Bioterrorism and Bioweapons: Past, Present and Future

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Biological warfare and terror are not new. The fanatics & extremists were always around. What is new is the potential to use it on an unprecedented scale with today's technology and religious fervor.

The ways of terror

- Conventional weapon used in a conventional way (usual war)
- Conventional weapon used in a non-conventional way (WTC bombings)
- Non-conventional weapon used in a conventional way (anthrax letters)
- Non-conventional weapon used in a non-conventional way (the future?)

Terror is a form of disaster, and there are many kinds of disaster events.

Types of Disaster Events

- Natural
- Technological
- Human

Natural Disasters

- Hurricane
- Tornado
- Severe thunderstorm
- Snowfall
- Blizzard
- Ice Storm
- Earthquake
- Tidal wave
- Temperature extremes
- Drought
- Flood, external
- Wild Fire
- Landslide
- Volcano

Technological events

- Electrical failure
- Generator failure
- Transportation failure
- Fuel shortage
- Natural gas failure
- Water failure
- Sewer failure
- Steam failure
- Fire alarm failure
- Communications failure
- Medical gas failure
- Medical vacuum failure
- HVAC failure
- Information systems failure
- Fire, internal
- Flood, internal
- Hazmat exposure, internal
- Unavailability of supplies

Human or Man-made events

- Mass casualty incident
  - Trauma
  - Medical
  - Hazmat
- Hazmat exposure, ext
- VIP situation
- Infant abduction
- Hostage abduction
- Civil disturbance
- Labor action
- Forensic admission
- Bomb threat

and

Weapons of Mass Destruction (WMD, CBRNE)

- Nuclear (and radiological)
- Biological
- Chemical
- Firearms, Explosives or Incendiary Devices
- Cyberterror

CDC Category A List

- Anthrax (*Bacillus anthracis*)
- Botulism (*Clostridium botulinum* toxin)
- Plague (*Yersinia pestis*)
- Smallpox (variola major)
- Tularemia (*Francisella tularensis*)
- Viral hemorrhagic fevers
  - filoviruses [e.g. Ebola, Marburg]
  - arenaviruses [e.g. Lassa, Machupo]

Why an "A" List?

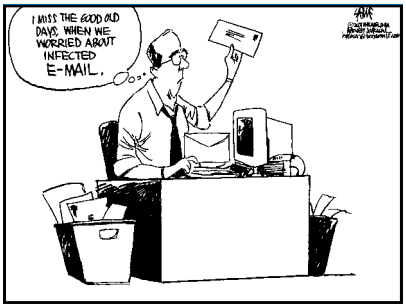
- Easily disseminated or transmitted from person to person
- Results in high mortality rates and the potential for major public health impact
- Causes public panic and social disruption
- Requires special action for public health preparedness

CDC Category B List

- Brucellosis (*Brucella* species)
- Epsilon toxin of *Clostridium perfringens*
- Food safety threats
  - *Salmonella* species
  - *Escherichia coli* O157:H7
  - *Shigella*
- Glanders (*Burkholderia mallei*)
- Melioidosis (*Burkholderia pseudomallei*)
- Psittacosis (*Chlamydia psittaci*)
- Q fever (*Coxiella burnetii*)
- Ricin toxin from *Ricinus communis* (castor beans)
- Staphylococcal enterotoxin B
- Typhus fever (*Rickettsia prowazekii*)
- Viral encephalitis
  - alphaviruses [e.g., Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis])
- Water safety threats
  - *Vibrio cholerae*
  - *Cryptosporidium parvum*)

Is a computer virus or worm a biological terrorist "agent"?

Is opening a suspicious envelope like opening an infected e-mail attachment?



The Chinese depict the word "crisis" with two characters*

Chinese symbol for danger.

Chinese symbol for opportunity.

Some Facts

Only 2% of the 14,000 cargo containers entering the US every day are inspected!

There are 850,000 facilities that store chemical agents

There are 103 nuclear power plants

Definitions

"I can't give you a definition of it but I can certainly recognize it when I see it."

Supreme Court Justice William Rehnquist
(pornography hearings)

Some Definitions

Coffee - a person who is coughed upon.
Flabbergasted - appalled over how much weight you have gained.
Abdicate - to give up all hope of ever having a flat stomach.
Esplanade - to attempt an explanation while drunk.
Willy-nilly - impotent
Negligent - a condition in which you absentmindedly answer the door in your nightie.
Lymph - to walk with a lisp.
Gargoyle - an olive-flavored mouthwash.
Balderdash - a rapidly receding hairline.
Testicle - a humorous question on an exam.
Rectitude - the formal, dignified demeanor assumed by a proctologist immediately before he examines you.
Oyster - a person who sprinkles his conversation with Yiddish expressions.
Circumvent - the opening in the front of boxer shorts.
Pokemon - a Jamaican proctologist

"Terror" comes from the Greek word *trein* which means "to be afraid, flee" and *tremein* which means "to tremble"

Terrorism

The unlawful use of force or violence against persons or property to intimidate or coerce a government or civilian population to further political, social or psychological objectives.

What is the definition of a terrorist*?

*Bio*terrorism*

The *intentional* use of microorganisms or their toxins to produce death or disease in humans, animals, or plants.

