BIOSAFETY AND INFECTION CONTROL ISSUES – TIPS FOR THE PHYSICIAN

DR E.O. SHOBOWALE
CONSULTANT MEDICAL MICROBIOLOGIST
PATHCARE NIGERIA

OUTLINE

- PRE-TEST
- INTRODUCTION
- BIOSAFETY CONCEPTS
- INFECTION CONTROL ISSUES
- CASE SCENARIO
- POST TEST
- CONCLUSION

PRETEST

- How many bio-safety levels are there
- How many risk groups are there in lab processing
- Risk group 3 have high individual risk and high community risk)
- Effective treatment and preventive measures are not available for risk group 3
- *Escherichia coli* is an example of a bio-safety level 1 organism.

PRE-TEST

- *Mycobacterium tuberculosis* is an example of a Bio-safety level 3 agent.
- In bio-safety level 1 specimens not known to consistently cause disease in healthy adults are processed.
- The Hepatitis B Virus is an example of a bio-safety level 2 organism.

OBJECTIVES

- At the end of this lecture physicians should be able to:
- Define barriers and procedures used by laboratories to protect staff and others from laboratory acquired infections
- Describe the bio-safety levels and the protective measures used by each type of laboratory when handling infectious materials
- Provide examples of the types of biological agents handled in each type of laboratory

PathCare

BIOSAFETY

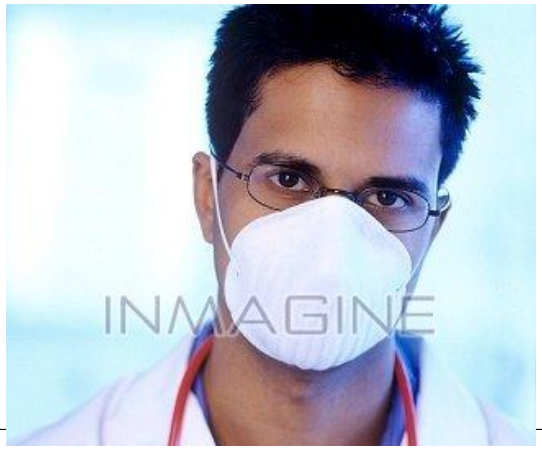
- Bio-safety is a concept that deals with recognizing the intrinsic hazards of potentially pathogenic organisms, categorizing them according to risk assessments and implementing barriers that prevent acquisition of these pathogens while handling them.
- All measures that prevent exposure to biological agents (micro-organisms and toxins) and infections and their release into the environment
- There are 4 levels of bio-safety

BIOSAFETY

- What is the relevance of bio-safety to the physicians practice?
- Protects the doctor
- Protects healthcare staff
- Protects the patient
- Protects the environment from hazardous agents

ROUTES OF EXPOSURE

- Droplets or droplet nuclei (upper or lower respiratory tract)
- Compromised skin or direct injection into the blood stream
- The mucosal membranes
- The gastrointestinal tract



CATEGORISATION OF PATHOGENS BY RISK

- Risk Group 1 (no or very low individual and community risk) a microorganism that is unlikely to cause human or animal disease

- Risk Group 2 (moderate individual risk, low community risk) a pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, effective treatment and preventive measures are available and the risk of spread of infection is limited.

CATEGORISATION OF PATHOGENS BY RISK

- Risk Group 3 (high individual risk, low community risk) a pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another effective treatment and preventive measures are available.

- Risk Group 4 (high individual and community risk) a pathogen that usually causes serious human or animal disease and that can be readily transmitted from one individual to another, directly or indirectly, effective treatment and preventive measures are not usually available.

BIOSAFETY LEVELS

BIOSAFETY LEVELS

- BSL 1: Material not known to consistently cause disease in healthy adults.
- BSL 2: Associated with human disease. Hazard is from per-cutaneous injury, ingestion, or mucous membrane exposure.
- BSL 3: Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences.
- BSL 4: Dangerous/exotic agents which pose a high risk of life-threatening disease, aerosol-transmitted lab infections or related agents with unknown risk of transmission.

