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PRE-ANALYTICAL PHASE ERRORS IN CLINICAL LABORATORY PRACTICE: EVIDENCE FROM A TERTIARY CARE TEACHING HOSPITAL

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ABSTRACT
Pre-analytical errors remain the most frequent source of inaccuracies in clinical laboratory testing and can significantly affect patient safety. This study was conducted in a tertiary care teaching hospital to identify and characterize the types of pre-analytical sampling errors observed in routine laboratory practice. Among the errors documented, haemolyzed samples, insufficient sample volume, and clotting in anticoagulant tubes were the most prevalent, while identification and transport-related errors, though less frequent, carried a higher clinical risk. The findings underscore the need for strict adherence to standard operating procedures, staff training, and continuous quality monitoring to reduce preventable errors in the pre-analytical phase.

INTRODUCTION
A laboratory is a facility equipped with specialized equipment and resources for conducting scientific research, experimentation, analysis, and testing. Laboratories are used in a wide range of fields, including chemistry, biology, physics, engineering, medicine, and environmental science.

- Pre-analytical errors can have a significant impact on laboratory test results, potentially leading to incorrect diagnoses, inappropriate treatments, and compromised patient care.
- Pre-analytical sampling errors were identified through the use of incident reporting and sample processing.
- The most common pre-analytical errors identified were related to patient identification, inadequate sample volume, and improper sample handling and transport.
- The study suggests that reducing pre-analytical errors in the laboratory. Improvements in laboratory procedures, such as the implementation of standard operating procedures (SOPs) and staff training and education.
- Pre-analytical sampling errors refer to mistakes or deviations that occur during the collection, handling, and processing of patient specimens before laboratory analysis. These errors can have a significant impact on laboratory test results, potentially leading to incorrect diagnoses, inappropriate treatments, and compromised patient care. Pre-analytical errors can arise from a variety of sources, such as errors in patient identification, improper collection techniques, inadequate sample volume or quality, improper sample storage and transport, and delays in sample processing.
- Pre-analytical mistakes still pose a serious problem in healthcare despite improvements in laboratory technology and automation. These mistakes could result from several things, such as human factors (such as inadequate training or a disregard for protocol), specimen-related problems (such as hemolysis or contamination), and environmental factors. The findings of the study may inform improvements in laboratory procedures to reduce pre-analytical errors and maintain high-quality patient care.

AIM:
The main aim of the study was to determine the causes of pre-analytical sampling errors in the laboratory.

OBJECTIVES OF THE STUDY:
- To determine and compare the blood specimen rejection rate of a clinical laboratory.
- To characterize and compare the types of pre-analytical errors.
- To study the need for corrective steps at various levels to reduce pre-analytical errors to optimize patient care and resource utilization.

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METHODOLOGY

Source of data:
The study was conducted in a tertiary care teaching hospital, established with the concept of providing medical facilities to needy people. A cross-sectional study has been carried out, which included the collection of information and data directly from the subjects of the study through a pre-designed questionnaire.

Study design:
The tool was a structured questionnaire developed by WHO training material for the detection, prevention, response, and control of Pre-Analytical errors. The practice items covered appropriate usage of personal protective equipment (PPE) at work and personal/social life.

The questionnaire was specially designed for the study using fixed response questions, Yes/No/Not sure.

Sample Size:
The study includes 115 participants from different cadres of healthcare workers selected by a random sampling technique covering the hospital.