In 1992, the Australia Group identified nearly 100 bacteria, viruses, fungi, and toxins against people, animals, and plants with potentials for Weaponization

To date, only 15-20 of these microorganisms have been used to produce biological weapons.

Thinking About the Unthinkable*

- 12 countries have nuclear weapons programs
- 18 countries have ballistic missiles
- 17 countries possess biological weapons
- 16 countries possess chemical weapons

*Herman Kahn

But what about the bioweapons themselves and their deployment?

Properties of Biological Weapons*

- Cheap and easy to make or procure
- Detection is difficult
- Easily disseminated
- Delayed onset

Properties of Biological Weapons* (continued)

- Overwhelm all available medical facilities
- Create great panic
- Incredibly toxic
- Surveillance systems don't work yet
- Labs are unfamiliar with them
- Perpetrator can escape

and

They are very, very cheap

Weapon type	Cost per death
• Nuclear	• $800 - $10,000
• Radiologic	• ?
• Chemical	• $10 - $600
• Explosive	• ~$2,000
• **Biological**	• **$1 - $10**
• Psychological	• ?
• Cyber	• ?

But there are also disadvantages

- Extremely unpredictable
- Difficult to control
- Long lifespan
- Messy to deal with
- If used outdoors, weather is unpredictable
- Socially unacceptable

What do terrorists need to get *started*?

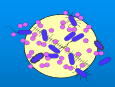
- Knowledge
  - Basic Microbiology
  - Weaponization
- Equipment
- Seed stock

Many are involved

- *The ill, the exposed & the worried well*
- *First responders – EMT, HAZMAT, fire*
- Public health authorities
- Hospitals & HCWs
- Investigative agencies
- The news media
- The perpetrator(s)

How can biologic weapons be deployed?

- Contaminating food or water supplies
- Releasing infected vectors (mosquitoes, fleas)
- Creating an inhaled aerosol cloud
- Sending a letter through the mail (aerosol & skin)



The "formula"

- An *effective terrorist group* or perpetrator
- A *target* population or effective host
- *Availability* of a selected biologic agent
- An effective method of *dissemination*
- Proper *environmental conditions**

How do we respond?

- *Preparation*
  - Public Health: infrastructure, surveillance, real-time data system, communications vehicle
  - Laboratory equipment & fingerprinting of isolates
  - Education
- *Crisis Management*
  - *Curbing public hysteria*
  - Dealing with the media
  - Early medical control of the outbreak
  - Decontamination & quarantine
- *Consequence Management*
  - Picking up the pieces

You have to be lucky all the time. We only have to be lucky once.

The IRA

Moving on to a history that may surprise you!

The Early History of Bioterrorism

- 6th Century B.C.
  The Assyrians poisoned the wells of their enemies with rye ergot.
  The master tactician Solon of Athens poisoned his enemy's water supply with skunk cabbage during the siege of Krissa.
- 184 B.C.
  During the naval battle against King Eumenes of Pergamon, Hannibal's forces hurled earthen pots filled with snakes on to enemy decks.

Plague through the Ages

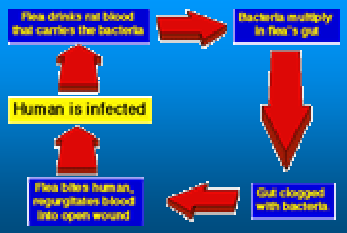
- Justinian's Plague of the 6th Century killed 100 million people (50% of Europe's population)
- The Black Death 1347-1351 killed 25 million (50% of the population) & militarizated plague
- The 3rd epidemic of the 19th and 20th Centuries
  - The Chinese pandemic of the late 19th Century
  - The Los Angeles outbreak in 1924-1925
- Japanese use of plague as a bioweapon
- Worldwide there are still 2,000 cases per year

Plague: The unholy trinity

- The bacteria - Yersinia pestis

- The rat - Rattus rattus

- The flea - Xenopsylla cheopis



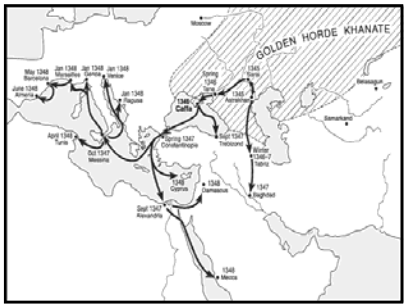
Justinian's "Plague"*

The Black Death

- In 1346, the second plague pandemic, also known as the *Black Death* or the *Great Pestilence*, erupted
- Within 5 years it ravaged the Middle East
- Killed more than 13 million people in China and 20-30 million in Europe (more than one third of the European population).

Plague As a Bioweapon*

- In 1346 the Tartar army hurled the corpses of plague victims over the walls of Kaffa, a seaport on the Crimean coast. This may have caused the European epidemic that resulted in 30-40 million deaths!
- In 1422 at the battle of Carolstein, bodies of plague-stricken soldiers plus 2,000 cartloads of excrement are hurled into the ranks of enemy troops.
- In 1710 Russian troops hurled the corpses of plague victims over the city walls of Reval during Russia's war with Sweden.
- In 1718 Russians used the same tactic against Sweden again



Implications of the Black Death

- Were the events at Kaffa relevant?
- How much was spread by rat fleas as opposed to humans and their fleas (bubonic vs. pneumonic)?
- A third to a half of the population died
- Anti-Semitism was revived and eventually led to a migration of the Jews east to Poland and Russia

"Ring-around the Roses, A pocket full of posies, Ashes, Ashes, We all fall down."

