International
BIOLOGICAL THREAT REDUCTION

Overview of Laboratory Risks

Laboratory Biosecurity and Biosafety

for BSL3 Laboratories

India

Jan 2007

www.biosecurity.sandia.gov

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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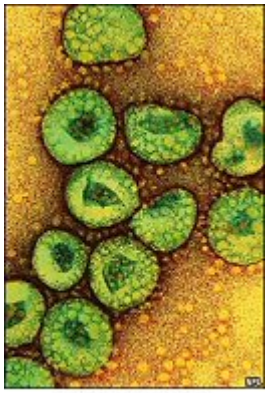
Sandia National Laboratories

The Infectious Disease Threat

- **Recent outbreaks of emerging infectious disease awakened the international community to threats to public and agricultural health**
- **Most threat mitigation strategies have focused on outbreak management**
- **Measures must also be developed to *prevent* outbreaks of highly infectious disease**
- **Laboratory biosafety and biosecurity are two such methodologies that can help prevent infectious disease outbreaks**
  - ***Biosafety***
    - **Protect laboratory personnel and the environment from accidental exposure to or release of potentially hazardous agents**
  - ***Biosecurity***
    - **Protect biological agents against theft by those who intend to cause deliberate exposure through malicious use**

Today, the infectious disease threat is a global problem that requires global solutions



SARS virus

Strengthening Biological Risk Management

Vision for Integrated BioRisk Management:

- ✓ Increased focus on "awareness" to change current culture
- ✓ Clarify terminology
- ✓ Development of targeted "training strategies"
- ✓ Securing "commitment" from key stakeholders, including government officials, who must be on board
- ✓ Continue increasing "capacity" based on Regional/Country needs and establish accountability through development of Country "report cards"

Severe Acute Respiratory Syndrome (SARS)

- In 2003, SARS infected over 8,000 people and killed almost 800

- The disease ravaged economies in the Pacific Rim and Canada and struck fear across the globe
- Laboratory acquired SARS outbreaks occurred in Singapore, Taiwan, and mainland China
  - Singapore—September 2003
  - Taiwan (China)—December 2003
  - Beijing and Anhui (China)—March 2004

Laboratory-Acquired Case of SARS

- ***Singapore – September 2003***
  - A graduate student acquired SARS in a BSL-3 laboratory in the Environmental Health Institute
  - Inappropriate laboratory procedures and a cross-contamination of West Nile virus samples with SARS-CoV in the laboratory led to the infection
    - No secondary transmission
- ***Taiwan (China), December 2003***
  - Scientist was working on SARS-CoV in a BSL-4 facility at the Institute of Preventative Medicine, National Defence Center (IPM-NDMC)
  - Disinfected spillage of material in the transportation chamber with 70% ethanol and manual cleaning
  - SARS-CoV was collected from the handle of an alcohol spray bottle from the transportation chamber and the switch panel of the cabinet
    - No secondary transmission
- ***China, March-April 2004***
  - Beijing and Anhui Province linked to the National Institute of Virology, China CDC
  - The source of the outbreak was incomplete inactivation of SARS-CoV by cold inactivation
  - Involved two verified chains of SARS-CoV transmission
    - Three generations, resulting in 9 cases
    - Three additional cases documented by seroconversion

Laboratory-Acquired SARS Outbreak in China, March-April 2004

- A (female research student) **25 March**
  - 2nd → B (A's mother) → **death**
  - C (nurse attending A)
    - 3rd → D (C's mother)
    - E (C's aunt)
    - F (C's father)
    - G (retired doctor sharing hospital room with C)
    - H (G's daughter-in-law)
- I (male laboratory researcher) **17 April**

SARS IgG (+)

J (female laboratory worker in BSL-3 laboratory)
K (female laboratory worker developed pneumonia)
L (male laboratory worker, A's supervisor)

China CDC

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Common Problems

- Bad practice in laboratory management
- Poor supervision of less experienced professionals
- A lack of accountability for occupational health and safety
- A lack of biosafety policy
- A lack of biosafety procedures and staff training in biosafety practice
- A lack of internal and external quality assurance

