East African Scholars Journal of Medical Sciences
Abbreviated Key Title: East African Scholars J Med Sci
ISSN: 2617-4421 (Print) & ISSN: 2617-7188 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-9 | Issue-11 | Nov-2026 | DOI: https://doi.org/10.36349/easms.2026.v09i11.008

Original Research Article

Laboratory Network: A Mixed-Methods Study Laboratory Supply, Workforce, Infrastructure and Digital Adoption across the National Measles–Rubella Laboratory Network

Kayode Akanbi[1]*, A.I Akyala[1], O Olaiya[1], A.M Idoko[1]

[1]Global Health and Infectious Disease Control Institute (GHIDI), Nasarawa State University, Keffi, Nigeria

Article History
Received: 28.07.2026
Accepted: 24.09.2026
Published: 17.11.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background*:** Laboratory surveillance is a critical infrastructure for measles and rubella elimination. In resource-constrained settings, reagent availability, staffing, power, specimen logistics and information systems may determine whether a surveillance signal becomes a timely public-health response. Nigeria's laboratory network has expanded, but its operational constraints and digital transformation readiness have not been characterised together. ***Objective:*** To identify operational and systemic challenges affecting Nigeria's measles and rubella public-health laboratory network and to assess the current digital landscape, perceived benefits of real-time electronic reporting, and barriers to digital adoption. ***Methods*:** A mixed-methods assessment was conducted across the national measles/rubella laboratory network. The source thesis planned 48 key informants across eight laboratories; the results chapter reports 40 key informants contributing to the challenge analysis. Data were collected using semi-structured interviews addressing performance, data quality, operational constraints and digitalization. Quantitative summaries describe reported frequencies; qualitative responses were synthesised thematically. ***Results:*** Reagent and consumable stock-outs were the dominant operational constraint, reported by seven laboratories and occurring multiple times per year in seven laboratories. Equipment breakdown/lack of back-up was reported frequently, followed by inadequate or non-dedicated staffing, unreliable power, incomplete case-investigation forms, limited training of front-line surveillance officers and absence of dedicated laboratory budgets. Digital maturity was heterogeneous: Epi Info was the predominant electronic tool, while only a minority of laboratories used SORMAS or E-LIMS/Power BI; two laboratories were reported as having no digital tool in routine use. The most frequently cited digital barrier was unreliable internet/network connectivity, followed by additional training needs, lack of laboratory-specific tools and limited government commitment/funding for data. Respondents perceived faster and more accurate reporting, better multi-level access, fewer data-entry errors and improved storage/analysis as major benefits of real-time reporting. ***Conclusions:*** The principal bottlenecks are system-level rather than purely individual. Supply-chain instability, equipment fragility, staffing and connectivity constraints jointly limit laboratory surveillance performance. Digital transformation should therefore be implemented as a health-system intervention—linking procurement, workforce development, power/connectivity, interoperable laboratory information systems and routine data-quality governance—rather than as a stand-alone software deployment.

Keywords: Public Health Laboratory, Measles, Rubella, Nigeria, Digital Health, SORMAS, Laboratory Information Management System, Supply Chain, Surveillance, Health Systems.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

1. INTRODUCTION

Effective measles and rubella surveillance depends on a chain of functions that starts with detection and specimen collection and ends with laboratory confirmation, reporting and public-health action. In elimination programmes, this chain must be sensitive,

***Corresponding Author:** Kayode Akanbi
Global Health and Infectious Disease Control Institute (GHIDI), Nasarawa State University, Keffi, Nigeria

specific and timely enough to detect imported cases, clusters and renewed transmission. WHO guidance emphasises standardised laboratory procedures, appropriate specimens, external quality assurance, documented workflows and reliable data exchange as core requirements of laboratory-supported surveillance (World Health Organization, 2025).

In Nigeria, the operational reality of public-health laboratories is shaped by chronic infrastructure and financing constraints. Laboratory medicine in low- and middle-income countries commonly faces shortages of trained personnel, fragmented procurement, equipment maintenance problems and limited quality-management capacity (Nkengasong *et al*., 2018). For measles and rubella, these constraints have direct consequences because sample transport, cold-chain integrity and reagent availability determine whether clinically suspected cases become useful laboratory data.