Nursery rhyme making a futile attempt to avoid plague

What's different between then and now?

- Sanitation was geared to industrial pollution and waste disposal, not rats and fleas
- We didn't understand the mechanism of spread
- We didn't have therapeutics available
- It spread along natural lines of least resistance and not intentional man-made ones

What do you do about plague?

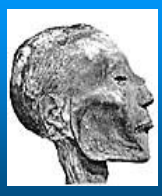
"Flee quickly, go far, and return slowly"

More "Old" History

- 1797: Napoleon attempted to force the surrender of Mantua by infecting the citizens with swamp fever (equine infectious anemia).
- 1860-1865: Sherman's memoirs contain an account of Confederate soldiers poisoning ponds by dumping the carcasses of dead animals into them.

What about Smallpox?

- First described in the Tcheou Dynasty in 1122 BC
- Seen in the mummy of Ramses V c.1000 BC
- In 590 BC the Sung Dynasty, used inoculation to prevent the disease.
- First described as a medical entity by the Persian physician, Rhazes in 930 AD, working in a Baghdad hospital
- No mention in Europe till the 6th Century



Smallpox in the Middle Ages*

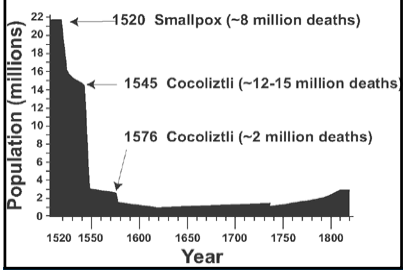
A mosaic from the early 14th century inside Kariye Mosque (Church of Christ the Savior), Chora, Istanbul, Turkey

The Spaniards Brought Smallpox to America

- 1507 – first recorded case in Western Hemisphere
- Brought to the Americas by Hernando Cortez in 1520, killing 3,500,000 Aztecs in two years
- During Pizarro's conquest of South America in 1532, he improved his chances of victory by presenting smallpox laden clothes to the natives as gifts
- Spaniards also brought smallpox to the Caribbean Islands and Florida in the 17th Century
- 1617-1619 – 1st epidemic in North America

The Europeans also brought to the Western Hemisphere other highly contagious diseases like measles and typhus

Population Collapse in Mexico



What about the French?

What about North America?

Bioterrorism: Smallpox & the French & Indian War (1754-1767)*

1763
During the Pontiac Rebellion, the British army provided the Delaware Indians with blankets and handkerchiefs from the "Smallpox Hospital"

1767
Sir Jeffrey Amherst gave his consent to give blankets laced with smallpox to Indians loyal to the French.

Even the 20th Century was not spared from smallpox. During this century 100 million people died from armed conflict & 300 million died from smallpox.

The Boston Smallpox Outbreak, 1901-1903*

- 1,596 cases & 270 deaths (pop = 560,900)
- 82 of 754 vaccinated died
- Detention hospital set up on Southampton St
- Disinfection, vaccination, revaccination of all contacts/exposed
- Surveillance of suspects for 2 weeks
- If vaccine refused - $5 fine or 15-day jail sentence
- Board of Health's policy re: the homeless
- The Pfeiffer Affair
- ANTI-COMPULSAY VACCINATION LEAGUE
- 108 additional cases, 4 deaths till 1932

The smallpox outbreak in India between 1926 and 1930 killed 423,000 people!

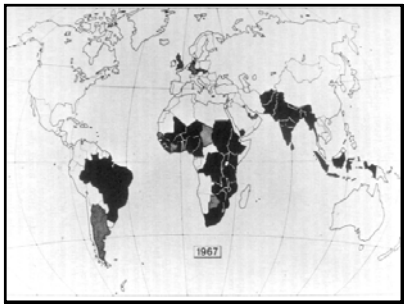
The NYC Outbreak in 1947*

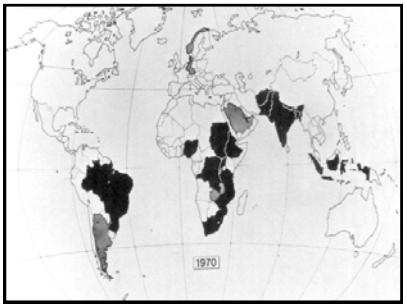
Between 1958 and 1973 there were 34 smallpox outbreaks in Europe with 573 cases (48% in hospitalized patients, 25% in household contacts)

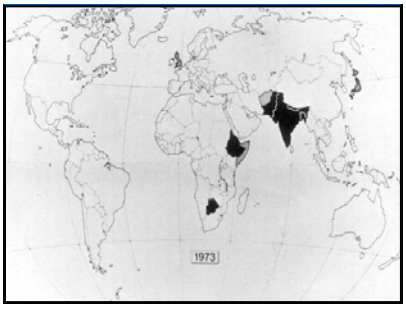
In 1967, the year WHO began their international eradication efforts, smallpox afflicted 15 million people annually and was responsible for 2 million deaths a year.

