India's preparedness against bioterrorism: biodefence strategies and policy measures

Kewal Krishan[1], Baljinder Kaur[2,*] and Anshula Sharma[2]

[1]Department of Defence and Strategic Studies, and
[2]Department of Biotechnology, Punjabi University, Patiala 147 002, India

Bioterrorism is a realistic threat to the security and well-being of all countries. Significant legal and biodefence measures must be taken to prevent the production and use of deadly biological weapons. Previous bioterror incidences, dense population and congenial climatic conditions of India, make it vulnerable to bioterrorism threats. This review provides a comprehensive picture of the potential biothreats to the country, the existing laws and policies to counteract such incidences with a strong need for their implementation, and biodefence strategies for preparedness and protection, to make India a bioterror free nation.

Keywords: Bioterrorism, biodefence strategies, policy measures.

IN the world of advanced weaponry and strategies, the threat of bioterrorism is of great concern not only to the safety of every country, but also to the health and well-being of its citizens[1]. Due to rapid increase in the technical skills of terrorists and fast growing research in the field of molecular biology and biotechnology, the risk of bioterrorism is increasing day by day. Another major factor which adds to the intricacy of situation is the rapid expansion of networks of transnational terrorist groups, accessibility to resources, technologies, and expertise required for developing a biological weapon. Thus, the ability to detect and respond to a bioterrorism attack is necessary to minimize adverse health effects and prevent fatalities[2].

Bioterrorism

Bioterrorism is defined as a planned or destructive use of biological agents such as viruses, bacteria, fungi or toxins produced from living organisms. The main aim of bioterrorism is to harm people, animals and plants by causing death, so as to achieve political or social destruction. The virulence and ability of an agent to cause a disease can be increased through creating mutations in that agent. Also, the agents can be designed in such a way that the current medical treatments are unable to cure and they can be easily spread through air, water, food, foamites or through infected hosts such as insects, animals, humans and other reservoirs[3]. Biological terrorism resulting in mass destruction or causalities further ensues disturbances or panic among population[4]. Detection of such biological agents may require several hours to weeks. Hence, the rate of mortality by utilizing bioweapons can be excessive, compared to the traditional ways of destruction[5]. Because of these facts, such agents are gaining importance around the world, than nuclear or chemical weapons[6].

Origin and history of biowarfare

The origin of bioterrorism dates back to pre-historic era when Hittites and Scythians sent infected rams to their enemies[7]. Assyrians poisoned enemy wells with rye ergot fungus in 600 BC (ref. 8). In 1346, during the siege of Feodosia (Ukraine), Tartar forces used plague victims as biological weapons to spread plague pandemic in the city, interpreted as *black death* which still remains controversial[9].

This outburst later spread through many countries like Europe, the Near East and North Africa during 14th century and is believed to be the most destructive and distressing public health disaster in recorded history[10]. The intended and planned use of smallpox-loaded clothing resulted in disease outburst among the South American natives and Indian tribes settled in the Ohio River Valley[11,12]. There were similar strategies of polluting water resources with infectious substances, use of diseased cadavers or animal carcasses in many wars among several European countries, American Civil War and other conflicts, in the 20th century[8]. Germans used diseased animals as delivery vectors during World War I to spread biological agents like *Bacillus anthracis* (anthrax), *Clostridium botulinum* (cholera), *Pseudomonas pseudomallei* (glanders) and *Yersinia pestis* (plague) in US, France, Italy and Russia[8]. In 1925, Geneva protocol was signed by many countries like France, Canada, Great Britain, US, Belgium, Italy, Poland, Japan, the Netherlands and the former Soviet Union to minimize use of bioterrorism agents. Despite this, these countries continued to use biological agents against each other[13]. During 1932–1945, Unit 731 biological warfare programme of Japan, known

*For correspondence. (e-mail: baljinderbt@hotmail.com)

to be the most dangerous bioterrorism operation caused mass casualties of more than 10,000 prisoners due to anthrax, plague, cholera and gas gangrene. Japanese military also spread plague-infected laboratory fleas into major Chinese cities, leading to its outbreak in China[14]. The United States was also blamed for using biological weapons during Korean War[15]. At the same time, other countries too were conducting biological warfare research programmes either officially or un-officially. Thus, to curb such incidences, a first multilateral treaty, known as Biological Weapons Convention (BWC) was proposed in 1972 (ref. 8). Even then the member countries continued their harmful biological research programmes[16]. During Persian Gulf War, the Iraqi regime planned and sponsored a total biological and chemical warfare programme utilizing *B. anthracis*, butulinum toxin and *C. perfringens*, to deliberately harm USA and allied countries who were running 'Operation desert shield' at that time[17].