PathCare

BIOSAFETY LEVEL 1

Laboratory testing conducted at bio-safety Level 1 involves little or no known potential hazard to laboratory personnel and the environment.

Work is generally conducted on the open bench top and special containment equipment, such as a bio-safety cabinet, is not required.

Escherichia coli is an example of a bio-safety level 1 organism.

PathCare

BIOSAFETY LEVEL 1

- Standard practices required:
- Frequent hand washing
- Doors that can be kept closed when working;
- Limits on access to the lab space when working;
- No smoking, eating, drinking, storage of food in laboratory;
- Care to minimize splashes and actions that may create aerosols (tiny droplets);
- Decontamination of work surfaces after every use and after any spill

BIOSAFETY LEVEL 1

- Decontamination of laboratory wastes;
- Use of mechanical pipettes only (no mouth pipetting);
- “Sharps" precautions, including special containers for disposing of needles and other sharp objects;
- Maintenance of insect/rodent control program;
- Use of personal protective equipment (lab coats, latex gloves, eye protection or face shields)
- Open bench top sink for hand washing

BIOSAFETY LEVEL 2

- Agent work conducted at Bio-safety Level 2 requires that bio-safety cabinets are used whenever aerosol generating procedures are performed.
- Training and hand-washing are also required.
- Access to the laboratory is limited while the testing is in progress.
- The Hepatitis B Virus is an example of a BL-2 organism.

BIOSAFETY LEVEL 2

- Agents associated with human disease
  - Generally required for any human-derived blood, bodily fluids, tissues in which infectious agent may be unknown
  - Other agents include measles virus, *Salmonella* species, pathogenic *Toxoplasma*, *Clostridium botulinum*.

PathCare

BIOSAFETY LEVEL 2

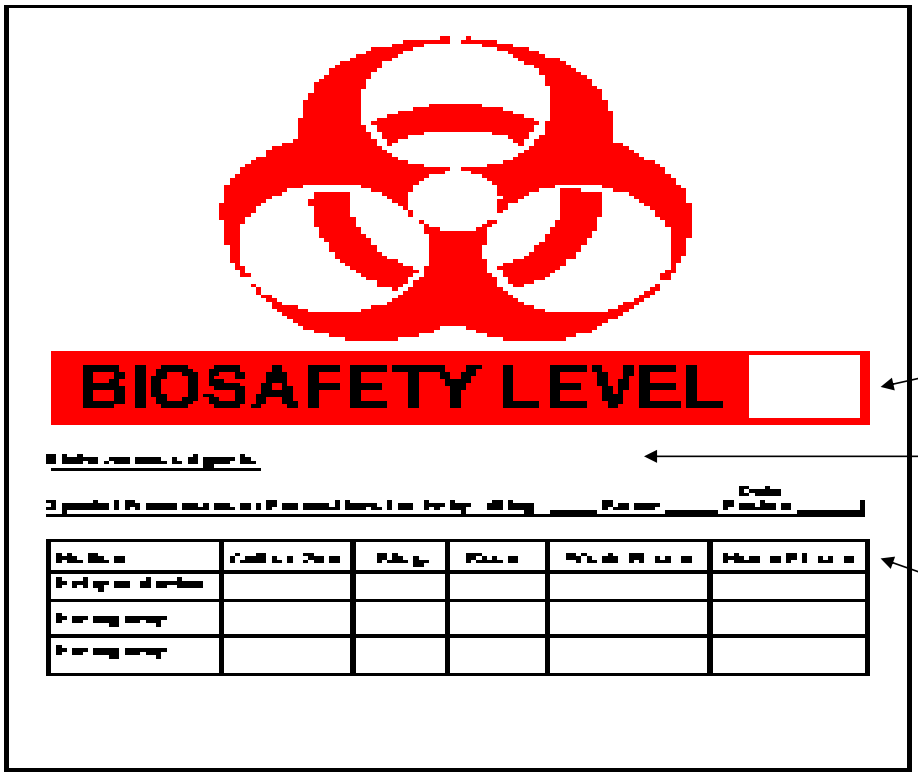
- Primary hazards:
  - Accidental needle sticks
  - Exposure to eyes and nose (mucous membranes)
  - Ingestion of infectious materials
  - Agents do not cause lethal infections, are not transmissible via airborne route
  - They do not cause infection if tiny droplets become airborne and are inhaled, which might occur if the material were splattered)
  - Agents are pathogens for which immunization or antibiotic treatment is available
  - Extreme care should be taken with contaminated needles and sharp lab instruments

