Chapter 4 Infectious Microorganisms

Work with Infectious Agents at University of Arizona

Research or teaching activities involving infectious agents must be conducted with prior approval by the Institutional Biosafety Committee. Researchers and students must follow requirements as specified in the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories Manual as the minimum containment required for this work. Containment requirements may be subject to modification by the IBC.

Infectious Agents and the Lab Worker

A laboratory-acquired infection was defined by Sulkin and Pike (1951) as one that resulted from laboratory work, whether it occurred in a laboratory worker or in another person who happened to be exposed, as a result of research or clinical work with infectious agents.

Storage of Infectious Materials

Infectious materials must be clearly identified and stored in such a manner as to preclude accidental exposure. This normally includes double containment (i.e., the primary containment is the tube holding the material which must be stored in a second, leak proof nonbreakable containers) and labeling the freezers and refrigerators in which the material is stored.

A number of infectious agents have been documented as causes of laboratory-acquired infections. They include bacterial, viral, chlamydial and rickettsial organisms, as listed below:

Principal Bacterial Infections

Brucellosis (This has the dubious distinction of being the most frequently acquired lab infection.)

Cholera

Diphtheria

Glanders and melioidosis (Glanders, a disease of horses transmissible to man, and melioidosis, acquired from rodents in the Far East used to be considered similar, but their causative agents are now considered to be unrelated. Causative organisms are Burkholderia mallei for glanders, and Burkholderia pseudomallei for melioidosis.)

Leptospirosis (Rodents and dogs, which are common lab animals, are the natural reservoir of leptospira.)

Plague

Rat bite fever (The causative agents of this disease, *Streptobacillus moniliformis* and *Spirillum minus*, are found in rodents.)

Shigellosis

Salmonellosis (Some of the reported cases have been unusual in some respect, such as those involving *S. abortus equi, S. senegal*, and that in which the infecting strain of *S. typhimurium* was thought to have become avirulent.)

Syphilis, gonorrhea and chancre (Lab-acquired infections are, of course, non-venereal, being cutaneous or ophthalmic.)

Typhoid fever

Tularemia

Tuberculosis (Lab-acquired TB has defied definition because its mode of spread, its prevalence and incidence in the general population, the opportunities for exposure outside the lab and its long incubation period make it difficult to determine the source of infection.)

Other Bacterial Infections and Agents that Cause Infection

Anthrax (*Bacillus anthracis*)

Whooping cough (*Bordetella pertussis*)

Campylobacter spp.

Clostridia

Erysipeloid

Escherichia coli

Haemophilus

Leprosy

Listeria

Meningitis (Neisserial)

Mycobacteriosis (After accidental inoculation with *M. marinum*. Chappler et al. 1977.)

Mycoplasma

Pasteurella

Relapsing fever

Serratia

Staphylococcus aureus

Streptococci

Vibrios (other than cholera)

Viral Infections

Adenoviruses

Bhanja fever

Catu fever

Chikunguya fever

Colorado tick fever

Congo-Crimean fever

Coxsackie B

Dengue fever

Eastern equine encephalitis

Germiston fever

Hantaan (Hanta, Korean hemorrhagic) fever and Sin Nombre Virus (pulmonary hemorrhagic fever)

Hepatitis (This has been one of the most frequently reported infections. There are at least 5 official types of hepatitis viruses: Hepatitis A, B, C, D and E. The University of Arizona is required to offer medically-supervised hepatitis B vaccination to lab workers with potential exposure to blood borne pathogens before they begin work in the laboratory.)

Influenza

Japanese encephalitis

Junin

Kunjin fever

Kyasanur Forest disease

Lassa fever

Louping ill

Lymphocytic choriomeningitis

Marburg disease

Mucambo fever

Mumps

Newcastle disease

Omsk hemorrhagic fever

Oropouche fever

Orungo disease

Piry fever

Pitchinde virus

Poliovirus

Pseudorabies (occurs primarily in pigs but is also known as Aujeszky's disease of cattle)

Rabies

Rift Valley fever

Russian spring summer encephalitis

Simian B virus

Venezuelan equine encephalitis

Vesicular stomatitis

Wesselbron virus

West Nile

Western equine encephalitis

Yaba and Tanavirus

Yellow fever

Other laboratory-acquired viral infections, reportedly occurring less commonly than those listed above include the following (numbers in parenthesis): Mayoro (5), Caraparu (5), Spondweni (4), St. Louis encephalitis (4), Bunyanwera (4), Zika (4), Semliki Forest (3), Powassa (2), Dugbe (2), Apeu (2), Marituba (2), Tacaube (2), Machupo (1), Ebola (1), Issk-kul (1), Kautango (1), Muructucu (1), O'nyong nyong (1), Modoc (1), Oriboca (1), Ossa (1), Keystone (1), Bebaru (1) and Bluetongue (1).