Apart from these rare but well documented state-sponsored and military-related biowarfare incidences, several private and civilian groups were also involved in the development and spread of highly infectious biological agents and chemical weapons. Religious groups like that of Rajneesh were charged for deliberately spreading *Salmonella typhimurium* in Oregon City (USA) in 1984 and in 1995 Aum Shinrikyo attempted sarin gas attack against Tokyo (Japan). Several incidences on the use of infected letters (with anthrax and plague) for harmful purposes by individuals were reported in the US between 1996 and 2001. In 2002, ricin, a chemical weapon was recovered from six terrorists in England. A year later, terrorists attacked the Russian embassy with ricin. In 2004, ricin was also found in the mail room of the US senate office. In 2013, a person was charged for mailing ricin contaminated letters to the US President, a senator and a local judge[5,18].

In India, prevalence of such bio-terror attacks is comparatively less. There are some rare incidences of spread of epidemics in India, but it is often difficult to monitor the origin of such diseases. A few such cases, though officially not confirmed include spread of pneumonic plague in Surat in 1994, dengue hemorrhagic fever in Delhi in 1996, anthrax in Midnapur in 1999 and encephalitis in Siliguri in 2001. It is in fact tough to differentiate natural epidemics from alleged biological attacks, because of several reasons, such as lack of evidences or confusion related to natural spread of the disease. Sometimes, political manipulation on the use of infectious agents as weapons, may distort the truth, as the facts become evident later. Nevertheless, in this article, we provide a concise overview of some likely biological warfare events that occurred in history. Regarding international bioterrorism, Barras and Greub provide an exclusive review where they summarize the main events that occurred during the modern microbiology era, from World War I to the US World Trade Center attack[7].

Potential biological weapons and characteristics of biowarfare agents

Biological weapons are those which contain replicating microorganisms such as bacteria, viruses, fungi, protozoa, prions or poisonous chemical toxins produced by living organisms. These are of many types based on the type of pathogen and are used against humans, animals, or crops[5,19]. These agents are easy to obtain and cultivate and hence countries manufacture and maintain them in bulk. Serious respiratory and contact precautions are recommended in case of infections caused by biological agents like *Bacillus anthracis* (anthrax), *Burkholderia mallei* (glanders), *Burkholderia pseudomallei* (ulcers, abscess), *Clostridium botulinum* (botulism), *Ebola virus* (ebola), *Rickettsia* (typhus and rickettsialpox), *Variola virus* (smallpox), *Yersinia pestis* (plague), etc. These organisms can be easily dispersed and cause very high morbidity and mortality in the infected population. Persons, who have not contracted these infections earlier, do not possess any natural immunity against these pathogens. Compared to other common diseases, diseases caused by these agents are difficult to diagnose and cure[20]. According to previous studies, different terrorist groups have relied on different disease transmission methods such as aerosols, contaminated food, water, explosives, pharmaceuticals or any other non-living object or direct contact with diseased individuals or cadavers. The factors which affect the effectiveness of an attack are weather conditions and stability of the agent[21]. Programmed robots and suicide coughers are also emerging as potential delivery tools of biological agents for mass destruction[22].

Methods of detection of biowarfare agent

Biowarfare agents are detected using combined molecular and microbiological sensing technologies. Presently, antibody-based immuno-assays, biochemical testing, mass spectrometry, microbiological culturing and genomic analysis using PCR (used in Biowatch program of USA) are recommended for primary identification of biological agents and their specific genes[23–25]. These techniques are highly reliable, sensitive and selective. However, some of the detection methods have drawbacks like difficulty in isolation, extraction and purification of samples for testing, poor detection capability in identifying differences in pathology and etiology, differences in physiochemical or structural properties of pathogens and the presence of different materials and matrices[5,23].

