

BIOLOGICAL DISASTERS-BIO-TERRORISM

Structure of the Content

1. Definitions

- Biological agents
- Biological warfare/bio-terrorism

2. Causes and Methods of dissemination of biological agents

3. Types

- Anthrax
- Smallpox
- Plague
- Botulism
- Tularemia

4. History: Major events across the globe

5. Impact

6. Prevention & Mitigation Measures

7. Action Plan for Biological Disaster Management in India: Early Warning System and Dissemination

8. Future Plans

9. Dos and Don'ts

10. Connected Links for Important Sites

11. References

Definition

Apart from the natural transnational movement of the pathogenic organisms, their potential use as weapons of biological warfare and bio-terrorism has become far more important now than ever before. Utilization of organisms causing smallpox and anthrax by such terrorist groups can cause greater harm and panic. **Biological agents** are living organisms or their toxic products that can kill or incapacitate people, livestock, and plants. **Bio-terrorism** can be defined as the use of biological agents to cause death, disability or damage mainly to human beings. Thus, bio-terrorism is a method of terrorist activity to prevail mass panic and slow mass casualties. The **three basic groups of biological agents**, which could be used as weapons, are bacteria, viruses, and toxins. Most biological agents are difficult to grow and maintain. Many break down quickly when exposed to sunlight and other environmental factors, while others, such as anthrax spores, are very long lived. Biological agents can be dispersed by spraying them into the air, by infecting animals that carry the disease to humans, and by contaminating food and water. Potentially, hundreds of human pathogens could be used as weapons; however, public health authorities have identified only a few as having the potential to cause mass casualties leading to civil disruptions.

Causes and Method of Delivery

There are number of causes why biological weapons are potentially more powerful agents to mass casualties leading to civil disruptions. To attract widespread attention and to harm a selected target, these outfits can utilize possibly any biological material, which fulfils some of the criteria of bio-weapons.

- Biological agents can be disseminated with readily available technology. Common agricultural spray devices can be adopted to disseminate biological pathogens of the proper particle size to cause infection in human population over great distances.
- The perpetrators can use natural weather conditions, such as wind and temperature inversions as well as existing building infrastructures (e.g.

ventilation system) or air movement related to transportation (e.g. subway cars passing through tunnels) to disseminate these agents and thus to infect or intoxicate a large number of people.

- The expense of producing biological weapons is far less than that of other weapon systems.

The methods of bio-logical agent dissemination and delivery techniques include:

- Aerosols - biological agents are dispersed into the air, forming a fine mist that may drift for miles. Inhaling the agent may cause epidemic diseases in human beings or animals.
- Animals – some diseases are spread by insects and animals, such as fleas, mice, flies, mosquitoes, and livestock.
- Food and water contamination - some pathogenic organisms and toxins may persist in food and water supplies. Most microbes can be killed, and toxins deactivated, by cooking food and boiling water. Most microbes are killed by boiling water for one minute, but some require longer. Follow official instructions.
- Person-to-person - spread of a few infectious agents is also possible. Humans have been the source of infection for smallpox, plague, and the Lassa viruses.

Types

There are three categories of biological agents potential enough to cause mass casualties. However, those in category A have the greatest potential for fear and disruption and most significant public health impacts. The list of these biological agents with a very brief description about them is given below.

- The disease anthrax is caused by the gram-positive, non-motile *Bacillus anthracis*. **Anthrax** has been a scourge of cattle and other herbivores for centuries. During the industrial revolution, the inhalation form was first recognized as an occupational pulmonary disease in workers in the wool industries of Europe. Anthrax makes an ideal biological weapon. The inhalation form of disease is highly lethal. The spores can maintain virulence for decades and they can be milled to the ideal particle size for optimum infection of the human respiratory tract. Different clinical forms of the disease are observed, depending on the route of exposure. Inhalational anthrax presents with non-specific symptoms that cannot be distinguished from many more common diseases based on early clinical manifestations or routine laboratory tests. Therefore, despite aggressive medical care sometimes develop rapidly progressive disease and die.
- If used as a biological weapon, **smallpox** represents a serious threat to civilian population because of its case fatality rate of 30% or more among unvaccinated persons and the absence of specific therapy. Smallpox has long been considered as the most devastating of all infectious diseases and today its potential for devastation is far greater than at any previous time. Smallpox virus is a member of genus Orthopoxvirus, and it is closely related to the viruses causing cowpox, vaccinia and monkey pox. It is one of the largest DNA viruses known, and it has a bricklike appearance on electron microscopy. Transmission of this virus can occur in several different ways: generally by droplets, occasionally by aerosol, by direct contact with secretions or lesions from a patient, and rarely by fomites contacted with the infection virus from a patient. Transmission risk increases if the index patient is coughing or sneezing or if he or she has hemorrhagic disease. Typically, the virus enters the respiratory mucosa and then travels to regional lymph nodes where it replicates. The incubation period from infection to onset of rash ranges from 7 to 17 days, averaging 12 to 14 days. Smallpox scabs remain infectious until they fall off, whereas chickenpox is no longer infectious once the lesions are crusted.

