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An Analytical Assessment of Potential Factors Contributing to tests Performance Variability in HIV screening tests in the Central Blood Bank in the Northern Borders Region of Saudi Arabia

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ABSTRACT

Accurate and reliable HIV screening is essential for effective diagnosis, treatment, and prevention. Variability in test performance can lead to false-positive or false-negative results, impacting patient care and public health efforts. Identifying the factors contributing to this variability is crucial for ensuring high-quality diagnostic services. This study employs a quantitative descriptive methodology to evaluate HIV screening tests at the Central Blood Bank in Saudi Arabia's Northern Borders Region. A structured questionnaire was administered to 30 laboratory technicians to assess pre-analytical, analytical, and post-analytical factors affecting test performance. Statistical analysis was conducted to determine key areas contributing to variability. Findings indicate that significant pre-analytical associations with standardized blood collection procedures ($p < 0.05$) and regular staff training ($p < 0.05$). Analytically associations with quality control measures, including corrective actions, were significantly linked to reliability ($p < 0.05$). Post-analytically, resolving inconsistencies and outcome verification showed significant relationships ($p < 0.05$), underscoring their critical role in ensuring accurate results. Variability in HIV screening performance arises from multiple factors across pre-analytical, analytical, and post-analytical stages. Strengthening quality control, ensuring staff competency, and implementing standardized laboratory protocols are essential for improving HIV testing accuracy. These findings contribute to the development of targeted interventions aimed at enhancing the reliability of HIV screening programs and reducing diagnostic inconsistencies.

INTRODUCTION

Background

Accurate and reliable HIV screening is fundamental to public health, guiding diagnosis, treatment, and prevention strategies. However, variability in test performance can impact the effectiveness of HIV screening programs, leading to potential false-positive or false-negative results. Understanding the factors contributing to this variability is crucial for enhancing testing accuracy and ensuring high-quality diagnostic services. HIV screening requires strict quality control measures, including well-calibrated laboratory equipment, validated reagents, and standardized operating procedures. Any deviations in these processes can introduce variability in test outcomes, potentially affecting patient management and public health interventions. Additionally, external factors such as environmental conditions, staff training levels, and sample handling practices may also contribute to

inconsistencies in test performance [1]. Previous studies have highlighted the significance of laboratory accreditation, external quality assurance programs, and continuous professional training in reducing errors in HIV testing[2,3]. Standardized protocols ensure reproducibility and reliability of test results, yet gaps remain in identifying specific operational and procedural factors that influence variability. Recent advancements in technology have improved the sensitivity and specificity of HIV screening assays, yet implementation challenges persist, particularly in resource-limited settings[4,5] . This study focuses on identifying potential factors contributing to variability in HIV screening tests conducted at the Central Blood Bank in Saudi Arabia's Northern Borders Region. By examining pre-analytical, analytical, and post-analytical factors, the research aims to provide a comprehensive analysis of laboratory procedures and their impact on test performance. The findings will help in developing targeted interventions to enhance the reliability of HIV screening tests, ensuring better patient outcomes and more effective public health response [6,7].

LITERATURE REVIEW

HIV diagnosis, treatment, and prevention require comprehensive laboratory testing. The highest HIV laboratory testing standards require strict quality control, frequent staff training and certification, standardized protocols, advanced testing technologies, and effective laboratory process management and supervision [1]. Quality HIV lab testing starts with strict control. Quality control verifies lab procedures and equipment for reproducible test results. Laboratory instruments must be calibrated and maintained, control samples used to verify test performance, and lab activities documented. High quality control standards help labs find and fix errors, reducing test result misrepresentation[8].

High-quality HIV testing requires lab staff training and certification. To ensure accurate results, lab staff must know the latest testing methods and protocols. HIV testing theory and practice training must continue. Certification guarantees lab staff proficiency and standards. Lab staff should take refresher courses and proficiency tests to maintain testing and quality assurance skills[1]. HIV laboratory testing quality is also assured by standard protocols. Testing and interpretation are standardized to reduce variability and improve lab reliability. National and international health organizations' best practices and guidelines inform these protocols. Laboratory protocols must be followed for accurate and comparable test results. Lab testing is tainted by protocol violations[9].

