

**Research Article****KNOW ERROR, NO ERROR: "IMPROVING ACCURACY IN CLINICAL LABORATORIES: STRATEGIES FOR REDUCING ERRORS IN NURSE-COLLECTED SAMPLES"****<sup>1</sup>Dr. Usha Banerjee and <sup>2,\*</sup>Poonam Soman**<sup>1</sup>Group Director of Nursing, Nursing, Indraprastha Apollo Hospitals New Delhi, India<sup>2</sup>Quality Assurance Officer, Nursing, Indraprastha Apollo Hospitals New Delhi, India**Received 19<sup>th</sup> July 2024; Accepted 24<sup>th</sup> August 2024; Published online 30<sup>th</sup> September 2024**

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**Abstract**

Over one year from April 2023 to March 2024, the main issues contributing to sample errors were identified as lack of staff knowledge, mishandling of samples, inadequate sample volumes, labeling mistakes, inexperience among new staff, and difficulties in collecting samples from challenging veins. Closed-method training, on-the-job reinforcement, and hands-on practice with dummy arms were implemented to address these issues. This study assesses the effectiveness of a focused intervention campaign designed to decrease errors in sample collection in a clinical laboratory, specifically focusing on samples collected by nurses. This study focuses on addressing sample errors in the context of nurse-collected samples within a clinical laboratory setting. Recognizing that nurses are pivotal in the sample collection process, the study aims to identify and address the specific factors contributing to sample errors in this group. By investigating the root causes of these errors and implementing targeted interventions, the goal is to enhance the accuracy and reliability of nurse-collected samples, ultimately improving the overall quality of laboratory testing and patient care. The results showed a significant decrease in sample error rates, with a decline from an average of 1.68, 1.69, and 1.53 errors per 1000 lab tests in the early months of the study to 1.28, 1.23, and 1.13 errors per 1000 lab tests by the end of the study period. This positive trend highlights the effectiveness of the campaign's interventions in improving the accuracy and reliability of nurse-collected samples. The findings emphasize the crucial role of continuous staff education and standardized procedures in enhancing laboratory performance. The study's success in reducing error rates illustrates the broader relevance of such targeted approaches in other areas of clinical practice, aiming to promote a culture of ongoing improvement and high-quality standards in laboratory testing.

**Keywords:** Sample Error, Clinical Laboratories, Sample Accuracy, Nurse-Collected Samples, Error Reduction, and Quality Improvement.

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**INTRODUCTION**

Laboratory testing constitutes a cornerstone in effective healthcare delivery as diagnostic investigations have a major impact on ensuring correct diagnoses and determining appropriate therapy. Accurate and trustworthy test findings depend on the sample's integrity and quality being maintained. In clinical laboratories, the precision and reliability of test results are paramount for accurate diagnosis and effective patient care. The quality of the samples that are obtained is one of the most important criteria that affects how accurate laboratory tests are.<sup>1</sup> Sample errors, which are instances where samples do not meet the required criteria for laboratory analysis, can significantly undermine the reliability of test results, leading to potential misdiagnoses or incorrect treatment plans. These errors, often originating from various stages of the sample collection process, can result in increased retesting, delayed diagnoses, and overall inefficiencies in the healthcare system. Possible consequences of pre-analytical errors include delayed treatment, wrong diagnosis, repeated sampling, and increased costs. According to the research, clotted samples, incorrectly labeled containers, empty or unsuitable samples, hemolyzed samples, patient identity issues, and transport-related errors are the most frequent pre-analytical errors.<sup>2</sup> Sample errors are not uncommon and can arise from several factors. These include issues related to the handling and processing of samples, such as incorrect mixing of additives, insufficient sample volume, or errors in labeling.