The WHO Smallpox Global Eradication Program* (1967-1977)

- The virus
  - No animal reservoir
  - Single serotype
  - Causes disease that is easily recognized clinically
  - No carrier or sub-clinical (asymptomatic) infection
- The vaccine
  - Cheap, potable vaccine and no cold chain
  - Ring vaccination
  - A prompt antibody response so the exposed can be immunized quickly and effectively
- The eradication program
  - Good surveillance
  - Ring containment







Why was the eradication program successful?

- **Man** is the only host
- Transmission only occurs **during the rash**
- There is permanent **immunity** after recovery
- Spread usually requires face-to-face contact
- Transmission stops **spontaneously** in remote areas
- Vaccine provides **long-lasting** protection

Today's smallpox concerns

- Destruction of stocks
- Stolen stocks
- Genetic manipulation
- Vaccine

The smallpox vaccine controversy

- 250 years old live vaccine taken from cows
- It is dangerous for HIV patients, those on immunosuppressive drugs, transplants, and eczema or atopic dermatitis
- Is it reasonable to vaccinate an entire population against a disease that we have not seen in 25 years?
- Liability

Vaccine and Immunity

- Today we are more susceptible than at any prior time in history
- No one under 32 years has been vaccinated and this makes up 45% of the population
- How different is the spread of natural infection from man-made?
- What about a genetically engineered strain?

The government's choices

- Don't vaccinate anybody
- Vaccinate those at highest risk
- Vaccinate anyone desiring to be vaccinated
- Make vaccination compulsory

The Voluntary Smallpox Vaccine Plan

- Phase 1
  - offered to front line health care workers
- Phase 2
  - moving to all first responders and doctors in private practice
- Phase 3
  - eventually extending to the general public

"Anthrax isn't worth much, … it doesn't spread, but smallpox -- that's a real biological weapon."

Gen. Pyotr Burgasov
November 2001 interview in the Moscow News

The final years of smallpox*

- 1949 – Last case in US
- 1972 – Last outbreak in Western World
- 1977 – last case worldwide
- 1980 – WHO declared eradication

What can you do to treat smallpox?

The art of medicine consists of amusing the patient while nature cures the disease.

Voltaire

Indian Medicine Man Cures

- Sweat baths followed immediately by ice baths
- Interpreting the dreams of the inflicted
- Forcing the ill to fast, dance, and sometimes through torture to produce dreams

Smallpox Vaccination*

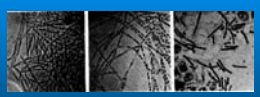
Edward Jenner

1797

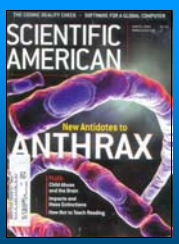
Lady Mary Montague

1718

Moving on to anthrax and the mail



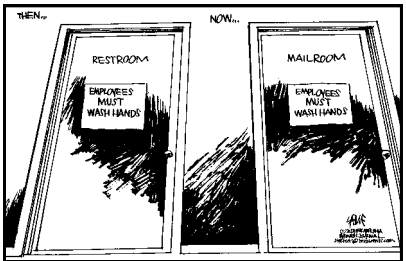
Robert Koch's original micrographs of the anthrax bacillus



DNA Mapping of Anthrax*

- 10,000 years ago – started in Africa
- Moved down the Nile
- To Europe and Asia with livestock and trade ships
- To Americas via Spaniards and their Andalusian horses
- Typing the Ames strain

*work of Paul Keim and Paul Hugh-Jones

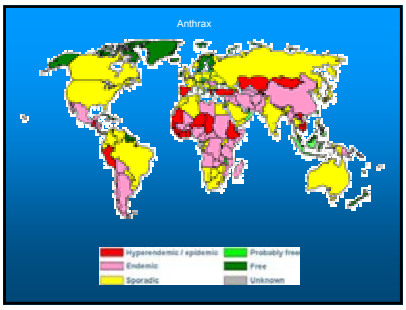


680 million pieces of mail are handled per day in the US

Known National Programs Using Anthrax as a Biological Weapon*

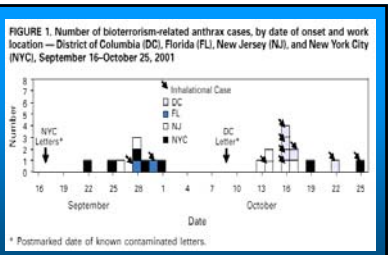
- Japan
- USA
- USSR
- Iraq
- South Africa

*17 nations are currently believed to have offensive biological weapons programs



The 2001 anthrax outbreak

- 5+ letters
- 22 cases (11 inhalational, 11 skin)
- 5 deaths
- 5,100 exposed
- 152 chose to be vaccinated



MMWR 2001. 50;941-8

What about antibiotics?

- CDC said to use cipro
- NIH said to use doxycycline
- The FDA said neither were licensed

What about testing?

- DOD tested 30,200 specimens
- CDC tested 7,500 specimens
- PHL's tested 84,010 specimens
- Thus there were ~121,710 environmental specimens tested + many clinical specimens as well
- Makes a good argument for a high throughput lab

The anthrax letters were weapons of Mass Disruption

- Communications
- Transportation
- Technology
- Cyberterror
- Financial system
- Postal system
- Civil liberties

Let's try to put the recent anthrax epidemic into perspective:

Great panic and anxiety
Very few cases
Lots & lots of money spent
Many unanswered questions

and

Thank goodness it did not coincide with a flu or SARS epidemic!

