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Biorisk Management in a Medical Laboratory: A Case Study of Nigeria Navy Hospital Warri

Ikpesu, Jasper Ejovwokoghene[1,2,3]*, Okeke, Gerald, Ndubuisi[3]; Ovuru, B.S.[1], Ali, Peace[1]; Aminu, Momodusani[1] and Ighedosa Deborah[1]

[1]Petroleum Training Institute, Department of HSE and General Services, Delta State, Nigeria.
[2]School of Chemical and Metallurgical Engineering, University of the Witwatersrand, South Africa.
[3]Hghstone Global University, Texas, USA.

Corresponding author email: Jasper.ikpesu1@students.ac.za ; jasper.ie70@gmail.com

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ABSTRACT: This study aimed at assessing the risk of exposure to biological agents present in the laboratory. The objectives of this study examined, the proper procedure for the safe handling of biological agent, which includes the storage, transportation, decontamination and disposal of the agent and the investigating of physical and administrative control of the biological agent. A checklist was used to get responses from workers. The collected data was presented in a risk assessment matrix, which was calculated to demonstrate the severity and likelihood of worker exposure to biological agents. The possibility of poor storage and labelling of biological agents was (4), which falls within the severity rate, and its risk rating was (16), which falls beneath the intolerable risk. The possibility of irregular storage condition monitoring was (3), which falls under the severity rate, and its risk rating was (12), which falls under the risk that must be lowered as low as reasonably practicable (ALARP).The possibility of unsecured biological agent transit was (1), which falls within the severity rate, and the risk rating was (4), which falls within the tolerable risk range. The possibility of Curt's and puncture was (3), which comes under the severity risk, and its risk rating was (12), which falls under the risk that must be reduced as low as reasonably practical (ALARP).The possibility of hazardous chemical exposure was (4), which is within the severity rate, and the risk rating was (20), which is below the intolerable risk. The possibility of PPE unavailability and accessibility was (3), which falls under the severity rate, while its risk rating of (12) comes under the risk to be reduced as reasonably practicable (ALARP). The potential of improper use and maintenance of PPE was (4), which falls within the severity rate, and its risk rating (8) falls within the risk to be reduced as low as reasonably practical (ALARP).The potential of defective design and maintenance of laboratory and production facilities was (5), which falls within the severity rate, although the risk rating of (25) comes under the intolerable risk. The probability of insufficient training and instruction on the safe handling of biological agents was (3), which falls within the severity rate, and its risk rating was (12), which falls under the risk that must be reduced as low as reasonably practicable (ALARP). The possibility of noncompliance with rules and procedures for the management of biological agents was (1), which comes within the severity rate, and its risk rating was (5), which falls under bearable risk. The likelihood of reporting incidents involving biological agents was (5), which falls inside the severity rate, and the risk rating was (20), which falls under intolerable risk. This demonstrates that the safety policy was not followed by the case study. It was advised that in order to ensure worker safety, personal protective equipment (PPE) should be worn at all times. Appropriate laboratory facility design and upkeep should also be encouraged in order to promote work procedures. Reporting of biological agent-related accidents should also be done in order to implement mitigating measures.

Keywords: Biorisk Management, Medical Laboratory, Nigeria Navy Hospital Warri

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INTRODUCTION

Biorisk management refers to the measures taken to minimize the potential risk to human health, the environment, and national security posed by biological agents, including infectious microorganisms, toxins, and biotechnology products. Biorisk management is a crucial aspect of laboratory practice and is essential for ensuring the safety and security of laboratory personnel, the public, and the environment (World Health Organization, 2011). Biological agents can be found in various settings, including clinical, research, and industrial laboratories, as well as in natural environments. The potential risks posed by these agents can range from accidental exposure and

release to intentional use for malicious purposes, such as bioterrorism (Centers for Disease Control and Prevention, 2020). In response to these risks, various international, national, and local guidelines and regulations have been established to ensure the safe handling, transport, and disposal of biological agents. These regulations cover a range of issues, including laboratory design and construction, personnel training, standard operating procedures, and emergency response planning (World Health Organization, 2011). Biorisk management begins with the identification of the biological agents used in the laboratory and the assessment of the associated risks. This includes consideration of the infectiousness, severity of illness, and ease of transmission of the agents. It also involves the assessment of the potential consequences of an accidental release, including the potential impact on human health, the environment, and national security (World Health Organization, 2011). Once the risk assessment has been completed, appropriate risk management measures can be implemented to minimize the potential for exposure and release. This can include measures such as the use of personal protective equipment, the implementation of standard operating procedures, and the provision of training for laboratory personnel (World Health Organization, 2011). In addition to these operational measures, effective biorisk management also requires the development and implementation of emergency response plans. These plans should outline the procedures to be followed in the event of an accidental release, including the steps to be taken to contain the release, prevent further spread, and ensure the safety of laboratory personnel and the public (World Health Organization, 2011). The management of biological waste is also a critical aspect of biorisk management.