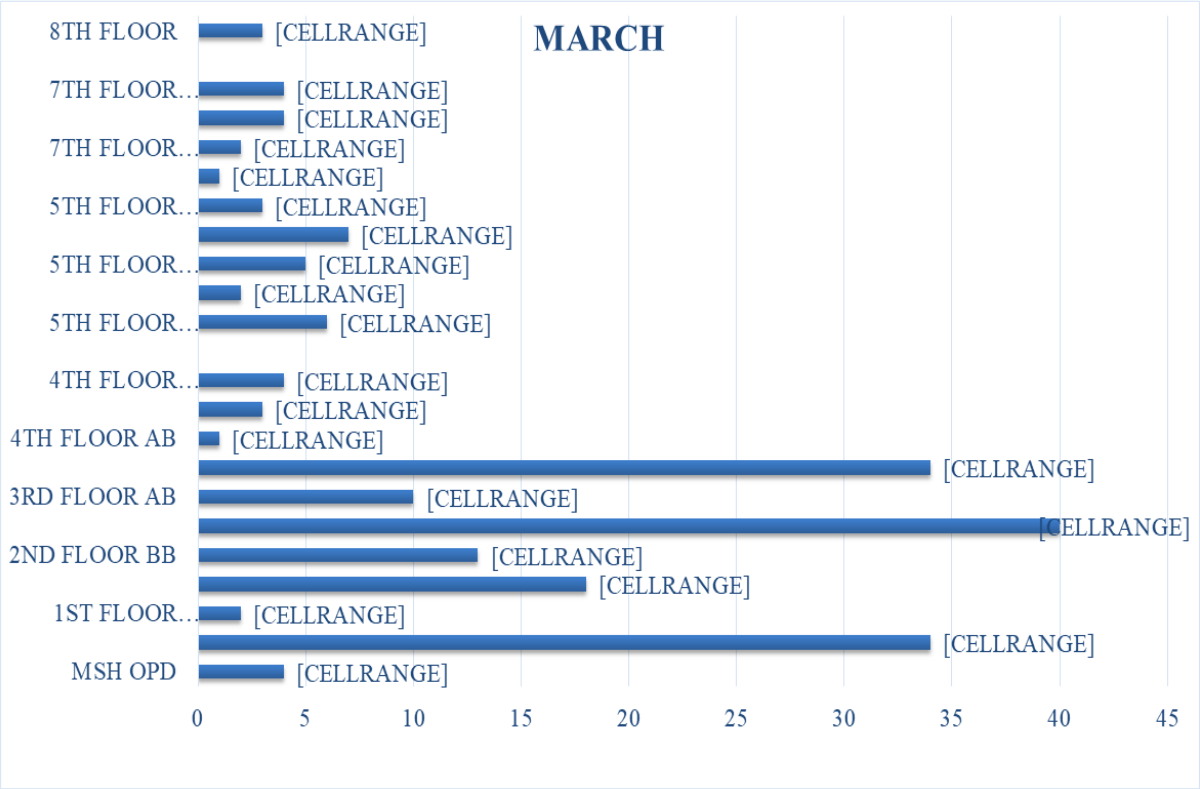
Method Of Data Collection:
The structured questionnaire was administered and interviewed to the study participants, and thus the data was collected.

Their responses were recorded strictly based on anonymity to avoid social desirability bias.

RESULTS:
The current study aimed to assess errors that occur in the pre-analytical phase of laboratory testing and their impact on patient safety and medical diagnosis. The study was conducted at a Clinical Laboratory in a tertiary care hospital from February 2023 to July 2023. The data of all cancelled tests and requests were retrieved from the laboratory information system and evaluated for pre-analytical errors. The findings emphasize the importance of the pre-analytical phase in ensuring the quality of laboratory results and highlight the need for enhanced educational efforts and training in sample collection among hospital staff to minimize errors and improve patient safety.

- **To determine and compare the blood specimen rejection rate of a clinical laboratory**.

Determination and comparison of the blood sample rejection rate of a clinical laboratory:



