Biological Weapons: History, Use, and Nonproliferation Strategies

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February 2003

Sand No. 2003-0610P

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For the United States Department of Energy under contract DE-AC04-94AI8600

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Overview

- Terms and Definitions
- Types of Agents and their Characteristics
- State Biological Weapons Programs – History and Threat
- The Biological Weapons Convention
- Protection of Dangerous Pathogens and Toxins
- Public Health Surveillance
- Biological Export Control
- Biological Sensor Technologies
- Summary

Terms and Definitions

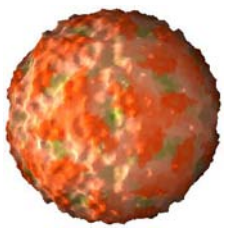
- **Biological Weapon**
  - **Any pathogen or toxin used in a nefarious way against a human, animal, or plant target**
- **Bioterrorism**
  - **Unlawful threat of, or use of, viruses, bacteria, and/or toxins against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political, social, and/or economic objectives**
- **Select Agents**
  - **Pose a severe threat to public health safety, animal or plant health, or to animal or plant products**
- **High Consequence Pathogens and Toxins (HCPTs)**
  - **Those microorganisms and their by-products that are capable, *through their use as a weapon*, of severely affecting national or international public health, safety, economy, and security**
  - **Those agents that have the properties and attributes that would make them effective weapons material**

High Consequence Pathogens and Toxins

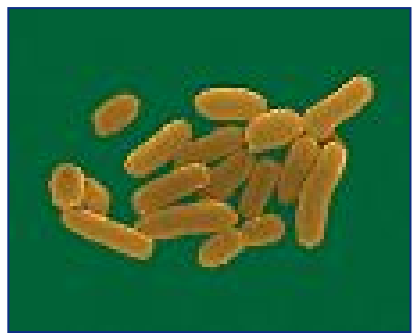
- **Valuable for many legitimate, defensive, and peaceful commercial, medical, and research applications**
- **Widely available**
  - **Can be isolated from nature**
  - **Exist in a variety of biomedical research institutes, clinical facilities, biotechnology industries, and culture collections around the world**
- **Living and self-replicating organisms**
  - **Can be continually amplified throughout legitimate research activities**
  - **Exact quantities and types of organisms and by-products constantly vary as organisms replicate and die**
- **Exist in many process streams in legitimate facilities**
  - **Petri dishes, cell cultures, environmental samples, clinical specimens, infected animal models, animal waste, and animal carcasses**
  - **Stored in refrigerated or freeze-dried forms**
  - **Research often spread across several laboratory suites**
- **Generally used in very small amounts and cannot be reliably quantified**
  - **Makes diversion of useable quantities difficult to detect**
- **Yet theoretically one cell could be grown, processed, weaponized, and deployed with commercially available equipment**

Types of Biological Weapons (BW) Agents

- Anti-human agents
  - Incapacitating
    - Staphylococcal Enterotoxin B
    - Venezuelan Equine Encephalitis
    - Tularemia
  - Lethal
    - Botulinum Toxin
    - Smallpox
    - Plague
    - Anthrax
- Anti-animal agents
  - Foot and Mouth (FMD)
  - Brucellosis
  - Glanders
  - Anthrax
- Anti-plant agents
  - Wheat stem rust
  - Rice Blast
  - Late Blight of Potato



FMD virus

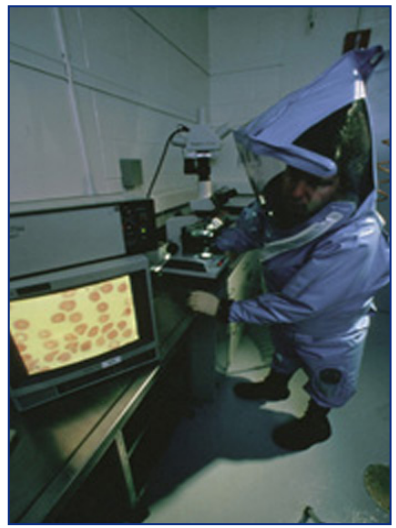


Plague bacteria

Potato infected by Late Blight disease

BW Agent Characteristics

- **Infectious disease risk**
  - **Infectivity**
  - **Pathogenicity**
  - **Lethality**
  - **Transmissibility**
- **Likelihood agent would be used as a weapon**
  - **Availability**
  - **Ease of amplification**
  - **Ease of processing**
  - **Environmental hardiness**
  - **Availability of countermeasures/immunity**
  - **Ability to camouflage as an endemic/common disease**



