

Quality Control Practices in a Tertiary Government Hospital Laboratory: Assessment of Documentation, Calibration, and Error Detection

Melrose Porca¹, Belma Dumangeng¹, Erika Joyce Arellano¹, Camille De Guzman¹, Elijah Wayne Marin¹, Dr. Rufo Calistro Jr.¹

¹*Master of Science in Clinical Laboratory Science (MSCLS), University of Perpetual Help System Laguna, National Highway, Sto. Niño, City of Biñan, Laguna, Philippines*

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Email of Corresponding Author: c25-3002-857@uphsl.edu.ph

Abstract

This study evaluated the quality control (QC) practices of medical technologists in a tertiary government hospital laboratory in the Philippines, focusing on quality control documentation, equipment calibration, and analytical error detection, as well as the relationships among these domains and selected demographic variables. The study was conceptually anchored on the integrated nature of laboratory quality management, wherein documentation, calibration, and analytical error detection collectively support laboratory performance and compliance with quality standards. A descriptive–correlational research design was employed involving twelve licensed medical technologists selected through total enumeration. Data were collected using a structured, validated questionnaire and analyzed using weighted mean, standard deviation, Spearman rank correlation, Kruskal–Wallis test, and Cronbach's Alpha at a 5% level of significance. The findings revealed very high levels of quality control documentation, equipment calibration, and analytical error detection practices among the respondents. No statistically significant relationships were found between quality control practices and respondents' age, years of experience, or employment status. However, a very strong positive relationship was identified between quality control documentation and equipment calibration, indicating the interdependent nature of these quality management components. Due to the study's small sample size, single-site setting, and reliance on self-reported measures, findings should be interpreted cautiously. The study concludes that quality control performance in the selected laboratory is supported by an integrated, systems-oriented approach. It recommends sustaining effective documentation, calibration, and analytical error detection practices while reinforcing the integration of documentation and calibration processes to promote continuous quality improvement. The study aligns with Sustainable Development Goal (SDG) 3: Good Health and Well-Being, SDG 9: Industry, Innovation and Infrastructure, and SDG 16: Peace, Justice and Strong Institutions by supporting reliable laboratory diagnostics, quality management systems, and adherence to recognized healthcare standards. Its findings contribute to public health, institutional, and innovation sustainability by providing evidence that may strengthen laboratory quality management and continuous quality improvement in government hospital laboratories.

Keywords: Analytical Error Detection, Equipment Calibration, Laboratory Quality Management, Medical Technologists, Quality Control Documentation, Quality Control Practices, Tertiary Government Hospital Laboratory

1. Introduction

Quality control (QC) is fundamental to clinical laboratory practice because accurate, reliable, and timely laboratory results support diagnosis, treatment planning, disease monitoring, and patient safety. As laboratory findings influence a substantial proportion of clinical decisions, effective quality management is essential for healthcare delivery. Medical laboratories therefore operate within structured quality systems guided by international standards, including ISO 15189:2022 (International Organization for Standardization, 2022), and quality principles promoted by the WHO (World Health Organization, 2021). However, maintaining consistent QC practices remains challenging, particularly in resource-constrained government hospital laboratories. This study evaluates quality control documentation, equipment calibration, and analytical error detection practices among medical technologists in a tertiary government hospital laboratory in the Philippines and examines the relationships among these QC domains and selected demographic variables.

1.1 Background of Quality Control Practices in Tertiary Government Hospital Laboratories

Quality control ensures the accuracy, reliability, and timeliness of laboratory results, making it an essential component of clinical decision-making and patient safety. International quality standards, including ISO 15189:2022 (International Organization for Standardization, 2022) and the quality principles of the WHO (World Health Organization), provide structured guidance for laboratory competence and quality management. Nevertheless, government hospital laboratories frequently encounter challenges such as high testing volumes, workforce shortages, delayed procurement, aging equipment, limited financial resources, and inconsistent quality management practices. These conditions may adversely affect

documentation, calibration compliance, preventive maintenance, analytical error detection, and overall diagnostic reliability, ultimately influencing patient safety and laboratory performance (Nordin et al., 2024).