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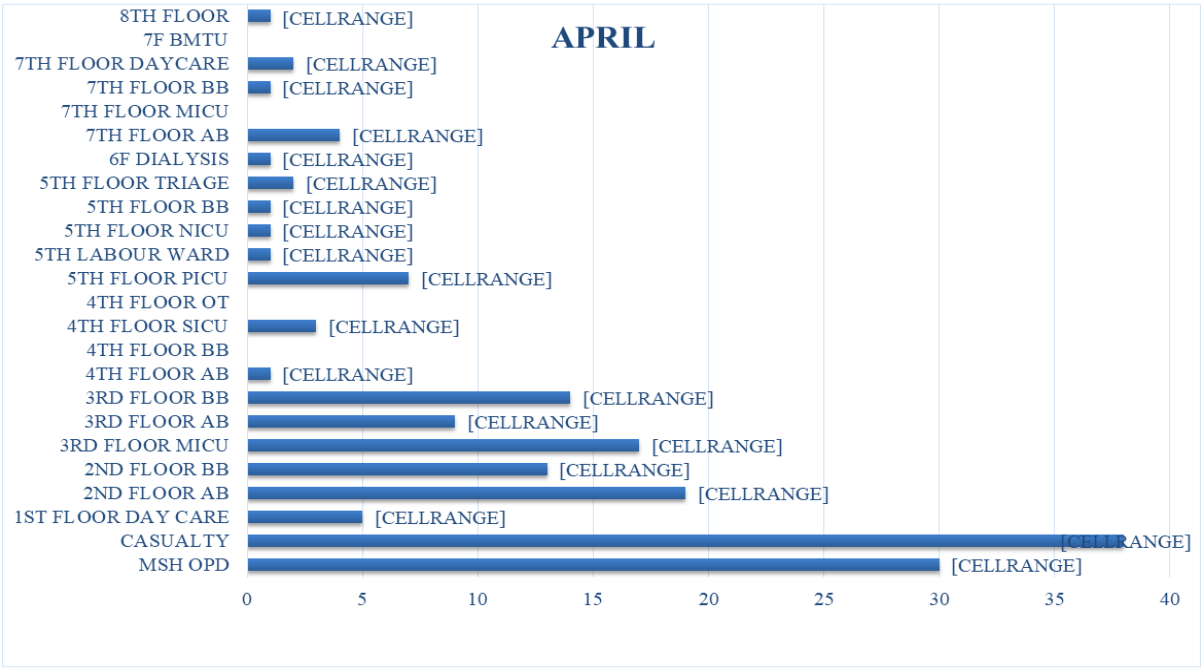

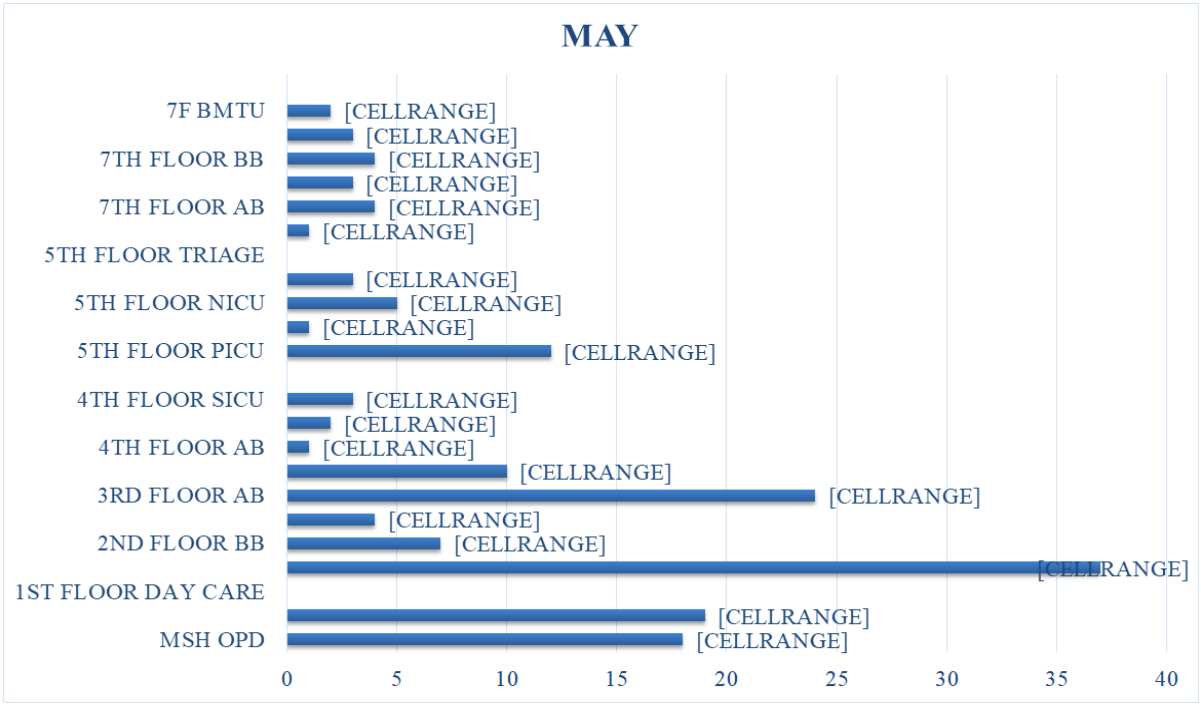

Generally, the highest rejection rate was from the casualty department , followed by the ICUs.