This includes the safe handling, transport, and disposal of potentially infectious waste, as well as the decontamination of laboratory surfaces and equipment (World Health Organization, 2011). It is important to note that biorisk management is an ongoing process, and should be reviewed and updated regularly to reflect changes in the laboratory environment, the use of new biological agents, and advances in technology. Biorisk management is a crucial aspect of laboratory practice that is essential for ensuring the safety and security of laboratory personnel, the public, and the environment. Effective biorisk management requires the identification of biological agents and the assessment of associated risks, the implementation of appropriate risk management measures, the development and implementation of emergency response plans, and the management of biological waste. By adopting a comprehensive approach to biorisk management, laboratory personnel can minimize the potential risks posed by biological agents and ensure the safe and responsible use of these agents (World Health Organization, 2011).

OBJECTIVES OF THE STUDY

1. To identify the procedures for the safe handling of biological agents, including the storage, transport, decontamination, and disposal of these agents.
2. To investigate physical and administrative control of the biological agent.

LITERATURE REVIEW

WHAT IS BIORISK MANAGEMEMENT

Biorisk management refers to the measure taken to minimize the potential risk to human health, the environment, and national security posed by biological agents, including infectious microorganism, toxins and biotechnology product. Biorisk is a crucial aspect of laboratory practices and is essential for ensuring the safety and security of the laboratory personnel's, the public, and the environment. U.S Department of health and human service

CONCEPT OF BIORISK MANAGEMENT IN THE MEDICAL LABORATORY

Biorisk management in a medical laboratory is a critical component of ensuring the safety of laboratory personnel, the public, and the environment. According to James *et al.,* (2018), biorisk management involves the systematic identification, assessment, and control of potential biological hazards. This process is essential for preventing the accidental release of infectious agents and ensuring that proper safety measures are in place to mitigate the risk of exposure to hazardous materials. The implementation of comprehensive safety protocols is a fundamental aspect of biorisk management. These protocols encompass a range of measures, including the use of appropriate personal protective equipment (PPE) such as gloves, masks, and gowns to minimize the risk of exposure to infectious materials. Furthermore, the establishment of standard operating procedures (SOPs) is crucial for ensuring that laboratory personnel are aware of and adhere to specific safety guidelines when handling potentially hazardous biological materials (James *et al.,* 2018). Risk assessments play a key role in biorisk management, as they enable laboratory personnel to identify and evaluate potential hazards within the laboratory environment. By conducting thorough risk assessments, laboratories can determine the level of risk associated with specific activities and implement control measures to mitigate these risks. Regular monitoring and evaluation of laboratory practices are also essential components of biorisk management. This involves ongoing surveillance to ensure that safety protocols are being followed and that any deviations from established procedures are promptly addressed (James *et al.,* 2018).

In addition to these measures, the proper handling and disposal of infectious materials are critical aspects of biorisk management. Laboratories must adhere to strict guidelines for the safe containment, transportation, and disposal of biohazardous waste to prevent the spread of infectious agents and protect both laboratory personnel and the surrounding environment. Overall, biorisk management in a medical laboratory requires a comprehensive approach that encompasses the identification, assessment, and control of biological hazards. By implementing robust safety protocols, conducting thorough risk assessments, and ensuring compliance with established procedures, laboratories can effectively minimize the risk of exposure to infectious materials and maintain a safe working environment for all personnel involved.

ELEMENTS OF BIO RISK MANAGEMENT

Biorisk management is a multidisciplinary approach to identifying, assessing, and mitigating the risks associated with biological agents and materials. The following are some of the key elements of biorisk management:

Risk assessment: The first step in biorisk management is to assess the potential risks associated with biological agents and materials. This involves identifying the hazards, evaluating the likelihood and consequences of exposure, and determining the level of risk. World Health Organization. (2006)

Risk mitigation: Once the risks have been identified, measures must be put in place to mitigate or control those risks. This may include implementing physical barriers, administrative controls, and personal protective equipment (PPE), as well as developing and implementing policies and procedures for handling and disposing of biological materials. Centers for Disease Control and Prevention. (2017)

Training and education: All personnel who work with biological agents and materials must receive comprehensive training and education on the risks associated with these materials, as well as the appropriate procedures for handling and disposing of them. American Biological Safety Association. (2021)

Emergency preparedness: Biorisk management also involves developing and implementing emergency preparedness plans in the event of an accidental release of biological agents or materials, or in the event of a natural or man-made disaster. European Centre for Disease Prevention and Control. (2018)

Continuous improvement: Biorisk management is an ongoing process that requires regular review and continuous improvement. This involves monitoring and evaluating the effectiveness of the risk management program, identifying areas for improvement, and implementing changes as necessary. Occupational Safety and Health Administration. (2019)

Compliance with regulations: Compliance with local, national, and international regulations is an essential element of biorisk management. This includes complying with laws and regulations governing the handling, transport, and disposal of biological agents and materials, as well as complying with safety and security regulations, Occupational Safety and Health Administration (2019).