1.2 Themes and Insights on Quality Control Documentation, Equipment Calibration, and Analytical Error Detection

Related literature emphasizes that effective laboratory quality systems depend on institutional commitment, adequate resources, and efficient project management. Recent evidence also highlights that strengthening laboratory quality systems reduces preanalytical errors and enhances patient safety through standardized quality improvement strategies (Nordin et al., 2024). Contemporary studies increasingly recognize QC as an integrated system rather than a collection of isolated technical activities (Pillai et al., 2025). Quality indicators have become valuable tools for monitoring laboratory performance, while documentation control, calibration monitoring, and corrective-action systems are consistently identified as critical components of laboratory reliability, regulatory compliance, and audit preparedness, particularly in resource-limited settings.

1.3 Local, National, and Global Context of Laboratory Quality Control Practices

Globally, laboratories implement internationally recognized quality frameworks to ensure competence and patient safety. However, laboratories in low- and middle-income countries continue to experience implementation challenges due to resource limitations. Within the Philippine setting, evidence from tertiary government hospital laboratories remains limited, particularly regarding integrated assessments of QC practices. Furthermore, the experiences of frontline medical technologists responsible for implementing daily QC procedures remain insufficiently represented in existing research.

1.4 Conceptual Basis of Quality Control Documentation, Equipment Calibration, and Analytical Error Detection

This study is conceptually anchored on the integrated nature of laboratory quality management, where quality control documentation, equipment calibration, and analytical error detection function as interconnected components that collectively strengthen laboratory performance, diagnostic reliability, and compliance with quality standards. The investigation evaluates these domains simultaneously while examining their relationships with selected demographic characteristics of medical technologists.

1.5 Research Gaps and Rationale for Assessing Quality Control Practices Among Medical Technologists

Although previous studies have examined laboratory quality systems, many have focused on documentation, calibration, or analytical error detection independently rather than as interconnected quality components. Moreover, limited evidence exists regarding QC implementation in tertiary government hospital laboratories in the Philippines, and the perspectives of frontline medical technologists remain underrepresented. Addressing these gaps may provide evidence to strengthen laboratory quality management and support continuous quality improvement initiatives.

1.6 Alignment of the Study on Quality Control Practices with Relevant Sustainable Development Goals (SDGs)

This study aligns primarily with SDG 3 – Good Health and Well-Being by promoting accurate laboratory diagnostics that contribute to safe, effective, and high-quality healthcare services. It also supports SDG 9 – Industry, Innovation and Infrastructure through the enhancement of laboratory quality systems, equipment calibration, and quality management processes, and SDG 16 – Peace, Justice and Strong Institutions by encouraging adherence to recognized quality standards, institutional accountability, and reliable healthcare services. These alignments are supported by the study's emphasis on laboratory quality improvement, ISO 15189 preparedness, and quality management initiatives.

1.7 Importance of Assessing Quality Control Practices to Multidisciplinary Sustainability

The study contributes primarily to public health sustainability by supporting reliable diagnostic services that improve patient safety and clinical decision-making. It also contributes to institutional sustainability by identifying opportunities to strengthen standard operating procedures, quality monitoring systems, staff training, and ISO 15189 preparedness. In addition, the study supports innovation and digital sustainability through its potential contribution to digital quality management initiatives that enhance laboratory efficiency and continuous quality improvement within government hospital laboratories.

2. Material and methods

2.1 Research Design

The study utilized a descriptive–correlational research design, which is appropriate for describing existing conditions and examining relationships among variables without manipulating them (Creswell & Creswell, 2018). The descriptive component determined the level and characteristics of quality control documentation, equipment calibration, and analytical error detection practices as naturally implemented by medical technologists without manipulating any variables. The correlational component examined the relationships between demographic variables, specifically age and years of experience, and each QC domain, as well as the interrelationships among the QC domains, without implying causation.

2.2 Locale of the Study

The study was conducted in a tertiary government hospital laboratory in the Philippines that provides a wide range of diagnostic services to a diverse patient population. The setting was selected because it reflects the operational conditions of public healthcare laboratories, including compliance with DOH (Department of Health, 2023) regulations, resource limitations, high patient volume, and workforce demands, all of which may influence the implementation and effectiveness of quality control procedures.

2.3 Respondents of the Study

The respondents were twelve licensed medical technologists employed in the selected hospital laboratory who were directly involved in implementing quality control procedures. As registered professionals under the Philippine Medical Technology Act of 1969 (Republic Act No. 5527), they possess the qualifications and competencies necessary for clinical laboratory practice, enabling them to provide informed and experience-based perspectives on laboratory quality management.