Social, emotional and behavioural impacts of bioterrorism

Bioterrorism causes damage, fear, and anxiety among people and affects the society and government of a

country[26]. It restricts scientific investigations on concerned pathogens as well as exchange of scientific information[27,28]. It is responsible for the change observed in the current scenario of emergency medical awareness and responses[29].

Defensive and serious actions are required against bioterrorism so as to protect the society and its people. Legally there is a provision for reviewing criminal charges and fine against bioterrorist activities[30]. For example, in USA, one graduate researcher was charged under the new anti-terrorism law for mishandling anthrax-tainted cow tissue during 1960s (ref. 31). Similarly, in another case, a well-known US researcher was charged for concealing information, mishandling and illegally importing plague-infected laboratory samples[32]. In UK, a top research institute was charged nearly $65,000 as fine for improper handling of biological agents and negligence towards the security of laboratory workers and public[33].

Besides being lethal, the psychological impact of bioweapons is equally damaging and long lasting. The impact includes horror, panic, fear of invisible agents, anger towards terrorists, government or both, acknowledgement of awakening symptoms to infection, suspicion, social isolation, demoralization and loss of faith in social institutions[34]. Sometimes, biowarfare agents have direct impact on the central nervous system and produce a wide range of psychological implications such as restlessness, depression, irritability, headaches, fatigue, mood swings or even long-term cognitive impairment[35].

Bioterrorism: Indian scenario

Dense population, poor hygiene and deprived sanitation facilities along with congenial climatic conditions make India vulnerable for the spread of infectious diseases caused by biological agents. Highly infectious and virulent agents occur naturally in India because of easy availability of extended water-locked agricultural fields and animal farms. In addition, India does not have adequate medical facilities, i.e. on an average a single government doctor serves nearly 12,000 people. Hence, most of the people remain untreated and when they move across the country, the release and spread of disease becomes quite easy leading to the outbreak of bioterrorism[36]. Research authorities also need time to differentiate between the nature and type of biological agents, i.e. whether they are natural or man-made and how to deal with them[36].

A number of challenges arise during fight against bioterrorism. The very first challenge is the proper collection of specimens at the site and their identification. It is usually hard to find the site where the original outbreak occurred or from where it was initiated. If samples are not accurately identified, it becomes difficult to control the bioterrorism crisis. Secondly, it is also a challenge to recognize the occurrence of the attack and quick management of the outbreak. Thus to combat bioterrorism, synchronized and determined efforts of different agencies like intelligence agency, Indian army, Border Security Force, law enforcement machinery, all health departments and civil administration are needed[36].

India's preparedness against bioterrorism

Preparedness will focus on risk analysis of biological weapons, medical and public health consequences, medical countermeasures and long-term strategies to combat and prevent future threats. The National Disaster Management Authority (NDMA), Govt. of India (GoI) has proposed a model instrument where participation of both government and private sectors is a pre-requisite to manage the menace of biological disaster. According to NDMA, a sound infrastructure is necessary for both medical countermeasures and for research and development to evolve novel instruments and methods of testing.

Biological disasters cause socio-economic upheavals and decline of population. Depending upon the vulnerability of populations to specific biological agents, these may cause mass destruction similar to chemical and nuclear weapons. Epidemics can result in heavy losses due to depletion of crops, domestic animals and natural resources like air, water and productive soil. So, a multisector approach has to be adopted, for which judicial involvement of the government is a prerequisite. In India, there are several nodal ministries for dealing with epidemics caused by bioterrorism. Similarly, several acts related to management of environment, human, animal health, crops, etc. have been enforced to punish miscreants of such unlawful activities (Figure 1).

The Ministry of Health and Family Welfare (MoH and FW) is one of the main ministries dealing with epidemics. The national health sector guidelines are designed and regulated by this ministry. It also provides directions and technical support for capacity building in surveillance and in the early detection of any outburst. This ministry also helps in employment of Rapid Response Teams' manpower and logistic support. The Ministry of Home Affairs (MHA) is another nodal ministry for prevention of bioterrorism and works in conjunction with MoH and FW. MHA is responsible for assessment of threat sensitivity by providing intelligence inputs and then establish and implement preventive mechanisms. The Ministry of Defence (MOD) manages the matters and consequences of biowarfare. Clinical case management is supported by the Indian armed forces, as they have a number of hospitals around the country. They use ambulances, aircrafts and ships to handle casualties. The Defence Research and Development Organization (DRDO) is actively engaged in developing protective systems and equipment for troops to fight against nuclear, biological and chemical warfare[22].

