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Short Article

Current Issues in Bioterrorism and Their Mitigation

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A B S T R A C T

Bioterrorism is a modern warfare weapon using microorganisms dispersed through air, water, or food sources to cause human mortality among human communities or terrorise a civilian population in the present scenario of increased terrorist activity. They are highly contagious, have a short and predictable incubation period, capable of mass production with little or no prophylaxis or treatment in humans. The target population need to have little or no immunity against the organism. Bioterrorist agents of major concern have been categorised as A, B and C based on their capacity to pose a risk to national security and the ease with which they can be disseminated. Their mitigation activities in dealing with a bioterrorist attack are (i) preparedness phase, (ii) early warning phase, (iii) notification phase, (iv) response phase and (v) recovery phase. The response phase is vital and includes rapid epidemiological investigation, quick laboratory support, mass casualty management and initiation of preventive, curative and specific control measures for containing the further spread of the disease.

Keywords: Bioterrorism, Routes, Safety, Threats

Background

Bioterrorism is a modern warfare weapon using bacteria, viruses, fungi or other micro-organisms through air, water, or food sources causing purposeful harm to humans leading to death among human communities or terror in a civilian population in the present scenario of increased terrorist activity.[1] It is rare but threatens people, governments, and even countries. The growth of religious cults also enhanced its threat in the present time. Although India did not have documented proof of bioterrorism, the episode of intentional contamination of restaurant salad bars with Salmonella by a religious cult in Oregon during 1984 is an example with at least 17 countries having these biological weapons programmes: thus remains a legitimate threat from both domestic and international terrorist angles.

Biological agents are in some ways the perfect weapons of terror. With the exception of smallpox, they all occur naturally in the wild - in soil, air, water, and animals. The skills and equipment for making a biological weapon are the same as those used in medicine, agriculture, and other fields. There is increased concern about the intentional development of pathogens with pandemic potential that could be used by adversaries to inflict widespread harm. A bioterrorism attack in a public place is a public health

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emergency. Hence it is time to create awareness about this form of terror before it becomes a formidable challenge to the public health system and society.

Characters and Categories of Bioterrorism Agents

There can be following definitions of bio-terrorism in technical terms. A biological attack, or bio-terrorism, maybe the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops. In other words, bioterrorism therefore may comprise the intentional release or dissemination of biological agents. These agents include bacteria, viruses, insects, fungi, and/ or toxins, and may be in a naturally occurring or a human-modified form, in much the same way as in biological warfare. Besides, the present agri-business is vulnerable to anti-agricultural attacks by terrorists, and such attacks can seriously damage the economy as well as consumer confidence. The latter destructive activity is called agro-bioterrorism and is a subtype of agro-terrorism.

The different channels namely Air, Water, Land (porous borders), Migratory Birds, Agriculture pests (rodents), drones and illegal use of Biosafety Laboratories for culturing pathogens. An ideal agent should be highly contagious, and have a short and predictable incubation period. The target population should have little or no immunity against the organism. The agent should be amenable to economic mass production, difficult to identify in the target population and little or no prophylaxis or treatment should be available with the native population. Bioterrorist agents of major concern have been categorised as A, B and C based on their capacity to pose a risk to national security and the ease with which they can be disseminated. The attacks could be covert and caused by virtually any pathogenic microorganism and can be easily disseminated or transmitted from person to person. The bioterrorist agents with the highest priority are the causes of anthrax (*Bacillus anthracis*), botulism (*Clostridium botulinum*), plague (*Yersinia pestis*), smallpox (variola major), tularaemia (*Francisella tularensis*) and viral haemorrhagic fevers (filoviruses and arenaviruses). There are many other common foods or water-borne agents that could potentially be used in a bioterrorist attack. Based on virulence, they are categorised as A, B and C.

The Characters of A-category bioagents include (i) high mortality rates causing a major public health impact, panic and social disruption, (ii) needs special action for public health preparedness, (iii) easy transmission from person to person that results in high mortality rates and have the potential for major public health impact and (iv) requires special action for public health preparedness. These diseases include- Anthrax (*Bacillus anthracis*), Plague (*Yersinia pestis*), Smallpox (*variola major*), Tularemia (*Francisella tularensis*), Viral haemorrhagic fevers of Filo and Arena (Ebola, Lassa etc.).

Normally, these are high-priority organisms or toxins that pose the greatest risk to national security, according to the National Institute of Allergy and Infectious Diseases. These deadly pathogens could be readily spread in the environment or transmitted from person to person, triggering public panic and requiring special public health precautions. The hurling of the dead bodies of plague victims over the walls of the city of Kaffa by the Tartar army in 1346 and the spreading of smallpox via contaminated blankets by the British to the Native American population loyal to the French in 1767 are the most frequently cited episodes of poisoning.[2]

Category B agents are ones that could conceivably threaten water and food safety Agents include those that are (i) moderately easy to disseminate; (ii) result in moderate morbidity rates and low mortality rates; and (iii) require enhancements in diagnostic capacity and enhanced disease surveillance. The agents include Brucellosis (*Brucella* species), food safety threats viz., Salmonellosis, *E. coli*, Shigella, Psittacosis (*Chlamydia psittaci*), Q fever (*Coxiella burnetii*), *Staphylococcal enterotoxin* B, Typhus fever (*Rickettsia prowazekii*), Viral encephalitis and Water safety threats (*Vibrio cholerae*, *Cryptosporidium parvum*).

