College of Medicine **Microbiology**

Environmental microbiology

Microorganisms and Bioterrorism: **Dr.Jawad Kadhim Tarrad**

Bioterrorism is defined as intentional uses of microbial pathogens (bacteria, viruses, fungi , or toxin from living organisms) or other materials as potential weapons to produce death or disease in human , animals , and plants.

The systematic use of terror to demoralize, intimidate ,and subjugate through use of materials capable of producing catastrophic damage in population.

Historical highlights:

The most notable intentional uses of biological agents for criminal or terror intent are:

- The first recorded use of biological warfare dates to Roman times when dead animals were put into enemy water supplies.
- In sixth century B.C, poisoning of water supplies with fungus , *Claviceps purpurea* by Assyrians.
- 1346, Tatars (Mongol army) hurled dead bodies (cadavers)of plague-infected victims over the wall of Kaffa city(in Ukraine)by catapulted machines.
- 1767, during the French and India war , British gave blankets used on smallpox victims to native Americans who were allied with French.
- 1940, Japan sprayed bubonic plague-infected fleas over parts of China from aircraft.
- 1943, Great Britain tested anthrax spore viability and spread spore over Gruinard Island , which remained quarantined for next 48 years.
- 1951, U.S Navy ship sprayed *Serratia marcescens* toward San Francisco from San Francisco Bay to test and model the spread of the microbe.

- 1966, U.S released *Bacillus subtilis* into New York subway system to test and model the spread of the microbe.
- 1984, use of *Salmonella enterica* serovar Typhimurium in 10 restaurants salad bars . The contaminated salads result in 751 cases with salmonellosis in Dalles,oregon .
- 1996, intentional release of *Shigella dysentariae* type-2 among laboratory workers by microbiologist in Dallas,Texas. 45 developed with gastroenteritis(shigellosis).
- 2001,use of *Bacillus anthracis* spores in series letters through U.S postal system in mailed letters or packages. The spores infected 22 persons documented(11 cases of inhalation anthrax,and 11 cases of cutaneous anthrax) and were the cause of 5 death.

A bioterrorism event (biocrime) is either overt (announced) or covert(unannounced). Letters sent with powder of anthrax spore to Senators Daschle and Leahy are example of overt event. The package sent to journalist at Florida is example of covert event .

The potential impact of bioterrorism attack could be enormous , leading to thousands of deaths and extensive morbidity, acts of bioterrorism would be expected to produce their greatest impact through fear and terror they generate.

Biological agents are likely to be chosen as means of localized attack (biocrime) or mass casualty (bioterrorism)for several reasons. They are mostly ; invisible, odorless, tasteless and difficult to detect and to control. Furthermore , the use of biological agents in terrorism result in fear, panic and chaos.

Several key indicators of bioterrorism event; sudden increased number of sick human and sudden increased number of animal diseases.

In some circumstances , biological weapons can be as devastating as a nuclear explosion- a few kilograms of anthrax kill as many people as Hiroshima size nuclear bomb.

Select agents:

Working group for civilian biodefense has put together a list of key features that characterize the elements of biological agents that make them particularly effective as weapons.

1. High morbidity and mortality.
2. Potential for person to person spread(easy of dissemination).
3. Low infective dose and highly infectious by aerosol.
4. Lack of rapid diagnosis capability or extremely difficult to detect .
5. Lack of universally available effective vaccine and difficult to manage medically..
6. Potential to cause anxiety.
7. Availability of pathogen and feasibility of production.
8. Environmental stability.
9. Database of prior research and development.
10. Potential to be weaponized (weaponization), late term used to describe processing of microbe or toxin in manner that would ensure a devastating effect of a release.

These Criteria for inclusion in select agents.

CDC classification of potential biological agents into three categories:

Category-A:

- Highest-priority pathogens; there are most dangerous such as (*Bacillus anthracis, clostridium botulinum,Yersinia pestis,* Variolla major virus(smallpox),*Francisella tularensis*,viral hemorrhagic fever as Filoviruses and Arenaviruses.
- Easily disseminated or transmitted from person to person.
- Result in high morbidity and mortality.
- Potential for major public health impact.
- Cause public panic and social disruption.
- Require special action for public health preparedness.