HIV lab testing requires advanced technology for accuracy and efficiency. Technology enables sensitive and specific nucleic acid testing (NAT) and chemiluminescence immunoassays. Early HIV detection technologies speed up detection. Advanced testing technologies require lab infrastructure and staff training. Accuracy and reliability justify test costs by improving patient outcomes and public health[4]. Good HIV testing requires lab process management and supervision. Laboratory managers and supervisors oversee quality, operations, and issues. Lab quality management should include sample collection, processing, reporting, and record keeping. Quality management streamlines lab testing and operations[5].

HIV lab QAA is done externally. A third party distributes and analyzes proficiency testing samples to evaluate a lab's EQA. The programs improve lab performance. Lab accreditation often requires EQA programs. EQA programs assess lab skills and improve testing[2]. HIV testing quality depends on lab accreditation. An independent body certifies labs' standards compliance. Laboratory accreditation requires quality and performance. Accreditation examines a laboratory's quality management system, personnel qualifications, testing protocols, and quality control. An accredited lab tests accurately and reliably[3].

Along with technical and procedural elements, laboratory staff, healthcare providers, and public health authorities must collaborate and communicate for HIV testing quality. Clear test results are essential for clinical decision-making and patient management. For proper patient care, doctors and labs must share test results. Monitoring HIV trends and informing interventions and policies requires public health collaboration[10]. HIV lab testing quality depends on IT. IT streamlines lab sample tracking, test result reporting, and quality control. LIMS reduce manual errors and streamline lab workflows, improving data integrity. IT integrates lab data with EHRs, making test results easy to share with doctors. IT improves lab HIV testing accuracy and efficiency[5].

Quality HIV lab testing requires ethical lab practices. Labs must handle patient samples ethically, keep test results private, and get informed consent. Lab ethics require patient and test result confidentiality. Patients consent to testing knowing its consequences. Laboratory ethics foster patient-provider trust and healthcare system integrity[11]. Maintain and improve HIV lab testing through quality improvement. Systematic identification, analysis, and targeted interventions improve quality. Process mapping, root cause analysis, and performance benchmarking help labs improve. Laboratory staff quality improvement activities promote quality culture and proactive problem-solving[12].

Patient feedback improves HIV lab testing quality. Labs use patient feedback to improve. Patient satisfaction surveys can assess testing accessibility, timeliness, and results communication. Laboratory services are patient-

centered and responsive when quality improvement includes patient feedback[13]. Regulation and policy greatly affect HIV lab testing quality. Labs must follow national and international regulations for accurate test results. Follow these rules for lab testing quality. Politicians must establish and enforce quality assurance rules. Encourage evidence-based policies and regulations to equip labs for high-quality testing[14].

HIV lab testing quality and advancement require R&D. R&D develops testing technologies, methods, and quality assurance. Science and research require collaboration between academia, research, and industry. HIV testing and lab services improve with R&D[15]. International partnerships and organizations determine HIV laboratory testing quality. Quality assurance is supported by WHO, UNAIDS, and the CDC with funding, expertise, and best practices. International partnerships help low-resource labs grow by sharing knowledge, resources, and expertise. Every lab needs global collaboration to test HIV accurately and reliably[7].

Lab workflows must include QA practices to ensure HIV testing quality. All laboratory activities—from sample collection and processing to result reporting and record keeping—must be quality managed. Routine laboratory quality assurance requires clear staff roles and responsibilities. Laboratory workflows can include quality assurance for consistency and reliability[16]. Maintaining HIV lab testing standards requires monitoring and evaluating quality assurance practices. Laboratory monitoring includes quality, proficiency, and patient feedback. Evaluation examines quality assurance and suggests improvements. Continuous monitoring and evaluation help labs make data-driven decisions and improve quality with targeted interventions[17].

HIV lab testing quality assurance requires capacity building. Capacity building provides high-quality testing knowledge and resources. Improving infrastructure, training lab staff, and offering advanced testing technologies are examples. Laboratory capacity building should be sustainable and customized. Capacity building improves HIV testing accuracy[18]. Good HIV lab testing requires leadership and governance. Leadership defines quality, sets QAI goals, and provides resources and support. Effective governance, procedures, and oversight ensure quality assurance. Good leadership and governance boost lab accountability, quality, and improvement[19].

