Biocontainment Laboratories' (RBLs) having BSL-3 biocontainment facilities are being constructed to assist national, state and local public health efforts against bioterrorism or infectious disease emergency (www.niaid.nih.gov). These projects provide the genome sequence that will help in the identification of vaccine and drug targets thereby the production of diagnostic kits against the bioweapons (Greene *et al.*, 2007).

Initiatives against bioterrorism in India

Few episodes in the past have heightened the threat of bioweapons in India such as the Scrub typhus outbreak in Assam and West Bengal of India during the Indo-Pakistan war in 1965 (Singh, 2004). The outbreaks of pneumonic plague in Surat (Gujarat) and Bubonic plague in Beed (Gujarat) in 1994 resulted in mass casualties and increased attention to defense and intelligence outfits of India (Sharma, 2001). The 'Defense Research and Development Establishment' (DRDE) is the India's primary biodefense laboratory of the 'Defense Research and Development Organization' (DRDO), located in Gwalior, Madhya Pradesh. They are mainly involved in the development of defense against malicious biological, chemical as well as toxicological materials (www.drdo.gov.in). The 'Special Chemicals, Organisms, Materials, Equipment, and Technologies' (SCOMET) guidelines of India provide stringent export product control list that include goods, technologies and services related to dual- use items. However, SCOMET list lacks P3 or P4 containment facilities (equivalent to BSL-3 or BSL-4 labs) and several research equipments (dgft.gov.in). In November 2004, 'Integrated Disease Surveillance Project' (IDSP) was started by the Government of India that integrates the rural and urban health system as well as the government and the private sector for communicable and non-communicable disease information (Suryakantha, 2009; idsp.nic.in). India has also revised 'International Health Regulations' (IHR) that came into force in June 2007 which account for rapid detection and countermeasures of health emergencies (www.whoindia.org). In addition, the 'National Disaster Management Authority' (NDMA) in partnership with the 'Ministry of Health and Family Welfare and State Governments' (MOHFW) has started projects on the up-gradation of BSL laboratories and creation of Trauma Centers (www.ndma.gov.in).

In June 2015, India and the US signed a new 10-year defense framework agreement, highlighting the provisions to work together to develop a lightweight protective suit effective in chemical and biological hazard environments (Garamone, 2015).

The 'Department of Health Research' (DHR) is going to establish about 160 virology laboratories throughout the country in 12th Five Year Plan (Mourya *et al.,* 2014). ICMR network and the DHR supported institutes have already established sixteen BSL-2/BSL-3 laboratories and several BSL-3 laboratories are straightforward at their strategic locations as per XII Plan document (2012-2017), DHR, Government of India (Callaway, 2012). BSL-4 laboratory facility is available in 'Microbial Containment Complex' (MCC) of 'National Institute of Virology' (NIV), Pune which is the first of its kind in the Asian region (pib.nic.in). The 'Institute of Microbial Technology' (IMTECH), Chandigarh; 'National Centre For Disease Control' (NCDC), New Delhi; 'Centre for Animal Disease Research and Diagnosis', ICAR-IVRI, Izatnagar (Uttar Pradesh); 'National Research Centre on Equines', Hisar (Haryana); 'Lala Ram Sarup Institute of Tuberculosis & Respiratory Diseases Hospital', New Delhi; 'National Institute of Mental Health and Neuro Sciences' (NIMHANS), Bangalore (Karnataka); 'National Institute of Cholera and Enteric Diseases', Kolkata (West Bengal); 'International Centre for Genetic Engineering and Biotechnology' (ICGEB), New Delhi *etc.* are some of the working BSL-3 laboratories in India. However, at present there are several milestones for proper functioning of BSL laboratories such as lack of national guidelines or standards available for operation and maintenance as well as absence of national agencies to audit and validate BSL-3 laboratories (Mourya *et al.,* 2014). For the Fiscal Year 2014, NIAID has funded India for carrying research on unpredictable health issues such as HIV/AIDS, drug-resistance tuberculosis (TB), malaria *etc.* (www.niaid.nih.gov).