- The mere mention of the word **plague** conjures up many images because it has already demonstrated a historical potential to kill millions of people across the globe. It is a disease that results from infection by non-motile, gram-negative coccobacillus *Yersinia pestis*. When stained, its bipolar appearance is often described as resembling a safety pin. *Y. pestis* has two important properties that differentiate it from *B. anthracis*- person-to-person transmissibility and a lack of spore production. Following the bite of an infected flea, plague bacilli are carried via the lymphatic to the regional lymph nodes where they multiply exponentially. This is only weapon besides smallpox, which can cause devastation beyond those persons who are initially infected. With modern air travel, containing an outbreak of plague could be challenging. A vaccine for plague does exist; however, it is no longer being produced, and it does not demonstrate efficacy against infection by aerosol.
- **Botulism** or Botulinum toxins are deadly. A toxin is any toxic substance that can be produced in an animal, plant, or microbe. The toxins produce serious disease in human beings. Many natural toxins can be produced by chemical synthesis or can be expressed artificially. Toxins are natural and non-volatile and generally do not penetrate intact skin, which happens in case of chemical weapons. There are different types of toxins and they are immunologically distinct, meaning that antibodies developed against one do not cross-react against others. Those that most commonly cause human disease are types A, B, and E. Humans can be intoxicated either by oral means, inhalation, or wound infection. Mass casualties can be produced through contamination of food source or by aerosol dissemination. The incubation period of botulism can range from as short as 24 to 36 hours to several days from the time of inhalation.
- **Tularemia** is caused by *Francisella tularensis*, which is a gram-negative, non-motile coccobacillus. Tularemia is a zoonotic disease acquired in a natural setting by humans through skin or mucous membrane contact with the body fluids or tissues of infected animals or from being bitten by infected deerflies, mosquitoes, or ticks. It can remain viable for weeks in the

environment or in animal carcasses and for years if frozen. Unlike anthrax, which requires thousands of spores to infect someone, tularemia can cause illness with as few as 10 to 50 organisms. After an incubation period of 2 to 10 days, pneumonia symptoms develop associated with weight loss and non-productive cough. The drug of choice for treatment is streptomycin with other aminoglycosides.

History: Major Events across the Globe

Biological warfare has a long history of mass destruction through epidemic and pandemic diseases. Limited biological warfare is reported to have been carried out by Japan during World War-II. Recently, mycotoxins have been reported to be used in Afghanistan. Even before that it has also been documented that the Red Indians in North America were given the smallpox infected blankets. Nevertheless, the recent Anthrax attack in 2001 through letters caused worldwide concerns regarding the threats of bio-terrorism. Beginning in mid-September 2001, the USA experienced unprecedented biological attacks involving the intentional distribution of bacillus anthracis spores through the postal system. The full impact of this bio-terrorist activity has not been assessed, but already the toll is large. Hundreds of people were affected. In the 20th-century series of cases, the mortality rate of occupationally acquired Inhalational anthrax was 89%, but majority of these cases occurred before the development of critical care units and in most cases before the advent of antibiotics. Prior to 2001 attacks, at Sverdlovsk, it had been reported that 68 of the 79 patients with Inhalational anthrax dies. However, a separate report from a hospital physician recorded 358 ill with 45 dead. A recent analysis of available Sverdlovsk data suggests that there may have been as many as 250 cases with 100 deaths.

