



Emerging Global Challenges in Medical Laboratory Science: A Narrative Review

Dunga Excel Kingsley², Nnodim Johnkennedy^{1*} and Nnodim Amarachi Promise¹

¹Department of Medical Laboratory Science, Kingsley Ozumba Mbadiwe University, Ideato, P.M.B 006, Orlu, Imo State, Nigeria

²Department of Medical Laboratory Science, Imo State University, Owerri, Nigeria



WebLog Open Access Publications
Article ID : wjms.2026.g2702
Author : Nnodim Johnkennedy

Abstract

Medical Laboratory Science (MLS) is still an integral part of modern health care that plays an important role in illness diagnosis, surveillance, prevention and therapeutic management. Laboratory technologies have evolved greatly, but the profession is confronted with several worldwide concerns that jeopardise patient outcomes and the delivery of healthcare. These include workforce shortages, antimicrobial resistance, emerging infectious diseases, poor laboratory infrastructure in low-resource settings, quality assurance concerns, automation and artificial intelligence integration, ethical issues, biosafety risks, inadequate funding, and disparities in access to diagnostic services. The COVID-19 pandemic has revealed the inadequacies of laboratory systems around the world and the vital role of medical laboratory personnel. This narrative overview describes the current significant difficulties affecting Medical Laboratory Science worldwide, their impact on health care systems and potential solutions to enhance such systems. Meeting these problems will need coordinated action by governments, health care institutions, professional organisations and international agencies to strengthen laboratory systems and improve global health outcomes.

Keywords: Medical Laboratory Science; Global Health; Laboratory Workforce; Antibiotic Resistance; Quality Assurance; Diagnostics; Artificial Intelligence; Laboratory Infrastructure; Biosafety

OPEN ACCESS

*Correspondence:

Nnodim Johnkennedy, Department of Medical Laboratory Science, Kingsley Ozumba Mbadiwe University, Ideato, P.M.B 006, Orlu, Imo State, Nigeria, E-mail: johnkennedy23@yahoo.com

Received Date: 27 May 2026

Accepted Date: 25 Jul 2026

Published Date: 27 Jul 2026

Citation:

Kingsley DE, Johnkennedy N, Promise NA. Emerging Global Challenges in Medical Laboratory Science: A Narrative Review. *WebLog J Med Sci.* wjms.2026.g2702. <https://doi.org/10.5281/zenodo.21706664>

Copyright© 2026 Nnodim

Johnkennedy. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Medical Laboratory Science is one of the most important cornerstones of modern healthcare. It is important for diagnosing, treating, monitoring and preventing diseases. Accurate laboratory investigations are important to almost every element of clinical medicine, and medical laboratory experts are an integral part of the healthcare team. Laboratory services provide reliable diagnostic information to doctors through the fields of haematology, clinical chemistry, microbiology, immunology, molecular biology, histopathology, blood transfusion science and parasitology [1]. It is well known that test results underpin a large percentage of medical choices. In spite of its great contributions to healthcare delivery, Medical Laboratory Science is plagued by multiple global difficulties that continue to jeopardise the efficiency, accessibility and sustainability of laboratory services worldwide [2].

One of the most acute global problems in Medical Laboratory Science is paucity of skilled laboratory professionals. Many countries, especially the developing ones, are faced with serious shortage of skilled medical laboratory scientists due to low salary, migration of the specialists, poor career progression chances and inadequate training institutions [3]. Brain drain – the movement of highly trained professionals from developing countries to developed countries – has damaged health systems in many parts of Africa and Asia. This scarcity raises the workload of the remaining staff, leading to stress and burnout, delayed laboratory results and increased risk of diagnostic errors. In some health care institutions, one laboratory scientist may be managing enormous amounts of samples on a day-to-day basis. This may have an effect on productivity and quality of service delivery. Governments and healthcare institutions could enhance compensation, work conditions, and invest in ongoing professional development initiatives to tackle staff shortages [4].

Another significant problem affecting Medical Laboratory Science worldwide is the advent and re-emergence of infectious illnesses. Over the past few decades, the emergence of outbreaks of diseases such as COVID-19, Ebola virus disease, monkeypox, avian influenza and Zika virus infection has highlighted the crucial role of laboratory medicine in disease surveillance and outbreak control. The

COVID-19 pandemic has highlighted the shortcomings of laboratory systems across the world, including shortages of diagnostic kits, inadequate molecular laboratories, poor surveillance systems and limited testing capacity. Many countries lacked the infrastructure and skilled personnel needed for prompt diagnostic services. During the pandemic, medical laboratory scientists became front line healthcare professionals, doing molecular testing, tracking the spread of the disease and supporting vaccine research efforts [5, 6]. The pandemic has accentuated the urgent need to develop public health laboratories in countries, improve molecular diagnostic capacity and establish robust disease surveillance systems that can respond swiftly to future outbreaks.

