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Evaluating pre-analytical sample error in haematology laboratory at a tertiary care teaching hospital in Nepal

Surya Dev Kumar Sah[1], Ram Prasad Sharma G[2], Sanjay Ray Yadav[3]

[1]Department of Haematology, Madan Bhandari Academy of Health Sciences, Hetauda, Nepal
[2]Department of Hospital Administration, Chitwan Medical College, Bharatpur, Chitwan, Nepal
[3]Department of Biochemistry, Chitwan Medical College, Bharatpur, Chitwan, Nepal

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Abstract

Introduction: The pre-analytical phase, from test ordering to sample processing, is significantly affected by sample errors and impacts the accuracy of haematology laboratory results. The majority of errors occur during this period, which affects diagnosis and patient care. This study aims to recognise prevalent pre-analytical sample errors occurring in the haematology laboratory and reduce these errors, possibly improving the quality management systems.

Method: A cross-sectional descriptive study was conducted in the haematology laboratory of Chitwan Medical College and Teaching Hospital, Nepal, using data collected from September 2024 to August 2025. Data sources included the laboratory information system and handwritten registers. Pre-analytical errors assessed included haemolysis, clotted samples, missing identification, delayed transport, and insufficient samples. Descriptive statistical analysis of error frequencies and percentages was performed using IBM SPSS version 21.

Result: Out of 100,995 samples analysed, 2,037 (2.0%) exhibited pre-analytical errors. Within these errors, the haematology central laboratory accounted for the majority with 1,519 (74.6%), while the emergency laboratory accounted for 518 (25.4%). Insufficient sample volume and haemolysis were identified as the most common types of pre-analytical errors.

Conclusion: he most common pre-analytical errors in the haematology laboratory were insufficient sample volume and haemolysis. Ongoing staff training, implementation of automated systems, adherence to standard operating procedures, and compliance with quality standards are essential for improving laboratory efficiency, diagnostic accuracy, and patient safety.

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Correspondence

Mr. Surya Dev Kumar Sah, Lecturer, Department of Haematology, Madan Bhandari Academy of Health Sciences, Hetauda, Nepal. Email: suryadevsah06@gmail.com, Telephone: +977 9702022045

Introduction

Total quality in laboratory medicine ensures every testing step is done right, leading to useful medical judgment and effective patient care.[1] A medical laboratory is crucial for delivering quick and accurate test results for patient treatment.[2] One of the busiest areas of the clinical laboratory is the haematology lab.[3] There are three stages involved in testing blood samples in a haematology lab: pre-analytical, analytical, and post-analytical. The pre-analytical phases cover everything from when the doctor submits a laboratory request until the sample is ready for testing.[4,5] Common pre-analytical errors include wrong test orders, improper sample collection, transport delays, and poorly written requisition forms.

Pre-analytical errors represent 46%–70% of all errors in laboratory results, and emerge as the most crucial phase.[6] The laboratories must take responsibility for any discrepancies or false reports caused by these errors.[7] Lab errors may occur during the testing procedure due to inadequately prepared protocols, poor communication between laboratory staff, and issues from other processes.[3] The involvement of multiple professionals, including nurses, doctors, laboratory scientists, technicians, and phlebotomists, makes the pre-analytical phase both highly important and particularly difficult to control and oversee.[8]

Studies revealed that the laboratory errors occur in the different departments within the same institutions.[9] Due to workload challenges and the involvement of multiple medical experts, pre-analytical errors are more likely to occur.[10] This study aims to find out the prevalence of pre-analytical errors occurring in the Haematology Laboratory.

Method

A cross-sectional study was conducted to evaluate pre-analytical errors in the Haematology Laboratory of the Department of Laboratory Medicine at Chitwan Medical College and Teaching Hospital, Nepal. Data covering a one-year period from Sep 2024 to Aug 2025 were included. The 750-bed hospital provides inpatient, outpatient, and emergency services. Specimen transport across all hospital departments and wards is performed by non-laboratory personnel, who receive continuous training coordinated by the infection prevention and control committee. Ethical approval for the study was obtained (Ref: CMC-IRC/081/082-022).