Additionally, the skill and training of the personnel collecting the samples play a crucial role. In many clinical settings, nurses are frequently responsible for the collection of samples, making their training and adherence to protocols essential to minimizing errors. Despite their critical role, nurses often face challenges such as varying levels of experience, inadequate training, and difficult sampling conditions, which can contribute to higher error rates. Wrong tube, insufficient sample, and clotting. Misleading lab values and delays in care can result from using the incorrect tube, collecting an inadequate amount, and blood clotting. Errors involving the wrong tube can be practically eliminated using electronic devices that produce labels that define the sort of tube to use. If not, ask the lab for advice if you're not sure which tube to use. Venepuncture, sometimes known as phlebotomy, is the process of taking a patient's blood with a needle. There are a number of collecting techniques utilized in this procedure. The haemolysis of preanalytical blood samples is influenced by the technique of collection. Red blood cell breakdown, or hemolysis, renders the sample inappropriate. A thorough review of the literature revealed a dearth of published data about the relationship between staff confidence and knowledge and hemolysis, despite the availability of research regarding the common causes.

**Objective**

The primary objective of this study is to reduce the error rates associated with nurse-collected samples in clinical laboratories. Specifically, the study aims to:

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1. **Identify the Root Causes of Sample Errors:** Investigate the underlying factors contributing to sample errors in nurse-collected samples, including issues related to training, technique, and procedural adherence.
2. **Implement Targeted Interventions:** Develop and introduce strategic interventions to address the identified root causes. This includes enhancing training programs, improving procedural guidelines, and providing hands-on practice to reinforce proper techniques.
3. **Evaluate the Impact of Interventions:** Assess the effectiveness of the implemented interventions by analyzing changes in sample error rates over time. This involves comparing error rates before and after the introduction of the interventions to determine their impact on sample accuracy.
4. **Promote a Culture of Continuous Improvement:** Foster an environment of ongoing education and procedural refinement to maintain high standards of sample collection and laboratory practices.

## Materials and Methods

### Study Design

This study utilized a longitudinal approach to evaluate the impact of targeted interventions on reducing sample errors in nurse-collected samples within a clinical laboratory setting.

**Study Period:** April 2023 to March 2024

### Setting and Participants

The study was conducted in clinical laboratories across multiple departments, including Haematology, Microbiology, Histopathology, Biochemistry, and the Blood Bank. The participants were staff nurses responsible for sample collection.

- Inclusion Criteria: All samples collected by staff nurses.
- Exclusion Criteria: Samples collected by the sample collection area, phlebotomists, and doctors.
- Working Formula:  $(\text{Number of rejected samples in a month} / \text{Total number of lab tests}) \times 1000$ .

### Data Collection Methodology:

1. Reporting of errors by staff or laboratory to the concerned unit, monitored by the in-charge/supervisor.
2. Daily data capture with monthly cumulative reporting to the Nursing office.

**Data Sources:** Haematology lab, Microbiology lab, Histopathology lab, and Biochemistry lab.

### Root Cause Analysis

The following root causes of sample errors were identified:

1. Lack of Staff Knowledge: Inconsistent training and knowledge gaps.
2. Improper Inverting of Samples: Improper mixing of additives can significantly alter test results, leading to inaccurate or unreliable outcomes."

3. Inadequate Quantity of Samples: Insufficient volumes leading to sample rejection.
4. Labelling Issues: Errors in sample labeling cause misidentification.
5. Newly Recruited Staff: Inexperience among new staff increasing error rates.
6. Difficult Sampling: Challenges in collecting samples from patients with difficult veins or complications.

### Action Plan

#### 1. Identify the Root Causes of Sample Errors

- Objective: Investigate the underlying factors contributing to sample errors in nurse-collected samples.
- Actions Taken:
  - Conducted a comprehensive analysis of sample errors, focusing on training, technique, and procedural adherence.
  - Collected data from clinical laboratories and reviewed error logs to identify common patterns and issues related to sample collection.