Finally, HIV laboratory testing quality requires strict quality control, staff training and certification, standardized protocols, advanced testing technologies, and laboratory process management and supervision. Communication, collaboration, IT, accreditation, and external quality assessment are crucial. HIV laboratory testing is high-quality due to ethical conduct, quality improvement initiatives, patient feedback, regulatory and policy frameworks, research and development, international partnerships, quality assurance, continuous monitoring and evaluation, capacity building, and effective leadership and governance. These elements improve lab results, patient outcomes, and public health interventions when addressed[6].

METHODOLOGY

Research Design

The study will utilize quantitative methodology, employing descriptive. Descriptive study will help to bind the observation and statistic data to gather and translate them in a clear picture. The study evaluates HIV screening tests for blood donors in Saudi Arabia's Northern Borders Region using quantitative method. Laboratory staff completed standardized questionnaire to acquire quantitative data. This questionnaire covers areas for identifying potential factors contributing to tests performance variability in HIV screening tests.

Research Setting

Since it borders Iraq and Jordan, the Central Blood Bank in Saudi Arabia's Northern Borders Region was chosen because of strategically important for research. Due to its diversified population, this northern region poses unique problems and potential for public health programs, particularly blood donation and screening.

Sample Size

For questionnaire, 30 lab technicians will be participated which represent all working at the Central Blood Bank. All 30 laboratory technicians working at the Central Blood Bank will be included in the study to provide comprehensive data on staff proficiency and satisfaction.

Study Instrument

To identify potential factors affecting the performance of HIV screening tests, structured questionnaire was developed and administered to laboratory staff. This questionnaire was designed to gather comprehensive data on various aspects of the testing process, including pre-analytical, analytical, and post- analytical.

Data Collection

- ***Survey Administration:*** The structured questionnaires will be distributed to laboratory staff at the Central Blood Bank. This method ensures that data is collected from individuals directly involved in the HIV testing process.

- ***Areas Covered:*** The questionnaires will cover a range of topics, including pre-analytical, analytical, and post-analytical factors that may influence test performance. This comprehensive approach will help identify key factors contributing to variability in test results.

Data Analysis

- ***Content Analysis:*** The qualitative data from the survey responses will undergo categorization and thematic analysis. This process will identify recurring themes and key factors that impact the performance of HIV screening tests.
- ***Statistical Tools:*** Descriptive and inferential statistics will be employed to analyse the impact of identified factors on test performance, providing insights into areas for improvement.

RESULTS

Thematic Analysis

This particular analysis focuses on the HIV screening test performance variability. It is divided into 3 main themes: pre-analytical, analytical, and post-analytical.

Theme 1: Pre-analytical identifies several contributing factors that contribute to test performance variability in HIV screening tests, including standardized procedures and validation of HIV test kits and reagents.

Theme 2: The analytical focus on ensuring the quality and consistency of the analytical process, which also contributes to tests performance variability in HIV screening. It includes established equipment procedures and quality assurance methods.

Theme 3: Post-analytical involves interpreting and reporting results for HIV screening tests and can contribute to the test performance variability, it includes clear guidelines for interpreting the findings, results verifications, secure data storage, confirmation of positive HIV cases and timely notification of HIV infection. Together, these contributing factors can contribute to the HIV screening test performance variability (Figure 1).