BSL-3 and -4 equipment

Sin Nombre Virus (causal agent for HPS)

Ciprofloxacin antibiotic

History of State BW Programs

- **World War I**
  - **Germany, France - Sabotage program (non-human targets)**
- **The Inter-War Years**
  - **France, Japan, the USSR, the UK, Canada – Human, animal, plant research**
    - **Japan Begins Human Experiments**
- **World War II – 1972**
  - **Germany, Japan, USSR, US, UK, Canada**
    - **Japanese Use Against Chinese Targets**
    - **Alleged USSR Use Against German Soldiers**
- **Suspected BW Programs Since 1972**
  - **USSR/FSU, Iraq, Iran, China, Syria, Libya, India, Pakistan, North Korea, South Africa, Bulgaria, Sudan, Cuba, Israel, and Egypt**
- **Motivation for BW Programs**
  - **Suspicion/lack of transparency measures; low cost; deniability**

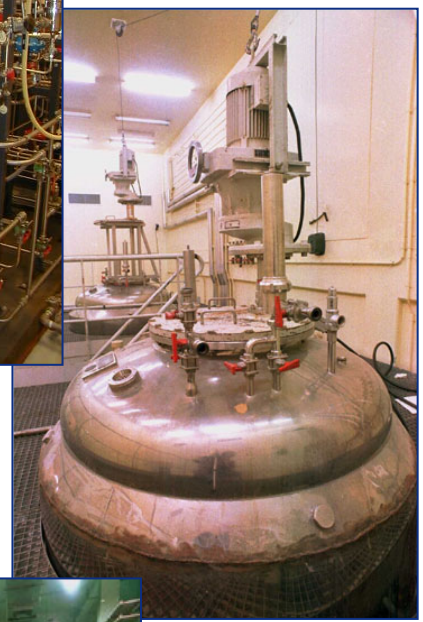
History of State Use of BW

- World War I
  - Germany
    - Anti-Livestock
  - France (Alleged)
    - Anti-Livestock
- World War II
  - Japan
    - Anti-personnel
  - USSR (Alleged)
    - Anti-personnel
- Other Incidents
  - Bulgarian Assassination
  - South Africa BW Program (Alleged)
    - Assassination of Anti-Apartheid Opponents
    - Use During Zimbabwe (now Rhodesia) Independence War

(ARCHIVE)

General Pattern of State BW Use

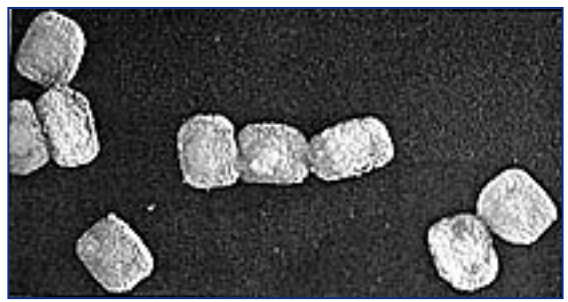
- **State BW programs have conducted research on a wide array of agents, including those that cause high-fatality diseases**
- **Wide dissemination capabilities**
  - **Aerosolization**
  - **Utilization of vectors**
- **Potential to cause a high consequence BW event**
- **Willingness to use BW during wartime conditions**
- **Intent and effect of BW use has been tactical, not strategic (influence battle, not war)**



Fermentation vessels

Biological and Toxin Weapons Convention (BTWC)

- Prohibits the development, production, & stockpiling of biological weapons agents, toxins, equipment, & means of delivery by State Parties
- Open for signature April 10, 1972
- Entered into force March 26, 1975
- 144 State Parties
  - 18 signatories have not ratified
  - 31 non-signatory nations
- No provisions for verification of compliance