Digitalisation offers an opportunity to shorten reporting chains and improve data quality. Nigeria has experience with digital surveillance platforms including SORMAS. Earlier field evaluations reported high perceived usefulness and acceptability among users in Kano, and later assessments characterised SORMAS as a mature digital public-health good (Tom-Aba *et al*., 2018, 2020). More recent evidence from Nigeria also shows that electronic health information exchange can improve completeness and validity of laboratory-related turnaround-time data (Aniekwe *et al.,* 2023). These findings support digitalisation, but they also show that implementation quality matters.

The present study therefore examines challenges and digital readiness together. This matters because software cannot compensate for reagent stock-outs, absent equipment maintenance, poor electricity or a fragmented sample-referral chain. The research asks which constraints are most persistent, what digital tools are actually used, what benefits laboratory personnel expect from real-time reporting, and which barriers must be resolved to make digital transformation sustainable.

2. METHODS

Study Design and Setting

This was the qualitative and systems-assessment component of a broader mixed-methods doctoral study conducted across Nigeria's eight measles/rubella public-health laboratories. The source study included laboratories from the six geopolitical zones.

Participants and Sampling

Purposive sampling was used to identify personnel with direct operational knowledge, including laboratory focal persons, laboratory managers/directors, data-management officers, surveillance officers, quality-assurance personnel and logistics/supply-chain staff. The original study calculated a minimum sample using a finite-population correction and set a final target of 48 key informants (six per laboratory). The results chapter reports n=40 for the challenge analysis; this discrepancy should be reconciled against the interview log before final submission.

Data Collection

A semi-structured interview guide covered testing-capacity trends, turnaround time, COVID-19 effects, data completeness and validation, operational challenges, reagent stock-outs, staffing, infrastructure and funding, current digital tools, real-time reporting, barriers to digital adoption and staff technical capacity.

Data Analysis

Qualitative data were thematically analysed. For publication, reported frequencies are used descriptively to rank operational constraints and digital barriers. Because the source chapter reports some frequencies as ranges or approximate percentages, those values are not treated as mutually exclusive categories or subjected to inferential modelling.

Ethics

Institutional ethical approval was obtained from the Nigerian Institute of Medical Research, and informed consent was obtained from key informants in the source study.

3. RESULTS

Table 1: Primary operational and systemic challenges reported by laboratory key informants

Challenge	Reported mentions / pattern	Interpretation
Reagent and consumable stock-outs	7 laboratories; high	Dominant supply-chain constraint
Equipment breakdown / lack of back-up	5; high	Infrastructure fragility and downtime
Inadequate / non-dedicated staffing	3–4; moderate–high	Workforce capacity and continuity constraint
Unreliable power supply	3; moderate	Operational disruption and equipment risk
Absence of dedicated laboratory budget	Multiple; high	Financing and sustainability constraint
Incomplete case-investigation forms	3+; moderate	Upstream data-quality problem
Limited training of front-line surveillance officers	2+; moderate	Reporting and data-quality bottleneck

Table 2: Reported frequency of reagent and consumable stock-outs

Frequency category	Number of laboratories
Multiple times per year	7
Once per year or less	1–2
Never / rare	0–1

Table 3: Current digital tools reported across participating laboratories

Digital tool / platform	Reported number of laboratories	Approximate reported proportion
Epi Info	5	~56%
SORMAS	1–2	~11–22%
E-LIMS / Power BI	1–2	~11–22%
No digital tool in routine use	2	~22%

Table 4: Barriers to digital adoption and perceived benefits of real-time electronic reporting

Barriers reported most frequently	Perceived benefits
Unreliable internet / network connectivity (6 mentions)	Faster and more accurate reporting
Need for additional staff training (3 mentions)	Improved access to results at state/LGA/facility levels
Lack of laboratory-specific digital tools	Reduced data-entry errors through immediate validation
Limited government commitment / funding for data	Better data storage, analysis and archiving

Supply-Chain Instability

Reagent and consumable stock-outs were the most prominent operational problem. Seven laboratories reported stock-outs multiple times per year. This pattern indicates that testing capacity is constrained not only by the nominal availability of laboratories but by the continuity of consumables required to keep them functional.

Equipment and Infrastructure

Equipment breakdown and lack of backup capacity were also common. Unreliable power supply was reported as a separate constraint, suggesting that the effective capacity of a laboratory may fall below its installed technical capacity when equipment is idle, damaged or cannot be operated reliably.