Characterization of the types of pre-analytical errors that occurred in the hospital.

2500 **samples** processed in the Clinical Laboratory of a Tertiary Care Teaching Hospital over 3 months.

Type of Pre-Analytical Error	Frequency (n)	Percentage (%)
Hemolyzed samples	63	8.4%
Insufficient sample volume	54	7.2%
Clotted samples (in anticoagulant tubes)	45	5.9%
Wrong container/tube used	23	3.0%
Improper labeling (name/ID mismatch)	18	2.4%
Delayed transport to laboratory	12	1.6%
Leakage/spillage during transport	6	0.8%
Others (e.g., sample without requisition form)	5	0.7%
Total Errors	**226**	**Approximately 30.0%**

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The most common pre-analytical errors identified were related to hemolysed samples , followed by inadequate sample volume, clotted samples, wrong tube used, patient identification, , and improper sample handling and transport.

The need for corrective steps at various levels to reduce pre-analytical errors to optimize patient care and resource utilization was collected in the form of questions to put in the interventions .

The questionnaire was distributed to 150 participants, out of which 115 responded, thus the response rate was 76%.

The results of the study are as follows:

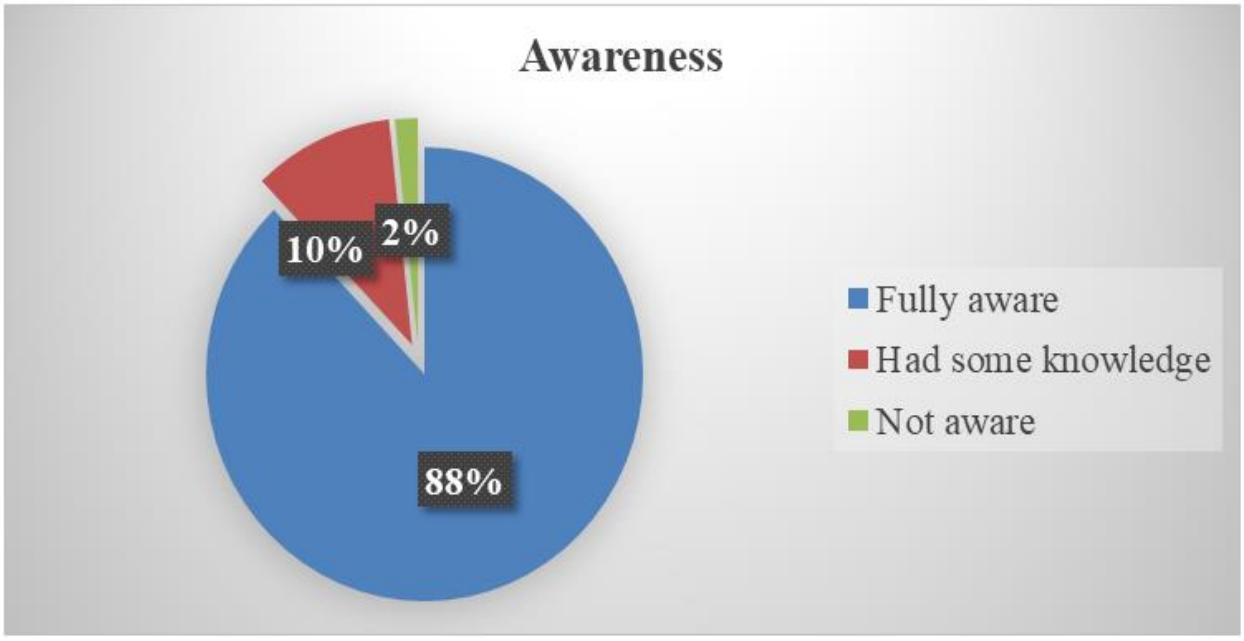

FIG 1: Awareness of the study participants to assess the concept of pre analytical errors in sample collection