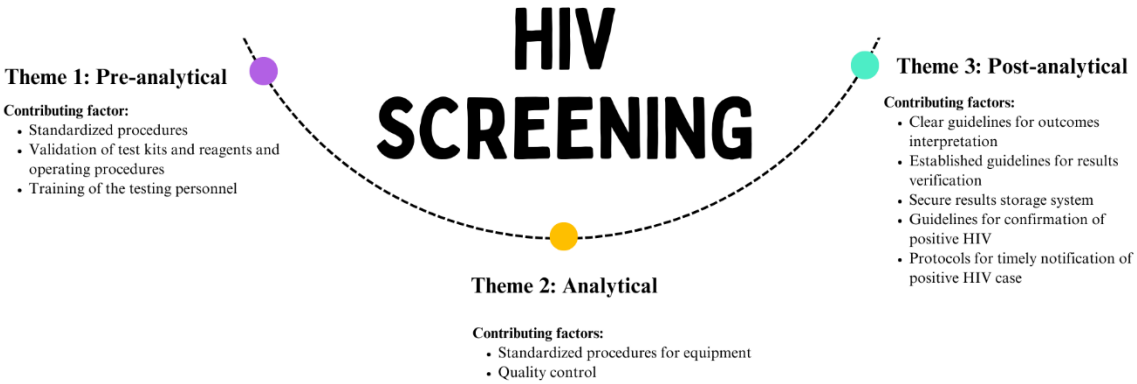

Figure 1. Different contributing factors for HIV screening test performance variability.

Descriptive Analysis

Pre-Analytical

Table 1 summarizes 32 participants' responses to pre-analytical variables in HIV testing, highlighting key guidelines and challenges. The majority of participants (29, 90.6%) had more than six months of experience with significant differences ($p<0.05$). A high percentage reported using standard procedures for blood sample collection (29, 90.6%, $p<0.05$) and ensured labeling (32, 100%) and safe storage of samples (32, 100%). However, sometimes and occasionally, problems, such as samples causing hemolysis or clotting, were common (50% (16), 46.9% (15), $p<0.05$). Preventive measures against contamination were frequently reported, with (15, 46.9%) participants using all available methods like the use of sterile equipment, staff training, controlled storage, and handling protocols. Regular training and competency assessments of staff involved in screening were 78.1% (25) and 71.9% (23), respectively, both of which were significantly related ($p<0.05$) to best practices and screening. Rigorous procedures (27, 84.4%) for high-risk behavior and collection of medical history (29, 90.6%) were also used for the screening of donors ($p<0.05$). Verified test kits and reagents were used in all the labs. Most participants (28, 87.5%) confirmed compliance with quality control measures for test kits and standard procedures for HIV testing (30, 93.8%). Furthermore, 28 (87.5%) had adequate training for testing HIV in donors, with statistically significant

difference. Overall, the findings highlight a high level of compliance with pre-analytical standards ($p<0.05$) (Table 1 and Figure 1-12).

Table 1. Summary of responses from participants on pre-analytical variables for HIV testing (N=32).

Study variable	**N**	**%**	**p**
Experience (months)			
>6	29	90.6	<0.05
<6	2	6.2	
6	1	3.1	
Pre-analytical			
Standardized procedures used for blood collection			
Yes	29	90.6	<0.05
No	2	6.2	
Maybe	1	3.1	
Samples properly labeled			
Yes	32	100	Not calculated
Procedures used to ensure proper sample separation, transport and storage conditions			
Yes	32	100	
Encounter issues like hemolyzed or clotted samples			
Occasionally	15	46.9	<0.05
Sometimes	16	50	
Often	1	3.1	
Measures in place to prevent sample contamination			
Sterile equipment	9	28.1	<0.05
Staff training	5	15.6	
Controlled storage	2	6.2	
Handling protocols	1	3.1	
All of above	15	46.9	
Phlebotomists and other staff involved are regularly trained			
Yes	25	78.1	<0.05
No	4	12.5	
Maybe	3	9.4	
Phlebotomists and other staff involved are regularly assessed for competency			
Yes	23	71.9	<0.05
No	6	18.8	
Maybe	3	9.4	
Rigorous procedures for screening donors for high-risk behavior			
Yes	27	84.4	<0.05
No	1	3.1	
Maybe	4	12.5	
Medical history of donor collected			
Yes	29	90.6	<0.05
No	1	3.1	
maybe	2	6.2	
HIV kits and reagents are validated and approved			
Yes	32	100	Not calculated
Procedures used to check test kit and reagent details			
Yes	31	96.9	<0.05
Maybe	1	3.1	
Quality control materials used to validate new test kit lot			
Yes	28	87.5	<0.05