PathCare

BIOSAFETY LEVEL 2

- Standard practices include BSL-1 plus:
  - Policies to restrict access to lab;
  - Biohazard warning signs posted outside lab;
  - Surveillance of laboratory personnel with appropriate immunizations offered;
  - Bio-safety manual with definitions of needed waste decontamination or medical surveillance policies;
  - Supervisory staff who have experience working with infectious agents and specific training for laboratory personnel in handling these agents

BIOSAFETY LEVEL 2



BIOHAZARD SIGN

BIOSAFETY LEVEL 3

- Agent work conducted at bio-safety Level 3 is required for agents that may cause serious or lethal disease by the inhalation route.
- All bio-safety level 3 procedures are conducted within a bio-safety cabinet; the lab has special engineering features to prevent a release of the bio-safety level 3 agent to the environment. Lab workers may need to wear a respirator.
- *Mycobacterium tuberculosis* is an example of a bio-safety level 3 agent.

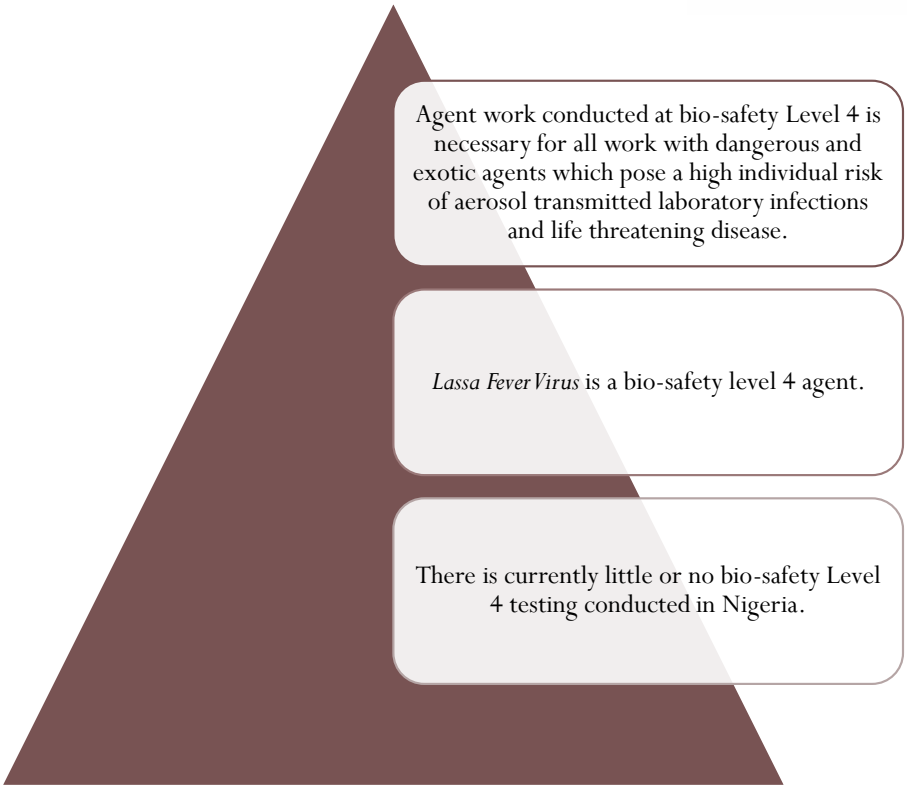
BIOSAFETY LEVEL 3

- Agents with potential for respiratory transmission, may cause serious and potentially lethal infection.