Figure 1. List of supporting nodal ministries and their activities for protection against bioterrorism.

The Ministry of Environment, Forests and Climate Change is responsible for evaluation of short- and long-term consequences. The Ministry of Agriculture deals with biological disasters related to plants, animals, livestock and fisheries, which works in conjunction with the Department of Animal Husbandry, Dairying and Fisheries. The Department of Agriculture and Co-operation in the Ministry of Agriculture, deals with crop diseases. The Directorate of Plant Protection, Quarantine and Storage, deals with pests. For research on agriculture and allied sciences, the Indian Council of Agricultural Research works under the supervision of the Department of Agricultural Research and Education.

Urban or Rural Development Ministry and Department of Drinking Water Supply are key supporting ministries for maintaining proper sanitation facilities, drinking water and hygiene. Indian Railways also plays a key role in providing medical facilities with the help of trained personnel, as it has many tertiary care hospitals across the nation. It also conducts mass evacuation of the affected community. MoH and FW chalks out strict standards for water, food, shelter, sanitation, hygiene, etc. It helps in the development of human resources through various capacity development programmes, establishment of attentive and supportive socio-political environment.

NDMA is responsible for laying down policies on management, approving plans of different ministries or departments of GoI in accordance with the national plan and preparing guidelines to be followed by the authorities of different states to prevent any disaster. It also works for the further improvement of development plans and projects and accomplishment of disaster management. The National Crisis Management Committee (NCMC) co-ordinates and monitor responses in crisis situations especially in disasters. It provides strong co-ordination and implementation of relief measures during disasters. The National Disaster Response Force (NDRF) provides specialized response in a threatening disaster situation. This force is well trained for multitasking in different disciplines. NDRF also provides training to the State Disaster Response Forces personnel, police and civil defence home guards in the field of disaster response.

Existing laws and policies

Any biological disaster response policy can only be raised using a well-defined national biosecurity and biosafety protocol. The implementation of such a policy should follow a judicial framework within which the main grassroot level implementers such as health officials, private as well as government hospital doctors, paramedics, general public and most importantly the gram panchayats, district, state and national level health authorities work. They need to be carefully revised and monitored from time to time. The laws or policies should have sufficient safeguards to prevent their misuse. Some

of the existing laws or policies for protection against bioterrorism are described below.

A Plant Quarantine Regulatory Act was passed to provide protection against any harmful insect, fungus or other pests, that cause destruction of the crops. This act was operational through the 'Destructive Insects and Pests Act', 1914, in India. The significance of Plant Quarantine Act has increased due to present globalization and liberalization in international trade of plants and plant materials. The National Security Act, 1980 was passed to strengthen the national security by allowing the government to arrest a person, if his actions are suspected to cause harm to the defence of the country or affect its foreign relations. Such preventive arrests can also be made to protect the security of a state or public or any community. The other act which plays an important role in preventing terrorist activities is 'The Terrorist and Disruptive Activities (Prevention) Act, 1985'. This act was passed in May 1985, due to increase in terrorist activities in some parts of the country. With further growth in terrorist incidences, especially in states like Punjab, this act was continued and improved. To further strengthen its power in order to cope up with the threat of terrorism, the Terrorist and Disruptive Activities (Prevention) Act 1987 was enacted. The Prevention of Terrorism Act (POTA) 2002, was passed by the Parliament of India to strengthen the anti-terrorism operations. This act was established especially after the attack on the Parliament.

The Epidemic Diseases Act, EDA (Act 111 of 1897) was established to prevent the spread of dangerous epidemic diseases by allowing the states to take strict actions and preventive measures for the control of epidemics. The Water (Prevention and Control of Pollution) Act, 1974 and The Air (Prevention and Control of Pollution) Act, 1981 have been established for prevention, control and abatement of water and air pollution respectively. To enhance the level of environmental protection and improve safety of human races, other living creatures, plants and property, Environment Protection Act was passed in 1986. The entry of livestock and livestock products was regulated by 'The Livestock Importation Act, 2001'. This act also provides modalities of International Animal Health Certification. For better management of disasters, the Disaster Management Act (DM Act), 2005, was enacted and with the establishment of operational framework, this act provides prevention, improvement, preparedness and recovery against any disaster[37].

