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Biosafety Protocols and Biohazard Management

Payel Kar[1], J.B. Rajesh[2]*
[1]MVSc scholar, Department of Veterinary Medicine, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University (I), Selesih PO, Aizawl, Mizoram:796015
[2*]Assistant Professor (SG), Department of Veterinary Medicine, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University (I), Selesih PO, Aizawl, Mizoram: 796015
*Corresponding author: leovet@gmail.com

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Abstract

Biosafety protocols and biohazard management procedures for the safe handling and control of biological agents and materials pose serious threats to humans, the environment, and communities. By following biosafety procedures and applying adequate biohazard management techniques, laboratories may provide a safe working environment by reducing the dangers associated with handling biological materials. This article focuses on the concepts and techniques of biosafety and biohazard management, offering a framework for reducing risks and preventing adverse outcomes.

Keywords: Biosafety, biohazard, biosafety levels, containment, risk assessment

Introduction

The manipulation of microbial, animal, and plant cells may be a part of bio-related research activities. These activities carry a risk because of the samples and/or the needs of the procedure. To prevent laboratory-acquired illnesses, researchers should follow standard microbiological procedures and use facilities appropriate for the pathogen's risk level. Emerging infectious diseases have become more prevalent worldwide in recent years. In response to these diseases, the World Health Organization (WHO) established the Research and Development Blueprint (R&D Blueprint) strategy to hasten the creation of safe and efficient medical countermeasures, including as diagnostics, treatments, and vaccines.

The implementation of safety measures that lower a worker's risk of coming into contact with a potentially contagious substance and prevent contamination of the workplace and, eventually, the community is known as biosafety. On the other hand, biosafety generally refers to the methods, controls, and measures used to stop, reduce, and steer clear of possible unplanned biohazards that endanger environment or human. Any biological or chemical material that poses a risk to people, animals, or the environment is referred to as a biohazard. A biohazard could also be anything that is detrimental for the environment and other animals. The degree of biohazard posed by the biological substance being handled directly affects the appropriate level of biosafety precautions. Higher levels of biohazard call for more stringent biosafety measures.

Importance of Biosafety

- To keep a regular observation on hazardous biological agents, chemicals, toxins and radiation.
- Helps the laboratorians to recognize of processing hazardous agents.
- With the help of advancement of genetic engineering, biosafety protocols have gained its importance to assure public and environmental safety from potentially hazard biological substances.
- Mandatory to follow the biosafety guidelines to minimize biosafety.

Risk Assessment

The biological risk assessment process is used to determine the hazardous characteristics of an infectious or potentially infectious agent or material, if known; the activities that can expose a person to an agent; the likelihood that such exposure will result in a laboratory-associated infection (LAI); and the likely consequences of such an infection. The information gathered during the risk assessment will serve as a guide for selecting relevant mitigations, such as the use of Biosafety Levels and good microbiological practices, safety equipment, and facility safeguards to prevent LAIs. Risk assessments should be completed before beginning work with a biohazardous agent, as well as whenever existing processes or protocols are changed

Classification of Biohazardous Agents by Risk Group

Biohazardous agents are classified under Risk Groups 1 to 4

1. **Risk Group 1** (RG1)
   (No to minimal individual and community risk)
   Biological agents or organisms that are unlikely to cause disease in healthy people or animals.
2. **Risk Group 2** (RG2)
   (Moderate individual risk, minimal community risk)
   Pathogens in RG 2 are those that are likely to infect humans or animals but have little chance of posing a major threat to the environment, the community, or the workers.
3. **Risk Group 3** (RG3)
   (Low community risk, high individual risk)
   Pathogens that cause severe illnesses in humans or animals but do not usually spread from one infected person to another, for which there may be treatment interventions and prevention measures are available.
4. **Risk Group 4** (RG4)
   (High risk to individuals and the community)
   Pathogens that cause severe illnesses in humans or animals and that can be spread either directly or indirectly, for which treatment and prevention measures are necessary.

Principles of Biosafety

When discussing safe practices for handling or maintaining infectious pathogens in a laboratory setting, the word "containment" is employed. Good microbiological technique and the use of the right safety equipment offer primary containment, which protects the immediate laboratory environment and personnel from infectious agent exposure. Vaccination may offer a higher degree of individual protection. Design of laboratory facility and operating procedures will simultaneously create secondary containment, which shields the environment outside the lab from infectious material exposure. The goal of containment is to limit the exposure of laboratory personnel and other individuals to potentially harmful chemicals and to stop them from escaping into the surrounding environment. The three components of containment include laboratory practice and methods, safety equipment, and facility design.