BIOSAFETY LEVEL 3

- Standard practices include BSL-2 plus:
- Strictly controlled access to the lab;
- Specific training for lab personnel in handling potentially lethal agents;
- Decontaminating all waste;
- Changing contaminated protective lab clothing, decontaminating lab clothing before laundering;
- Institutional policies regarding specimen collection and storage from workers to establish exposure

BIOSAFETY LEVEL 4



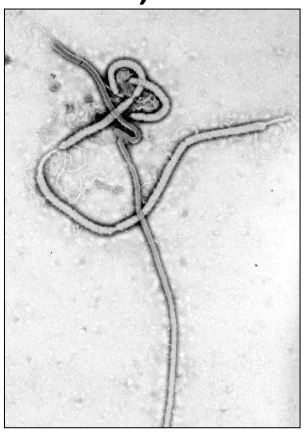
Agent work conducted at bio-safety Level 4 is necessary for all work with dangerous and exotic agents which pose a high individual risk of aerosol transmitted laboratory infections and life threatening disease.

Lassa Fever Virus is a bio-safety level 4 agent.

There is currently little or no bio-safety Level 4 testing conducted in Nigeria.

BIOSAFETY LEVEL 4

- Dangerous and exotic agents with high risk of life-threatening disease, aerosol-transmitted
- Related agents with unknown risk of transmission
- Agents (all are viruses) include Marburg virus, Ebola virus, viruses that cause Congo-Crimean hemorrhagic fever, Lassa fever



MR HAZMAT

ASSESSMENT OF RISK

- Pathogenicity of material – disease incidence and severity
- Routes of Transmission – parenteral, airborne or ingestion
- Agent Stability – ease of decontamination
- Infectious Dose – LD50
- Concentration – infectious organisms/vol. & working volume
- Origin of material - Wild Type, exotic, primary cells
- Availability of effective prophylaxis – Hepatitis B vaccine
- Medical surveillance – exposure management
- Skill level of staff

PathCare

ASSESSMENT OF RISK

- Risk of Activity – same agent can have different containment levels at different stages of protocol:
- Procedures that produce aerosols have higher risk
- Procedures using needles or other sharps have higher risk
- Handling blood, serum or tissue samples may have lower risk
- Purified cultures or cell concentrates may have higher risk
- Larger volumes (10 L) have higher risk

PRIMARY CONTAINMENT

- Lab practices – standard lab practice, limited access, biohazard warning sign, sharps/needle precautions, SOPs for decontaminating medical waste.
- Safety equipment – bio-safety cabinets (BSC), sharps containers, sealed rotors.
- Personal protective equipment (PPE) – lab coat, gloves, goggles.

PathCare

PRIMARY CONTAINMENT

"The patient in the next bed is highly infectious. Thank God for these curtains."

PRECAUTIONS WHEN GENERATING AEROSOLS

- Use centrifuges with bio-safety covers.
- Do not use a syringe for mixing infectious fluids.
- Cultures, tissues, specimens of body fluids, etc., are placed in a container with a cover that prevents leakage during collection, handling, processing, storage, transport or shipping.

AEROSOLS

NEEDLE AND SHARPS PRECAUTIONS

- Precautions are for any contaminated sharp item, including needles and syringes, slides, pipettes, capillary tubes, and scalpels.
- Plastic ware should be substituted for glassware whenever possible.
- Needles and syringes or other sharp instruments should be restricted to parenteral injection, phlebotomy, or aspiration of fluids from patients.
- Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for injection or aspiration of infectious materials.
- Syringes which are re-sheatheable are to be avoided.

PathCare

NEEDLE AND SHARP PRECAUTIONS

- Used disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal. Dispose in puncture-resistant containers which must be located near work.
- Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for decontamination, preferably by autoclaving.
- Broken glassware must not be handled directly by hand. Pick up by mechanical means such as a brush and dustpan, tongs, or forceps.