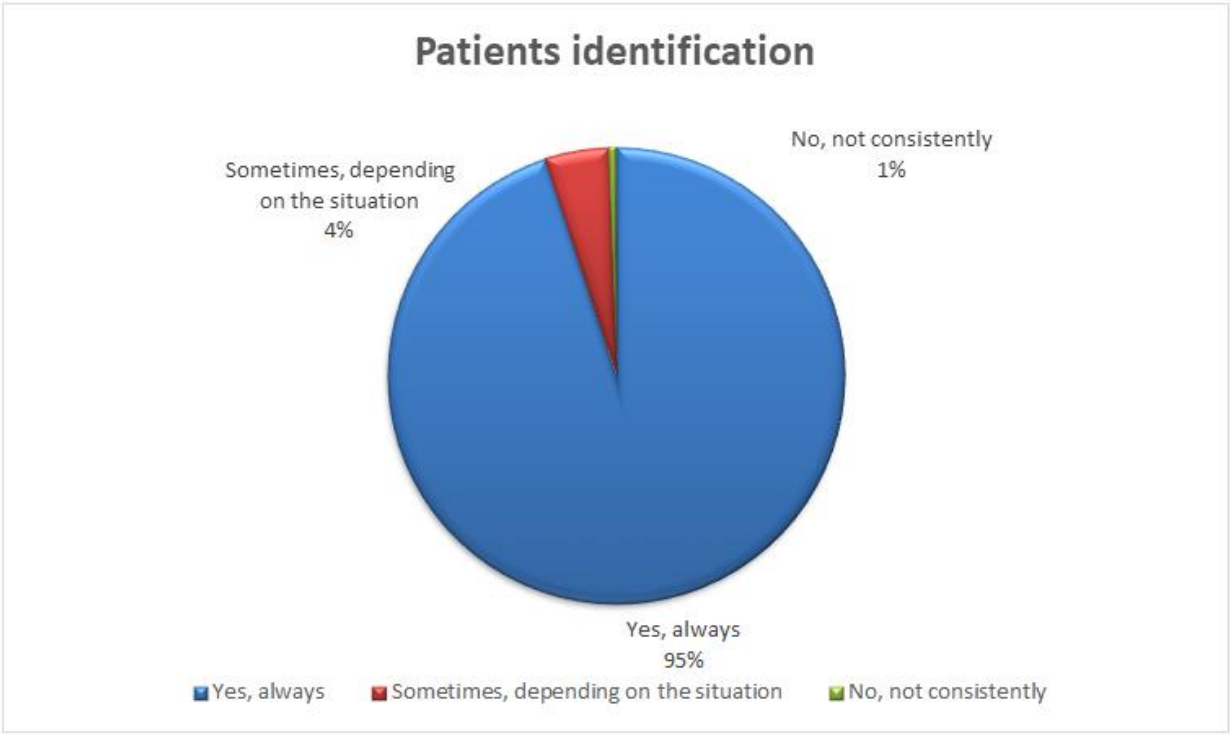

FIG 2: Study participants in verifying the patient identification before the sample collection

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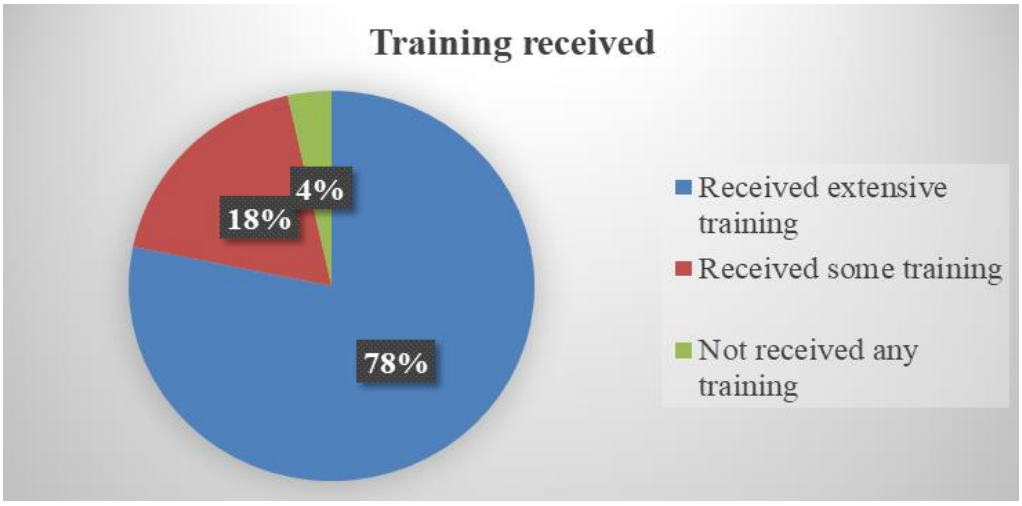