"Weapons Grade" Anthrax – biological and chemical properties

- Particle size uniformity ~ 5 microns
- Virulence
- Coating
  - No electrostatic charge
  - Non-hydrophobic
  - Non-self-adhering (flowability)
- Viability of agent within each particle
- Antibiotic resistance?
- Milling to remove clumps, stabilizing

Is it possible to make an anthrax strain that is resistant to all antibiotics and vaccines?

Bio Kaczynski

or

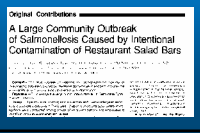
Bio bin Laden?

Bio-Kazinski or Bio-bin Laden?

- Some of the hijackers lived near the media building in Florida
- One of the hijackers was seen in the ER with a skin lesion suspicious for anthrax (in June in Florida, Alhaznawi and Ziad al-Jarrah)
- A bioweapons lab was found near Kandahar (and in the mountains in the Shah-e-Kot region of Afghanistan near Gardez)
- Looked at Crop dusters

Very recent Frightening Examples

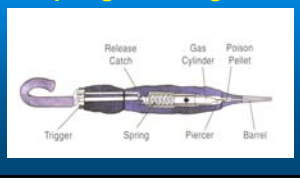
In 1984 the Bhagwan religious cult put *Salmonella* in the salad bars of 10 restaurants to incapacitate voters in Dallas, Oregon, to influence a local election. 715 people became sick.



Original Contributions

A Large Community Outbreak of Salmonellosis Caused by Intentional Contamination of Restaurant Salad Bars

In 1978 the Bulgarian Jorge Markov was poked with a ricin-laden umbrella with a spring-loaded gun



Osama bin Laden

Osama bin Laden

- 44 y/o former Saudi Arabian
- 17th of 53 children born in Yemen to a Saudi billionaire
- Graduated from Riyadh University
- Joined US-backed fight against the *Soviets* after their 1979 *invasion of Afghanistan*
- After the *Persian Gulf War* in the 1990s he formed a group dedicated to a holy war against America
- He ran his organization like a mutli-national corporation
- Has he *successfully* used bioterror yet?
- al Qaeda, the "database" from the Afghan resistance
- He is very patient

A Cult Leader's Charisma

- Bin Laden successfully reached out to multinational groups of believers in Afghanistan
- Uses his money generously
- Participated in Jihad and encourages every individual Muslim to wage jihad and assures them of a place in heaven
- Claimed divine Inspiration
- Is known to be soft spoken, devout and able to arouse the deepest passions in those he speaks to
- Has had successful military campaigns against two superpowers

"Al Qaeda was on the brink of a bioterror program more advanced than analysts knew."

Germs
J Miller, S Engelberg, W Broad

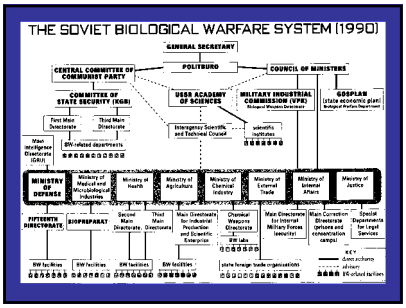
Documents found with Khalid Sheik Mohammed show evidence that al Qaeda leaders had plans and obtained materials to manufacture botulinum toxin, salmonella and cyanide

Internationally, many countries have been involved in bioweapons development and testing.

What about the Russians?

The Soviet Bio-weapons Program

- Continued *even after* signing 1972 BWC
- *Biopreparat* of the Soviet Union
  - Agency under Ministry of Defense
  - 32,000 - 60,000 scientists and technicians
  - 6 research labs, 5 production facilities
- Program inherited by Russia
  - In 1992 President Yeltsin promised to terminate the program but:
  - Still employs ~25,000 people
  - Defections to rogue states is a problem
- Is there still an existing program?



The Russian Criteria for an Effective Bioterror Agent

- Easy and inexpensive to produce
- The first sign is illness
- The agent can be disseminated over great distance
- It is stable for storage
- Odorless, colorless and tasteless making it difficult to detect
- Particle size of 1-5 microns
- Contagious
- Even the threat causes panic
- The perpetrator can be protected and thus easily escape

Soviet BW Priorities
"Agents Likely to be Used"

Smallpox	26
Plague	23
Anthrax	21
Botulism	21
VEE	20
Tularemia	20
Q Fever	20
Marburg	18
Influenza	17
Melioidosis	17
Typhus	15

Vorobjev, A., et al., "Criterion Rating" as a Measure of Probable Use of Bioagents as Biological Weapons, International Symposium, Severe Infection Diseases, Kirov, June 1997

The Russians produced tons of weaponizable biologic agents!

Agent	Quantity (metric tons)
Anthrax	>1,000
Plague	>1,000
Smallpox	100
Glanders	2,000
Tularemia	1,500
Marburg	150

Anthrax & the white powder*

- There are ~10^{11} particles/gm in weapons grade anthrax
- Assume an efficiency of 1/100 of 1% = 10^7 disease-producing particles/gm
- ~20 bacteria per 5 micron particle
- ~10^4 bacteria or 500 particles are needed for infection
- ~1,000 people infected/gm
- The Russians had enough to infect > trillion people

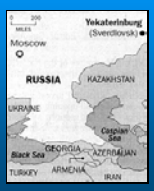
*Silica, silicon dioxide bentonite?