No	1	3.1	
Maybe	3	9.4	
Standardized operating procedures for HIV test performance			
Yes	30	93.8	<0.05
Maybe	2	6.2	
Testing personnel's have adequate training and competency assessment			
Yes	28	87.5	<0.05
No	1	3.1	
Maybe	3	9.4	

Analytical

The majority (26, 81.2%) reported that procedures for selecting, approving, and installing laboratory equipment were available, and 31 (96.9%) reported that procedures for verification of equipment before use were also available ($p<0.05$). Similarly, internal quality control materials were used in tests, as most of the respondents (30, 93.8%) highlight, and a similar percentage established standards for quality control (QC) results in review and corrective action. Additionally, 26 (81.2 %) participated in external quality control programs ($p<0.05$). These findings indicate that appropriate statistical procedures for HIV testing were strictly followed. This increases the reliability and validity of the results (Table 2 and Figure 13-18).

Table 2. Summary of responses from participants on analytical variables for HIV testing (N=32).

Study variable	**N**	**%**	**p-value**
Procedures to ensure proper lab equipment selection, acceptance, and installation			
Yes	26	81.2	<0.05
No	4	12.5	
Maybe	2	6.2	
Procedures used to ensure proper equipment verification before use			
Yes	31	96.9	<0.05
Maybe	1	3.1	
Procedures used to ensure proper equipment periodic maintenance and functions			
Yes	31	96.9	<0.05
Maybe	1	3.1	
Internal quality control materials included in each test run			
Yes	30	93.8	<0.05
Maybe	2	6.2	
Established protocols for QC results review and corrective actions			
Yes	30	93.8	<0.05
Maybe	2	6.2	
Is there participation in an external quality assurance program			
Yes	26	81.2	<0.05
Maybe	6	18.8	

Post-Analytical

The majority of participants (30, 93.8%, $p < 0.05$) reported adherence to clear criteria for interpreting and reporting results, with procedures for dealing with discrepant or indeterminate outcomes (28, 87.5%, $p < 0.05$) and a system for independent verification of results (26, 81.2 %, $p < 0.05$). All participants (32, 100%) confirmed that the results were recorded correctly, had access to the laboratory database, and were kept confidential. Additionally, 30 (96.9%) reported secure storage and access ($p < 0.05$). In comparison, 93.8% reported that diagnosis of positive HIV was verified before reporting and had guidelines in place to identify positive donors in a timely manner ($p < 0.05$). These findings highlight the importance of post-analytical practices for the reliability and safety of HIV testing (Table 3 and Figure 19-24).

Table 3. Summary of responses from participants on post-analytical variables for HIV testing (N=32).

Study variable	**N**	**%**	**P**
Clear criteria for interpreting and reporting HIV results			
Yes	30	93.8	
Maybe	2	6.2	<0.05

Procedures used to resolve any discrepant or indeterminate results			
Yes	28	87.5	
Maybe	4	12.5	<0.05
Process used for independent verification of results			
Yes	26	81.2	
No	2	6.2	
Maybe	4	12.5	<0.05
Results accurately transcribed and entered in the lab information system			
Yes	32	100	Not calculated
Confidentiality of results			
Yes	32	100	Not calculated
System used for secure storage and retrieval of results			
Yes	31	96.9	
maybe	1	3.1	<0.05
Positive HIV results are confirmed before reporting			
Yes	30	93.8	
Maybe	2	6.2	<0.05
Protocols for timely identification of donors with positive results			
Yes	30	93.8	
No	1	3.1	
maybe	1	3.1	<0.05

Impact of Experience on the Practices Performed by the Participants

A significant pre-analytical association was observed for the use of standardized procedures for blood sample collection ($p < 0.05$) and regular training of phlebotomists and staff ($p<0.05$), indicating the importance of these factors. To predict the stability of pre-analytical quality, other factors such as sample contamination prevention and performance measures should also be taken into account, despite the experience of the participants having a non-significant association. Furthermore, there was no significant association ($p > 0.05$) from an analytical point of view. Key findings included criteria for reviewing quality control results and taking corrective actions that had a significant association ($p<0.05$), highlighting the role of quality control in ensuring test reliability. Post-analytical analyses revealed a significant relationship between the steps used to resolve inconsistencies in the outcomes and verification of the outcomes ($p < 0.05$), indicating that these steps played an important role (Table 4).