Antimicrobial resistance has also become a severe worldwide health hazard to Medical Laboratory Science. Antimicrobial Resistance (AMR) is when microorganisms such as bacteria, viruses, fungi and parasites stop an antimicrobial from working against it. Misuse and overuse of antibiotics, poor infection prevention measures, self-medication and absence of antimicrobial stewardship programs have propelled the global spread of resistance organisms. Laboratory scientists are critical in the identification of resistant diseases. This includes culture and antibiotic susceptibility testing. However, many laboratories, especially in resource-limited settings, lack the appropriate facilities and standardisation for successful antibiotic resistance surveillance. The rise in the prevalence of multidrug resistant organisms has made disease management more complex and has resulted in longer hospital admissions, increased mortality, and greater healthcare expenses [7]. The fight against antimicrobial resistance involves investment in microbiology laboratories, effective stewardship of antibiotics, health education of the public and worldwide collaboration on surveillance and research.

Poor laboratory infrastructure is a key barrier to successful healthcare delivery in many poor nations. Many laboratories operate with old technology, little space, unreliable electricity, restricted water, and inadequate maintenance. In certain rural healthcare institutions, the laboratory services are either non-existent or very limited and the clinicians have to rely on empirical diagnosis and treatment. Poor infrastructure affects the accuracy of diagnosis and raises the chances of laboratory errors. Lack of bad laboratory services also reduces public confidence in the diagnostic services and contributes to poor health outcome. Governments and healthcare stakeholders prioritise investments in laboratory infrastructure with the provision of new equipment, a culture of maintenance and reliable utility services [8].

Other global issues in Medical Laboratory Science are quality assurance and diagnostic accuracy. Errors in laboratory testing might be encountered in the pre-analytical, analytical or post-analytical phase. Pre-analytical errors may be caused by inappropriate sample collection, faulty handling of the specimen or mis-labeling of the sample. Analytical errors can arise from equipment failure, reagent issues or technical faults in the testing procedures. Common errors beyond the analysis stage are delays in reporting, misinterpretation, or transcribing issues. Diagnostic errors can result in improper treatment, increased healthcare expenses, and poor patient outcomes. Laboratories need to have full quality assurance programs, standard operating procedures, external quality assessment schemes and certification systems in order to reduce errors and improve reliability. Also, continuous training of laboratory personnel is necessary to maintain high professional standards [9].

Technology innovation including automation and artificial

intelligence is changing the Medical Laboratory Science profession at a rapid rate. Automated analysers, robotic sample processors, digital pathology systems and artificial intelligence driven diagnostic tools have enhanced laboratory efficiency, accuracy and turnaround time. Artificial intelligence can help with picture analysis, disease prediction and interpretation of complex lab data. Automation lowers human error and boosts productivity, especially in high-volume labs. However, the integration of new technology comes with a number of hurdles, including high installation costs, cybersecurity concerns, the requirement for specialised technical competence and fears of job displacement among laboratory personnel. Automation is predicted to supplement rather than replace medical laboratory scientists, although continual education and skills development are becoming increasingly important for experts to adapt to developing technologies [10].

Ethical and legal challenges are becoming increasingly important in Medical Laboratory Science with the breakthroughs in molecular diagnostics, genomics and digital health technology. There are many key ethical considerations in the field including patient confidentiality, informed permission, privacy of genetic data and misuse of laboratory information; Genetic testing raises problems about ownership and confidentiality of genetic information. The unauthorised release of laboratory results has the potential to lead to psychological, social and legal ramifications for patients. In addition, manipulation of results, professional carelessness and malpractice charges are still challenges for the integrity of laboratory practice. Therefore, medical laboratory scientists must closely adhere to ethical standards, professional rules and regulatory laws to maintain the trust of the public and protect the safety of patients.

Biosafety and biosecurity are also key global issues in laboratory medicine. Laboratory workers are frequently exposed to dangerous biological agents, chemicals, radiation and sharp instruments that may be damaging to health. Infectious illness laboratories that work with highly pathogenic organisms must have stringent biosafety procedures in place to prevent laboratory-acquired infections and unintentional pathogen discharge. The threat of bioterrorism and abuse of deadly biological materials has intensified the necessity for robust biosecurity systems. Use of personal protective equipment, frequent biosafety training, vaccination of laboratory personnel and effective waste disposal techniques are vital for the maintenance of safe laboratory environments [11].