Table 2: Classification of biosafety levels (BSL) laboratories (Mourya *et al.*, 2014)

S.No	FEATURES	BSL-1 (*P1)	BSL-2 (*P2)	BSL-3 (*P3)	BSL-4 (*P4)
1	Agent type	Well-characterized and non-pathogenic agents	Non-respiratory and non-lethal agents	Respiratory and potentially lethal agents	Dangerous and exotic infectious agents
2	Personnel and environmental hazards	No minimal laboratory personnel and environmental hazard	Pose moderate hazards to personnel and environment	Hazard to the personnel, and may contaminate environment	Environmental risk of life-threatening disease, aerosol or unknown transmission
3	Training requirements	Good microbiological technique practices	Restricted access, use of autoclaves and biological safety cabinets	Laboratory personnel training in handling pathogenic and potentially lethal agents	Laboratory personnel specific training in handling pathogenic and potentially lethal agents
4	Safety practices	Good laboratory practices, aseptic techniques and proper waste disposal	Good laboratory practices, safe waste disposal measures and aseptic techniques	Two-person rule, communication method for routine and emergency contacts	Two-person rule, communication method for routine and emergency contacts
5	Containment facilities	No containment facility is required	Containment during aerosols processes	Bio -contained environments using proper engineering controls	Mandatorily work wearing positive pressure BSL-4 suits
6	Examples	*Escherichia coli*	*Clostridium difficile*, Chlamydiae, Human Immunodeficiency Virus (HIV) *etc.*	*Francisella tularensis*, *Mycobacterium tuberculosis*, Venezuelan Equine Encephalitis virus, SARS Coronavirus *etc.*	Marburg virus, Ebola virus, Lassa virus, Crimean-Congo hemorrhagic fever *etc.*

*P- pathogen or protective

iv). Planning for risk management

Planning is outlining necessary actions, identifying resources, assigning roles and responsibilities, and ensuring overall coordination which is crucial for combating bioterrorism. The response to the events of September 11, 2001 or natural devastation of Hurricane Katrina in Louisiana and Mississippi in 2005 was failure due to lack of effective systems for communication, workforce capacity, technological sophistication, and more importantly, the level of funding specifically available for such a response. Therefore, the CDC was adapted surveillance program in 2002, to check bioterrorism and emergency response readiness (www.phppo.cdc.gov).

a) National laboratory system (NLS) depends upon the participation of clinical laboratories, both to report test results that represent public health threats and to submit specimens and isolates to public health laboratory (PHLs) for additional or confirmatory testing (Astles *et al.*, 2010).

b) Hospital preparedness program (HPP) is to prepare the nation's healthcare system to respond appropriately to mass-casualty incidents, whether due to bioterrorism, natural disaster, or other public health emergencies.

c) Social media comprises Buttons and Badges, Widgets, Content Syndication and many more social networking websites that are used to provide information, commentary and descriptions of events and highlight certain audio or video contents for emergency preparedness.

d) National Notifiable Diseases Surveillance System (NNDSS) is a multifaceted program that enables all levels of public health (local, state, territorial, federal, and international) for collection, analysis, and sharing of notifiable disease-related health information (wwwn.cdc.gov). *NNDSS Modernization Initiative* (NMI) is underway to give more comprehensive, timely, and higher quality data than ever before for public health decision making.

e) BioSense is a syndromic public health surveillance system that provides efficient, rapid and collaborative monitoring as well as response to harmful health effects of exposure to diseases or hazardous conditions (www.cdc.gov).

f) National Pharmaceutical Stockpile (NSP) program was also established by the CDC which is an essential response element for the Bioterrorism Preparedness and Response Initiative. This program is mainly concerned with the maintenance of pharmaceuticals and medical supplies that should be delivered to the communities during mass casualties due to biological or chemical terrorist attacks (Pesik *et al.*, 2002).

v). Bioterrorism acts

The events of September 11, 2001, reinforced the need to pass several laws to better prepare the nation against bioterrorism (**Table- 3**) (www.fda.gov).

Table 3: Bioterrorism acts and their functions.

ACTS	COUNTRY	YEAR	FUNCTIONS
The Pandemic and All-Hazards Preparedness Act (PAHPA)	United States	2006	Improve the nation's public health, medical preparedness and response capabilities in emergencies.
Public Readiness and Emergency Preparedness Act (PREP Act)	United States	2005	Protects from liability claims arising from administration, vaccine manufacturers, distributors, program planners, and qualified persons involved in the administration.
Biodefense and Pandemic Vaccine and Drug Development Act	United States	2005	Provides incentives for domestic manufacturing of vaccines and broad liability protections to the companies.
The Project Bioshield Act	United States	2004	Provides permanent funding for the procurement of medical countermeasures during emergencies.
Public Health Security and Bioterrorism Preparedness and Response Act (Bioterrorism Act)	United States	2002	Issue regulations on enhancing controls on dangerous biological agents and toxins, protecting safety and security of food and drug supply, drinking water Security and safety.
Homeland Security Act	United States	2002	Create the Department of Homeland Security (DHS), that prevent or minimize damage and assist in recovery for terrorist attacks
USA Patriot Act	United States	2001	Uniting and strengthening America by providing appropriate tools required to intercept and obstruct terrorism
Chemical and Biological Weapons Control Act	United States	1991	Strengthen efforts to control chemical and biological agents, precursors, and equipment.
Biological Weapons Convention (BWC)	United Nation	1972	Prohibition of the development, production, and stockpiling of bacteriological (biological) and toxin weapons and on their destruction
Department of Defense Research and Development (DRDO)	India	1958	Formulates and executes programs of scientific research in the fields of induction of new weapons, platforms and other equipment's required by the Armed Forces.

