

## Historical Roots of Bioterrorism and Implications for the Future

Satellite Conference  
Wednesday, April 27, 2005  
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Produced by the Alabama Department of Public Health  
Video Communications Division

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## Objectives

- Become familiar with the historical context of bioterrorism.
- Learn the basic classification and organization of bioterrorism organisms by class.
- Become familiar with emerging diseases which are potential bioterrorism threats.



History begins with the Sumerian tablets (3000 BC) that relate knowledge of contaminated objects leading to pestilence. Nergal was the god of plague.

Over 2000 years later, the earliest recorded use of a definite bioweapon occurred when the Assyrians poisoned enemy wells with rye ergot – a fungal toxin.

## Pandora's Box - An Early Conception of Containment of Disease



Source: Major, A., *Biological and Chemical Warfare in the Ancient World*, Duckworth, NY, 2003

Apollo, the archer of the Greek gods whose arrows conveyed plague.



Source: Major, A., *Biological and Chemical Warfare in the Ancient World*, Duckworth, NY, 2003

Lord Shiva, the destroyer whose arrows carried pestilence and death.



The Scythians traced their lineage from Scythes, son of either Zeus or Hercules by a viper-woman. They were skilled in the use of poison arrows and thus invincible for over 400 years (500-100 BCE). The Persians fared poorly against them.



China during the Han Dynasty (206 BC – 220 AD). Records indicate numerous formulae for generating poisonous smoke to be used on enemies.



Plague broke out among the Philistines after stealing the Ark of the Covenant (1<sup>st</sup> Samuel).

Depicted by Nicholas Poussin (1594-1665)  
(The Louvre, Paris)

Model of the temple of Solomon (built 957 BCE). Early traditions reiterated in the pseudoepigraphic Testament of Solomon (circa 100-400 CE) related Solomon enclosing demons including plague in copper vessels.

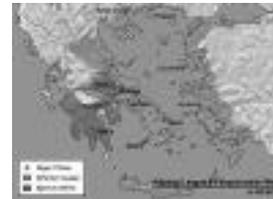


Solon of Athens (638-569 BCE) who used hellebore roots (skunk cabbage) in enemy water supplies to induce diarrhea (so called incapacitating agent).

Typhus of Class B bioterror agent has continued to kill millions in times of war or other calamities, including more than 3 million during the 1918-1922 Russian Civil War.



The Peloponnesian War was influenced by the plague of Athens (circa 420BC), probably typhus from which one-third of the city died, including Pericles.



Source: [Archaeonia.com/history/classical/civil\\_war.htm](http://Archaeonia.com/history/classical/civil_war.htm)



Hannibal ordered his soldiers to hurl clay pots with serpents onto enemy ships in 184 B.C.E.



Parthian warriors with horse (circa 150 CE). They were adept at archery but also experienced in using mass poisoning of enemies with natural toxins.

Marcus Aurelius Antonius, the philosopher emperor, died of a plague in 180 AD following its importation by legions returning from Mesopotamia (pestilentia manu facta). This began what some historians consider the decline of the Roman Empire.



Roman Skeleton Mosaic – bodies were associated with contagion.

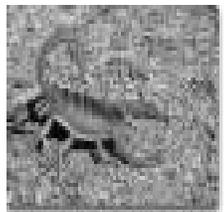


Romans frequently used dead animals to poison enemy's wells.

Source: Major, A., Biological and Chemical Warfare in the Ancient World, Duckworth, NY, 2003



Ruins of Ancient Hatra, South of Mosul where Parthians hurled scorpion bombs down on Roman soldiers.



Scorpion bombs were used against Romans at Hatra in 199 AD.



Catapults were first used to throw plague victims into cities by Mongols in 1346 AD at Kaffa, (present day Feodosiya), subsequently used by Lithuanian Prince Coribat at Carolstein (1422) and Peter the Great at Reval (1710).

One of Cortes' men had acquired smallpox in Africa. When held as a hostage, he caused an epidemic in Techotitlan (now Mexico City) resulting in the conquering of millions of Aztecs by 300



General Sir Jeffrey Amherst authorized small pox blankets to be given to Delaware Indians at a peace conference in 1763. Smallpox blankets later caused decimation of Missouri River tribes.