Table 4. Association of experience with pre-analytical, analytical and post-analytical responses.

Questions	**p-values**
Pre-analytical	
Standardized procedures used for blood collection	<0.05
Encounter issues like hemolyzed or clotted samples	0.50
Measures in place to prevent sample contamination	0.76
Phlebotomists and other staff involved are regularly trained	<0.05
Phlebotomists and other staff involved are regularly assessed for competency	0.07
Rigorous procedures for screening donors for high-risk behaviour	0.57
Medical history of donor collected	0.13
Procedures used to check test kit and reagent details	0.94
Quality control materials used to validate new test kit lot	0.37
Standardized operating procedures for HIV test performance	0.89
Testing personnel's has adequate training and competency assessment	0.97
Analytical	
Procedures to ensure proper lab equipment selection, acceptance, and installation	0.10
Procedures used to ensure proper equipment verification before use	0.94
Internal quality control materials included in each test run	0.89
Established protocols for QC results review and corrective actions	<0.05
Is there participation in an external quality assurance program	0.68
Post-analytical	
Clear criteria for interpreting and reporting HIV results	0.89
Procedures used to resolve any discrepant or indeterminate results	<0.05
Process used for independent verification of results	<0.05
System used for secure storage and retrieval of results	0.94
Positive HIV results are confirmed before reporting	0.89
Protocols for timely identification of donors with positive results	0.99

DISCUSSION

This study explored the variability in HIV screening test performance at the Central Blood Bank in Saudi Arabia's Northern Borders Region, highlighting critical factors across the pre-analytical, analytical, and post-analytical phases. The findings reinforce that variability in testing outcomes is not solely attributed to test kits or equipment but is deeply influenced by procedural consistency, staff training, and quality control practices.

The pre-analytical phase demonstrated strong adherence to standardized procedures, such as proper labeling, storage, and validated test kits. A significant association ($p < 0.05$) was observed between the use of standardized blood collection procedures and the experience level of staff. This supports previous studies emphasizing that rigorous pre-testing protocols reduce test discrepancies and ensure sample integrity[1] [2]. However, problems such as hemolysis or clotting of samples were commonly reported, with 50% (n=16) indicating 'sometimes' and 46.9% (n=15) suggests gaps in phlebotomy practices or sample handling protocols, indicating a need for continual competency assessments.

In the analytical phase, the study found strong compliance with internal and external quality control measures. Most participants followed protocols for equipment verification and maintenance and participated in external quality assurance programs. A statistically significant relationship was noted between quality control review procedures and corrective action implementation ($p < 0.05$), consistent with literature emphasizing the importance of quality control systems in laboratory reliability[4] [10]. However, the non-significant association between analytical factors and experience implies that quality procedures may be more dependent on institutional standards than on individual proficiency.

The post-analytical phase revealed near-universal adherence to procedures for interpreting and reporting HIV results, with systems in place for resolving discrepancies and verifying outcomes. These practices are crucial in preventing false-positive or false-negative reporting, aligning with best practices outlined by WHO and CDC[13] [20]. Notably, significant associations were found between experience and both the resolution of inconsistent results and verification steps ($p < 0.05$), highlighting the impact of procedural clarity and oversight on final test accuracy.

The data also show that experience, while relevant in certain pre- and post-analytical steps, is not a consistent predictor of performance quality across all phases. This suggests that formalized protocols and institutionalized training may play a more pivotal role than individual tenure in ensuring testing reliability.

The implications of this study extend to broader public health efforts. As HIV screening is foundational to treatment and prevention strategies, the identification of these variability factors supports policy recommendations for continuous training, updated SOPs, and rigorous quality assurance measures. Especially in regions with diverse populations and resource limitations, standardizing practices across all testing stages is vital.

While the findings provide robust insights, limitations include the relatively small sample size and geographic confinement to a single center, which may restrict generalizability. Future studies should involve multi-center data and longitudinal designs to assess the long-term impact of intervention strategies on screening consistency.