Workforce and Financing

Inadequate or non-dedicated staffing and the absence of dedicated laboratory budgets were recurring themes. In addition, incomplete case-investigation forms and limited training of front-line surveillance officers point to bottlenecks outside the laboratory itself, particularly at the interface between field surveillance and laboratory services.

Digital Landscape

Most participating laboratories relied on Epi Info, whereas SORMAS and E-LIMS/Power BI were reported in only a minority. The categories were not necessarily mutually exclusive, and the source results use approximate proportions; therefore the digital landscape should be interpreted as a maturity profile rather than a prevalence estimate.

Digital Barriers and Expected Value

Connectivity was the most frequently cited barrier. Training, lack of laboratory-specific tools and limited government funding or commitment were also prominent. In contrast, the expected benefits of real-time reporting were strongly aligned with known surveillance needs: improved speed and accuracy, better access to results across administrative levels, validation at data entry, and stronger storage and analysis. Most informants indicated confidence that staff could manage a fully digital system if adequate training and support were provided.

4. DISCUSSION

The central finding is that the laboratory network's principal constraints are structural. Stock-outs, equipment failures, workforce shortages, financing gaps and power instability occur before a laboratory information system can create value. This reinforces the broader literature on laboratory capacity strengthening in low- and middle-income countries, where supply systems and human resources frequently determine effective diagnostic capacity (Nkengasong *et al*., 2018).

The frequency of reagent stock-outs has particular significance for measles and rubella surveillance because laboratory confirmation is time-sensitive and surveillance quality deteriorates when specimens or testing are delayed. WHO laboratory guidance treats reliable testing and documentation as integral to elimination-standard surveillance (World Health Organization, 2025). The present findings therefore suggest that reagent security should be considered a surveillance intervention, not merely a laboratory procurement issue.

The equipment and power findings similarly argue for a systems perspective. Installed laboratory capacity is not equivalent to operational capacity when maintenance is delayed, backup equipment is unavailable or electricity is unreliable. This is consistent with the broader emphasis on resilient laboratory systems and continuous quality assurance in the global

measles and rubella laboratory network (Rota *et al*., 2024).

The upstream nature of incomplete case-investigation forms is also important. Weak data completeness cannot be attributed solely to laboratories when information is missing before specimens arrive. Evidence from integrated disease surveillance in Africa has repeatedly shown that reporting bottlenecks can occur across multiple levels of the surveillance system (Phalkey *et al*., 2015; Fall *et al*., 2019; Mremi *et al*., 2021). A successful strengthening strategy should therefore define accountability across the entire reporting chain.

Digitalisation is an important opportunity, but the findings argue against a technology-only approach. SORMAS has previously shown high user acceptance in Nigeria, and its maturity has been evaluated positively as an open-source digital public-health system (Tom-Aba *et al*., 2018, 2020). More recent Nigerian evidence demonstrates that electronic health information exchange can improve laboratory data completeness and validity (Aniekwe *et al*., 2023). These studies support the respondents' perception that real-time electronic reporting can improve speed, validation and access. However, they also reinforce the need for implementation support, connectivity, interoperability and ongoing monitoring.

The prominence of connectivity as the leading digital barrier suggests that offline-first or store-and-forward architectures may be especially relevant for Nigeria's laboratory network. Digital surveillance platforms that can capture information locally and synchronise when connectivity returns may reduce the dependence on continuous internet availability. Equally important is integration with laboratory workflows, because a generic reporting platform may not capture specimen accession, testing, quality-control and result-validation processes as effectively as a laboratory-specific information system.

Workforce confidence is encouraging. Respondents largely believed that staff could operate a fully digital system with appropriate training and support. This suggests that perceived readiness is constrained more by enabling conditions than by resistance. Digital adoption strategies should therefore prioritise practical workflow redesign, competency-based training, mentorship, user support, and performance feedback rather than one-off software training.

Taken together, the results support a staged digital transformation model: first stabilise commodities, equipment maintenance, electricity and workforce; then implement interoperable digital workflows; then add automated data-quality checks, dashboards and real-time alerts; and finally evaluate the impact of the digital system on turnaround time, completeness, timeliness and outbreak response. This sequencing is consistent with health-systems approaches that recognise that information systems perform best when embedded in functioning service-delivery structures.