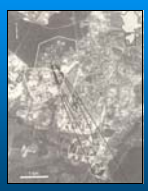
and they also had a few accidents.

The Sverdlovsk Incident: A biological experiment

- April-May 1979
  - 66 Anthrax fatalities
- 1988
  - Soviets present data:
    - 96 cases
    - 79 gastrointestinal
- May 1992
  - Yeltsin admits "military developments"

Sverdlovsk:
A case study of an anthrax accident





Another Russian Accident*

- 400 grams of smallpox released
- July 30, 1971 in Aralsk (current Kazakhstan)
- Picked up 15 kilometers from release point
- 50,000 residents vaccinated
- Hundreds placed in isolation
- Smallpox killed two children and a young woman and there were 7 survivors
- Health teams disinfected homes and quarantined hundreds of people

Moving on to Japan

Japan*

1925
- Refused to approve the Geneva Protocol that bans biological weapons.

1931
- Military officials attempted to poison the League of Nations investigatory commission with cholera. No one fell ill.

1932
- Began experiments on biological warfare.

1936
- Unit 731 is formed.

Japan's Unit 731 & Unit 100 (1932-1945)*

- The Japanese started an ambitious bioweapons program in Manchuria posing as a water purification unit
- POW'S were exposed to aerosolized anthrax resulting in 3,000 – 9,000 human deaths
- By 1945 400 kg of anthrax was designated for a specially designed fragmentation bomb

*Harris SH. Factories of Death: Japanese Biological Warfare, 1932-1945, and the American Coverup (1994)

Japan & Bioweapons

- Unit 731 carried out large scale biological warfare experiments in Northern China
- 10,000-12,000 people died in Japanese laboratories after they were infected with typhoid, anthrax, cholera, plague among other pathogens
- >250,000 civilians were killed as a result of Japanese field tests in the Chinese countryside

Japan's "Plague Tactics"

Planes overfly Manchuria & China

↓

They drop infected fleas and grain

↓

The grain attracts the rats

↓

Rats became infected from the fleas (24,000 organisms can be regurgitated in a single feeding)

↓

Disease spreads to humans

AND THE PERPETRATORS WERE NEVER PROSECUTED

Aum Shinrikyo, Sarin and the Tokyo Subway

Aum Shinrikyo*

- 1995 sarin *chemical* attack in Tokyo subway in 5 simultaneous attacks
- Purchased a 48,000 acre farm in Australia to test biological agents on livestock
- Sent members to Africa for Ebola samples
- Built two biologic research centers
- Had $1 billion
- *Previously had 8 unsuccessful anthrax attacks*
- *Were not initially prosecuted**

The Consequences

- The incident was timed to coincide with rush hour when trains were packed with commuters
- >5,500 injuries and 11 deaths in 5 simultaneous attacks.
- ~600 victims were transported by ambulance
- ER's became overcrowded → diversion to ER's that were as far as 500 miles away
- Victims even climbed through windows to get into hospitals

What happened at hospitals?

- 641 victims were treated at one hospital alone
- 260 Tokyo hospitals were affected
- 23 hospital employees were contaminated by patients

What if this had happened in Los Angeles or Ithaca?

The United States

- We signed the 1925 Geneva Protocol, are a party to the 1972 Biological Weapons Convention and ratified Geneva Convention in 1975
- We had an offensive biological weapons program from 1943 to 1969 but only with small quantities of agents that a vaccine was available for
- In 1972 Cuba accused the CIA of bioterrorism with swine fever virus that killed 500,000 Cuban hogs
- and we did some "interesting" experiments between 1950 and 1973…

The San Francisco "Seaport vulnerability" test in 1950

- 2 tests used B.glabigii, a simulant for anthrax
  - @ 10 mph wind ➔ 400,000 people infected
  - @ 23-35 mph wind ➔ ineffective
- 1 test used Serratia marcescens, a simulant for tularemia
  - moderate inversion, 12 mph wind
  - ineffective since UV light killed vegetative form

The NYC Subway Dispersion Test, 1966

- The average commute of the 1 million people who used it daily was 8 minutes
- Used B.glabigii
- 3 Light bulbs thrown on the tracks ➔ very quickly contaminated the entire tunnel
- Nobody seemed concerned
- < 1 kg used ➔ 500,000 cases with 50% mortality

Operation "White Coat"*

- 153 army tests between 1954-73 on 7th Day Adventists
- Q fever used
- No deaths

"Eight Ball" spherical chamber

International WMD Treaties

- Nuclear
  - Non-proliferation Treaty (1968)
  - Anti-Ballistic Missile (ABM) Treaty (1972)
  - Comprehensive Nuclear Test Ban Treaty (1996)
- Chemical
  - Geneva Protocol (1925)
  - Chemical Weapons Convention (1934)
- Biological
  - Geneva Protocol (1925)
  - Biological Weapons Convention (1972, ratified 1975)
  - Biological Weapons Protocol

Should we care that talks on the Biological Weapons Protocol have failed?

Our verification experts recommended that we not sign the Biological Weapons Protocol, which is an extension of the Biological Weapons Convention

Iraq, Russia and South Africa signed the BWC

Iraq and Bioweapons: When Will Evidence be Enough?