CONCLUSION

The study assessed operational factors influencing the reliability of HIV screening at the Central Blood Bank in the Northern Borders Region of Saudi Arabia. Findings revealed that test performance variability arises from multiple interdependent factors across the pre-analytical, analytical, and post-analytical stages. In the pre-analytical phase, adherence to standardized procedures, validation of test kits, and continuous staff training significantly enhanced reliability. The analytical stage underscored the importance of robust internal and external quality control systems, equipment verification, and corrective action mechanisms. Meanwhile, the post-analytical phase demonstrated that clear reporting guidelines, result verification, and data confidentiality are pivotal for accurate diagnosis and public trust. Although staff experience contributed to improved performance in certain stages, institutionalized quality management systems and regular training were more consistent predictors of reliability. Overall, the study concludes that a comprehensive, system-based approach—anchored in procedural standardization, continuous professional development, and quality assurance—is essential to maintain the integrity of HIV screening programs.

RECOMMENDETIONS

- Strengthen Continuous Training: Implement structured, periodic competency-based training programs for laboratory staff to enhance technical skills and minimize human error during HIV screening.

- Standardize Operating Procedures: Ensure uniform application of standard operating procedures (SOPs) across all stages of testing, with regular audits to verify compliance and update protocols in line with international guidelines.
- Enhance Quality Control Measures: Expand participation in both internal and external quality assurance programs. Regularly review QC data to identify trends, address anomalies, and implement corrective actions promptly.
- Upgrade Laboratory Infrastructure: Invest in modern diagnostic equipment and automated data management systems to reduce manual errors and improve efficiency and traceability of test results.
- Establish Continuous Monitoring Systems: Develop a monitoring framework that includes regular performance evaluations, feedback loops, and benchmarking against national and international standards.
- Promote Ethical and Confidential Practices: Reinforce policies on data privacy, result confidentiality, and informed consent to ensure ethical standards and build patient confidence in screening programs.
- Encourage Multi-Center Collaboration: Extend the study framework to include multiple regional laboratories, promoting knowledge exchange and fostering consistency in HIV testing practices across Saudi Arabia.
- Integrate Policy and Governance Support: Advocate for national policies that emphasize laboratory accreditation, regulatory oversight, and sustained investment in workforce capacity building to ensure long-term testing reliability.

REFERENCES

Antonopoulou N, Schinas G, Kotsiri Z, et al. Testing Hepatitis E Seroprevalence among HIV-Infected Patients in Greece: The SHIP Study. *Pathogens*. 2024;13(7):536. doi:10.3390/pathogens13070536

Killick SB, Bown N, Cavenagh J, et al. Guidelines for the diagnosis and management of adult aplastic anaemia. *Br J Haematol*. 2016;172(2):187-207. doi:10.1111/bjh.13853

Kasraian L, Hosseini S, Salehi-Marzijarani M, Ebrahimi A, Ashkani Esfahani S. The Prevalence of Hepatitis C Infection in Blood Donors: A Meta-Analysis and Systematic Review. *Iran Red Crescent Med J*. 2020;In Press. doi:10.5812/ircmj.94998

Kotton CN, Kumar D, Caliendo AM, et al. The Third International Consensus Guidelines on the Management of Cytomegalovirus in Solid-organ Transplantation. *Transplantation*. 2018;102(6):900. doi:10.1097/TP.0000000000002191

Im YR, Jagdish R, Leith D, et al. Prevalence of occult hepatitis B virus infection in adults: a systematic review and meta-analysis. *Lancet Gastroenterol Hepatol*. 2022;7(10):932-942. doi:10.1016/S2468-1253(22)00201-1

ASCOMS, Jammu University, India, Arora S. Seroprevalence of HIV, HBV, HCV, Syphilis and Malaria among blood donors in a tertiary care hospital of Jammu. *J Med Sci Clin Res*. 2018;6(10). doi:10.18535/jmscr/v6i10.210