Documented Intentional Use of Biologicals

- Japan used plague bacilli in China during 1932-1945 causing 260,000 deaths

- Dispersal of anthrax spores due to accident in production unit in USSR caused 68 deaths in 1979
- In 1984, Osho followers used *Salmonella typhimurium* in salad in a restaurant in Oregon, USA leading to 751 cases
- *Shigella dysenteriae* Type 2 employed in Texas, USA in 1996
- Anthrax through postal envelopes in USA in Oct-Nov 2001 leading to 22 cases and 5 deaths

Impact

Even a small-scale biological attack with a weapon grade agent on an urban center could cause massive morbidity and mortality, rapidly overwhelming the local medical capabilities. For example, an aerosolized release of little as 100kg of anthrax spores upwind of a metro city of a size of Washington D C has been estimated to have the potential to cause up to three millions of deaths.

Prevention & Mitigation Measures: General Measures of Protection

1. The general population should be educated and the made aware of the threats and risks associated with it.
 - Only cooked food and boiled/chlorinated/filtered water should be consumed
 - Insects and rodents control measures must be initiated immediately.
 - Clinical isolation of suspected and confirmed cases is essential.
2. An early accurate diagnosis is the key to manage casualties of biological warfare. Therefore, a network of specialised laboratories should be established for a confirmatory laboratory diagnosis.
3. Existing disease surveillance system as well as vector control measures have be pursued more rigorously.

4. Mass immunization programme in the suspected area has be more vigorously followed up.
5. Enhancing the knowledge and skills of clinicians plays a vital role in controlling the adverse impact of the attack. As bio-terrorism related infections will remain rare events, creative ongoing strategies will be required to sustain attention to potential new cases.

Action Plan for Biological Disaster Management in India

Biological Disaster could arise from a source located either inside the country or outside the country (warfare). Management of such a situation could be dealt effectively only if there is a disaster plan well integrated in the system and also there is mechanism of post disaster evaluation.

Inter-disaster stage:

This is the period between two disasters in which pre-disaster planning in terms of system development should be done.

Action plan has following elements:

One of the simplest & easy method to suspect is to take notice of a situation during which more patients with similar ailments from a particular locality start consulting health guide at village level,

(a) Constitution of a Crisis Management Structure

- Identification of Nodal Officers for Crisis Management at District, State & Central Level.
- Identification of Focal points for control of epidemic at District, State & Central Level.
- Constitution of advisory committees - Administrative and Technical
- Preparation of contingency plan including Standing Operating Procedure at District, State & Central Level.

(b) System of Surveillance.

- System of information collection at District, State & Central Level.
 - System of data analysis
 - System for flow of information from District to State and to Central Level during crisis period.
 - Establishment of control rooms at District, State & Central Level.
- c) **System of Epidemiological Investigation.**
- System of field investigation
 - System of active surveillance
 - Arrangement for support facilities
- (d) **Confirmation of pathogens by laboratory set up.**
- System of laboratory investigation at District, State & Central Level.
 - Quality Control of Laboratory Practices.
- (e) Training to different level workers.

Pre impact stage of warning (Early Detection):

Early warning signals

Early identification of an outbreak of disease of international public health importance shall require knowledge of early warning signals amongst all the echelons of health care providers. Some of the suggested early warning signals which must command quick investigation by professionals may include followings :

- Sudden high mortality or morbidity following acute infection with short incubation period
- Acute fever with haemorrhagic manifestations
- Acute fever with altered sensorium and malaria and JE excluded in endemic areas
- Even one case of suspected plague or anthrax
- Occurrence of cases which are difficult to diagnose with available clinical and laboratory support and their non-responsive to conventional therapies

- Clustering of cases/deaths in time and space with high case fatality rate
- Unusual clinical or laboratory presentations

A comprehensive list of all the trigger events that shall attract immediate attention of local public health machinery need to be developed by a group of experts.

- By suspicion:

Management Plan should aim to identify crisis situation at a very early stage preferably confined to a limited area. This can be done only by suspecting danger of impending disaster by local health employees (at village by village health guide, at sub centre level by multi purpose worker and PHC level by doctors at PHC).

- Alertness of institution dealing with emergency health, medical services/ Confirmation by identified laboratories :-

If such a situation arises, after providing symptomatic treatment at PHC level, services of well **established laboratory at district or medical college level may be requisitioned to identify the organism** and also to seek guidance for specific treatment and management.

- Constant surveillance and monitoring till there is no risk of any outbreak.