PathCare

BLOOD, TISSUES AND FLUIDS

- Use bio-safety level 2 work practices and procedures.
- Additional requirements for HIV work.
- Everyone needs to be offered the Hepatitis B vaccine.
- Develop specific exposure plan SOPs.
- Specific training is required.
- Review needle/syringe use and replace with “safe” devices.
- Exposure incidents must be followed up.

SECURITY

- Control access to areas where biological agents or toxins are used and stored.
- Keep biological agents and toxins in locked containers.
- Know who is in the lab.
- Know what materials are being brought into the lab.
- Know what materials are being removed from the lab.
- Have a protocol for reporting incidents.
- Have an emergency plan.

EMERGENCIES

- Develop and practice plans for:
- Spills: large spills, spills inside Bio Safety Cabinets
- Accidental exposures: needle sticks, eye/mucous membrane splash, breathing aerosols
- Power/Utility failures: Bio Safety Cabinets, freezers, ventilation, lights, water
- Fires
- Medical emergencies

SAFE DISPOSAL OF WASTES

- Human samples, blood or tissues must go into the red bag:
- All human cells or anything that came in contact with it
- All BSL 2 material or anything that came in contact with BSL 2 material
- All needles/syringes regardless of use
- No need to autoclave human waste prior to disposal in red bag/box (material is incinerated by state authorities e.g. LAWMA).

EATING AND DRINKING

Hand to mouth transmission of disease is a common route of exposure while handling biological agents.

- Avoid eating, drinking, or smoking in laboratory work areas.
- Wash hands with disinfectant soap prior to leaving the work area.
- Do not store or heat/chill food or beverages in the lab.

PERSONAL PROTECTIVE EQUIPMENT

- Use personal protective equipment to prevent skin/mucous membrane exposure during agent use, such as:
- Gloves
- Safety glasses/face shield
- Lab coat
- Closed toe shoes/foot covers
- Respiratory protection

PathCare

ALWAYS HAVE THIS

SIGNS AND DISPLAYS

- Biohazard labels shall be placed on:
- The surface of all equipment (freezers, incubators, refrigerators) which may be contaminated with bio-hazardous materials.
- Sample transport outer containers.
- Medical waste bins
- The outer door of bio-safety level 2 labs.
- Medical waste storage areas

VACCINATION OF STAFF

- Vaccinations are available for some organisms and should be offered when feasible.
- Examples include
- - Hepatitis B Vaccine
- - Yellow fever
- - CSM
- - Influenza

CASE SCENARIO

- A 31 year old patient was rushed to a private hospital in Eastern Nigeria comatose.
- There was no clear cut history other than a vague abdominal pain and he underwent an exploratory laparatomy.
- A few days after the surgery the patient died.
- Shortly thereafter the lead surgeon began to complain of headaches, pain in the right hypochondrium and light headedness.
- A few days later he developed a non productive cough and hematuria.

CASE SCENARIO

- A nurse and the surgeons assistant developed similar illnesses
- About 3 weeks after the surgery the surgeon, his assistant, a scrub nurse, the lab scientist and two other hospital staff were dead including the index patient.
- Autopsy samples taken from them were analyzed and serologic alongside molecular techniques came back positive for Lassa fever virus.

POST TEST

- How many bio-safety levels are there
- How many risk groups are there in lab processing
- Risk group 3 have high individual risk and high community risk)
- Effective treatment and preventive measures are not available for risk group 3
- *Escherichia coli* is an example of a BL-1 organism.

POST TEST

- *Mycobacterium tuberculosis* is an example of a BL-3 agent.
- In bio-safety level 1 specimens not known to consistently cause disease in healthy adults are processed.
- The Hepatitis B Virus is an example of a bio-safety level 2 organism.

CONCLUSION

- There are potent hazards associated with the processing of human samples.
- Bio-safety guidelines developed to protect workers in medical labs through safeguards such as good work practices.
- Bio-safety levels should be incorporated into our daily side labs.
- Doctors need to understand processes in their labs for their own safety

THE END

- THANKS FOR LISTENING