Civil War: Confederate troops kill farm animals in ponds to pollute water supplies ahead of General Sherman and invading Union Army.



American cavalry drilling with gas masks in the 1930's in response to German gas attacks during World War I. This was not actually used in WWII but a German attack on an American cargo ship carrying mustard gas killed hundreds in Italy in 1943.



Japanese carried out extensive lethal bioexperiments on prisoners in Manchuria (1937- 45). Anthrax, plague, and typhus were all used.

General Shiro Ishii, Commander of the Infamous Manchurian-based Unit 731. Never prosecuted, he died unrepentant in 1959. "A trained microbiologist," he used Yersinia pestis obtained from U.S. laboratories prior to the war to infect rats, with which he infected fleas, to be dropped by air on Chinese towns, repeating Simond's 1898 work for bioterrorism. As Churchill said "The latest refinements in science are linked with the cruelties of the Stone Age."





**Axis Japan's Biological Warfare Testing Sites: Horrific Human Experiments** carried out with Plague, Typhoid, Dysentery, Anthrax and Typhus. Outbreaks of plague and typhus among others, continued in these areas for years after the war.

**US Bioweapons research at Fort Detrick, MD in 1950's. Offensive weapons developed but were eliminated by President Nixon in 1969.**



That historians should give their own country a break, I grant you; but not so as to state things contrary to fact.

Source: (Polybius, c. 208 – c.126 B.C.) [History](#).

### American Bioweapons Developed and Produced 1950 - 1969

- Lethal Biological Agents
  - Bacillus anthracis
  - Francisella tularensis
- Incapacitating Biological Agents
  - Brucella Suis
  - Coxiella burnetii
  - Venezuelan equine encephalitis virus

Source: Regis E., [The Biology of Doom](#), Holt, New York, 1999.

### American Bioweapons Developed and Produced 1950 - 1969

- Lethal Biotoxin
  - Botulinum
- Incapacitating Biotoxin
  - Staphylococcal enterotoxin B

Source: Regis E., [The Biology of Doom](#), Holt, New York, 1999.

### Soviet Bioweapons Programs of 1980's – 1990's

- Tens of thousands of employees
- Super plague bacilli, weaponized anthrax as well as genetically altered mycoplasma
- Tons of smallpox in dry form
- Long-range delivery systems
- Confirmed by defectors (Pasechnik, Alibek and Popov)

Source: History of Biowarfare, Nova Online WG BH, PBS.

### Soviet Bioweapons Programs – Agents Developed (1948-1991)

- Bacillus anthracis\* (anthrax)
  - Variola major (smallpox)
  - Yersinia pseudotuberculosis\*
  - Marburg virus
  - Yersinia pestis\* (plague)
  - Burkholderia mallei\* (glanders)
  - Francisella tularemia\*
- \* genetically engineered or antibiotic resistant stains

Source: Alibek, K. and Handelman, S., [Biohazard](#), Random House, NY, 1999.



University of Illinois, Chicago.  
Dean's Forum – R.C. Hershow M.D.  
Iraq declared to UN in 1995 that it stockpiled 8,500 liters of concentrated anthrax and 20,000 liters of botulinum toxin.



Cults such as Aum Shinrikyo have used poison gas (sarin) and anthrax.

### Attributes of Bioterrorism Agents

- High morbidity and mortality
- Potential for person-to-person transmission, directly or by vector
- Low infective dose and high infectivity by aerosol, with a commensurate ability to cause large outbreaks
- Ability to contaminate food and water supplies

Source: Lane HC, Montagne JL, Fauci, AS, Nat Med, 2001; 7: 1271- 1273

### Suggestive of Bioterror Related Infection

- Unusually large number of cases of similar type
- High number of unexplained deaths
- Increase severity or refractoriness
- Unusual by season, area, route or exposure or antibiotic resistance, or age
- Genetic typing identical in separate outbreaks
- Previously unreported disease

Modified from: Walker, DH, Western Regional Center for Biodefense, March 16, 2004

### Advantages of BW

- Easy to obtain
  - Relatively easy and inexpensive to produce
    - Cost of producing mass casualties per square kilometer (1969 UN Chem. – Bio Expert Panel):
- |                |        |
|----------------|--------|
| • Conventional | \$2000 |
| • Nuclear      | \$800  |
| • Chemical     | \$600  |
| • Biological   | \$1    |