Biological Weapons Convention

A long term debate on Geneva Protocol has led to the development of Biological Weapons Convention (BWC) as a new preventive measure that would serve as a supplement to the 1925 Geneva Protocol. This convention is known as 'Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and their Destruction'. This is the first multilateral disarmament treaty which prohibits the development, production and stockpiling of an entire category of biological warfare agents of mass destruction. This convention opened for signature on 10 April 1972; came into force on 26 March 1975 with the deposit of ratification by 22 states. By January 2015, 173 states (countries) gave their acceptance for the prohibition of development and stockpiling of toxic biological weapons. Use of biological agents is permitted for prophylactic, protective and other peaceful purposes. The successful operations of BWC was officially reviewed by state parties in 1980, 1986, 1991, 1996, 2001/02, 2006 and 2011. The scope of these review conferences was to highlight new technological and scientific developments, enhance transparency and strengthen BWC by adopting additional agreements[37].

International Health Regulations

Due to the rapid increase in international travel and trade, and occurrence and re-emergence of international disease threats and other health risks, 196 countries including all the Member States of World Health Organization (India also), have agreed to implement the International Health Regulations (IHR) (2005). These regulations encourage countries to work together to save lives and livelihoods which are affected by the outbreak of infectious diseases and other health problems. They also help countries to stay away from unnecessary interference with international trade and travel[37]. At the national level, the existing contingency plan of MoH and FW is about 10 years old and needs to be revised. To implement IHR (2005) guidelines, there should be strict and strong surveillance at borders, airports and ports. A well co-ordinated action plan of intelligence agencies, MoH and FW and MoD is needed for development and establishment of strong defence and deterrence strategies. Preparedness against any biological disaster will be possible with the implementation of these guidelines.

Strategies for defence against bioterrorism

Awareness against biothreats, biosurveillance, biomonitoring, disease diagnosis and recovery (hospital and community preparedness) are indispensable tools of defence against any bioterrorism[36]. A biodefence strategic plan consists of several important components as shown in Figure 2. The preparation to deal with bioterrorism must be widespread and versatile. The main focus should be on the development of trained biological disaster quick response teams (BDQRT) and their knowledge enhancement through regularly updated learning modules. Emergency operations can be executed by combined efforts of