Another key problem is the lack of proper financing for laboratory services. Although laboratory medicine plays a crucial role in health care, laboratory facilities are typically inadequately funded, especially in underdeveloped countries. The poor funding has affected purchase of reagents, maintenance of equipment, welfare of staff, research activities and overall delivery of services. In poorly funded laboratories, stock-outs of reagents and breakdown of equipment are commonly leading to delays in diagnosis and interruptions in patient treatment. The strengthening of laboratory systems worldwide requires more health care financing, government commitment, health insurance assistance for diagnostics and international partnerships [12].

Another key global concern is inequity in access to diagnostic services. Many rural and underprivileged populations find it difficult to get excellent laboratory services due to the lack of suitable healthcare facilities, poor transportation systems, paucity of skilled workers and high cost of tests. As a result, many diseases are detected late and this leads to poor treatment outcomes and increased

mortality. Innovations such as point-of-care testing, telemedicine, mobile laboratories and community-based diagnostic programs have improved access to diagnostic services in distant locations. Improving diagnostic coverage is critical to achieving universal health coverage and reducing disparities in health care [13].

Climate change and environmental health hazards are progressively affecting laboratory medicine worldwide. Changing ecological circumstances, environmental pollution, and flooding also have resulted in the proliferation of vector borne and waterborne diseases as a consequence of increasing global temperatures. Laboratories are essential for the surveillance of environmental dangers, for the detection of outbreaks and for the support of public health initiatives. As worldwide patterns of disease continue to evolve in response to environmental changes, laboratory systems must adapt to developing public health challenges [14].

Research and innovation deficits are also key constraints to the growth of Medical Laboratory Science, particularly in low-income nations. Many underdeveloped countries do not have adequate research facilities, financing options, mentorship programs, and support for publishing. Hence, they add little to the world scientific literature and technological innovation. Encourage research collaborations to advance the profession and improve health care outcomes, increase research funding and promote evidence-based laboratory practice [15].

Conclusion

Medical Laboratory Science continues to be a vital part of today's health care systems, but the field is challenged by multiple urgent global concerns that jeopardise its impact and viability. Workforce shortages, increasing infectious illnesses, antibiotic resistance, substandard infrastructure, diagnostic errors, insufficient funding, biosafety threats, ethical issues, and disparities in access to laboratory services remain a barrier to health care delivery worldwide. The COVID-19 pandemic has highlighted the criticality of, and gaps in, laboratory systems globally. Addressing these issues would need concerted efforts on the part of governments, healthcare institutions, professional organisations, and international bodies. To improve laboratory services and attain better global health outcomes in the future, laboratory infrastructure has to be strengthened, staff development needs to be invested in, research and innovation need to be promoted, and technological advances need to be adopted.

References

1. Petti CA, Polage CR, Quinn TC. Laboratory medicine in Africa: a barrier to effective healthcare. *Clin Infect Dis*. 2021; 42(3): 377-382.
2. Bates DW, Singh H. Two decades since To Err Is Human: implications for laboratory medicine. *BMJ Quality & Safety*. 2021; 30: 529-534.
3. Rodriguez H, Martinez A, Kim J. Quality assurance systems in modern medical laboratories: global perspectives. *Journal of Laboratory Medicine*. 2024; 48(1): 15-28.
4. World Health Organization. Global antimicrobial resistance and use surveillance system report. 2024.
5. Yao K, Maruta T, Luman ET, McKinney CA, Nkengasong J. The SLMTA programme: transforming laboratory quality systems in resource-limited settings. *Afr J Lab Med*. 2019.
6. Wilson ML, Fleming KA, Kuti MA, Horton S, Nkengasong J. Access to pathology and laboratory medicine services: a crucial gap. *The Lancet*. 2018; 391: 1927-1938.
7. Lippi G, Mattiuzzi C. The impact of artificial intelligence and automation in laboratory diagnostics. *Diagnostics*. 2024; 14(2): 188-197.
8. Centers for Disease Control and Prevention. Emerging infectious diseases and global laboratory preparedness. 2022.
9. United Nations. Climate change and global health impacts. 2023.
10. Rodney P, Hill K. Workforce shortages in laboratory medicine: global perspectives. *Journal of Medical Laboratory Science*. 2023; 58(4): 210-220.
11. Nkengasong JN, Yao K, Onyebujoh P. Laboratory medicine in low-income and middle-income countries: progress and challenges. *Lancet*. 2023; 391(10133): 1873-1875.
12. Plebani M. Diagnostic errors and laboratory medicine. *Clinica Chimica Acta*. 2022; 530: 1-7.
13. World Health Organization. Laboratory services in health systems strengthening. 2023.
14. Centers for Disease Control and Prevention. Biosafety in Microbiological and Biomedical Laboratories. 6th edn. 2020.
15. International Federation of Clinical Chemistry and Laboratory Medicine. Quality indicators in laboratory medicine. IFCC. 2022.