Category C includes the third highest priority agents including emerging pathogens that could be engineered for mass dissemination in the future because of (i) availability; (ii) ease of production and dissemination; and (iii) potential for high morbidity and mortality rates and major health impact. The agents include emerging infectious diseases such as the Nipah virus and the Hantavirus.

Anthrax spores were delivered through the US postal system in 2001, epidemics of plague in India, avian (H5N1) influenza in Hong Kong, ebola hemorrhagic fever in central Africa and Nipah virus (NiV) infection in Malaysia and Singapore, global flare-up of SARS-CoV-19 virus drawn the attention of national and international response.

Routes of Entry

The routes of entry of biological weapons into the human body are mainly inhalation, contact (skin/ mucous membrane) and the gastrointestinal tract. Methods of delivery could be through bomblets delivered by aircraft or the use of spray tanks mounted on aircraft/ tall buildings.

Threats and Risks

- Naturally occurring infections
- Given India's climate conditions, the country is vulnerable to vector-borne diseases such as malaria and dengue fever, among others.
- A high-density livestock population and a poorly guarded

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animal-human interface make India susceptible to zoonotic infections such as avian influenza, commonly called bird flu; pig influenza, commonly called swine flu; Nipah virus disease; and coronavirus diseases, such as COVID-19.
- Poor patient adherence to antibiotic treatment, nontherapeutic use of antibiotics to promote growth in farm animals, self-medication, and illegal over-the-counter access to antibiotics makes antibiotic resistance an emerging health threat that demands immediate policy attention.

Safety Concerns

- India has multiple laboratories with different biosafety levels (BSLs) set up across the country with higher-standard BSL-3 and BSL-4 labs.
- Implementation of the proper disinfection protocol to dispose of biomedical waste poses a serious biosafety hazard.
- Unforeseen infection of laboratory personnel or the accidental release of pathogens or other biological materials from designated laboratories, either due to negligence or poor understanding of biosafety protocols among laboratory workers.
- The deliberate introduction of genetically engineered organisms for beneficial purposes might have unintentional harmful consequences.
- Disease-causing pathogens are abundantly available in nature. Technologies needed to manipulate them are becoming more easily accessible.
- India is vulnerable to zoonotic diseases. Naturally occurring zoonotic pathogens can be manipulated in the lab to enhance their virulence, transmissibility, and/or resistance to therapeutic interventions.
- Because India shares porous borders with most of its neighbouring states, the possibility of cross-border infections is another major biological threat.
- In addition to manipulating pathogens that affect human health, bad actors could release naturally occurring invasive pathogens or synthetically created pathogens or pests to weaken the agricultural supply chain.

Safety and Security Regulations and Policies

- To address safety and security risks, India follows two different approaches—biosafety and biosecurity.
- Biosafety seeks to protect humans from pathogens while biosecurity protects pathogens from humans. Though these two concepts and practices reflect diverse scenarios and mitigate different risks, they complement each other. Robust implementation of biosafety protocols, in addition to reducing the risk of accidental exposure, limits risks of intentional theft or misuse.
- Biosafety regulations in India are defined under the 1986 Environment Protection Act, with implementation broadly distributed between the Ministry of Science and Technology and the Ministry of Environment, Forest, and Climate Change (MOEFCC). These regulations have three aims:
- To prevent biological materials from escaping designated places in laboratories
- To prevent laboratory workers from unintentional exposure
- To prevent unintended consequences when genetically modified organisms are released purposefully into the environment
- Like biosafety, biosecurity regulations in India, although not clearly defined and categorised, empower different ministries or agencies that are responsible for sectors usually associated with human health, food safety, agriculture, livestock, and the environment. As no uniform definition of biosecurity exists globally, the concept differs across human, animal, and plant health sectors. Biosecurity for public health often refers to "the protection of microbiological assets from theft, loss or diversion, which could lead to the inappropriate use of these agents to cause public health harm".[3] However, because biosecurity for plant and animal health entails protecting biological resources from foreign or invasive species,[4] regulations in India are broad enough to cover four major aims:
- To prevent unauthorised or ill-conceived release of naturally occurring biological agents
- To prevent cross-border entry and movement of dangerous pests and pathogens
- To prevent theft or acquisition of sensitive research, organisms, and information for nonlegitimate use
- To prevent weaponisation of pathogens by both state and non-state actors

Implementation

- Even though India has enacted laws and regulations to protect the country from biological threats, the coordination and monitoring of their implementation remains irregular.
- For the first category of biological threats—diseases emerging from natural sources—India has invested in public health infrastructure and has various laws and guidelines that drive preparedness and response to naturally occurring disease outbreaks. However, India's response to avian influenza, Nipah virus disease, and COVID-19 has exposed the country's rickety public health infrastructure, poor disease surveillance network, inadequate coordination between ministries to prevent zoonotic infections, absence of a national policy on biological disasters, and dismal investment in scientific research. Rather than using the time between outbreaks to develop national guidelines to tackle infectious diseases, India mostly relies on ad hoc notifications

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and guidelines, along with World Health Organization (WHO) advisories.