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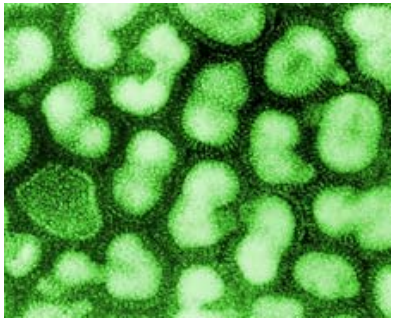
Laboratory-Acquired Cases of Ebola and Tularemia

- **Ebola**
  - 1994 Outbreak in Cote d'Ivoire
  - Swiss zoologist performs autopsy on wild chimpanzee
  - Accidental infection occurs; zoologist contracts Ebola

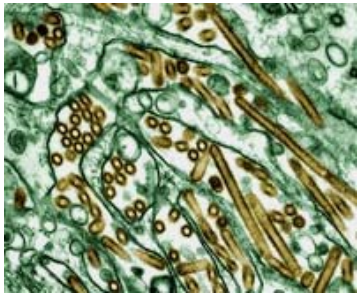
- **Tularemia**
  - In 2004, three laboratory workers at Boston University contracted tularemia
  - Concern that lax illness reporting practices could lead to outbreaks of infectious disease among the local community

Highly Pathogenic Avian Influenza

- Millions of poultry culled in response to outbreaks in South East Asia
- Over 60 human deaths since late 2003, elevated mortality
- Push to construct clinical and diagnostic laboratories for H5N1 throughout Southeast Asia
  - Imperative to establish sound biosafety and biosecurity practices to prevent accidental or intentional release of the virus
- Experts fear that if human-to-human transmission becomes more efficient, a pandemic looms
- Recently, sequencing data of the influenza virus strain that caused the 1918 pandemic revealed that the virus was very similar to H5N1 and had originated in birds *(Taubenberger 2005)*
  - Unlike the strains associated with the 1958 and 1967 pandemics

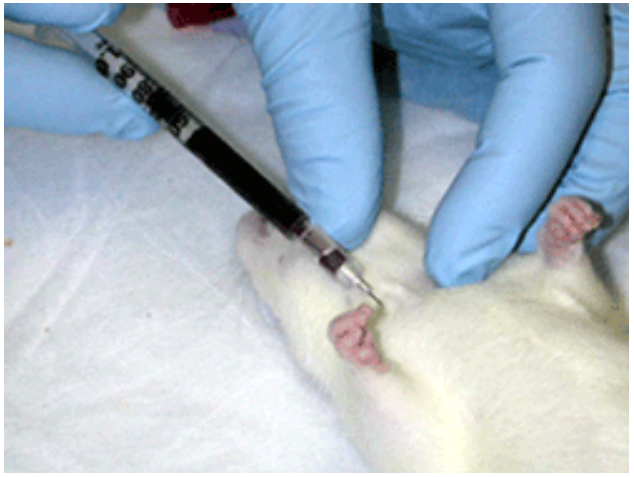


Avian influenza virus



Laboratory Accidents

- 27% - splashes and spills
- 25% - needlesticks
- 16% - cuts from sharp objects
- 14% - animal bite/scratches
- 13% - mouth pipetting
- 6% - other, unknown



From: Pike, R.M. 1976. Laboratory-associated infections: Summary and analysis of 3,921 cases. Hlth Lab Sci 13:105-114.

Laboratory-Acquired Infections

TABLE 1 Comparison of 10 most common overt laboratory-associated infections over time

1930–1978[a]			1979–1999		
Agent or disease[b]	**Cases**	**Deaths**	**Agent or disease**	**Cases**	**Deaths**
Brucellosis	426	5	*M. tuberculosis*	223	0
Q fever	280	1	Q fever	176	0
Hepatitis	268	3	Hantavirus	169	1
Typhoid fever	258	20	Arboviruses	164	3
Tularemia	225	2	Hepatitis B virus	84	1
Tuberculosis	194	4	*Brucella* sp.	81	4[c]
Dermatomycosis	162	0	*Salmonella* sp.	66	2[d]
Venezuelan equine encephalitis	146	1	*Shigella* sp.	56	0
Psittacosis	116	10	Hepatitis non-A, non-B	28	0
Coccidioidomycosis	93	2	*Cryptosporidium* sp.	27	0
Total	2,168	48	Total	1,074	11

[a]Adapted from Pike, 1978.
[b]Not included are 113 cases of hemorrhagic fever contracted from wild rodents in one laboratory in Russia in 1962 (Kulagin, 1962).
[c]Aborted fetuses.
[d]One death associated with a secondary exposure case.