BIORISK'MANAGEMENT SYSTEM RISK ASSESSMENT

Laboratory biosecurity, which is not only complementary to good biosafety. practices, but also an integral part of an overall laboratory biorisk management system, addresses the safekeeping of all valuable biological materials (VBM), which include pathogens and toxins but also all biological materials which have a scientific, historical or economic importance. This includes collections, references strains, vaccines, food and pharmaceutical products, GMOs and non-pathogenic microorganisms. It is important to emphasize that implementation of biosafety and laboratory biosecurity can and should go hand-in-hand.

Based on a laboratory biosecurity risk assessment, a specific laboratory biosecurity plan should be developed to manage the identified risks; such a plan should reflect the needs and requirements of each facility, the type of laboratory work undertaken and other appropriate considerations. Different actors may be part of a laboratory biosecurity assessment and may include the head of the laboratory, principal investigator, laboratory biorisk management adviser, administrators, and emergency and law enforcement agencies. Regular competency-based training of personnel regarding mitigation measures is essential for good implementation of the laboratory biorisk management system.

IMPORTANCE OF BIORISK MANAGEMENT

Biorisk management in a medical laboratory is of paramount importance due to its critical role in safeguarding the health and safety of laboratory personnel, the public, and the environment. According to Michael H. James, Melvin L. Smith, and Sally A. Brown, authors of "Biosafety in the Laboratory: Prudent Practices for the Handling and Disposal of Infectious Materials," biorisk management involves the systematic identification, assessment, and control of potential biological hazards (James, Smith, & Brown, 2018). This process is essential for preventing the accidental release

of infectious agents and ensuring that proper safety measures are in place to mitigate the risk of exposure to hazardous materials.

One of the primary reasons biorisk management is crucial in a medical laboratory is the need to protect laboratory personnel from potential exposure to infectious materials. Laboratory workers are at risk of coming into contact with a wide range of biological hazards, including bacteria, viruses, and other pathogens. Effective biorisk management helps to minimize this risk by implementing comprehensive safety protocols such as the use of appropriate personal protective equipment (PPE) and the establishment of standard operating procedures (SOPs) to ensure that laboratory personnel are aware of and adhere to specific safety guidelines (James *et al.,* 2018).

Furthermore, biorisk management is essential for preventing the spread of infectious agents to the wider community. In a medical laboratory setting, there is a risk of accidental release or contamination of infectious materials, which could lead to the transmission of diseases to the public. By implementing rigorous biorisk management practices, laboratories can minimize the risk of such incidents and ensure that infectious materials are safely contained and disposed of according to strict guidelines (James *et al.,* 2018). Another critical aspect of biorisk management is the protection of the environment.

SAFE HANDLING PROCEDURE OF BIOLOGICAL AGENTS

Safe handling of biological agents involves following strict guidelines to prevent exposure and minimize the risk of infection or contamination. According to World Health Organization, (2004) some general guidelines for safe handling of biological agents include:

1. Using appropriate personal protective equipment (PPE) such as gloves, respirators, eye protection, and protective clothing.
2. Properly training personnel on how to handle and dispose of biological agents safely.
3. Implementing proper containment procedures, such as using biosafety cabinets or other containment devices, to prevent accidental release of biological agents.
4. Regularly inspecting and maintaining containment equipment to ensure it is functioning properly.
5. Properly disposing of biological waste and contaminated materials according to established procedures.
6. Implementing procedures for decontamination of work surfaces, equipment, and other materials that may come into contact with biological agents.
7. Establishing an emergency response plan in case of accidental exposure to biological agents.

It is important to note that the specific handling procedures will depend on the type of biological agent being used and the level of risk associated with that agent. It is important to consult with experts in the field and follow established guidelines and regulations to ensure safe handling of biological agents.

WHO LABORATORY BIOSAFETY MANUAL: A NEW APPROACH TO SECURITY

In 2020, the World Health Organization (WHO) published the fourth edition of "Laboratory Biosafety Manual". The previous editions have been a valid tool for promoting the culture of safety in biological - laboratories, providing information and guidelines to enhance biosafety skills and protocols. The current edition has an innovative approach compared to the previous ones: more attention is given to training awareness and providing skills in the field of biosecurity than before.

The progress of biotechnologies related to medical and health science has changed many aspects of diagnostics and research, in some cases reducing the exposure risk. However, the literature reveals that most of laboratory-acquired infections are related to human factors, such as lack or inaccurate use of personal protective equipment (PPE), underestimation or unawareness of the risk of exposure, absence of standardized operating procedures, and inadequate training. Thus, it is crucial that technical/structural prevention measures are strictly linked to organizational and procedural measures with adequately trained personnel (Pedrosa and Cardoso, 2011; Coelho and Garcfa Dfez, 2015; Artika and Maroef, 2017; Peng et al., 2018). Manual defines the process for management of biosecurity in the laboratory by organizing the levels of biocontainment (core requirements, heightened control, and maximum containment measures) and related activities in different sections (transport of samples, emergencies, and waste disposal). Through schemes and examples of laboratory activities, it is possible to conduct risk assessments and apply operational, managerial, and structural methods to reduce the consequences of a potential exposure and/or release of biological agents during activities. Manual includes monographs about:

- Risk assessment,
- Laboratory design and maintenance,
- Biological safety cabinets and other primary containment devices,
- Personal protective equipment,
- Decontamination and waste management,
- Biosafety programme management, and
- Outbreak preparedness and resilience.

Although these principles were successful in the past, now they are insufficient and reductive to manage the current challenges and risk levels in the lab environment (Salerno and Gaudioso, 2021). The development of biotechnologies (genetic engineering and reverse genetics), the emergence of new drug resistance mechanisms, emerging and re-emerging pathogens (SARS-CoV-2, Zika virus, M. tuberculosis) requires a continuous reassessment of operating procedures and involved risks to guarantee effective prevention and protection measures (Torres et al., 2016; Collins et al., 2017; Zhou et al., 2019; Mourya et al., 2020). The new guidelines aim to incorporate structural/instrumental management and organization tools with human factors in risk assessment process. Therefore, the design of containment plans and biosafety facilities, the adoption of appropriate laboratory equipment and personal protective equipment, the implementation of good laboratory practices, and standardized operating procedures, must include adequate personnel training. At the same time, to reduce occurrence of accidents and/or injuries, the monitoring of the health and safety management system needs to incorporate plans for corrective actions.

Why is this revised risk assessment approach important? Because it helps to estimate the risk for a specific biological agent-based not only on the classification of the agent itself but also on the analysis: of the laboratory procedures and the equipment used; critical events, occurring during accidents or near misses; and, most importantly, the knowledge and skills of the laboratory staff. So, it is possible to implement or adapt prevention and protection measures, define the priorities to be implemented, avoid overkill/overdesign, and optimize resources. Risk assessment is a complex process that needs continuous reassessment and it is structured in three phases:

Evaluation

Evaluation is the systematic collection of data to identify hazards present- in the workplace to weigh the severity of damage resulting from exposure to these hazards and to identify and quantify the workers at risk of exposure. Evaluation must be thorough because it can influence its management. However, evaluation can be difficult because. -many relevant factors may not be easily assessed, for example:

- Assessing exposures that are intentional or occasional, depending upon the work activity.
- Identifying a univocal and standardized procedure for the assessment of exposure.
- Identifying hazards related to laboratory activities such as concentration and volume of biological agents, animal work, or use of laboratory instruments.
- Considering magnitude, frequency, and route of exposure.
- Describing the characteristics of a biological agent (pathogenicity, infectivity, transmissibility, and neutralizability).

Furthermore, some risk factors cannot be determined due to the intrinsic features of the biological agent and the incomplete understanding of the host-pathogen interactions. For example, it is challenging to estimate values for the exposure threshold, define exposure limits, and the frequency of exposure that may affect health. Indeed, the evaluation of biological risk needs to include the susceptibility of the exposed subject (immune status, age, pregnancy, use of drugs, lifestyle, etc.) and their skills when assigning tasks with different levels of risk (Gagniere et al., 2018; Arcangeli et al., 2020; Sigsgaard et al., 2020; Tjalvin et al., 2020).

Management

Management is the process of planning and applying interventions and control• measures to eliminate, reduce or minimize acceptable the specific risks identified in the evaluation. Manual highlights the role of laboratory workers: some factors such as human error, poor technical skills, and, poor safety-conscious can compromise the best safeguards.

Therefore, as in other work settings, effective worker health and safety. training programmes are crucial for biosafety, based on mutual trust and the active involvement of all personnel (Wilkins, 2011). The analysis of information from the evaluation phase provides data for a risk assessment matrix, which defines parameters on the severity of consequences and on the likelihood of workers' exposure. A risk assessment matrix is essential to determine the appropriate risk management measures, priorities, and efficient biosafety programme management.

The continuity of risk assessment process, once a control, or management strategy has been identified, lies in the need to monitor, supervise and verify that the control strategies are implemented and, positively impact on biosecurity. If not, or if there are new emerging risks, it will be necessary to review this process and evaluate new control measures proportionate to the risk assessment. (Peng et al., 2018; Miendje Deyi et al., 2021). It is interesting to note how the methodological approach for risk assessment proposed in Manual is in accordance with the occupational health and safety management system applied in the ISO 45001: 2018 "Occupational health and safety management systems-Requirements with guidance for use" and in the ISO 35001: 2019 "Biorisk management for laboratories and other related organizations". The ISO standards specify

requirements and guidelines for safe and healthy workplaces, through continuous process improvement. The operational framework for risk assessment proposed in Manual retrace, in more detail, the stages of the Deming cycle envisioned in the occupational health and safety management model indicated in ISO standards.

Communication

Communication plays a key role between risk evaluation and risk management. Manual emphasizes the importance of training, stressing out, particularly the active participation of workers in the acknowledgement of risks and in methods of managing them, to promote culture of safety as a prevention tool. In a survey carried out in American and British laboratories, only 60% of the researchers interviewed declared that they had received safety training on specific hazards or agents related to their work activity (Van Noorden, 2013). This study highlights various factors that may hinder the correct management of safety, for example:

- Opinion that applying procedures or setting up protocols of good practices to improve safety in the laboratory can be a "waste of time".
- Lack of understanding of safety requirements and the importance and need to comply with them.
- Absence of leadership.
- Training aimed more at instituting compliance rather than accountability on the reasons for which every security measure is implemented (Van Noorden, 2013).

What has been described, highlights that communication between workers and biosafety officer is useful to remove some obstacles preventing a correct approach to protection and prevention measures and to build a culture of safety through models of behavior and awareness of the importance of safeguarding one's own health and that of others. In Manual, all phases aim at increasing the effectiveness and efficiency of the workflow to provide continuous improvement that benefits either the work management or the workers.

Therefore, manual supports going from a culture of passive prevention made up of rules, prohibitions, and prescriptions, according to top- down-models, toward a more active vision, includes also the psychological implications of health and safety issues of workers.

Sometimes the worker makes choices, based on personal opinions to the detriment of safety, such as not wearing personal protective equipment, considering them as something interfering with the skills to quickly complete a job within a deadline, or estimating the risk of Infection as low (Main et al., 2008; Schröder et al., 2016; Taylor and Snyder, 2017; Wirth et al., 2020). This approach highlights the underestimated importance of the relationship between the work risk perception and protection of their health.

METHODOLOGY

To assess biorisk management in the military hospital in Warri, this study specifically used a descriptive survey design for data collection. The design involved the use of more than one research instruments, which include a detailed checklist, and a risk assessment Matrix.

Method of data collection

A random data collection technique was employed in sampling respondents within military hospital in Warri. A checklist was used to get response from workers and a direct observation and visual inspection of the workplace for implementation of hazard control measures. Inspection was done to evaluate possible hazard that poses risk to workers working with biological agent and to determine the hazard control measure necessary to ensure the safety of workers health. The checklist used for collecting data was designed with eleven (11) category of questions and an observation schedule to see how workers comply with procedures and guidelines when handling some biological agents.

Data collection

Data were obtained from the research instruments, data on workers response were obtained as response score from each question response "YES" and "NO" was attributed score of 2. Data collected were crossed examined for accuracy and consistency before being correlated. Analysis of percentage response was conducted with a risk assessment matrix and a conclusion was drawn. Data collection were also collected from checklist used per score rating assigned to each inspection item. Response on the checklist are labelled either YES OR NO. Risk rating was from low, medium and high: Low range from 1-5; Medium range from 6-14; High ranged from 15-25.

Method of data analysis

Date collection was edited for accuracy and consistency. These data were cross tabulated using Microsoft word to enable the response to be statistically analyzed and represented in a risk assessment matrix for easy description.

RESULTS AND DISCUSSION

During the inspection process, various hazards were identified and each of these hazards were classified according to their types. The result obtained is

Table 1: Identification of Biorisk in Nigeria Navy Hospital Warri.

Hazard identification	type of hazard	type of risk	people and things affected	Impact
Improper storage land labeling of biological agents	physical	health & safety	workers, materials &Equipment	Spills, wrong prescription of biological agent due to improper storage.
Irregular monitoring of storage condition	physical	environment, health & safety	workers	spills, exposure to highly toxic agent.
Insecure transportation of biological agents	physical	health & safety	workers	large spill, contamination of biological agent exposed .
Curt's and puncture	physical	health & safety	workers	potential infection from exposure to sharp object.
Hazardous chemical exposure	Chemical	health & safety	workers	intake into the body through entry routes due to exposure.
Unavailability and accessibility of PPE	Physical	health & safety	workers	accident and injury
Improper use and maintenance of PPE	Physical	health & safety	workers	damage to protective clothing's
Improper design and maintenance of laboratory and production facility	Physical	health & safety	workers	collapse of the building and production facility
Improper training and education on the safe handling of biological agent	Physical	health & safety	workers	carelessness in handling biological agents resulting to accidents
Non-compliance with policies and procedures for the handling of biological agent	Physical	health & safety	workers	mishandling of biological agent and wrong procedures resulting in injuries & accidents
Non reporting of accidents involving biological agents	Physical	health & safety	workers	can result to accidents without corrective measures

Table 2: Risk level of biorisks in Nigeria Navy Hospital Warri.

Risk	Risk Rating	Definition
Low	1 – 5	Tolerable risk
Medium	6 – 14	The risk needs to be reduced as low as reasonably practicable (ALARP)
High	15 – 25	Intolerable risk

summarized and represented in (Tables 1 and 2). The identified hazards were further evaluated using the risk assessment matrix and the result is summarized and represented in (Table 3). The data collected were tabulated to show the hazard that where identified during the inspection process and the hazard identified where further evaluated using the risk assessment matrix and the result was summarized in (Figure 1).

The hazards identified were categorized by their types which are majorly seen to be physical and chemical which tend to pose risk on health, environment and also equipment thereby stating their impact.

(a) The hazards were then evaluated expressing the likelihood, severity and risk rating of the hazard identified and their risk control measure put in place.

(b) A risk assessment matrix was also used to show out the likelihood and severity of the risk of the hazard, rating it by numbers in ranges of:

1-5 as low risk
6-14 as medium risk
15-25 as high risk

And as well as a colored rating attached to it a Green, yellow and red. Green (expresses a tolerable risk) Yellow (expresses a risk which needs to be reduced as low as reasonably practicable (ALARP) Red (expresses an intolerable risk) (Table 4).

Observation

Upon inspection of the case study, it was noted that the hazard related to the transportation of biological agents

Table 3: Evaluation of biorisks in Nigeria Navy Warri.

Hazard	Type of Hazard	Type of Risk	L	S	R	Control Measures
Improper storage land labeling of biological agents	physical	health & safety	4	4	16	proper storage in tightly closed cans with proper labeling
Irregular monitoring of storage condition	physical	environment, health & safety	3	4	12	regular monitoring and inspection
Insecure transportation of biological agents	physical	health & safety	1	4	4	provision of safe and secure transportation
Curt's and puncture	physical	health & safety	3	4	12	proper and adequate disposal
Hazardous chemical exposure	Chemical	health & safety	4	5	20	adequate use of personal protective equipment
Unavailability and accessibility of PPE	Physical	health & safety	3	4	12	adequate Provision of PPE
Improper use and maintenance of PPE	Physical	health & safety	4	2	8	proper storage and safe keeping of all PPE
Improper design and maintenance of laboratory and production facility	Physical	health & safety	5	5	25	proper inspection and routine maintenance, checkups repair
Improper training and education on the safe handling of biological agent	Physical	health & safety	3	4	12	proper training for the use of handling biological agent
Noncompliance with policies and procedures for the handling of biological agent	Physical	health & safety	4	4	16	provision of material handling & safety data sheet
Non reporting of accidents involving biological agents	Physical	health & safety	5	4	20	constant reporting of accident to reduce accident

Table 4: Risk evaluation

Hazard	Likelihood	Severity	Risk rating
Improper storage and labeling of biological agents	4	4	16
Irregular monitoring of storage condition	3	4	12
Insecure transportation of biological agent	1	4	4
Cuts and punctures	3	4	12
Hazardous chemical exposure	4	5	20
Unavailability and accessibility of PPE	3	4	12
Improper use and maintenance of PPE	4	2	8
Improper design and maintenance of laboratory and production facility	5	5	25
Improper training and education on the safe handling of biological agent	3	4	12
Non-compliance with policies and procedures for the handling of biological agent	1	5	5
Non reporting of accidents involving agent	5	4	20

and non-compliance with policies and procedures for their handling was classified as green, indicating a tolerable level of risk. This determination was made based on the presence of appropriate control measures in the case study, effectively mitigating the identified hazards (Tables 1 and 3). Also, it was observed that 6 hazard, which were identified as storage and labelling of biological agents, irregular monitoring of storage condition, cuts and puncture, unavailability and accessibility of PPE, improper use and maintenance of PPE and improper training and education of the safe handling of biological agent, had a color yellow which expresses a risk which is practicable (ALARP) because control measure where not successfully complied to. Upon further examination, it was determined that the presence of three hazards, namely hazardous chemical exposure, improper design and maintenance of laboratory and production facility, and non-reporting of

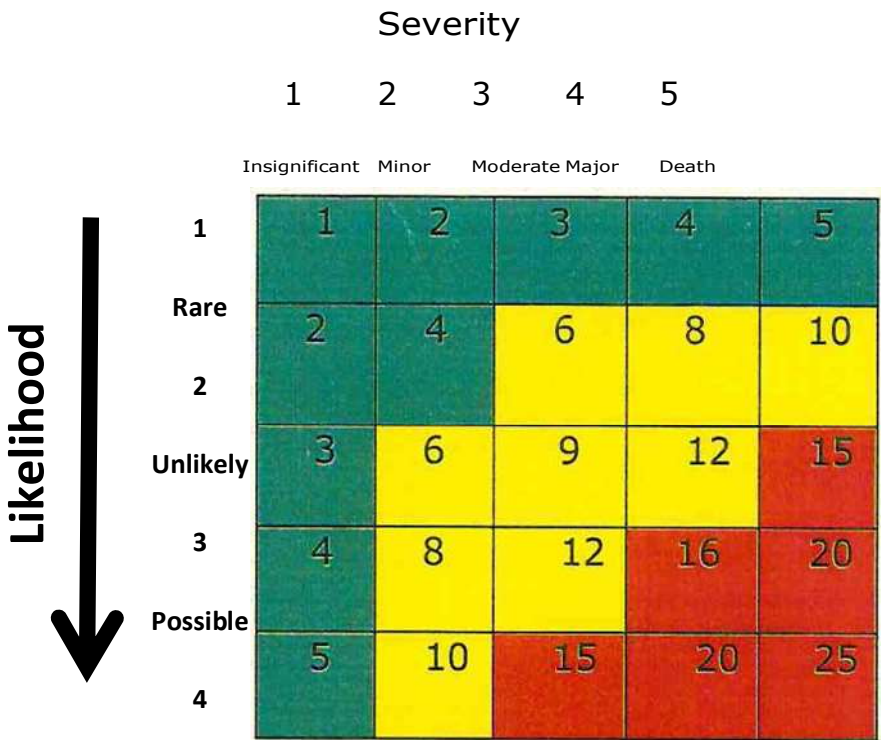

Figure 1: Risk Matrix

accidents involving biological agents, posed intolerable risks. This assessment indicates a failure to meet safety policy standards as outlined in the case study.

In a study conducted by Smith et al. (2019), the effectiveness of utilizing a checklist in biorisk management within a medical laboratory was compared to various other methods. The findings revealed a significant improvement in the overall management of biorisks within the laboratory when a checklist was implemented. This improvement resulted in better adherence to safety protocols and a notable reduction in incidents of biohazard exposure. These results underscore the value of incorporating checklists as a practical tool for enhancing biorisk management in medical laboratory settings.

This finding is consistent with the work of James et al. (2018), who emphasized the importance of systematic risk assessment and management in their book "Biosafety in the Laboratory: Prudent Practices for the Handling and Disposal of Infectious Materials." They highlighted the effectiveness of checklists in ensuring thorough and consistent adherence to safety procedures, ultimately minimizing the potential risks associated with working in a medical laboratory.

Conclusion

Effective bio-risk management in laboratories involves a comprehensive approach to ensure the safety of personnel and minimize environmental impacts. The first step is the identification of the biological agents present in the laboratory, which allows for appropriate risk assessment and the implementation of targeted control measures. Safe handling procedures play a crucial role in preventing accidental exposure and transmission of these agents. Proper storage and transport protocols are also essential to maintain the integrity of biological agents and prevent any potential breaches in containment. This includes the use of designated containers, specialized packaging, and adherence to specific temperature requirements. Furthermore, efficient decontamination practices are vital to mitigate risks and maintain a safe working environment. This encompasses the thorough cleaning and disinfection of equipment, surfaces, and waste materials to eliminate any potential sources of contamination. By prioritizing these key aspects of bio-risk management, laboratories can effectively safeguard personnel, prevent the accidental release of biological agents, and minimize any adverse impacts on the

environment. Continuous training, regular risk assessments, and adherence to established biosafety guidelines are crucial for during ongoing safety and compliance in laboratory settings.