Disaster Stage:

When disaster strikes following actions would be needed:

Public Health Control Measures:

Aim of control measures, is to contain the disease initially but eliminate ultimately by following public health measures:

- ◆ Identification of all infected individuals based on an established case definition
- ◆ Eliminating or reducing source of infection (Isolation and treatment of patients) identified by epidemiological and laboratory studies

- ◆ Interrupting Transmission of disease: Spread of disease depend of mode of transmission which could be prevented by:
 - Possibility of reducing direct contacts with patients;
 - Vector control: Rodents/Mosquitoes control.
 - Food control
 - Environmental control: Transmitted by water/air.
 - Control through sewerage system.
- ◆ Protecting persons at risk (Community) Immunisation and Health Education plays major role in protecting person at risk.

Trigger mechanism: The trigger mechanism is an emergency quick response mechanism like ignition switch when energised spontaneously sets the vehicle of management into motion on the road of disaster mitigation process.

- System of alert and mechanism of activation of Disaster Plan.
- Immediate organisation of field operation for curative and preventive medical care including immunization.
- Checking of initial information on an epidemic.
- Preliminary analysis of the situation.
- Arrangement for laboratory support.
- Emergency health services advisory committee meeting to take stock of the situation and to advise further action.
- Field investigation about:
 - Safety pre-cautions
 - Case finding
- ◆ Deputation of Quick Response Teams
 - Search for source of infection and contact tracing
 - Special investigation for common source of infection.

- ◆ Analysis of investigation data to identify type, source of out break and mode of transmission:
 - Ecological data
 - Clinical data
 - Epidemiological data
 - Laboratory data
 - Entomological data

- ◆ General control measures to prevent further out break:
 - Protective measure for contacts & Community
 - Control of common source of outbreak like food water or mosquito etc.
 - Immunization, emergency mass immunization and specific immunization, mass chemoprophylaxis.

Post disaster stage:

Evaluation after disaster is most important step in disaster management in order to rectify deficiencies in the management and to record the entire operation for future guidance for which following measures are necessary:

- Evaluation of control measures
- Cost effectiveness
- Post-epidemic measures
- Sharing of experience
- System for documentation of events.

Management of Biological disaster on above principles and steps should be taken by the health authorities of the State Government with the available infrastructure.

Future Plan

The followings are the some of the key issues and concerns across the globe that need to be included in the future plan of bio-terrorism management.

- Since vaccines against a number of potential biological warfare agents have already been developed and some have already been in use, mass immunization of the population would be done on a priority basis.
- Vaccines against remaining agents would have to researched and developed.
- Mass public awareness before, during and after such an attack must be emphasized upon.

The strategies that must be incorporated include accurate threat intelligence, physical countermeasures, medical countermeasures and education and training of physicians and ancillary health care providers including first-aid providers.

Dos & Don'ts in a Biological War Attack

Before:

- Children and older adults are particularly vulnerable to biological agents. Ensure from a doctor/the nearest hospital that all the required or suggested immunizations are up to date.

During

- In the event of a biological attack, public health officials may not immediately be able to provide information on what you should do. It will take time to determine what the illness is, how it should be treated, and who is in danger. Close the doors and windows when a biological attack is imminent.
- Watch television, listen to radio, or check the Internet for official news and information including signs and symptoms of the disease, areas in danger, if medications or vaccinations are being distributed, and where you should seek medical attention if you become ill.
- The first evidence of an attack may be when you notice symptoms of the disease caused by exposure to an agent.
- Be suspicious of any symptoms you notice, but do not assume that any illness is a result of the attack.
- Use common sense and practice good hygiene.

However, if you notice of an unusual and suspicious substance nearby:

- Move away quickly.
- Cover your head and nose
- Wash with soap and water.
- Listen to the media for official instructions.
- Seek medical attention if you become sick.

If you are exposed to a biological agent:

1. Ultra efficient filter masks can be used
2. Follow official instructions for disposal of contaminated items such as bag and cloths.
3. Take bath with soap and put on clean clothes.

4. Seek medical assistance. If required and advised, stay away from others or even quarantined.

After

- Pay close attention to all official warnings and instructions on how to proceed. The delivery of medical services for a biological event may be handled differently to respond to increased demand. The basic public health procedures and medical protocols for handling exposure to biological agents are the same as for any infectious disease. It is important for you to pay attention to official instructions via radio, television, and emergency alert systems.

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