- For the second category of threats—diseases caused by accidents—India has developed comprehensive biosafety guidelines to monitor the safety of biotechnological research.
- Although implementation of biosafety guidelines falls under the ambit of the Ministry of Science and Technology and MOEFCC, researchers often work in labs supported by the Indian Council of Medical Research (ICMR) and the Indian Council of Agricultural Research.
- The multiplicity of organisations operating under different ministries makes it difficult to ensure the implementation of biosafety guidelines across the country. Moreover, the system often experiences poor coordination between the centre and state regulatory units.
- For the third category of biological threats—threats emerging from intentional sources—India has no specific biosecurity policy or legislation but has a multiplicity of regulations that address threats emerging from different sources.
- However, entities set up under different ministries with inadequate collaboration among them leave India vulnerable to a variety of foreign threats.
- While security agencies, such as the National Security Council Secretariat, are responsible for investigating a security threat, response to an event is often coordinated by civilian ministries.
- Because threats emerging from biological sources have a technical component, security agencies often include experts from other government departments, such as the Defence Research and Development Organisation, for their scientific input.
- Some experts, however, highlight that biosecurity discussions are mostly confined to closed policy circles and rarely involve experts from outside the government, leading to poor nationwide biosecurity awareness in India. Further, most regulations cover the export and import of pests and pathogens but do not adequately cover commercially ordered (mostly through e-commerce platforms) deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) sequences that may encode virulent genes.
- At present, biosecurity regulations often empower customs officials as the only authority that can check the baggage of incoming passengers. However, most customs officials are inadequately trained to identify specific pests or pathogens. In addition, there seems to be no systematic assessment of vulnerabilities in the existing system nor development plans and methodologies to build a sustainable, functional, and well-equipped system to counter bio-threats.
- Beyond the need to prevent outbreaks caused by safety and security lapses, any system must also be able to respond to threats whether they occur through human action (and inaction) or through natural processes. Although security agencies require time to investigate if an outbreak is natural or man-made, the mitigation strategy to tackle the threat must be prepared in advance and implemented immediately after detection of an outbreak.

Actions to Deal with Bioterrorism

The five phases of activities in dealing with a bioterrorist attack are (i) preparedness phase, (ii) early warning phase, (iii) notification phase, (iv) response phase and (v) recovery phase.[5] These Standard Operation Procedures were issued by the Ministry of Home Affairs in 2006. Among them, the response phase is vital and the activities include rapid epidemiological investigation, quick laboratory support, mass casualty management and initiation of preventive, curative and specific control measures for containing the further spread of the disease

Challenges Posed by Biological Weapons

The challenges posed by the bioterrorism agents include (i) availability of multiple agents and delivery means, variable incubation periods, high mortality rates and potential for their spread due to travel during the incubation period. (ii) Prompt identification or distinction between a bioterrorist attack and natural disease outbreak, which may be difficult and (iii) Making timely availability of important prophylactic drugs/ vaccines, limited shelf lives and stockpiling during a bioterrorist attack.

Public Health Responses

The routes of entry of biological weapons into the human body are mainly inhalation, contact (skin/ mucous membrane) and the gastrointestinal tract. Viral transmission is usually through air as is for Hanta viral fevers and SARS-Cov-2. Methods of delivery could be through bomblets delivered by aircraft or the use of spray tanks mounted on aircraft/ tall buildings. The creation of awareness on these transmission routes is essential to the public. In PR China, Hanta viral diseases and Leptospirosis could be controlled with rodent vector control and Farmer Field Schools in rice-based ecosystems.[6] In view of these facts, preventive and curative measures need to be formulated based on real situations and also based on WHO extended guidance on Public Health Responses to biological and chemical weapons in 2004.

India's Preparedness to Address Bioterrorism

- Focus on risk analysis of biological weapons, medical and public health consequences, medical countermeasures and long-term strategies to combat and prevent future

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threats.

- The National Disaster Management Authority (NDMA), Govt. of India (GoI) is in place.
- Several acts related to the management of the environment, human and animal health, crops, etc. have been enforced to punish miscreants of such unlawful activities.

Mitigation

- Proactive disease surveillance
- Vector surveillance
- Sero-surveillance in animal reservoir
- Vigilance at PoEs on import of food, grains, livestock, insecticides, rodents, insect vectors etc.
- Monitoring of BSL Bio-safety laboratory at regular intervals

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