#### 2. Implement Targeted Interventions

- Objective: Create and implement strategic interventions to deal with the underlying issues that have been found.
- Actions Taken:
  - Closed Method Training: Standardized training protocols were established for all staff nurses to ensure consistency in sample collection techniques.
  - On-the-Job Training: Conducted continuous training sessions to reinforce proper techniques and address any emerging issues in real-time.
  - Training on Dummy Arms: Provided practical demonstrations and hands-on practice using dummy arms to enhance skills and confidence in sample collection.

#### 3. Evaluate the Impact of Interventions

- Objective: Assess the effectiveness of the implemented interventions by analyzing changes in sample error rates over time.
- Actions Taken:
  - Sample error rates were monitored and recorded before and after the introduction of the interventions.
  - Analyzed data from April-June 2023 and January-March 2024 to measure the reduction in error rates and assess the impact of the interventions.

#### 4. Promote a Culture of Continuous Improvement

- Objective: Foster an environment of ongoing education and procedural refinement to maintain high standards.
- Actions Taken:
  - Implemented regular review sessions and feedback loops to refine training programs and procedural guidelines continuously.
  - Encouraged a culture of continuous learning and improvement among staff to sustain the gains achieved and address any new challenges promptly.

The methodology of this study involves a detailed analysis of sample error rates over a one-year period, from April 2023 to March 2024. It includes a comprehensive examination of the existing protocols and training practices for nurses, followed by the implementation of strategic interventions designed to address identified issues. These interventions include standardized training programs, hands-on practice sessions, and ongoing support to ensure adherence to best practices. The effectiveness of these measures is evaluated through a comparison of error rates before and after the interventions, providing insight into the impact of improved training and procedural changes

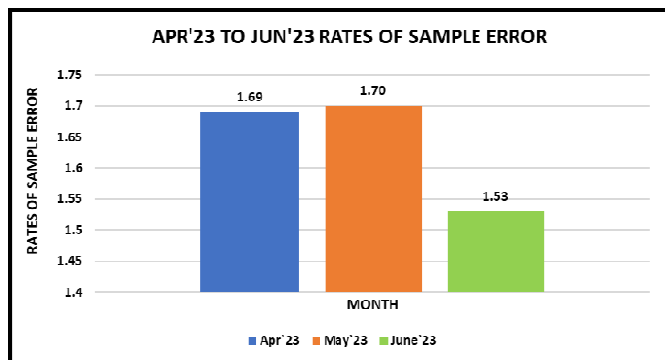
## RESULTS

The targeted interventions led to a significant reduction in error rates for nurse-collected samples:

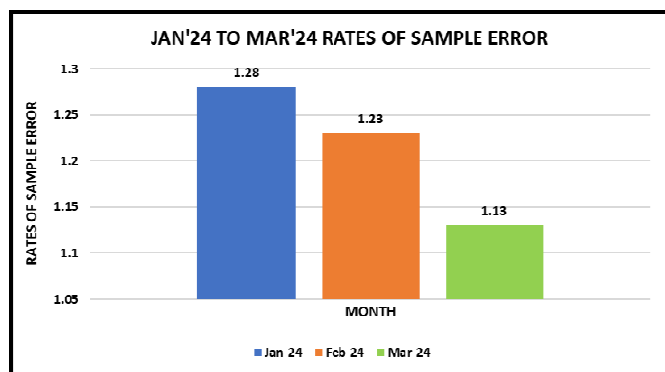
- **April-June 2023:** Error rates were 1.68, 1.69, and 1.53 per 1000 lab tests.
- **January-March 2024:** Rates improved to 1.28, 1.23, and 1.13 per 1000 lab tests.

The decrease in error rates reflects the success of the interventions and contributed to increased efficiency and reliability in laboratory operations. These results reflect the effectiveness of the interventions, including standardized training and hands-on practice, in reducing sample errors and enhancing the overall quality of laboratory testing. The decrease in error rates indicates a successful reduction in sample rejections and associated retesting frequency, leading to increased efficiency and reliability in laboratory operations.