2.4 Sample and Sampling Procedure

The study employed total enumeration, wherein all eligible licensed medical technologists directly involved in quality control procedures in the selected tertiary government hospital laboratory were included as participants.

2.5 Research Instrument

Data were collected using a structured questionnaire developed from established laboratory quality control frameworks, regulatory guidelines, and related literature. The instrument consisted of two sections: the first gathered demographic information, including age, years of professional experience, and employment status, while the second assessed quality control practices across three domains—quality control documentation, equipment calibration, and analytical error detection—using twenty-one indicators rated on a five-point Likert scale ranging from "Never" to "Always." The Likert scale was selected because it effectively quantifies perceptions and behavioral frequency for statistical analysis (Joshi et al., 2015). The instrument underwent content validation by experts in clinical laboratory science and research methodology to ensure clarity, relevance, comprehensiveness, and alignment with quality control standards. Internal consistency reliability was evaluated using Cronbach's Alpha, with a value of 0.70 or higher considered acceptable (Taber, 2018). The instrument achieved an acceptable Content Validity Index, while the reliability coefficients for the three quality control domains demonstrated acceptable to excellent internal consistency.

2.6 Data Gathering Procedure

Prior to data collection, formal approval was obtained from the hospital administration. Participants were informed about the study's purpose, scope, and voluntary nature, and informed consent was secured before participation. The structured questionnaire was administered electronically through Google Forms to facilitate efficient data collection. Responses were gathered within the designated period, monitored for completeness, and subsequently encoded, verified, cleaned, and organized for statistical analysis.

2.7 Data Analysis Techniques

The study employed descriptive and inferential nonparametric statistical methods appropriate for ordinal Likert-scale data and the relatively small sample size (Conover, 1999). Weighted mean and standard deviation described the level of quality control practices, Spearman rank correlation determined relationships among variables, Kruskal–Wallis tested differences among groups, and Cronbach's Alpha assessed instrument reliability. A 5% level of significance ($\alpha = 0.05$) was applied in all inferential analyses, with the null hypothesis rejected when $p \leq 0.05$ and retained when $p > 0.05$ (Conover, 1999; Field, 2018).

2.8 Ethical Considerations

The study adhered to established ethical standards for research involving human participants by ensuring voluntary participation, obtaining informed consent, maintaining participant confidentiality and anonymity, limiting data use to academic and research purposes, and securely storing electronic records in password-protected files. These procedures were consistent with the principles of the Declaration of Helsinki to safeguard the rights, dignity, and welfare of all participants throughout the research process.

3. Results and Discussion

3.1 Level of Quality Control Practices

3.1.1 Respondents' Demographic Profile

The respondents were predominantly female (75%), with most belonging to the 21–30 age group (58.33%). The participants represented both early-career and highly experienced medical technologists, with equal proportions having 1–5 years and 11 years or more of experience (33.33% each). Half of the respondents were employed under Job Order status, while the

remainder were regular or contractual employees. The demographic profile indicates that the study involved a relatively young workforce with varied professional experience and employment status, providing a suitable context for assessing quality control practices within a tertiary government hospital laboratory.

3.1.2 Quality Control Documentation Practices

The respondents reported a very high level of quality control documentation, with an overall mean of 4.357. Record storage, use of standard forms, adherence to documentation procedures, and correction of incomplete records received very high ratings, while supervisor review obtained the lowest, although still high, rating. These findings indicate strong compliance with documentation requirements and effective record management within the laboratory. The results support the importance of documentation in ensuring traceability, audit readiness, and corrective actions, consistent with the recommendations of Plebani (2017) and ISO 15189 quality requirements.

3.1.3 Equipment Calibration Practices

Equipment calibration practices were likewise rated very high, with an overall mean of 4.262. Immediate reporting of equipment issues received the highest rating, followed by documentation of calibration records and verification of results before testing. Calibration schedules and preventive maintenance obtained comparatively lower, though still high, ratings. The findings demonstrate that calibration procedures are consistently implemented despite operational challenges. Strong documentation, verification, and prompt reporting contribute to reliable laboratory performance, supporting recommendations of the Centers for Disease Control and Prevention (CDC), Westgard (2019), and recent studies emphasizing structured calibration monitoring systems in resource-constrained laboratories (Sciacovelli et al., 2023; Tanasiichuk et al., 2023).