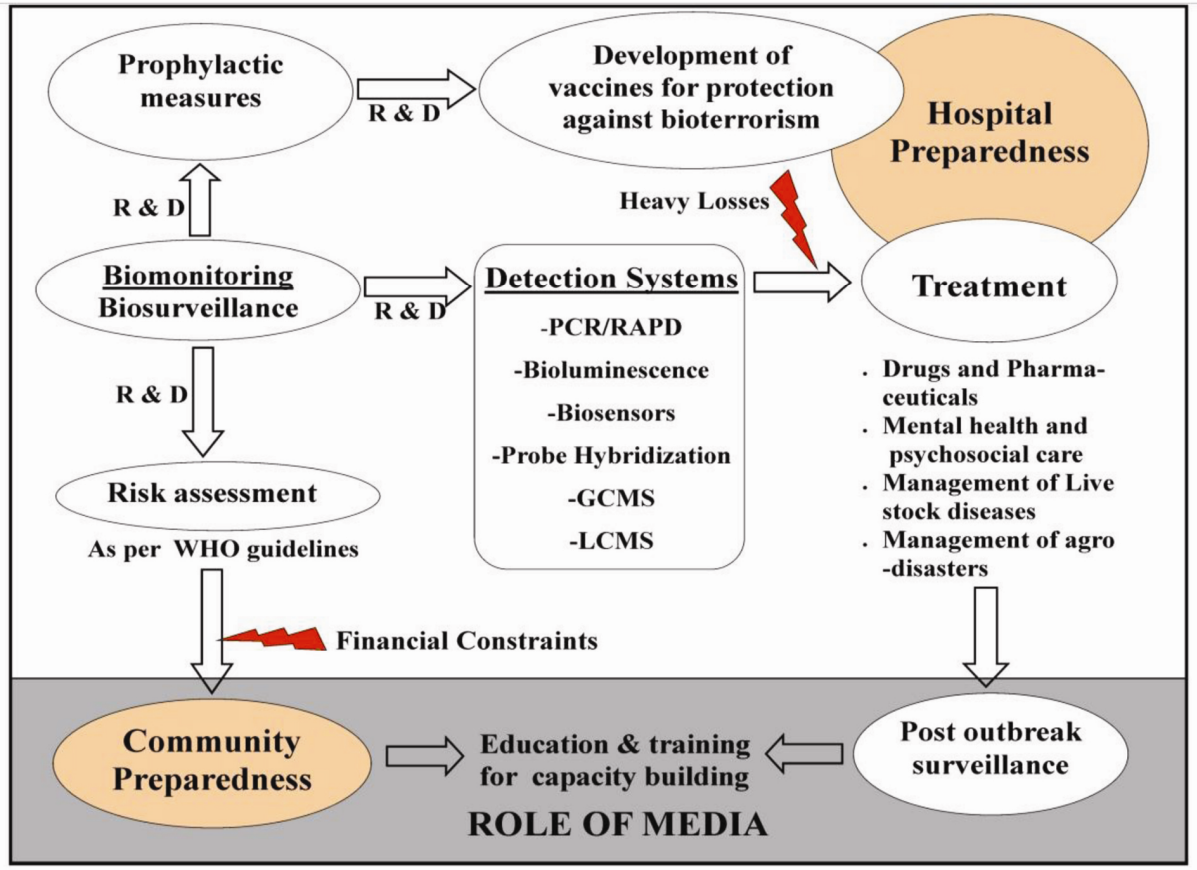

Figure 2. Important stages of a biological disaster management plan.

NDRF, BDQRT, public health departments and community workers.

Key regulatory parameters of biodefence strategic plan include efforts like development of full international co-operation to deal with bioterrorism, educating the populations at risk, proper monitoring of potential producers and users of biological weapons, improvement of biowarfare monitoring techniques and apparatus to stockpile biological weapons fighting supplies[38]. Collaborative efforts are needed to improve and develop new drugs, vaccines, new methods of diagnostics, detection and decontamination. Forensic techniques should be strengthened to detect the origin or presence of biological weapons[39]. India should utilize its advanced biotechnology techniques to keep a continuous vigil on the shifting terrorist strategies that disrupts its social and economic prosperity and control the possibility of such bio-terrorist attacks[40]. Highly sophisticated, rapid and ultra-sensitive methods like mass spectroscopy, Raman spectroscopy, biosensors, polymerase chain reaction (PCR) and other molecular techniques are currently available for detection of biowarfare agents in air, soil, water and food articles (Figure 2). Faster and standard disinfection methods need to be developed for decontamination of highly infectious biological agents[41].

Hospital preparedness is the primary and essential preventive measure required to combat bioterrorism[36,42]. Hospitals should be upgraded for managing chemical, biological, radiological and nuclear attacks. There should be a strong communication and networking system between NDMA and district and state level health departments, ambulance/transport services, state police departments, etc.[42]. The government should stock sufficient drugs to be used against harmful agents. Computer simulation models can be used to estimate the requirement of staff, antibiotics or medicines on the basis of number of patients[43]. Every doctor, specialist or clinical practitioner should remain up-to-date regarding current infectious diseases and should use web-based alerting systems to make use of relevant epidemiological information into their daily practice. In case face to face training programmes are not available, then people should make the best use of internet and web resources for the self-learning. Protective equipments like service gloves, gown, masks, respirators, etc., can be used in our daily practices to control infections caused by such biological agents. Health departments should own responsibility for short- and long-term medical follow-ups, casualty rate, risk site characterization and environmental decontamination and protection.

Community preparedness programmes, an important aspect of human resource development, should be implemented free of cost at high school, college and university levels so that the Indian young population can learn first aid methods and strategies to curb the menace of biological disaster. Establishment of more specialized health care and laboratory facilities and up-gradation of existing biosafety laboratories are important indicators of India's medical preparedness. In addition, proper hygiene of washrooms, cleanliness of environment and surroundings should be maintained.

Recommendations

Bioterrorism is a realistic threat and people should take it seriously and be aware of it. Therefore at the outset proper awareness programmes should be arranged for the citizens of our country. Biological warfare causes large-scale health problems and suffering of the population. This leads to the downfall and weakening of government[42]. In a country like India, where the population is increasing day by day and has exceeded a billion, preventive strategies and efforts against bioterrorism need to be strengthened, improved and made effective. It has become necessary to enhance research and development in our country to tackle bioterrorism.