### Effectiveness of campaign



Before the campaign



After the campaign

Figure 1. The declining trend shows the campaign's positive impact in reducing the sample errors



Figure 2. Improvement and Implementation- Showing glimpses of reinforcement training for all the nurses on sample collection and common errors

Order of Draw			
Tube Closure Color	Collection Tube	Mix by Inverting	Min. Clot Time
Yellow	Blood Cultures – SPS	8 to 10 times	N/A
Light Blue	Citrate Tube (Light Blue)	3 to 4 times	N/A
Gold and Tiger	Serum Separator Tubes (Gold and Tiger)	5 times	30 minutes
Red	Serum Tube (Red)	5 times (plastic) None (glass)	60 minutes
Orange	Rapid Serum Tube (Orange)	5 to 6 times	5 minutes
Green	Plasma Separator Tube	8 to 10 times	N/A
Green	Heparin Tube (Green)	8 to 10 times	N/A
Lavender	EDTA Tube (Lavender)	8 to 10 times	N/A
Pearl	PPT Separator Tube (Pearl)	8 to 10 times	N/A
Gray	Fluoride Tube (Gray)	8 to 10 times	N/A

Figure 3. Improvement and Implementation-showing the Sample Collection Process Flow & Order of Draw

The results of this study have significant implications for clinical laboratory operations. By reducing sample error rates, the study demonstrates the importance of rigorous training and continuous education for staff involved in sample collection. Furthermore, it highlights the potential for similar approaches to be applied in other areas of healthcare to enhance overall diagnostic accuracy and efficiency.

## DISCUSSION

The marked reduction in sample error rates from April 2023 to March 2024 underscores the effectiveness of the interventions aimed at improving nurse-collected samples. Data show a significant decrease in error rates, dropping from an average of 1.68 per 1,000 lab tests in the initial months of the study to 1.13 per 1,000 lab tests by the end. This notable improvement highlights the positive impact of targeted training and

procedural enhancements on the quality of sample collection. The root cause analysis identified several key factors contributing to sample errors, including gaps in staff knowledge, improper handling techniques, and challenges associated with newly recruited staff. By addressing these issues through a structured approach, including closed-method training, on-the-job training, and practical demonstrations, the study successfully mitigated many of the common sources of error. These interventions not only improved the technical skills of the nurses but also standardized the procedures across the board, reducing variability in sample collection practices. The success of the training programs and procedural changes reflects the importance of investing in continuous education and hands-on practice for clinical staff. The standardized training protocols ensured that all nurses were equipped with the necessary skills and knowledge to perform sample collections accurately, while the practical demonstrations provided valuable opportunities for real-world practice and immediate feedback. This combination of theoretical and practical training proved effective in addressing the initial root causes of errors. In addition to improving sample accuracy, the interventions contributed to enhanced overall laboratory efficiency. By reducing the number of rejected samples, the laboratory experienced fewer delays related to retesting and processing, which streamlined operations and optimized resource utilization. This efficiency not only benefits the laboratory but also has positive implications for patient care, as more accurate and timely test results support better diagnostic and treatment decisions. Furthermore, the success of this study highlights the broader applicability of similar approaches in other areas of healthcare. The principles of continuous improvement, standardized training, and practical reinforcement can be applied to various aspects of clinical practice to address similar challenges and enhance quality. The findings suggest that a structured approach to identifying and addressing specific issues can lead to substantial improvements in performance and outcomes.

## Conclusion

The project successfully reduced sample error rates through a combination of rigorous training and hands-on practice. These measures addressed existing challenges and fostered a culture of continuous improvement, ensuring sustained accuracy and reliability in laboratory testing. In conclusion, the study demonstrates that targeted interventions can significantly reduce sample error rates and improve laboratory practices. By focusing on enhancing staff training and standardizing procedures, the research has achieved its objective of reducing errors in nurse-collected samples and has set a precedent for ongoing improvements in clinical laboratory settings. The results underscore the value of rigorous training programs and the need for continuous evaluation and refinement of practices to maintain high standards of accuracy and reliability in laboratory testing.

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