3.1.4 Analytical Error Detection Practices

Analytical error detection achieved the highest overall rating ($M = 4.571$, Very High). Corrective actions following detected errors, verification of unexpected results, delta checking, protocol adherence, and monitoring systems all received very high evaluations, indicating strong implementation of analytical error detection procedures. These findings suggest a high level of vigilance among medical technologists in identifying and managing analytical errors. They are consistent with the recommendations of the Clinical and Laboratory Standards Institute and Plebani (2017), which emphasize continuous monitoring and immediate corrective actions. The results also support recent literature describing laboratory quality management as an integrated system in which documentation, equipment management, competence, and monitoring function collectively despite operational constraints (Pillai et al., 2025).

3.2 Relationship Between Quality Control Practices and Demographic Variables

3.2.1 Relationship Between Quality Control Practices and Age

No statistically significant relationship was found between age and any of the quality control domains, with all p-values exceeding 0.05. This indicates that respondents demonstrated comparable quality control practices regardless of age. The absence of significant relationships suggests that compliance with quality control procedures is influenced more by standardized institutional protocols than by age. This supports the World Health Organization's concept of structured laboratory systems that promote consistency in practice.

3.2.2 Relationship Between Quality Control Practices and Years of Experience

Similarly, no statistically significant relationship was observed between years of experience and any quality control domain. Both less experienced and more experienced medical technologists reported comparable levels of compliance with quality control procedures. These findings suggest that standardized training, established protocols, and routine monitoring minimize performance variation among personnel. They are consistent with Total Quality Management principles and studies showing that structured laboratory quality systems improve operational consistency regardless of individual experience.

3.2.3 Difference in Quality Control Practices by Employment Status

No significant differences were found in quality control practices when respondents were grouped according to employment status. Although Job Order personnel showed slightly lower mean scores in some areas, these differences were not statistically significant. The findings indicate that employment classification does not substantially influence the implementation of quality control procedures. Consistent quality management systems and standardized monitoring appear to support uniform laboratory performance despite differences in employment conditions, consistent with recent findings (Sciacovelli et al., 2023; Tanasiichuk et al., 2023).

3.3 Relationship Among Quality Control Practice Domains

A strong and statistically significant positive relationship was found between quality control documentation and equipment calibration ($p = 0.848$, $p < 0.001$). In contrast, no significant relationships were observed between quality control documentation and analytical error detection and between calibration and analytical error detection. The significant

association between documentation and calibration demonstrates the interconnected nature of laboratory quality systems. Accurate documentation supports calibration monitoring, trend identification, traceability, and timely corrective actions, while effective calibration strengthens testing reliability. These findings reinforce the integrated quality system framework advocated by ISO 15189 and are supported by recent literature emphasizing the value of coordinated quality indicators and laboratory monitoring systems for maintaining laboratory consistency.

4. Conclusion & Recommendations

This study found that medical technologists in the selected tertiary government hospital laboratory reported high levels of quality control practices in documentation, equipment calibration, and analytical error detection. No statistically significant relationships were observed between quality control practices and respondents' age, years of experience, or employment status, while a very strong positive relationship was identified between quality control documentation and equipment calibration. Overall, the findings indicate that quality control performance is supported by an integrated, systems-oriented approach within the laboratory.

The laboratory should continue strengthening its quality control system by sustaining effective documentation, equipment calibration, and analytical error detection practices while maintaining standardized procedures that support consistent implementation across personnel. Particular attention should be given to reinforcing the integration of documentation and calibration processes to further support laboratory quality management and continuous quality improvement.

The findings of this study should be interpreted with caution because they were based on a small sample of twelve respondents from a single government hospital laboratory and relied on self-reported measures. These limitations restrict the generalizability of the results and should be considered when interpreting the study's findings.

Compliance with ethical standards

The authors conducted this study in accordance with established ethical standards for research involving human participants. Prior to data collection, permission was obtained from the hospital administration. Participation was voluntary, and all participants were informed of the purpose and scope of the study before providing informed consent. The authors ensured the confidentiality and anonymity of all participants, used the collected data solely for academic and research purposes, and securely stored all electronic records in password-protected files. The study was conducted in accordance with the principles of the Declaration of Helsinki to protect the rights, dignity, and welfare of all participants throughout the research process.

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