CONCLUSIONS

Over the years, the weapons have been shifted from swords to malevolent biological weapons. Although, very few pathogens can be used as bioweapon, their considerable ease of production along with the immense mass casualty and civil disruption made them effective arms. Since bioterrorism attacks are unpredictable, early detection, containment, treatment and communication are crucial for appropriate response against it. New programs and systems should be designed to insure our national security. In addition, to limit the access to biological materials, laboratory biosecurity and regulations should be created and updated according to the risk assessment by the policy-makers. There is heightened and urgent need of increased collaborations among the academic sector, government-private industry and nations which will provide benefits far beyond protection from deliberate acts of bioterrorism.

FUTURE PERSPECTIVES

Technological advancement in any field comes with new national security risks and use of bioweapons is the cruelest act in the current dates. Therefore, current surveillance, awareness and preparedness strategies have been the focus for improvement and research in health emergencies. There are needs of methods and technologies that can generate effective diagnostics and therapeutics against a new as well as variant infectious agent within days or weeks after its identification. In addition, robust plan should be prepared which are hopeful, flexible and rapidly responsive. Biosensoring technology should be started at the regional, state and federal levels as they are financially feasible. Furthermore, preliminary detection of biological agents is made through mobile rapid-screening units that play important role in surveillance programme and various such devices may soon more frequently used in future (Grundmann, 2014).

Federal agencies such as the NIH and the NSF (National Science Foundation) engaged in funding for biodefense research programs. These funds have been reallocated yearly, to NIAID at the NIH focusing on advancing drugs, vaccines and diagnostics for emerging pathogens and hazardous bioweapons.

With the advancement in the research field, regulations should be updated so that the risks should be minimized. In addition, independent committees of industry leaders, agency officials, and academics should be appointed to design and reform regulations based on the risk assessments. The fight against terrorism is high on NATO's (North Atlantic Treaty Organization) agenda as they are acting decisively on chemical, biological, radiological and nuclear (CBRN) threats and related issues. In India, efficient medical preparedness and latest BSL facilities are on high demand. Moreover, coordinated and concerted efforts of multiagency are required to successfully curb the intentional or accidental release of biological materials.

Conflict of Interest: None

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Abbreviations: Chemical, biological, radiological, or nuclear (CBRN);Centre for Disease Control and Prevention (CDC); World Organization for Animal Health (OIE); Epidemic information exchange (Epi-X); Early aberration reporting system (EARS); Joint biological point detection system (JBPDS); Organic light-emitting devices (OLEDs); Real time public health surveillance system (RODS); Peptide nucleic acid fluorescence in situ hybridization (PNA FISH), Bioterrorism and Epidemic Outbreak Response Model (BERM); Desktop cDNA Annotation System (dCAS); Papillomavirus Episteme (PaVE); National Institute of Allergy and Infectious Diseases (NIAID); National Science Advisory Board for Biosecurity (NSABB); Centers of Excellence for Translational Research (CETR); Defense Research and Development Establishment (DRDE); Defense Research and Development Organization (DRDO); Special Chemicals, Organisms, Materials, Equipment, and Technologies (SCOMET); Integrated Disease Surveillance Project (IDSP); National Disaster Management Authority (NDMA); Ministry of Health and Family Welfare and State Governments (MOHFW); Department of Health Research (DHR); Microbial Containment Complex (MCC); Institute of Microbial Technology (IMTECH), National Centre For Disease Control (NCDC); Indian Council of Agricultural Research- Indian Veterinary Research Institute (ICAR-IVRI); National Institute of Mental Health and Neuro Sciences (NIMHANS); International Centre for Genetic Engineering and Biotechnology (ICGEB); Tuberculosis (TB); National laboratory system (NLS); public health laboratory (PHLs), Hospital preparedness program (HPP); National Notifiable Diseases Surveillance System (NNDSS); NNDSS Modernization Initiative (NMI); National Pharmaceutical Stockpile (NSP); Pandemic and All-Hazards Preparedness Act (PAHPA); Public Readiness and Emergency Preparedness Act (PREP Act); Biological Weapons Convention (BWC); National Institutes of Health (NIH); National Science Foundation (NSF); North Atlantic Treaty Organization (NATO)

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