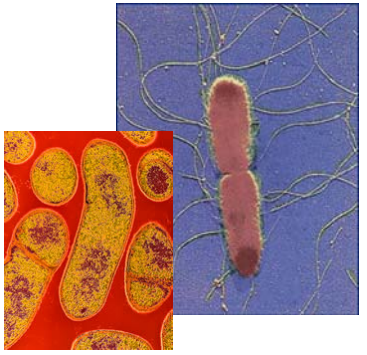
From: Fleming, D.O. and D.L. Hunt. *Biological Safety: Principles and Practices*. ASM Press, 2000

Examples of Illicit Acquisition

- Rajneeshees acquired *Salmonella typhimurium* from a medical supply company (1984)
- Larry Wayne Harris, a white-supremacist, ordered 3 vials of *Yersinia pestis* from the ATTC (1995)
- J.A. Krantz stole *Ascaris suum* eggs and used against roommates (1970)
- Laboratory technician Diane Thompson removed *Shigella dysenteriae* Type 2 from hospital's collection and infected co-workers (1995)
- Weathermen group attempted to get an employee at Ft. Detrick to obtain pathogens (1970)
- Dr. Suzuki stole *Salmonella typhi* cultures from the Japanese National Institute of Health (1964)

Bhagwan Shree Rajneesh

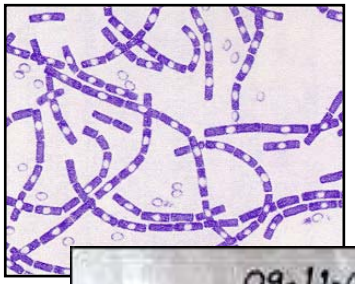
Larry Wayne Harris



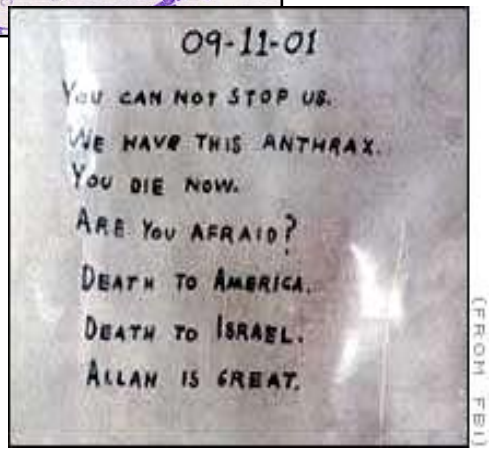
Anthrax

- **In 2005 natural outbreaks have occurred in the North America, South America, Asia, and Europe**
  - **Thousands of cattle, sheep, horses, llamas and wild bison have been affected**
  - **High zoonotic potential**

- **In 2001 *Bacillus anthracis* spores were maliciously released through the United States postal system in 2001**
  - **Resulting in 5 deaths and 22 additional illnesses**
  - **The attack has increased U.S. awareness of the biological weapons and bioterrorist threat**
    - **Suspicion that the material was obtained from a bioscience laboratory**
  - **As result, the U.S. has imposed new rules that are designed to improve the security and agent accountability of legitimate bioscience research laboratories**



Bacillus anthracis



Conclusions

- **Infectious diseases pose significant threats to public and agricultural health**
- **Research on harmful biological agents is crucial to mitigate the threat**
  - **However, release and theft of biological agents must be avoided**
  - **Imperative to protect public and agricultural health, and safeguard laboratory workers**
- **Managing risks in the laboratory is dependent on both biosafety and biosecurity**
  - **Helps reduce the threat of infectious disease**
  - **Established international guidance on laboratory biosafety and evolving international expectations for laboratory biosecurity**