### Advantages of BW

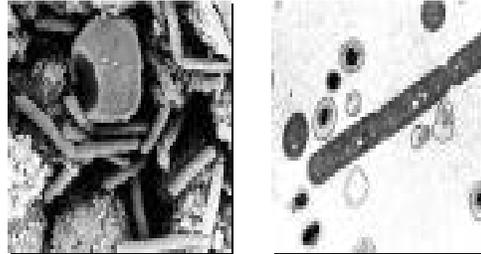
- Easy to deliver
- Dissemination over large areas
- Difficult to detect (odorless, tasteless)
- Large numbers of casualties possible
- Threat of use creates fear and panic
- Delayed onset of effects allow escape

## Category A Pathogens

Some of the Category A Pathogens include:

- *Bacillus anthracis* (anthrax)
- *Clostridium botulinum*
- *Yersinia pestis*
- *Variola major* (smallpox) and other pox viruses
- *Francisella tularensis* (tularemia)
- Viral Hemorrhagic fevers

Scanning and transmission electron micrographs of anthrax agent – note spore formation



## Anthrax Bioterrorism

1998: U.S. Secretary of Defense William Cohen approves anthrax vaccination plan for all military service members.

2001: A letter containing anthrax spores is mailed to NBC one week after the September 11 terrorist attacks on the Pentagon and World Trade Center. It was the first of a number of incidents around the country.

## Anthrax Bioterrorism

2001: In Florida, a man dies after inhaling anthrax at the office of American Media Inc. Later, four others die, including two postal workers. Five letters infect 22 people, 5 die - economic cost 5 billion dollars.

## Inhalational Anthrax

- CXR: mediastinal widening, effusion
- Meningitis seen in up to 50% of cases, nearly always fatal
- GI hemorrhage in up to 80%



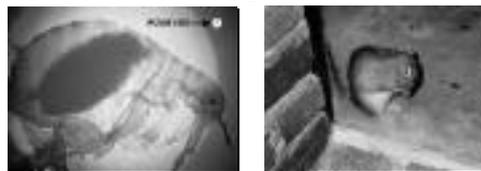
Hemorrhagic  
Mediastinitis



Hemorrhagic Meningitis  
"Cardinal's cap"

Source: Courtesy of Dr. David Walker, UTMB, Director Western Center for Biodefense and Emerging Infections

## The Major Source of Bubonic Plague



Simond did not establish that the rat flea *Xenopsylla cheopis* was the vector until work in China in 1898, when he allowed fleas to transfer the disease from dead to healthy rats.

The first great pandemic of plague began in 541 CE in the reign of Justinian I (Plague of Justinian).



It spread from central Asia and then continued more or less until about 700 CE. Overall, 25% of the population of Mediterranean Europe died, and the disease spread as far as Ireland, again through maritime commerce. This would be repeated on a far larger scale 800 years later.

### Plague Epidemics: Extension of the Black Death

- 1300 – 1399                      27 Epidemics
- 1400 – 1499                      28 Epidemics
- 1500 – 1599                      21 Epidemics
- 1600 – 1699                      18 Epidemics
- 1700 – 1799                      32 Epidemics
- 1800 – 1867                      33 Epidemics

Source: Wild, R. in "The Black Death", History Magazine.com

### Ackworth Plague Stone

Associated with the outbreak of plague in 1645 in Yorkshire. The hollow was intended to hold vinegar to disinfect coins used in payment for supplies left at the boundaries. Numerous similar stones are found throughout rural England, indicating empirical desire for disinfection.

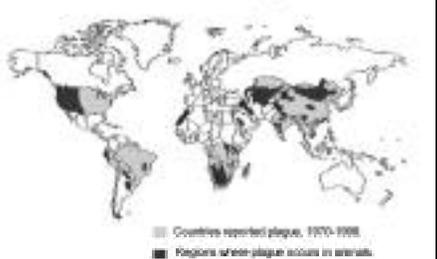


### Extension of the Plague of Canton (1772-1938)

<u>Area</u>	<u>Death</u>
India	12,500,000
China and Taiwan	250,000
Indonesia	214,000
Africa	120,000
Madagascar	32,000
South America	24,000
North America	1,000
Europe	1,000
Other	1,000

Source: Graham Twigg in Benfield Hazard Research Centre, Disaster Studies Working Paper 10 (Sept. 2004)

World Distribution of Plague, 1996



Present world distribution of plague – note endemic status in Western U.S.