As we know, detection of biological weapons is difficult during an attack. They could remain undetected for several hours, days or weeks which lead to mass casualties. Hence, to stop the spread of the disease and to minimize destruction, combined efforts of human intelligence, scientific and health communities are essential. Bioterrorism not only affects humans, it also affects plants, animals and environment and thus can cause heavy losses to biodiversity and economy. Thus laws and policies for protection against biowarfare agents and bioterrorists need to be strictly implemented in our country. We propose the following recommendations to make India safe from bioterrorism:

- Development of rehabilitation centres and financial assistance to affected individuals;
- Development of e-learning modules on methods to combat bioterrorism;
- Judicial involvement of media and internet for community awareness and preparedness;
- Encourage interested citizens to register and get trained to be a part of national disaster management quick response teams in addition to Indian Army;
- Environmental and disaster management curriculum should be designed and introduced in engineering, management, humanities, social and material science courses;
- Free teaching camps should be organized for community preparedness in border areas where the population is more at risk;
- Mass level immunization can offer protection to populations at risk;
- Prophylactic measures should be lawfully enforced; otherwise it would cause massive destruction due to rapid spread of infectious agents which usually have very less cell doubling time.

Conflict of interest: Authors report no conflicts of interests.

1. Henderson, D. A., Bioterrorism as a public health threat. *Emerg. Infect. Dis.*, 1998, **4**, 488–492.
2. Salerno, R. and Hickok, L., Strengthening bioterrorism prevention: global biological materials management. *Biosecur. Bioterror.*, 2002, **5**, 107–116.
3. Fong, I. and Alibek, K., *Bioterrorism and Infectious Agents*, Springer, New York, 2010.
4. Kortepeter, M. G. and Parker, G. W., Potential biological weapons threats. *Emerg. Infect. Dis.*, 2000, **5**, 523–527.
5. Madad, S. S., Bioterrorism: an emerging global health threat. *J. Bioterror. Biodef.*, 2014, **5**(1), 129 (1–6).
6. Dworkin, M. S., Ma, X. and Golash, R. G., Fear of bioterrorism and implications for public health preparedness. *Emerg. Infect. Dis.*, 2003, **9**, 503–505.
7. Barras, V. and Greub, G., History of biological warfare and bioterrorism. *Clin. Microbiol. Infect.*, 2014, **20**(6), 497–502.
8. Riedel, S., Biological warfare and bioterrorism: a historical review. In Proceedings Baylor University Medical Center, 2004, vol. 17, pp. 400–406.
9. Wheelis, M., Biological warfare at the 1346 siege of Caffa. *Emerg. Infect. Dis.*, 2002, **8**, 971–975.
10. Norris, J., East or west? The geographic origin of the black death. *Bull. Hist. Med.*, 1977, **51**, 1–24.
11. Christopher, G. W., Cieslak, T. J., Pavlin, J. A. and Eitzen, E. M., Biological warfare: historical perspective. *JAMA*, 1977, **278**, 412–417.
12. Henderson, D. A. *et al.*, Smallpox as a biological weapon: medical and public health management: working group on civilian biodefense. *JAMA*, 1999, **281**, 2127–2137.
13. Eitzen and Takafuji., Historical overview of biological warfare. In *Medical Aspects of Chemical and Biological Warfare* (eds Sidell, Takafuji and Franz), Borden Institute, Walter Reed Army Medical Center, Washington, DC, 2004, pp. 415–423.
14. Harris, S. H., *Factories of Death: Japanese Biological Warfare, 1932–1945 and the American Cover-Up*, Routledge, New York, 1994, p. 385.
15. Poupard, J. A. and Miller, L. A., History of biological warfare: catapults to capsomeres. *Ann. NY Acad. Sci.*, 1992, **666**, 9–20.
16. Meselson, M., Guillemin, J., Hugh-Jones, M., Langmuir, A., Popova, I., Shelokov, A. and Yampolskaya, O., The Sverdlovsk anthrax outbreak of 1979. *Science*, 1994, **266**, 1202–1208.
17. Zilinskas, R. A., Iraq's biological weapons. The past as future?. *JAMA*, 1977, **278**, 418–424.
18. Sinha, B. K., *Biological Warfare*, Surindra Publications, New Delhi, 2010.
19. Rogers, P., Whitby, S. and Dando, M., Biological warfare against crops. *Sci. Am.*, 1999, **280**, 70–75.
20. Horn, J. K., Bacterial agents used for bioterrorism, *Surg. Infect. (Larchmt)*, 2003, **4**(3), 281–287.
21. Spencer, J. and Scardiville, M., *Understanding the Bioterrorist Threat: Facts and Figures*, The Heritage Foundation, Washington, DC, 2001.
22. Bhardwaj, P., Srivastava, J. and Karan, J., Bioterrorism: an imminent public health threat. *Int. J. Epidemiol.*, 2009, **7**(1), 7.