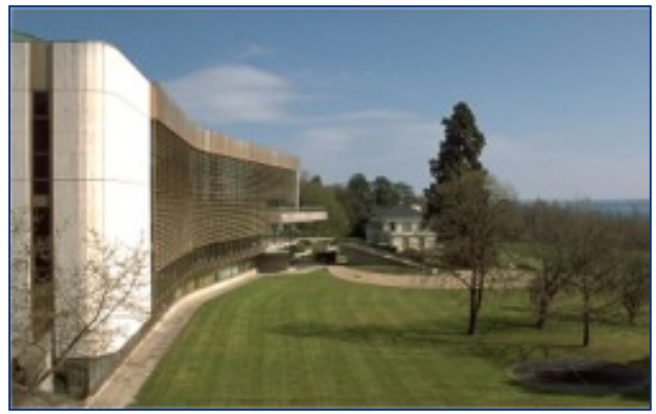


Smallpox virus

250 Gauge Bombs

5th Review Conference Conclusions

- Experts Groups to discuss
  - Adopting national measures to implement Convention's prohibitions (2003)
  - Establishing national mechanisms to maintain security and oversight of pathogens and toxins (2003)
  - Enhancing international capabilities to respond to, investigate, and mitigate the effects of cases of alleged use of biological weapons or suspicious outbreaks of disease (2004)
  - Strengthening national and international mechanisms for surveillance, detection, diagnosis, and combating of infectious disease (2004)
  - Adopting codes of conduct for scientists (2005)
- Experts Groups to report to 6th Review Conference in 2006