Biosafety Cabinet (BSC)

Biosafety cabinets are among the most effective safety equipment under primary containment devices used in laboratories working with infectious agents. Infectious aerosols produced by numerous microbiological processes are primarily contained by the biological safety cabinet. Class I, II, and III biological safety cabinets are the three categories used in microbiological laboratories. When utilized with proper microbiological procedures, open-fronted Class I and Class II biological safety cabinets—partial containment cabinets—offer considerable levels of protection for both the environment and laboratory workers. The highest possible level of environmental and worker protection is offered by the gastight Class III biological safety cabinet.

Biosafety Levels (BSL)

BSL is a set of biocontainment measures intended to safeguard laboratory workers, the community, and the surrounding environment. The four risk groups that are represented by the four biosafety levels are made up of combinations of laboratory procedures and methods, safety equipment, and facility designs that are appropriate for the work carried out, the risk posed by infectious agents, and the laboratory function or activity. If a biological risk assessment is conducted, a lower risk group may be given a higher biosafety level.

Biosafety level 1 (BSL-1)

The lowest of the four, pertains to laboratory environments where personnel work with low-risk microorganisms that present little to no danger of infection in healthy adults. A non-pathogenic strain of *E. coli* is an example of a microorganism that is commonly handled at a

BSL-1. Usually, research in this laboratory environment is conducted on benches without the use of specialized contamination equipment. Activities requiring only conventional microbiological practices are housed in a BSL-1 lab, which does not need to be isolated from nearby facilities. After spills, BSL-1 labs must also be decontaminated right away. Before being disposed of, infection materials are further decontaminated, usually using an autoclave.

Biosafety level 2 (BSL-2)

This level of biosafety includes labs that handle agents that are linked to human diseases (i.e., pathogenic or infectious organisms) that present a moderate risk to health. Agents commonly handled in a BSL-2 include HIV, equine encephalitis viruses, and *Staphylococcus aureus*. Although BSL-2 labs follow the same conventional microbiological standards as BSL-1 labs, they additionally take extra precautions because of the possible threat posed by the previously stated bacteria. Even more precautions must be taken by workers in BSL-2 labs to avoid ingestion, exposure of mucous membranes, and injuries including cuts and other skin breaches. Compared to a BSL-1 lab, access to a BSL-2 lab is much more restricted. When work is being done, access is frequently restricted to outside workers or those who pose a higher risk of contamination.

Biosafety level 3 (BSL-3)

Building on the two previous biosafety levels, a BSL-3 laboratory usually works with native or exotic bacteria that can cause serious or even fatal diseases through inhalation. The bacteria that cause tuberculosis, West Nile virus, and yellow fever are a few examples of the microorganisms that are handled in a BSL-3. Because the germs are so dangerous, the work is frequently closely monitored and registered with the relevant government organizations. Additionally, laboratory workers are monitored by medical professionals and may be vaccinated against the microorganisms they handle. A BSL-3 laboratory's access is always restricted and regulated.

Biosafety level 4 (BSL-4)

BSL-4 labs are not common. Some do, however, exist in a few locations both in the US and abroad. A BSL-4 lab, which has the greatest level of biological safety, handles extremely hazardous and unusual microorganisms. These microorganisms can cause infections that are sometimes fatal and for which there is no cure or vaccine. The Marburg and Ebola viruses are two instances of such microorganisms. Extremely isolated, a BSL-4 laboratory is frequently housed in a different building or in a limited area of the structure. In addition, the lab has vacuum lines, disinfection systems, and a separate supply and exhaust air.

Biohazard Management

To stop infectious diseases from spreading and to keep people safe, effective biohazard management is crucial in a variety of contexts, such as hospitals, labs, and research institutes.

It includes:

- Identification and classification of biohazards: This entails identifying and classifying various biological material types according to their possible level of risk.
- Risk assessment: assessing the possibility of biohazard exposure and the corresponding health concerns.
- Control measures in action: Implementing engineering controls (e.g., biosafety cabinets), safe handling techniques, and personal protective equipment (PPE) as ways to reduce the risk of exposure
- Waste management: Properly segregating, packaging, labelling, and disposing of biohazardous waste according to regulations
- Education and training: Ensuring that employees have the knowledge and abilities needed to safely handle biohazards.

Conclusion

To safeguard people, communities, and the environment from the possible dangers posed by biological agents, biosafety procedures and biohazard management are essential. Effective biosafety and biohazard management necessitates a culture of responsibility, accountability, and ongoing development. By implementing these principles, individuals and organizations may ensure a safe and healthy environment for everyone.

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