Erikstrup C, Hother CE, Pedersen OBV, et al. Estimation of SARS-CoV-2 Infection Fatality Rate by Real-time Antibody Screening of Blood Donors. *Clin Infect Dis Off Publ Infect Dis Soc Am*. 2020;72(2):249-253. doi:10.1093/cid/ciaa849

PENTA Steering Committee. Paediatric European Network for Treatment of AIDS response to 2010 revision of World Health Organization recommendations on "Antiretroviral therapy for HIV infection in infants and children." *HIV Med*. 2011;12(6):385-386. doi:10.1111/j.1468-1293.2011.00914.x

Nagi MA, Rezq MAA, Sangroongruangsri S, Thavorncharoensap M, Dewi PEN. Does health economics research align with the disease burden in the Middle East and North Africa region? A systematic review of economic evaluation studies on public health interventions. *Glob Health Res Policy*. 2022;7(1):25. doi:10.1186/s41256-022-00258-y

Jones JM, Opsomer JD, Stone M, et al. Updated US Infection- and Vaccine-Induced SARS-CoV-2 Seroprevalence Estimates Based on Blood Donations, July 2020-December 2021. *JAMA*. 2022;328(3):298-301. doi:10.1001/jama.2022.9745

Hongjaisee S, Khamduang W, Sripan P, et al. Prevalence and factors associated with hepatitis B and D virus infections among migrant sex workers in Chiangmai, Thailand: A cross-sectional study in 2019. *Int J Infect Dis IJID Off Publ Int Soc Infect Dis*. 2020;100:247-254. doi:10.1016/j.ijid.2020.09.004

Hermosilla J, Sánchez-Martín R, Pérez-Robles R, et al. Comparative Stability Studies of Different Infliximab and Biosimilar CT-P13 Clinical Solutions by Combined Use of Physicochemical Analytical Techniques and Enzyme-Linked Immunosorbent Assay (ELISA). *BioDrugs Clin Immunother Biopharm Gene Ther*. 2019;33(2):193-205. doi:10.1007/s40259-019-00342-9

Hart TA, Moore DM, Noor SW, et al. Prevalence of HIV and sexually transmitted and blood-borne infections, and related preventive and risk behaviours, among gay, bisexual and other men who have sex with men in

Montreal, Toronto and Vancouver: results from the Engage Study. *Can J Public Health Rev Can Sante Publique*. 2021;112(6):1020-1029. doi:10.17269/s41997-021-00546-z

Gosadi IM. Epidemiology of communicable diseases in Jazan region. *Saudi Med J*. 2023;44(11):1073-1084. doi:10.15537/smj.2023.44.11.20230269

Sul V, Deshpande N, Gadgil P. Seroprevalence of HIV, HBV, HCV and Syphilis among Blood Donors in Western Maharashtra and a Newer Proposed Donor Screening Algorithm. *J Blood Disord Transfus*. 2017;08. doi:10.4172/2155-9864.1000384

Obeagu EI, Obeagu GU. Transfusion Therapy in HIV: Risk Mitigation and Benefits for Improved Patient Outcomes. *Asian J Dent Health Sci*. 2024;4(1):32-37. doi:10.22270/ajdhs.v4i1.62

Moglad EHO, Ahmed DAO, Awad Al-Kareem SMM, Elgoraish AG, Ali HTO, Altayb HN. Prevalence of human immunodeficiency virus among pulmonary tuberculosis patients: A cross-sectional study. *Microbiol Immunol*. 2020;64(12):810-814. doi:10.1111/1348-0421.12856

Custer B, Quiner C, Haaland R, et al. HIV antiretroviral therapy and prevention use in US blood donors: a new blood safety concern. *Blood*. 2020;136(11):1351-1358. doi:10.1182/blood.2020006890

Curtin JM, Aronson NE. Leishmaniasis in the United States: Emerging Issues in a Region of Low Endemicity. *Microorganisms*. 2021;9(3):578. doi:10.3390/microorganisms9030578

Steele WR, Dodd RY, Notari EP, et al. HIV, HCV, and HBV incidence and residual risk in US blood donors before and after implementation of the 12-month deferral policy for men who have sex with men. *Transfusion (Paris)*. 2021;61(3):839-850. doi:10.1111/trf.16250