Category-B:

- Second highest-priority pathogens; less dangerous **pathogens**(*Brucella spp., Coxiella burnetii, Burkholderia pseudomallei* (melioidosis), *Ps.mallei* (glanders)*, Rickettsia prowazeki , Chlamydia psittaci ,*viral encephalitis viruses as Eastern equine encephalitis(EEE),Western equine encephalitis (WEE) and Venezuelan equine encephalitis(VEE). **Toxins** as Ricin from castor beans*(Ricinus communis),*enterotoxin-B of Staph., Epsilon of *Cl.perfringens* , aflatoxin. **Water-safety threats** as *Vibrio cholerae, Cryptosporidium parvum.* **Food-safety threats** as *E.coli* O157:H7*, Salemonella* spp. and *Shigella spp.*
- Moderately easy to disseminated .
- Moderate morbidity and mortality rates.
- Require specific enhancements of CDC diagnostic capacity and enhanced disease surveillance.

Category-C:

- Third highest-priority pathogens; that may be potential future threats (SARS coronavirus, Nipah virus, Hantavirus, Influenza virus, Yellow fever virus, tick-borne hemorrhagic virus ,tick-borne encephalitis, and MDR-TB.
- Emerging pathogens that could be engineered for mass dissemination because availability ,easy to produce and disseminate.
- Major health impact potential.
- Potential for high morbidity and mortality.

Mechanisms for dispersion of biological agents into environment:

1. Direct contact with infected animal or contaminated materials.
2. inhalation of aerosols(air) that contaminated with biological agent.
3. Ingestion of contaminated food or water.

Biological agent transmission(routes of infection):

Skin;

- Cuts.
- Abrasions.
- Mucosal membranes.

Respiratory

- Inhalation of spores, droplets and aerosols.

Gastrointestinal

- Food.
- Water.

Terrorists might acquire such agents in several ways:

1. Produce agent themselves; this requires microbiological expertise, laboratories and equipments.
2. Obtain from rogue states which have developed biological and chemical weapons ,probably still have stockpiles.
3. Steal existing agent from laboratories ,hospitals,..etc. select agent regulation try to control access to the select agent, terrorists may be prevented obtaining and using these agents in an attack.

Advantages and disadvantages of biological weapons;

Advantages of Biological weapons

- are relatively easy and inexpensive to obtain or produce.
- easier to conceal than conventional weapons.
- potentially easy to spread .
- have potential to cause widespread panic and fear .
- have been developed by military in a few countries to high level of sophistication.

It has some important limitations (Disadvantages of BW)

- easier to backfire on those using them.
- Unproven the weaponry may not work.
- Potentially traceable to original source by DNA typing.
- Control on BW is very difficult.
- It is difficult to employ a bioweapons in a way that only the enemy is affected and not friendly forces.

Government laws and regulations:

The bombings at federal building in Oklahoma city and world center led congress to pass antiterrorism and effective death penalty act of 1996.

A companion law, the uniting and strengthening America by providing appropriate tools required to intercept and obstruct terrorism act of 2001 prohibit any person to knowingly possess any biological agent.

Laboratories possessing any select agents must register with CDC.

Iraq s preparation of biologic warfare

The BW program in Iraq began in 1970s and was expanded in 1985. Two pathogenic bacteria were studied; B.anthracs and C.perfringens. five viruses were involved; Yellow fever virus, hemorrhagic virus, Enterovirus 17,rotavirus,and camelpox virus. Toxins were produced; aflatoxin ,botulism toxin, ricin,tricothecene mycotoxins .

100 bombs were filled with botulinum toxin ,50 with anthrax, and 7 with aflatoxin.

The united nations special commission and international atomic energy agency investigated Iraqs weapons of mass destruction from 1991 to 1998 , and followed by destroy these weapons.

In March 2003 , United states with Great Britain –and with other counties –invaded Iraq, because of Iraq weapons of mass destruction, but in months before the invasion ,the United Nations inspectors had not found any such weapons.

Disease	ID50	Water threat	Aerosol threat
Anthrax	6000-10000 spores(inh.)	yes	yes
Brucellosis	10-100 cells	probable	?
Cholera	1000(ing.)	yes	no
Plague	100-1000(inh.) 70(ing.)	yes	yes
smallpox	10-100(inh.)	?	yes
Tularemia	10-50 cells(inh.) 100,000,000(ing)	yes	yes
Q-fever	25(unspecified route)	possible	?
Glanders	3.2 x1000,000	unlikely	?
Cryptosporidiosis	9-132 oocysts(ing)	yes	no

Characteristics of some potential microbes that could be used bioterrorist agents: