

Knowledge gaps in biosafety biosecurity and good laboratory practices among medical laboratory scientists in a Nigeria tertiary healthcare facility

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Research Article

Keywords: Biosafety, Biosecurity, Good laboratory practice, Knowledge, Medical laboratory scientists, Nigeria, Laboratory safety

Posted Date: October 7th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10944798/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background: Biosafety, biosecurity, and good laboratory practices (GLP) prevent laboratory-acquired infections and misuse of biological agents. Medical Laboratory Scientists (MLS) implement these standards, yet data on their knowledge in Nigerian tertiary hospitals remain scarce. This study assessed knowledge of biosafety, biosecurity, and GLP among MLS in a tertiary hospital in South-South Nigeria.

Methods: A cross-sectional study of 100 MLSCN-registered MLS at the University of Calabar Teaching hospital, Calabar. A structured, self-administered questionnaire assessed knowledge across three domains. Responses were Yes/No/Unsure or 5-point likert scale. Chi-square test determined the associations. Data were analyzed using SPSS v25.0 with $p \leq 0.05$ considered significant.

Results: 54.0% understood biosafety and biosecurity ($p < 0.001$), only 4.0% reported training on emergency plans for biological toxins. 54.0% indicated proper storage of contaminated waste ($p = 0.004$), and 28.0% were aware of staff vaccination. 64.0% reported no biosafety discussion forum ($p < 0.001$). PPE availability was suboptimal: 32.0% agreed PPE was always available ($p = 0.002$), and 48.0% reported no incident reporting system ($p = 0.034$). For GLP, 34.0% agreed access to biological agents was restricted, 36.0% were unsure about transport of agents. 92.0% reported no SOP for biological spills or biosafety drills ($p < 0.001$). Only 30.0% used biosafety cabinets for aerosol, while 92.0% denied use ($p < 0.001$). 30.0% lacked Formal handwashing policies ($p = 0.024$).

Conclusion: There were gaps in practical implementation of biosafety, biosecurity, and GLP despite knowledge of definitions. Deficiencies in training, emergency preparedness, waste management, PPE, incident reporting, and SOPs highlight an urgent need for targeted training, policy enforcement, and resources to improve safety and compliance.

Introduction

Clinical laboratories are central to disease diagnosis, surveillance, and research, but they also represent environments where exposure to hazardous biological agents poses significant risks to healthcare workers, patients, and the community. Tertiary laboratories in Nigeria operate under significant infrastructural constraints and high disease burden, making adherence to biosafety and good laboratory practice standards critical for workforce and public safety. Laboratory-acquired infections and the potential misuse of biological materials remain an ongoing concerns for global health security. To address these risks, the World Health Organization (WHO) has established the Laboratory Biosafety Manual, (4th edition (LBM4) as the de facto global standard for biosafety, promoting a risk-based approach to the safe handling of biological agents in clinical and public health laboratories [1, 11]. Complementing the LBM4, WHO updated the Laboratory Biosecurity Guidance in 2024 which emphasizes strengthening institutional governance, cybersecurity, and risk assessment to prevent the loss, theft, or misuse of high-consequence biological materials [2, 14, 16]. Biosafety, biosecurity, and adherence to good laboratory practices (GLP) are interdependent pillars of laboratory quality management. Biosafety focuses on preventing unintentional exposure or accidental release of

pathogens, while biosecurity addresses the deliberate misuse or diversion of biological agents. GLP encompasses standardized procedures for equipment maintenance, documentation, waste management, and personnel safety that underpin reliable and safe laboratory operations. Medical Laboratory Scientists, being the frontline personnel in diagnostic services, play a critical role in implementing these standards during specimen handling, testing, and waste disposal. Despite their central role, evidence from sub-Saharan Africa indicates persistent gaps in knowledge, attitudes, and practices related to biosafety and biosecurity. A 2024 cross-sectional study in Togo reported 49.1% of good knowledge of biosafety and biosecurity among Medical Biology Laboratory Professionals, gaps were linked to inadequate training and working environment deficiencies. Similarly, a 2024 study in Ethiopia reported low adherence to biosafety training (18.5%) and emergency preparedness (34.6%) among Clinical Laboratory Professionals, highlighting the need for continuous education and institutional support.

In Nigeria, tertiary hospitals function as referral centers for complex diagnostics involving potentially high-risk pathogens. The Medical Laboratory Science Council of Nigeria (MLSCN) has recently reviewed critical biosafety guidance documents and is providing remote and onsite training to strengthen biosafety standards across the healthcare system. However, structural challenges persist. A 2026 review of Laboratory quality in Nigeria noted severe infrastructural deficits, high disease burden, and the need to transition from reactive quality control to risk-based thinking as mandated by ISO 15189:2022 [3, 13]. These realities suggest that gaps in biosafety, biosecurity, and GLP knowledge among laboratory personnel may undermine safety and quality assurance efforts. Given these concerns, baseline assessment of knowledge among Medical Laboratory Scientists is essential to identify training needs and inform institutional policies. This study therefore aimed to assess the level of knowledge of biosafety, biosecurity, and good laboratory practices among Medical Laboratory Scientists in a tertiary health care facility, South-South Nigeria. The findings will provide evidence to guide targeted continuing professional development and strengthen compliance with national and international biosafety standards in resource-constrained settings.

Methods

This study was a hospital-based cross-sectional study conducted among Medical Laboratory Scientists working in University of Calabar teaching hospital, South-South Nigeria. The study center is a federal tertiary referral center that provides specialized diagnostic services and routinely handles clinical specimens containing potentially high-risk pathogens. The study population comprised all Medical Laboratory Scientists employed in the hospital's diagnostic laboratories. Inclusion criteria include having current practicing license, actively involved in sample analysis or supervisory roles, and informed consent. Students on laboratory posting, and non-Medical laboratory scientists were excluded. Data were collected using a structured, self-administered questionnaire developed based on the WHO Laboratory Biosafety Manual, Biosecurity Guidance, (2024) [2, 7]. The questionnaire consisted of four sections via sociodemographic characteristics, knowledge of biosafety and biosecurity, knowledge of good laboratory practice, and perceived barriers to compliance. The knowledge domains assessed

concepts, practices, and institutional policies aligned with WHO LBM4 risk-based principles and ISO 15189:2022 requirements for risk-based thinking in Medical laboratories. The instrument was adapted from validated tools used in recent sub-Saharan African studies. For biosafety and biosecurity items, “Yes” responses were scored 1, while “No” and “Unsure” were scored 0. For GLP items, “Strongly Agree” and “Agree” to correct statements were scored 1, while other responses were scored 0. The total possible score was 20. Adequate knowledge was defined as a score $\geq 70\%$, consistent with cut-offs used in comparable studies in Togo and Ethiopia. The UCTH laboratory comprise of four units which are Haematology/Blood Transfusion, Histopathology, Chemical pathology, and Medical Microbiology/Parasitology. Each of the units comprise of 25 registered medical laboratory scientists, given the total sample size of 100 used in the study. Participants were approached during working hours. The purpose of the study was explained, and written informed consent was obtained. Questionnaires were distributed and collected on the same day to minimize attrition. Confidentiality and anonymity were maintained throughout. Data were entered and analyzed using SPSS version 25.0. Descriptive statistics, including frequencies and percentages, were used to summarize sociodemographic characteristics and responses to knowledge items. Chi-square test was used to examine associations between categorical variables, with statistical significance set at $p \leq 0.05$. Clinical trial number: not applicable. Ethical approval was obtained from the Research Ethics Committee of the University of Calabar Teaching Hospital. Participation was voluntary, and written informed consent was obtained from all participants. No personal identifiers were collected, and data were stored securely in accordance with institutional policy.

Results

Table 1 shows the Sociodemographic Characteristics of Respondents. A total of 100 MLSCN-registered Medical Laboratory Scientists participated, achieving a 100% response rate. Majority of the participants (52.02%) had working experience between 6-10 years. This was followed by 26.0% who had worked between 11-15 years. 16.0% had working experience of 0-5 years, while 6.0% had more than 15 years’ experience. This distribution reflects a predominantly mid-career workforce responsible for core bench activities in the laboratory.

Table 2 presents the Knowledge of biosafety and biosecurity among respondents. The findings revealed that slightly over half of the respondents (54.0%), reported understanding the meaning of biosafety and biosecurity. Similarly, 54.0% indicated that contaminated waste was properly stored in standard containers and bags before disposal. However, critical gaps were observed in other areas. Only 4.0% of respondents had received training in biosafety and understood the emergency plan for incidents involving biological toxins. Furthermore, just 16.0% reported that their laboratory had a program for discussing and communicating biosafety and biosecurity issues. Additional deficits were noted in preventive health measures, as only 28.0% of respondents affirmed the existence of a vaccination program for personnel working with biological agents in the laboratory. While basic conceptual knowledge and waste management practices were fair, there were significant deficiencies in emergency

preparedness (96.0%), risk communication (84.0%), and occupational health protection among laboratory personnel (72.0%).

The findings in Table 3 revealed major deficiencies in good laboratory practices among the respondents. Only 34.0% reported restriction of biological agents to authorized persons, and 28.0% reported procedures for moving biological agents within and outside the laboratory, indicating weak biosecurity measures. Critical safety measures were also severely lacking, with just 8.0% reporting the existence of SOPs for spill cleaning and biosafety drills, and 8.0% using eye protection when handling infectious agents. Furthermore, 32.0% reported the use of biosafety cabinets during aerosol-generating procedures, while the highest compliance was observed in basic hygiene, with 52.0% affirming formal hand-washing policies.

Discussion

This study assessed the level of knowledge of biosafety, biosecurity, and good laboratory practice among Medical Laboratory Scientists in a tertiary hospital in South-South Nigeria. The findings revealed significant gaps in both theoretical understanding and practical implementation of biosafety measures. The study also revealed that 54.0% of respondents correctly identified the meaning of biosafety and biosecurity, indicating that basic conceptual awareness itself is incomplete in the Medical Laboratory personnel. The finding that only less than half of the respondents understood the core definitions of biosafety and biosecurity is of great concern. This study agrees with the studies in Togo and Ethiopia that reported high levels of basic knowledge, at 49.1% and 68.5% respectively. The current results suggest an even more fundamental gap, of which it is a fact that without clear understanding of what biosafety entails, adherence to procedures in the Medical Laboratory is unlikely which could be detrimental to the Scientists and even patient care. This is compounded by the very low rates of practical application that was observed where only 4.0% respondents reported receiving biosafety training and understanding emergency plans for biological toxins, while 92.0% of them denied the existence of SOPs for cleaning biological spills or conducting biosafety drills.

The mismatch between low awareness and poor practice creates a compounded risk for laboratory-acquired infections and environmental release [4, 5, 8, 9]. Again, the absence of biosafety training and communication structures in the Medical Laboratories further weakens the safety system where only 16.0% of respondents reported that there is a program for discussing biosafety issues, and 18.0% indicated procedures for reporting and documenting incidents. Incident reporting and open communication are core elements of ISO 15189:2022 for Medical Laboratories. A 2026 review of laboratory quality management in Nigeria highlighted the need to move from blame-oriented responses to systems that encourage error reporting mechanisms, near-misses and exposures remain hidden, preventing corrective action [3, 14].

Availability of PPE was reported by 32.0% of the respondents, while 30.0% reported use of biosafety cabinets for aerosol-generating procedures. This reflects constraints in both supply and enforcement of

safety protocols. The WHO Laboratory Biosafety Manual, 4th edition identifies PPE and primary containment devices as fundamental barriers to exposure. The low reported use of biosafety cabinets is particularly problematic in a tertiary hospital where high-risk specimens are routinely processed [15, 16]. While 54.0% reported proper storage of contaminated waste, awareness of vaccination programs for staff handling biological agents was low at 28.0%. Medical care for laboratory-related injuries was also poorly reported, and accountability for biological agents was unclear for most respondents. These gaps align with WHO's 2024 Laboratory Biosecurity Guidance, which stresses consequence-driven biosecurity risk assessment, accountability for high-consequence materials, and staff health protection as integral to institutional governance [12, 13]. In Nigeria, where the Medical Laboratory Science Council of Nigeria is currently reviewing and disseminating updated biosafety documents, these findings suggest that dissemination has not yet reached the frontline workforce [6, 14]. This results underscore an urgent need for targeted interventions in the following areas: mandatory biosafety and biosecurity training with competency assessment; establishment of institutional biosafety committees and incident reporting systems; provision and enforcement of PPE and engineering controls; regular biosafety drills and SOP audits; and staff vaccination and medical surveillance programs. The MLSCN's ongoing efforts to provide remote and onsite training are critical and should be prioritized for facilities where basic awareness remains below 60%. Regular audits, competency assessments, and leadership commitment are needed to close the gap between knowledge and practice [6, 10].

Limitations

This study was conducted in a single tertiary hospital, which may limit generalizability. Self-reported data may be subject to response bias. Multi-center studies are needed to confirm the extent of knowledge deficits across different regions of Nigeria.

Conclusion

The present study revealed that while Medical Laboratory Scientists possess low theoretical awareness of biosafety and biosecurity concepts, critical gaps persist in the practical application of biosafety measures, emergency preparedness, personal protective equipment availability, incident reporting, and adherence to good laboratory practice. The low rates of biosafety training, absence of standard operating procedures for spills and drills, and inconsistent use of engineering controls expose both laboratory personnel and the wider community to preventable biological risks. These findings highlight an urgent need for institutional and national action. Strengthening biosafety and biosecurity requires more than policy documents, it demands mandatory competency-based training, functional institutional biosafety committees, enforced use of PPE and biosafety cabinets, regular safety drills, and accessible incident reporting systems. The ongoing efforts by the Medical Laboratory Science Council of Nigeria to review and disseminate updated biosafety guidance provide a timely opportunity to translate policy into practice at the facility level. Closing these gaps is essential to align Nigerian tertiary laboratories with WHO standards and ISO 15189:2022 requirements for risk-based thinking. Only through sustained

investment in training, infrastructure, and safety culture can laboratories fulfill their role in disease diagnosis while protecting the health and safety of the workforce and the public.

Declarations

Authors' contributions

D.A.A and J.O.A led the manuscript writing, interpreted the data and substantially revised the manuscript; E.C.A conducted data management and analysis and contributed to the manuscript. All authors read and approved the final manuscript.

Funding

We did not receive any funding to conduct this analysis

Data availability

Data is provided within the manuscript. The data used and/or analyzed during the current study are available from the corresponding author upon responsible request.

Ethics approval and consent to participate

The study, the questionnaire and methodology was approved by the University of Calabar Teaching Hospital Health Research Ethics Committee in accordance with the Declaration of Helsinki. Informed consent was obtained from all individual participants prior to be included in the study.

No generative AI tools was used in the writing or analysis of this manuscript.

Human Ethics and Consent to Participate

Ethical approval was obtained from the University of Calabar Teaching Hospital Health Research Ethics Committee. Written informed consent was obtained from all participants.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Tables

Tables 1 to 3 are available in the supplementary files section

Supplementary Files

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- [Tables.docx](#)