As per hospital protocol, all samples received in the haematology laboratory were recorded manually in a register, documenting the sample details, time of receipt, and the personnel involved in transport and receipt. Using the laboratory information system, data on all unacceptable, rejected, or cancelled tests in the haematology laboratory were retrieved, analysed, and recorded for pre-analytical errors.

All samples were analysed on automated haematology analysers (Yumizen H2500 and H1500, Horiba) and a VISION-A ESR analyzer. Laboratory requests and patient samples from the emergency, outpatient, and inpatient departments received during the one-year study period were included. Samples outside the scope of the haematology department were excluded.

Collected data were processed for descriptive analysis. Frequency, percentage, and cross-tabulation were performed using IBM SPSS version 21.

Result

Out of a total of 1,00,995 samples received by the haematology departments, pre-analytical sample errors were found in 2037 (2.0%), the majority in the haematology central laboratory, 1,519 (74.6%), followed by 518 (25.4%) in the emergency laboratory, Figure 1.

Out of total errors, the most common errors observed in the haematology central and emergency laboratory were insufficient samples 903 (44.3%), followed by haemolysed samples 364 (17.9%), and the least common errors being lipemic samples 25 (1.2%) and wrong test orders 10 (0.5%), Table 1.

Most of the sample errors were from the outpatient department, observed in 1,418 (69.6%), followed by 540 (26.5%) from inpatient wards. The least number of errors occurred in the dialysis facility, accounting for 60 (2.9%), and day care, 22 (1.1%), Figure 2.

The distribution and analysis of pre-analytical sample errors revealed that the outpatient department had 1,418 (69.6%) errors, most common being insufficient samples 751 (53.0%), followed by haemolysis 329 (23.2%), and the least common errors being clotted samples, overlapping barcodes, and specimen leakage (each 0.8%), Table 2.

Inpatient wards had 540 (26.5%) errors, the most common being clotted samples 186 (34.4%), followed by insufficient samples 108 (20.0%), and the least common error being wrong orders 10 (1.9%), and zero lipemic samples.

The dialysis centre had 60 (2.9%) errors, most common being insufficient samples 33 (55.0%) and clotted samples 27 (45.0%).

The day care unit had 22 (1.1%) errors, both insufficient samples and haemolysis, each 11 (50.0%), Table 2.

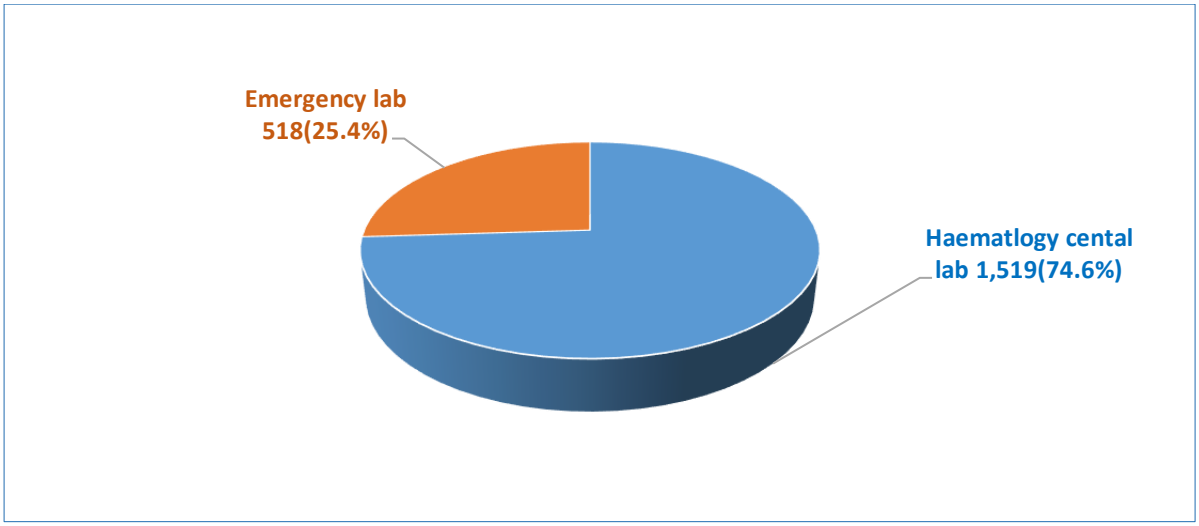

Figure 1. Distribution of pre-analytical sample errors in haematology lab of a tertiary care teaching hospital of a medical college, n=2037