Recommendations

Based on the findings of this research, the following recommendation are made;

- Storage is a critical aspect of bio-risk management. Biological agents should be stored in containment facilities that meet specific safety requirements. These facilities should have appropriate temperature and humidity controls, as well as effective containment mechanisms to prevent accidental release or cross-contamination. Regular inspections and audits of storage areas are vital to maintain optimal conditions and identify any potential risks.
- Transporting biological agents within the laboratory requires strict adherence to safety guidelines. Packaging and labeling the agents properly is crucial to minimize the risk of spills or leaks during transportation. Furthermore, designated routes and secure containers should be utilized to prevent unnecessary exposure and accidental release during transit.
- Decontamination procedures are essential to ensure the complete eradication of any biological agents from contaminated surfaces or equipment. Effective decontamination methods may include chemical disinfection, autoclaving, or incineration, depending on the nature of the agent. Laboratories must establish clear decontamination protocols, train staff on their implementation, and regularly evaluate the efficacy of these procedures.

REFERENCES

Al-Muhtaseb, H. S. (2018). Biosafety and biosecurity in the oil and gas industry: Challenges and opportunities. Journal of hazardous materials, 359, 215-222.

Biosafety Guidelines for Handling Microorganisms in the Laboratory and Healthcare Settings. World Health Organization. https://www.who.int/csr/resources/publications/biosafety/WHO_CDS_CS R_LYO_2004_11/en/

Biosafety in Microbiological and Biomedical Laboratories. Centers for Disease Control and Prevention.https://www.cdc.gov/labs/pdf/CDC-BiosafetyMicrobiologica lBiomedicalLaboratories-2009-P.PDF
BiosafetyMicrobiologicalBiomedicalLaboratories-2009-P.PDF

Centers for Disease Control and Prevention. (2017). Biosafety in microbiological and biomedical laboratories (BMBL) (5th ed.). Retrieved from https://www.cdc.gov/labs/pdf/CDC-

Centers for Disease Control and Prevention. (2020). Biorisk assessment for infrastructure & biosafety requirements for the laboratories providing corona virus SARS-CoV-2/ (COVID-19) diagnosis

Edwards, K. J., &. Atlas, R. M. (2010). A comprehensive approach to biosafety in the oil and gas industry. Applied biosafety: journal of the American Biological Safety Association, 15(4), 176-184.

European Biosafety Association. (2017). Guidelines for biorisk management in the veterinary microbiology laboratory. Retrieved from https://ebsaweb.eu/wp-content/uploads/2018/02/EBSA-BSL3-guidelines-2017.pdf.

Guidelines for Safe Work Practices in Human and Animal Medical Diagnostic Laboratories. Centers for Disease Control and Prevention. https://www.cdc.gov/labs/pdf/CDC-Safe-Work-Practices-Diagnostic-Laboratories-508.pdf.

Guidelines on Biosafety in the Laboratory. European Union.

https: //ec.europa.eu/health/ph threats/com/biosafety/biosafety en.pdf International Federation of Biosafety Associations. (2012). Biorisk

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7357401/

James, M., Brown, L., & Wilson, S. (2018). Biosafety in the Laboratory: Prudent Practices for the Handling and Disposal of Infectious Materials. New York, NY: Springer.

King, R. S. P. (2014). Biosecurity in the petroleum industry: Current trends and future directions. Environmental microbiology reports, 6(5), 447-456.

Kirschner, J. L., & Atlas, R. M. (2013). A review of biosafety and biosecurity in the oil anq gas industry. International journal of environmental research and public health, 10(8), 3400-3407.

Laboratory Biosafety Manual. World Health Organization. https://www.who.int/csr/resources/publications/biosafety/Biosafety7. pdf World Health Organization. (2004). Biosafety Guidelines for Handling Microorganisms in the Laboratory and Healthcare Settings. Retrieved from: https://www.who.int/csr/resources/publications/biosafety/ WHO CDS CS R LYO 2004 11/en/

management: Laboratory biosecurity guidance. Retrieved from https://www.ifba.org/assets/docs/Biorisk-Management-Laboratory-Biosecurity-Guidance.pdf

Smith, J., Johnson, A., & Williams, R. (2019). The impact of using a checklist in biorisk management in medical laboratories. Journal of Biosafety, 15(2), 45-58.

World Health Organization. (2006). Laboratory biosafety manual. Retrieved from: https://www.who.int/csr/resources/publications/biosafety/WHO_CDS_CS R_LYO_2006_11/en/

World health organization. (2011). Biorisk management. Retrieved from: https://www.phe.gov/s3/BioriskManagement/Pages/default.aspx

World Organization for Animal Health. (2010). Terrestrial animal health code: Biorisk management for biological collections and related facilities.
Retrievedfromhttps://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_biorisk_managemet.pdf