Iraq: Background

- Used chemical weapons against Iran and the Kurds
- Attacked Kuwait
- They have killed 1.5 million of their own people
- Nuclear program affected by Israel's bombing of their nuclear power plant in 1981
- Had stockpiles of bio and chem weapons
- Inspectors hindered at every turn

In 1991 Iraq's influence in the region stemmed from its ability to bully its neighbors, from Jordan to Kuwait to the tiny states scattered across the Gulf. To the Iraqis, the benefits of keeping their germ, chemical and nuclear programs alive were substantial, even at the risk of losing billions of dollars of oil revenues. The bugs were their atom bomb. Even if the biological weapons were never used, the rumor of their existence could make little nations take note and might give Western powers reason to pause.

Iraq's Bioweapons Programs*

- Research and development facility
- Dedicated production facility
- Agent production, weaponization, testing and filling of munitions
- Revived during the Persian Gulf War
- Genetic engineering research
- Mobile facilities

It wasn't until 1989 that the Commerce Dept banned sales of anthrax and other pathogens not only to Iraq but to Iran, Libya, and Syria which were also suspected of trying to develop biological weapons.

Nonetheless, in 1990 the Iraqis bought 40 top-of-the-line "aerosol generators" from an Italian company. Each one was capable of dispersing 800 gallons per hour, and they had no other purpose than to disseminate biological or chemical weapons!

Iraq & the Persian Gulf War

- Iraq was found to have 19,000 liters of botulinum toxin, 2,200 liters of aflatoxin and 8,500 liters of anthrax.
- They acknowledged filling 25 missiles and 157 bombs with anthrax and botulism toxin.

Delivery Systems

- aerosol generators that could be carried on trucks, boats or helicopters
- cluster bombs
- spray tanks for high performance aircraft
- artillery shells
- and…

Iraqi's Delivery Systems for Biological Weapons

SCUDS:

- 13 with Botulism Toxin
- 10 with Anthrax Spores
- 2 with Aflatoxin

Bombs:

- 100 with Botulism Toxin
- 50 with Anthrax Spores
- 16 with Aflatoxin

Plus at least one remote control MiG-21 with a 500-gallon sprayer.

We knew where these facilities were. Why didn't we bomb them during the Persian Gulf War?

During the Gulf War there was uncertainty about the "fallout" from bombing biologic and chemical installations.
The US even had bombs that would cause bunkers to implode and the blast of heat would kill the spores anyway.
It didn't matter much since our "smart" bombs missed most of them anyway.

Why didn't Iraq use biological weapons in the Persian Gulf War?

- The US made it clear that if used, Baghdad would be "returned to the Middle Ages"
- There was a fear that Israel would retaliate with nuclear weapons
- The chain of command was broken so Sadam couldn't give the order
- They would contaminate their own people

Between 1991 and 1998, when the last inspectors left, more than 10,000 warheads adapted for chemical and biological use were destroyed!
Thousands more are still unaccounted for.
Baghdad claimed to have destroyed them but never provided proof.

Despite 6 yrs of the most aggressive inspection in arms-control history, the fate of >150 Iraqi bombs and warheads built before the Gulf War to disperse germs, as well as a dozen special nozzles to spray germs from helicopters has remained unknown*

Operation Iraqi Freedom: the pros and cons

The Cons

- America perceived as the bully
- Inspections will eventually work
- Killing of innocents
- Lack of majority world and UN unity
- Increased terrorism
- Opening Pandora's box
- No imminent threat

The Pros

- They have weapons of mass destruction?
  - Chemical – yes
  - Biological – yes
  - Nuclear - unknown
- It will deter future terrorism?
  - They subsidize the families of suicide bombers.
  - They have far more capabilities than a very well funded terrorist organization like Al Qaeda
  - They can make these weapons available to terrorist groups
- Economics
  - We want their oil?
  - They owe large sums of money to countries like Russia and France?
  - The French (and others) will be caught for illicitly supplying them?
- Politics
  - It sets a precedent for future dictators who want WMD, i.e. Korea?
  - It will send a shock wave throughout the Middle East?
  - They have disobeyed all 18 UN Security Council resolutions?
  - Regime change and democratization

"Is it a historical process to promote Arab peace, liberty or democracy or a cruel reappearance of demons that have haunted (the Arabs) for centuries, (exposing) a … saga of weakness, failure, vulnerability and chronic humiliation…?"

Rami G Khouri
Executive Editor of the Beirut-based Daily Star newspaper
March 21, 2002
Commentary, LA Times

So why the escalating concern now?

Major disturbances in the "*force*"

- 1st World Trade Center bombing
- Oklahoma City bombing
- Sarin gas attack in the Tokyo subway
- *Recent 9-11 airplane bombs*
- *The anthrax letters*
- *Unsettling situation in the Middle East, India and elsewhere*

Paradigm shift

- Infectious disease epidemics
- Nuclear attack planning
- Earthquake planning for the 8.3
- Nuclear power plant – HAZMAT
- Los Angeles riots
- Environmental & social protests
- School shootings
- Cold War to the War on Terrorism

1995: The Awakening*

- The Aum Shinrikyo sarin attack in Tokyo subway
- The defection of Sadam Hussein's son-in-law
- The Oklahoma City bombing
- The defection of Ken Alibek

Why is it a more appealing time now for terrorists*?