Swollen lymph node or "Bubo" typical of bubonic plague.

The black tailed prairie dog: primary reservoir of plague in the southern USA.

## Spread from Asia and India in Antiquity



Pock-marked face of mummy Ramesses V.



Omolú, spirit of plague and smallpox in Candomblé, a South American spirit religion of ancient African origins.



Riots following forced evacuation of smallpox patients in early 19th century England. A modern epidemic would test every medical and civil organization.



Extensive late lesions of smallpox in a 1960's case.



Typical skin lesions of monkey pox infection.

## Clinical Spectrum of Tularemia

- Ulceroglandular (70% - 85%)
- Glandular (2% - 12%)
- Typhoidal (7% - 14%)
- Oculoglandular (1% - 2%)
- Oropharyngeal (2% - 4%)
- Pneumonic (8% - 13%)

## Tularemia

### Modes of Transmission

- Arthropod bites (ticks, mosquitoes, and deer flies)
  - Bacteria in tick fecal material, not found in tick salivary glands
- Inoculation of skin (wounds), conjunctiva, mucous membranes
  - Contaminated water
  - Blood/tissue from infected carcasses

## Tularemia

### Modes of Transmission

- Ingestion of insufficiently cooked meat of infected animals
- Drinking contaminated water
- Dust inhalation from contaminated soil (Bioterror potential)



Typical cutaneous lesion of tularemia. In a bioterror assault, aerosols would induce tularemia pneumonia with a high mortality rate.



Marked tendency for tularemia to localize in South Central U.S.

### Bioterrorism in the Future

- Recombinant organisms carrying abnormal toxins or antigens (i.e. Tularemia or plague with diphtheria toxin or botulinum toxin)
- Multiply antibiotic resistant pathogens (i.e. plague, tularemia, anthrax)
- Organisms adapted to naturally occurring vectors (mosquitoes, ticks, fleas)

### Bioterrorism in the Future

- Aerosol adapted organisms
- Exotic tropical viral diseases (i.e. Ebola, Lhasa, Marburg)
- Emerging pathogens such as SARS and avian influenza

### Other Possible Future Scenarios

- Suicide carriers injected with devastating diseases with direct (ebola, Marburg, smallpox) or indirect (plague, typhus) transmission
- Suicide blood donors to spread panic and disruption
- Combined releases of multiple organisms or as a concomitant to explosions or radiological terrorism
- Targeting of enclosed areas during events

### Estimates of Casualties Produced by Hypothetical Biological Attack\*

Agent	Downwind	No. Dead	No. Incapacitated
Rift Valley Fever			
Fever	1	400	35,000
Tick-borne Encephalitis	1	9,500	35,000
Typhus	5	19,000	85,000
Brucellosis	10	150	125,000
Q Fever	>20	150	125,000
Tularemia	>20	30,000	125,000
Anthrax	>20	95,000	125,000

\*Release of 50kg of agent by aircraft along a 2 km line upwind of a population center of 500,000 from WHO study published 1970, slide courtesy of David Walker, M.D., University of Texas Medical Branch

## Emerging Diseases as Bioterror Threats

- **Definition:** Tropical and subtropical diseases spreading to North America
- **Basis:** Globalization, immigration and importation of animals; possible intentional introduction
- **Examples:** Avian Influenza, SARS, West Nile Virus, Monkey Pox, Hansen's Disease, other viral encephalitides

In addition to German attempts to spread anthrax and glanders to allied horses, during World War I, the influenza epidemic of 1918 killed 20 million in just 18 months. Over 25 million Americans were alone infected during the influenza epidemic. The epidemic effectively ended the war. Acquisition of the ability for the virus to spread from person to person is acquired by passage of avian strains through swine. A similar process will likely result from the recent avian influenza in Asia.



## Upcoming Programs

Psychological Sequelae of Weapons of  
Mass Destruction on First Responders  
Satellite Conference  
Friday, May 6, 2005  
12:00-1:30 p.m. (Central Time)

To view all upcoming programs, visit  
our website: [www.adph.org/alphtn](http://www.adph.org/alphtn)