The Infectious Disease Threat and Laboratory Biosafety

Training Seminar on Laboratory Biosecurity and Biosafety

Manila, Philippines
12 July 2006
And
Cebu, Philippines
17 July 2006

www.biosecurity.sandia.gov

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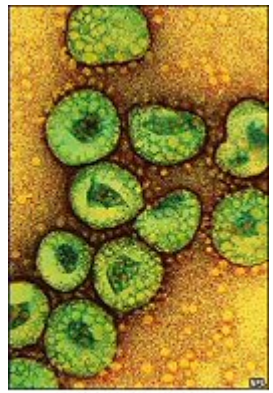
International
BIOLOGICAL THREAT REDUCTION

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 is one aspect of the solution
  - Ensures the safety and well being of workers in the laboratory
  - Safeguards public and agricultural health by preventing the accidental release of harmful biological agents



SARS virus

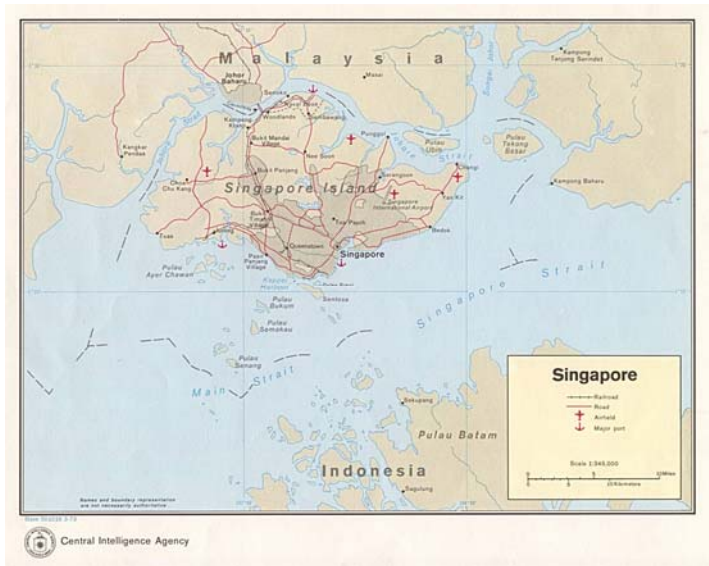
Today, the infectious disease threat is a global problem that requires global solutions

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

- **Patient: 27-year-old male graduate student**
- **Place of infection: BSL-3 laboratory, Environmental Health Institute**
- **Onset of illness: August 26, 2003**
- **Hospitalization: September 3, 2003**
- **Confirmed day: September 8, 2003**



Summary of the WHO Investigation, Singapore

- The graduate student acquired the infection in the BSL-3 laboratory in the Environmental Health Institute where he worked
- Inappropriate laboratory procedures and a cross-contamination of West Nile virus samples with SARS-CoV in the laboratory led to the infection
- No evidence could be found of any other source of infection
- Isolated event: no evidence of secondary transmission

Laboratory-Acquired Case of SARS Taiwan (China), December 2003

- **Patient: 44-year-old male laboratory scientist**
- **Place of infection: BSL-4 laboratory, Institute of Preventative Medicine (IPM), National Defense Medical Center (NDMC)**
- **Onset of illness: December 11, 2003**
- **Hospitalization: December 16, 2003**
- **Confirmed day: December 17, 2003**

Summary of WHO Investigation, Taiwan (China)

- Scientist was working on SARS-CoV in a BSL-4 facility at the IPM-NDMC
- He found a spillage of material in the transportation chamber and disinfected it with 70% ethanol and cleaned it manually
- The environment specimens collected from the handle of an alcohol spray bottle from the transportation chamber and the switch panel of the cabinet yielded positive results for SARS-CoV
- Isolated event: no evidence of secondary transmission

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

- Occurred in Beijing and Anhui Province, linked to the National Institute of Virology,
- The source of the outbreak was failed or inactivation of SARS-CoV (co
- Involved two verified chains of SARS-CoV trans
  - Three generations, resulting in 9 cases
- Serological analysis on the laboratory staff revealed three more seroconverted cases and one of them is most likely to have been infected early in February 2004

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**

China CDC

SARS IgG (+)

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

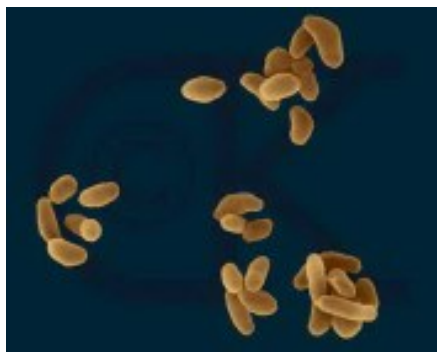
Common Problems

- 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

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**



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

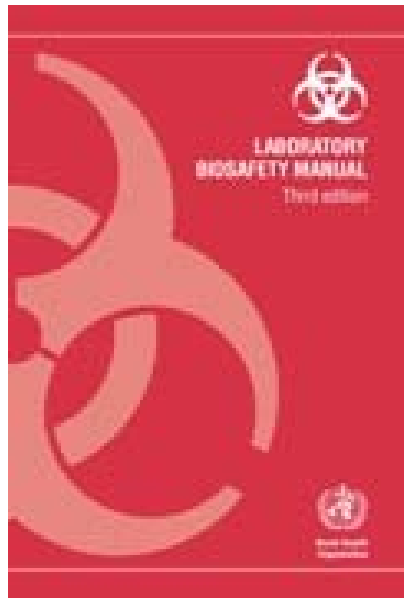
1930–1978[a]			1979–1999		
Agent or disease[b]	**Cases**	**Deaths**	**Agent or disease**	**Cases**	**Deaths**
Brucellosis	426	5	*M. tuberculosis*	223	0
Q fever	280	1	Q fever	176	0
Hepatitis	268	3	Hantavirus	169	1
Typhoid fever	258	20	Arboviruses	164	3
Tularemia	225	2	Hepatitis B virus	84	1
Tuberculosis	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

Laboratory Biosafety

- **Provides a means to reduce outbreaks of highly infectious diseases**
- **WHO biosafety:**
  - **“Laboratory biosafety” describes containment principles, technologies, and practices implemented to prevent unintentional exposure to pathogens and toxins, or their accidental release**
- **Achieving biosafety**
  - **Important to develop national biosafety policies**
  - **Critical to develop a culture of biosafety**



Laboratory Biosafety Manual, 3rd Edition

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"

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**