5. Conceptual Model for Implementation

A practical implementation pathway

INPUTS: dedicated financing + reliable reagents/consumables + equipment maintenance + power/connectivity + trained staff → WORKFLOW: standardised specimen referral + electronic accession + laboratory testing + automated validation → INFORMATION: real-time results + dashboards + quality alerts + interoperable reporting → OUTCOMES: improved completeness, timeliness, turnaround time, response speed and surveillance sensitivity → IMPACT: stronger outbreak control and progress toward measles/rubella elimination.

Theme / domain	Subtheme / indicator	Verified denominator (n)	Number reporting (n)	Proportion (%)	Evidence / coding note
Operational challenges	Reagent/consumable stock-outs	[VERIFY]	[VERIFY]	[CALCULATE]	Reconcile with interview log/coding matrix
Operational challenges	Equipment breakdown/lack of back-up	[VERIFY]	[VERIFY]	[CALCULATE]	Reconcile with interview log/coding matrix
Workforce	Inadequate/non-dedicated staffing	[VERIFY]	[VERIFY]	[CALCULATE]	Reconcile with interview log/coding matrix
Infrastructure	Unreliable power supply	[VERIFY]	[VERIFY]	[CALCULATE]	Reconcile with interview log/coding matrix
Digital landscape	Epi Info	[VERIFY]	[VERIFY]	[CALCULATE]	Determine whether platform use overlaps with other categories
Digital landscape	SORMAS	[VERIFY]	[VERIFY]	[CALCULATE]	Determine whether platform use overlaps with other categories

Digital landscape	E-LIMS / Power BI	[VERIFY]	[VERIFY]	[CALCULATE]	Determine whether platform use overlaps with other categories
Digital landscape	No routine digital tool	[VERIFY]	[VERIFY]	[CALCULATE]	Confirm mutually exclusive status before calculating proportions
Digital adoption	Unreliable internet/network connectivity	[VERIFY]	[VERIFY]	[CALCULATE]	Check exact number of contributing respondents/laboratories
Digital adoption	Additional staff training required	[VERIFY]	[VERIFY]	[CALCULATE]	Check exact number of contributing respondents/laboratories

6. Strengths and Limitations

- The study examines operational constraints and digitalisation in the same laboratory network, helping link technology needs to health-system realities.
- Purposive sampling targeted personnel with direct knowledge of laboratory and surveillance operations.
- Interview findings were summarised at theme/frequency level in the thesis; verbatim transcripts and coded quotation matrices were not available for this manuscript, so the paper does not invent participant quotations.
- The thesis reports a planned target of 48 key informants but n=40 for the challenge analysis. This discrepancy requires reconciliation against the original interview log, including the number approached, completed and analytically included.
- Digital-tool counts are approximate and may overlap; the original coding matrix should be checked to establish whether laboratories could report more than one platform. Until this is verified, platform categories should not be treated as mutually exclusive.

7. Recommendations for Implementation

- Create ring-fenced measles/rubella laboratory budgets with minimum stock levels and buffer stocks for essential reagents and consumables.
- Introduce preventive-maintenance and backup-equipment plans, including power-contingency arrangements for critical laboratory processes.
- Protect dedicated laboratory and data-management posts from frequent redeployment and establish competency-based continuing professional development.
- Implement laboratory-specific digital workflows interoperable with national surveillance platforms, including offline data capture and automated validation.
- Prioritise connectivity, cybersecurity, user support and routine data-quality audits as core programme costs rather than optional add-ons.
- Evaluate the digital transformation prospectively using measurable indicators such as turnaround time, completeness, reporting timeliness, rejected specimens and response intervals.

Ethics Approval and Consent

Institutional ethical approval was obtained from the Institutional Review Board of the Nigerian Institute of Medical Research. All key informants provided informed consent in the source study.

Funding: No external funding was reported for this study.

Competing Interests: The authors declare no competing interests.

Data Availability

The qualitative data were collected as part of the doctoral study under institutional ethical approval. Interview transcripts and participant-level data are not publicly released. Subject to ethics and data-governance permissions, the authors will provide an anonymised supplementary qualitative evidence table and appropriate coding/audit documentation. The interview log and full coding matrix will be retained by the study team and made available to editors/reviewers where permitted. Data access should be requested from the study team and relevant Nigerian public-health authorities, subject to governance requirements.