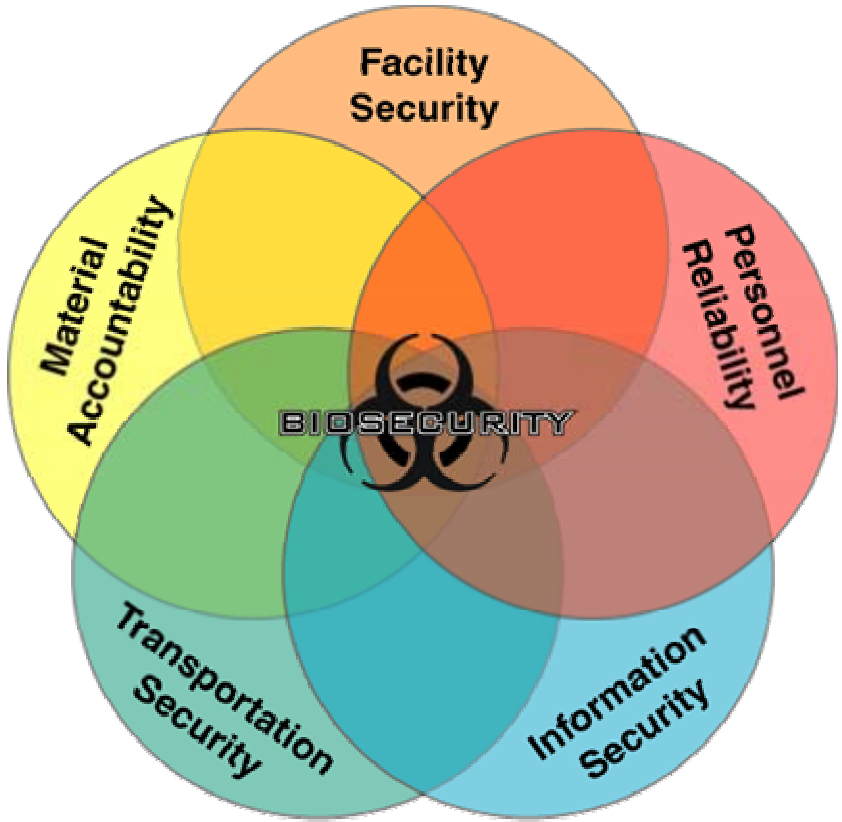


United Nations

Inspection & monitoring of BW facility in Iraq

Security of High Consequence Pathogens and Toxins

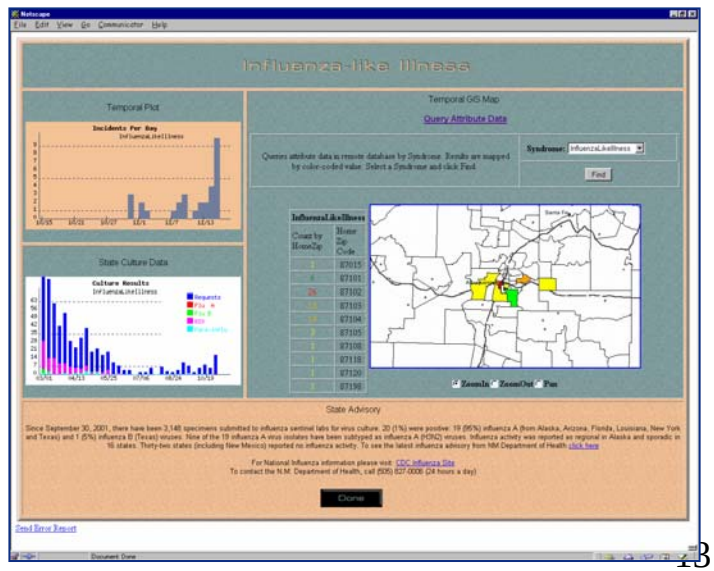
- New U.S. Legislation (2002) and Codes of Federal Regulation for biological security (2003)
- Objective: protect against diversion of high consequence pathogens and toxins, which could be used in bioterrorism or biological weapons proliferation
- Strategies
  - Define risk by evaluating probabilities and consequences
  - Protect defined assets against defined threats
  - Apply a graded approach: high consequence assets receive highest level of protection
  - Integrate security technologies, procedures, and protocols
  - Impact operations only to the level required



Rapid Syndrome Validation Project (RSVP)™

- Rapid detection of infectious disease outbreaks
- Tracks syndromes of infectious disease geographically and temporally
- Internet-based, secure, inexpensive, simple, fast, sustainable, scalable reporting system
- Provides several-day advantage over current disease detection and reporting technologies
- Maintains communication between clinicians and public health officials
- Benefits to day-to-day public health as well as BW nonproliferation and terrorism response
- Operational in many U.S. states

RSVP Log-on & Flu-like Illness Screens



Biological Export Control

- **Australia Group**
  - **Founded in 1985 to harmonize export controls on materials that could be used to produce chemical weapons**
  - **Controls on materials that could be used to produce biological weapons added in 1990-91**
  - **33 countries now members; voluntary membership**
  - **Common Control List of 20 viruses, 4 rickettsiae, 13 bacteria, and 19 toxins**
- **U.S. Commerce Control List (from the Export Administration Regulations)**
  - **Same as Australia Group's Common Control List**
- **State Department's International Traffic in Arms Regulations ("munitions list") places export controls on "biological agents" without definition**

Anthrax bacteria

Biological Sensor Technologies in Infancy

- **Biological agents extremely difficult to detect**
  - **Used in very small quantities**
  - **Difficult to separate background microorganisms in air from a contaminating biological**
- **Quickest and most reliable detection technology requires sampling and analysis**
  - **Polymerase chain reaction (PCR): both lab- and field-based systems**
- **U.S. currently experimenting with environmental sensor technologies**
  - **Biological Aerosol Sentry and Information System (BASIS) portable system of networked sensors and relocatable laboratory**
- **Principal problem is that sensors can only detect what they are looking for**

PCR Machine

Deployed BASIS System

Laboratory Diagnostics for Anthrax

Summary

- Dual-use nature of biotechnology
  - Suitability for both legitimate public health and illicit weapons applications
- Wide availability of materials, equipment, and expertise required to develop biological weapons
- Traditional arms control (inspections, verification, and compliance) may be impossible to achieve
- Best hope of slowing and reversing proliferation is to create international norms and incentives for implementing national regimes
  - Protection of high consequence pathogens and toxins
  - Export controls of high consequence pathogens and toxins
- Develop and enhance surveillance, detection, and diagnosis technologies
- Improve availability of medical countermeasures (vaccines, antibiotics) that could be used to respond to a biological weapons incident