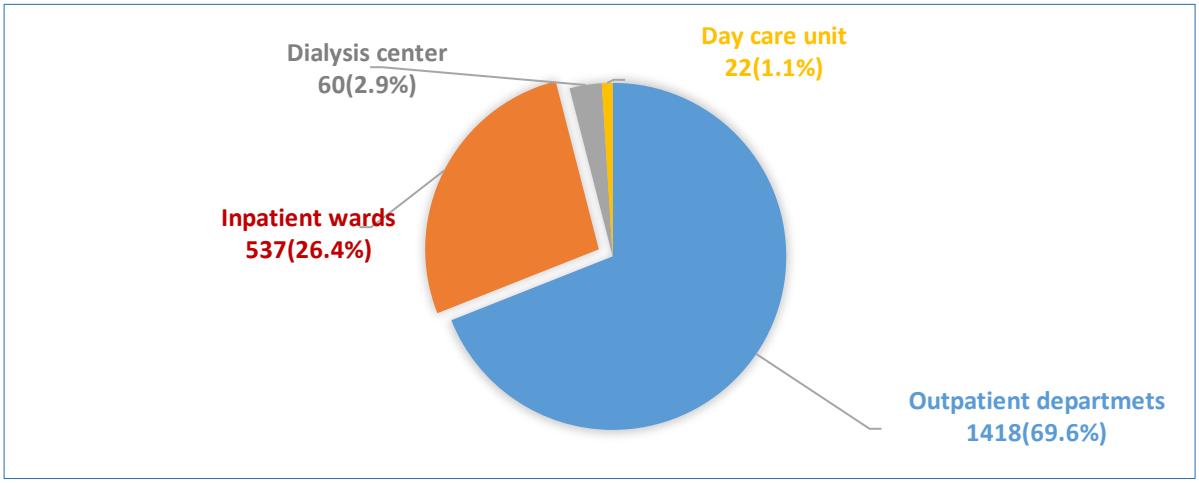

Figure 1: Distribution of pre-analytical sample error percentage from different departments, n=2037

Table 1. Pre analytical error in sample received by haematology laboratory of at a tertiary care hospital, n=2037

Preanalytical errors	n(%)
Insufficient samples	903(44.3)
Haemolysis samples	364(17.8)
Missing identification samples	259(12.7)
Clot detected samples	225(11.0)
Diluted samples	130(6.4)
Delay transport samples	49(2.4)
Overlapping of barcode (barcode errors) samples	35(1.7)
Specimen leakage samples	37(1.8)
Lipemic samples	25(1.2)
Wrong orders samples	10(0.5)

Table 2. Distribution of pre-analytical sample error types by different departments, n=2037

Pre analytical sample errors	Total n(%)	Outpatient n(%)	Inpatient n(%)	Dialysis n(%)	Day care n(%)
Insufficient samples	903(44.3)	751(53.0)	108(20.0)	33(55.0)	11(50.0)
Haemolysis samples	364(17.8)	329(23.2)	24(4.4)	0	11(50.0)
Missing identification samples	259(12.7)	192(13.5)	67(12.4)	0	0
Clot detected samples	225(11.0)	12(0.8)	186(34.4)	27(45.0)	0
Diluted samples	130(6.4)	58(4.1)	72(13.3)	0	0
Delay transport samples	49(2.4)	27(1.9)	22(4.1)	0	0
Overlapping of barcode (barcode errors) samples	35(1.7)	12(0.8)	23(4.3)	0	0
Specimen leakage samples	37(1.8)	12(0.8)	25(4.6)	0	0
Lipemic samples	25(1.2)	25(1.8)	0	0	0
Wrong order of samples	10(0.5)	0	10(1.9)	0	0

Discussion

This study found a pre-analytical sample error rate of 2.0% (2037 out of 100,995 samples) in the haematology laboratory, with the majority of errors from outpatient (69.6%) departments. Insufficient sample volume was the leading cause in the outpatient and day care settings, whereas clotted samples were the primary issue in the inpatient and dialysis settings.