23. Suter, K., The troubled history of chemical and biological warfare. *Contemp. Rev.*, 2003, **28**, 161–165.
24. Sapsford, K., Bradburne, C., Delehanty, J. and Medintz., Sensors for detecting biological agents. *Mater. Today*, 2008, **11**, 38–49.
25. Das, S. and Kataria, V. K., Bioterrorism: a public health perspective. *MJAFI*, 2010, **66**(3), 255–260.
26. Geiger, Protecting civil liberties. In *Terrorism and Public Health* (eds Levy and Sidel), Oxford University Press, UK, 2003, pp. 322–334.
27. Enserink, M. and Malakoff, D., Congress weighs select agent update. *Science*, 2001, **294**, 1438.
28. Wallerstein, M. B., Science in an age of terrorism. *Science*, 2002, **297**, 2169.
29. Hoffman, R. E., Preparing for a bioterrorist attack: legal and administrative strategies. *Emerg. Infect. Dis*., 2003, **9**, 241–245.
30. Bhattacharjee, Y., Scientist pleads guilty of receiving illegally imported avian flu virus. *Science*, 2004, **305**, 1886.
31. Mestel, R., Scientists experiment with caution. *Los Angeles Times*, 2002.
32. Malakoff, D. and Drennan, K., Butler gets 2 years for mishandling plague samples. *Science*, 2004, **303**, 1743–1745.
33. Pickrell, J., Imperial college fined over hybrid virus risk. *Science*, 2001, **293**, 779–780.
34. Bhui, K. J., Dinos, S. and James, E., Psychological process and pathways to radicalization. *J. Bioterror. Biodef*., 2012, **5**, 1–5.
35. Pesik, N., Keim, M. E. and Iverson, K. V., Terrorism and the ethics of emergency medical care. *Ann. Emerg. Med.*, 2001, **37**, 642–646.
36. Bhargava, R., Challenges in bio-defense for India – a plausible approach. *OIIRJ*, 2014, **4**(3), 182–191.
37. National Disaster Management Guidelines – Management of Biological Disasters, 2008. A publication of National Disaster Management Authority, Government of India, New Delhi, July 2008, ISBN978-81-906483-6-3.
38. Kumar, A., Verma, A., Yadav, M., Sabri, I. and Asthana, A., Biological warfare, bioterrorism and biodefence. *J. Indian Acad. Forensic Med.*, 2011, **33**(1), 69–73.
39. Milanovich, F., Reducing the threat of biological weapons. *Sci. Technol. Rev.*, 1998, **6**, 4–9.
40. Plianbangchong, S., Strategies of preparedness against the threat of biological warfare and bioterrorism in South-East Asia. *Asian Biotech. Dev. Rev.*, 2005, **8**, 77–98.
41. Rose, L. J., Rice, E. N., Jenson, B., Muoga, R., Peterson, A., Darkan, R. M. and Ardenno, M. J., Chlorine inactivation of bacterial bioterrorism agents. *App. Environ. Microbiol*., 2005, **71**, 566–568.
42. Syal, S., Bioterrorism: time to wake up. *Curr. Sci*., 2008, **95**(12), 1665–1666.
43. Hupert, N., Mushlin, A. I. and Callahan, M. A., Modeling the public health response tobioterrorism: using discrete event simulation to design antibiotic distribution centers. *Med. Decis. Making*, 2002, **22**, 1–9.

Received 25 August 2016; revised accepted 27 July 2017

doi: 10.18520/cs/v113/i09/1675-1682