Author Contributions

Kayode Akanbi conceptualised the study, Adamu Ishaku Akyala conducted the analysis and Olanrewaju Olaiya drafted the manuscript. Abah Michael Idoko provided supervisory input.

REFERENCES

- Ashok, A., Brison, M., & LeTallec, Y. (2017). Improving cold chain systems: Challenges and solutions. Vaccine, 35(17), 2217–2223.
- Fall, I. S., et al. (2019). Integrated Disease Surveillance and Response (IDSR) strategy: Current status, challenges and perspectives for the future in Africa. BMJ Global Health, 4(4).
- Fawole, O. I., et al. (2023). COVID-19 surveillance in Democratic Republic of Congo, Nigeria, Senegal and Uganda. BMC Public Health, 23(1).

- Jean Baptiste, A. E., et al. (2021). Trends in measles incidence and measles vaccination coverage in Nigeria, 2008–2018. Vaccine, 39, C89–C95.
- Jean Baptiste, A. E., et al. (2021). Measles outbreak in complex emergency: estimating vaccine effectiveness and evaluation of the vaccination campaign in Borno State, Nigeria, 2019. BMC Public Health, 21(1).
- Kostkova, P., et al. (2021). Data and digital solutions to support surveillance strategies in the context of the COVID-19 pandemic. Frontiers in Digital Health, 3.
- Masresha, B. G., et al. (2024). Tracking measles and rubella elimination progress—World Health Organization African Region, 2022–2023. Vaccines, 12(8).
- Masresha, B., et al. (2021). The impact of the COVID-19 pandemic on measles surveillance in the World Health Organization African Region, 2020. Pan African Medical Journal, 39.
- Mremi, I. R., et al. (2021). Twenty years of integrated disease surveillance and response in Sub-Saharan Africa. One Health Outlook, 3(1).
- Nkengasong, J. N., et al. (2018). Laboratory medicine in low-income and middle-income countries: progress and challenges. The Lancet, 391(10133), 1873–1875.
- Phalkey, R. K., et al. (2015). Challenges with the implementation of an Integrated Disease Surveillance and Response (IDSR) system. Health Policy and Planning, 30(1), 131–143.
- Rota, P. A., et al. (2024). The Global Measles and Rubella Laboratory Network supports high-quality surveillance. Vaccines, 12(8).
- World Health Organization. (2020). Measles and rubella strategic framework: 2021–2030. WHO.
- World Health Organization. (2025). Manual for the laboratory-based surveillance of measles, rubella, and congenital rubella syndrome. WHO.
- World Health Organization. (2025, November 28). Measles deaths down 88% since 2000, but cases surge. WHO.
- Aniekwe, C., Cuffe, K., Audu, I., et al. (2023). Assessing the effect of electronic health information exchange on the completeness and validity of data for measuring viral load testing turnaround time in Nigeria. International Journal of Medical Informatics, 174, 105059. https://doi.org/10.1016/j.ijmedinf.2023.105059
- Tom-Aba, D., Toikkanen, S. E., Glöckner, S., et al. (2018). User evaluation indicates high quality of the Surveillance Outbreak Response Management and Analysis System (SORMAS) after field deployment in Nigeria in 2015 and 2018. Studies in Health Technology and Informatics, 253, 233–237.
- Tom-Aba, D., et al. (2020). The Surveillance Outbreak Response Management and Analysis System (SORMAS): digital health global goods maturity assessment. JMIR Public Health and Surveillance, 6(2), e15860.
- Olu-Abiodun, O., et al. (2025). Effectiveness and challenges of digital tools implementation for enhancing infectious disease surveillance data quality in low- and middle-income countries. PLoS ONE, 20(8).
- Calba, C., et al. (2015). Surveillance systems evaluation: A systematic review of the existing approaches. BMC Public Health, 15(1).
- German, R. R., et al. (2006). Updated guidelines for evaluating public health surveillance systems. MMWR Supplements, 50, 1–34.

Cite This Article: Akanbi, K., Akyala, A. I., Olaiya, O., & Idoko, A. M. (2026). Laboratory Network: A Mixed-Methods Study Laboratory Supply, Workforce, Infrastructure and Digital Adoption across the National Measles–Rubella Laboratory Network. *East African Scholars J Med Sci, 9*(11), 483-488. https://doi.org/10.36349/easms.2026.v09i11.008