In the past few decades, there has been notable progress in the field of medical laboratory testing.[11] Laboratory errors can negatively impact diagnosis, patient care, and the quality of the test.[12] In the present study, pre-analytical errors were more common in outpatient departments than in inpatients. High patient volumes lead to more blood collections, creating a heavy workload and increased pressure on phlebotomy staff. This study's finding of pre-analytical errors of 2.0% from the total samples is lower than the rates found in similar studies by reporting a rate of 4.7% to 39%.[13-16] However, it is higher than the findings reported as low as 0.3% to 1.3%.[3,17] The present study's findings are similar to some other studies reporting sample error rates of 2.2%[18] and 2.1%[19].

The most common sample error identified was insufficient sample volume (44.3%). Similar findings have been reported, with insufficient sample amounts leading to rejection in 25%[13] of samples from Nepal, 33.1%[20] from Pakistan, and 54.18%[3] in a study from Saudi Arabia. This could be due to a high workload and improper coordination between phlebotomy and

laboratory staff regarding the required test volume.

In this study, we identified several crucial pre-analytical errors, such as haemolysis (17.9%) and missing identification (12.7%), mostly from outpatient departments. Similar findings were reported in other studies with haemolyzed samples in 20%[13] and 29.2%[12] of total pre-analytical errors, respectively. The relatively low frequency of sample errors in the present study may be due to adherence to standard operating procedures (SOPs), implementation of ISO 15189:2022 guidelines,[21] and quality control measures. These include automated barcode systems, automated sample transportation via pneumatic channel systems, appropriate sample processing, and efficient communication between laboratory and clinical staff.

After careful investigation, we found that some staff members lacked awareness and demonstrated negligence during phlebotomy procedures, along with inadequate patient preparation before sample collection, leading to pre-analytical errors. This has also been highlighted in previous studies.[3] Consequently, after analysing the data, we provided training to nursing and phlebotomy staff on proper sample collection techniques and patient preparation. Automation in the pre-analytical phase has been shown to reduce errors, as suggested in the literature.[22]

This study has several limitations. As a single-centre audit, the findings may not be generalizable to other settings. Additionally, only errors identifiable at the point of laboratory receipt—such as insufficient volume, haemolysis, or clotted specimens—were captured. We did not include a formal root-cause analysis, which would be necessary to implement targeted corrective actions. Other pre-analytical errors that are not visually apparent were likely under-reported, including patient misidentification, incorrect order of draw, improper sample storage, or collection at inappropriate times. Issues such as using the wrong sample type (e.g., serum instead of EDTA plasma) may also go unnoticed if testing proceeds, albeit with suboptimal performance. Errors affecting labile analytes, such as delayed transport or prolonged tourniquet application, can yield analytically acceptable but clinically misleading results without triggering sample rejection.

Future multi-centre studies incorporating structured root-cause analyses and evaluating the downstream clinical impact of these errors would provide a more comprehensive basis for quality-improvement initiatives.

Conclusion

This study identified a 2.0% pre-analytical error rate in haematology samples, with the majority occurring in the central laboratory. Overall, insufficient sample volume was the leading cause of errors. However, the error profile differed significantly by patient location: it was predominantly an insufficient sample problem in the outpatient and day care settings, but primarily a clotting problem in inpatient and dialysis settings.

Thus, targeted interventions, such as improved phlebotomy training for outpatient collections and better anticoagulant mixing for inpatient samples could effectively reduce pre-analytical errors.

Nevertheless, this study provides only baseline data on pre-analytical errors. For meaningful quality improvement, the root causes and clinical impacts behind these numbers must be further analysed.

Author contribution

Conception, design: SDKS, SRY; Data acquisition: RPSG; Data analysis, interpretation: SDKS; Drafting: SDKS; Revision and Agreement to be accountable for all aspects of the work: All.

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Conflict of interest

None

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Supplementary material

Data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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