- A lack of constraints
- Religious and cultural fervor
- More concentration of people in cities
- More extensive global travel
- Global food processing & shipping
- Mass food production

The only difference between reality and fiction is that fiction has to make sense.

Tom Clancy

What about the future?

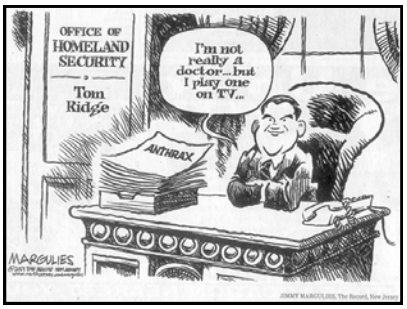
A new era of therapeutics and diagnostics; or a new era of failed public health?

"Predictions are a difficult thing, especially when they involve the future."

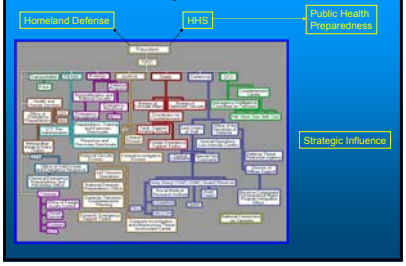
Dan Quayle
(although previously attributed to Yogi Berra)

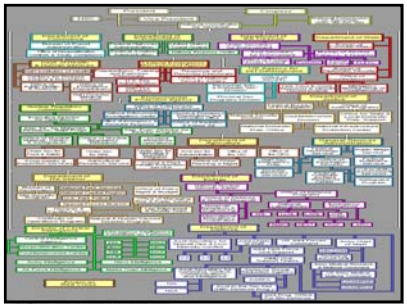
"We're prepared to take care of any contingency, any consequence that develops or any kind of bioterrorism attack."

Tommy Thompson
Secretary of Health and Human Services
CBS "60 Minutes"
Sept. 21, 2001 (a few days before the first anthrax cases)



Federal Response Framework





From anthrax to SARS*

- Thousands of cases and dozens of deaths
- Poor int'l cooperation
- Poor public health response
- Effects on global trade and int'l travel

It's hard to imagine that bioterrorism could be countered until the containment of natural diseases like SARS is mastered!

The Pessimist's View

- Unlimited opportunity for terrorists
- Governments at all levels running around doing their own thing
- Food fights over funding
- There is jockeying for territory and position

The Optimist's View*

- We have tremendous resources
- We are committed for the long term
- This is just a new phase of "3rd wave" civilization's clash with 1st and 2nd wave civilizations that we will get through
- We're the "good guys" and hold the moral high ground

The man of thought who will not act is ineffective; the man of action who will not think is dangerous.

Richard M. Nixon

More Exotic Potential Threats

- Combinations or mixes of spores, bacteria, toxins and/or viruses
- Altered antigenicity agents (for vaccine evasion)
- Antibiotic resistant organisms
- Chimera or "fusion" agents (i.e. Ebola/smallpox)
- Attacking > 1 location simultaneously
- Combining a civilian attack with a military

A Somber Thought

Scientists from the Commonwealth Scientific and Industrial Research Organization have created a potential monster:

IL4 gene + mousepox virus = vaccine resistance

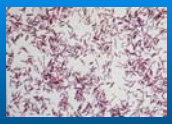
What about the "synthesis" of poliovirus?

One reason for hope: Environmental constraints

- **Sunlight**
- **Wind**
- **Temperature**
- **Desiccation**
- **Inversions**

Bacteria can be extremely hardy. They can thrive on:

- Boiling springs
- Antarctic ice
- Radioactive waste dumps



To appreciate what happened in the recent anthrax attack we need perspective

Dustin Hoffman was paid more to star in "Outbreak" than the CDC received that year to combat bioterrorism.

Causes of death (1998)*

Heart Disease	724,859
Cancer	541,532
Stroke	158,448
Chronic Pulmonary Disease	112,584
Accidents	97,835
Pneumonia/Influenza	91,871
Diabetes	64,751
Suicide	30,575
Kidney disease	26,182
Liver Disease	25,192
Anthrax	0

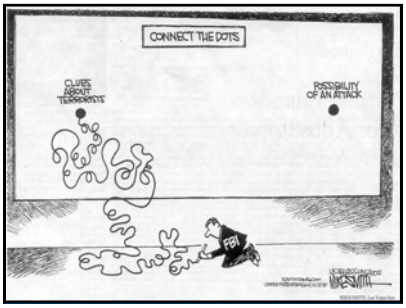
National Vital Statistics Reports, Vol. 48, No. 11

More perspective

- 1/3 of the world's population is infected with tuberculosis → 3 million deaths/yr worldwide, ~1,600 US cases per year
- There have been ~35 million people infected with HIV
- There have been no epidemic cases of anthrax in California or New York

How do we prepare?

- Enhance the public health *infrastructure*
- Strengthen on-site medical *response capability*
- Maintain a *stockpile* of pharmaceuticals & vaccines
- Have rapid *laboratory* diagnostic capability, fingerprint isolates
- *Educate* public health, the medical community and the public
- Gather intelligence



The end.