Chlamydial and Rickettsial Infections

Psittacosis

Q fever (the second most common source of laboratory-associated infection)

Rocky Mountain spotted fever

Scrub typhus

Trachoma

Typhus (epidemic and murine)

Fungal Infections

Blastomycosis

Coccidioidomycosis

Cryptococcosis

Dermatomycoses

Histoplasmosis

Sporotrichosis

Parasitic Infections

Babesiosis

Cryptosporidiosis

Fascioliasis

Giardiasis

Isosporiosis

Malaria

Toxoplasmosis

Trypanosomiasis

Microorganisms can enter the body through the mouth, the respiratory tract, broken or intact skin and the conjunctivae. It should be noted that in laboratory-acquired infections, the route may not be the same as when the disease is acquired naturally.

Modes of Infection

Modes of infection can be classified into two categories:

1. Infections preceded by overt personal accidents, which include:

A. Inoculation (resulting from pricking, jabbing or cutting the skin with contaminated instruments such as hypodermic needles, scalpels and glassware; and from animal bites or scratches).

B. Ingestion (resulting from mouth-pipetting, eating, drinking and smoking, which is why these practices are not permitted in the lab).

C. Splashing into the face and eyes.

D. Spillage and direct contact.

2. Infections not preceded by personal accidents:

A. Aerosols, droplets and fomites. These are speculated (from Pike's 1976 data) to be responsible for up to 82 percent of all laboratory-acquired infections. Aerosols are defined as a cloud of very small liquid droplets produced whenever energy is applied to a liquid, and such liquid is allowed to escape into the environment. The larger droplets (greater than 0.1 mm in diameter) will settle quickly and contaminate the surfaces upon which they come to rest. The smaller droplets do not settle, but rather evaporate very rapidly. It was found that those with diameter of 0.1 mm would evaporate in 1.7 seconds, and those with a diameter of 0.05 mm would evaporate in 0.4 seconds.

It has been shown that many laboratory techniques using both simple and complex mechanical equipment, as well as laboratory accidents, produce aerosols. These include: use of inoculating loops, heating over an open flame, pipettes, syringes and needles, opening tubes and bottles, use of centrifuges and blenders, harvesting of eggs and other virological procedures, lyophilization and breakage of culture vessels.

There are many regulations in place to forestall potential laboratory-acquired infections. The responsibility for compliance with the regulations lies primarily with the PI and, secondarily, with the laboratory staff.

In addition, it is crucial for the PI and laboratory groups to always bear in mind that a large number of organisms that would ordinarily be innocuous can be infective in immuno-compromised persons. Therefore, additional and more stringent measures must be established by the PI in an effort to prevent the occurrence of lab-acquired infections in such individuals.

Quiz

1. The term LAI refers to:

- ❑ Leave after injured.
- ❑ Los Angeles International.
- ❑ Laboratory-acquired infection.
- ❑ None of the above

2. A laboratory-acquired infection is defined as one that resulted from laboratory work, whether it occurred in a laboratory worker or in another person who happened to be exposed, as a result of research or clinical work with infectious agents.

- ❑ True
- ❑ False

3. Committee that reviews research and teaching activities involving infectious agents.

- ❑ Human Subjects Protection Committee.
- ❑ Institutional Biosafety Committee.
- ❑ Institutional Animal Care and Use Committee.
- ❑ None of the above.

4. Major classifications of infectious agents that can cause LAI's include:

- ❑ Bacterial.
- ❑ Viral.
- ❑ Chlamydial/Rickettsial.
- ❑ Parasitic
- ❑ All of the above.

5. The main ways microorganisms can enter the body are:

- ❑ Mouth (ingestion).
- ❑ Respiratory tract.
- ❑ Broken or intact skin.
- ❑ Conjunctivae.
- ❑ All of the above.

6. Modes of LAI are categorized by either an identified preceding incident or no identified preceding incident.

- ❑ True
- ❑ False

7. According to Pike (1976), aerosols, droplets and fomites may be responsible for up to 82 percent of all LAI's.

- ❑ True
- ❑ False

8. Sources of aerosols in biological research laboratories include all except:

- ❑ Centrifuges.
- ❑ Blenders.
- ❑ Gel Electrophoresis.
- ❑ Inoculating loops.
- ❑ Pipettes.

9. An aerosol is defined as a cloud of very small liquid droplets produced whenever energy is applied to the liquid, and such liquid is allowed to escape to the environment.

- ❑ True
- ❑ False

10. The major identified causes of LAI include:

- ❑ Inoculation (resulting from pricking, jabbing or cutting the skin with contaminated needles, scalpels or glassware or animal bites.)
- ❑ Ingestion (resulting from mouth-pipetting, eating, drinking and smoking, which is why these practices are not permitted in the lab).
- ❑ Splashing into the face and eyes.
- ❑ Spillage and direct contact..
- ❑ All of the above.