FIG 3: Depicting the Study participants receiving training for pre analytical errors in sample collection

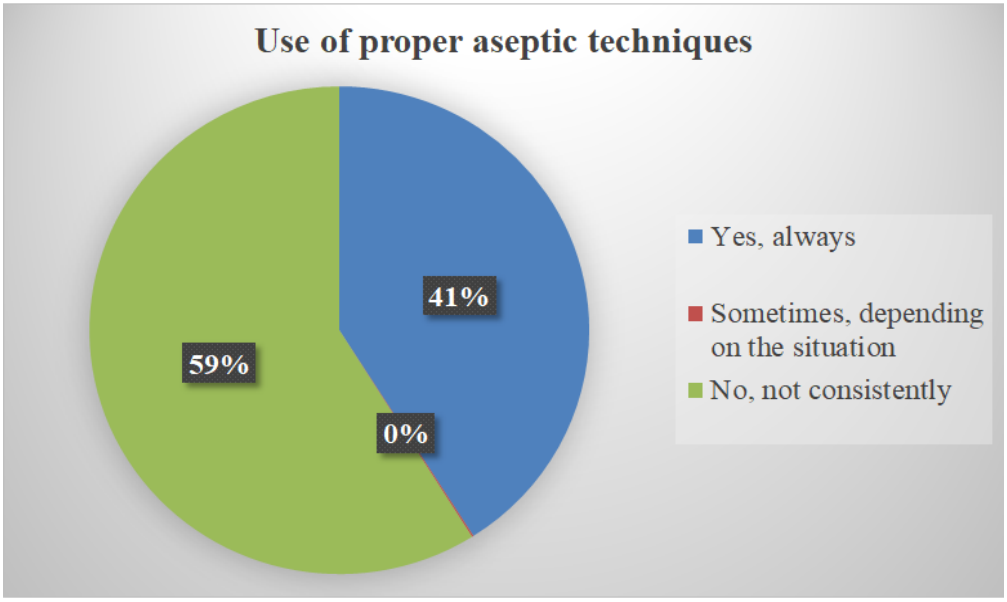

Figure 4: Distribution of the study participants in the use of proper aseptic techniques when collecting blood samples.

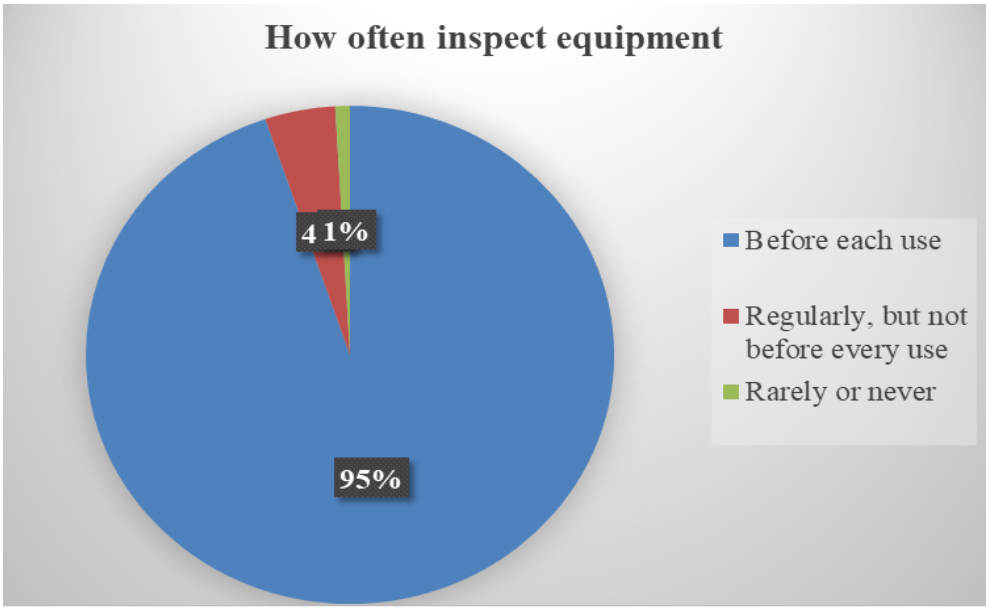

Figure 5: Distribution of the study participants in how often inspect and maintain blood collection equipment.

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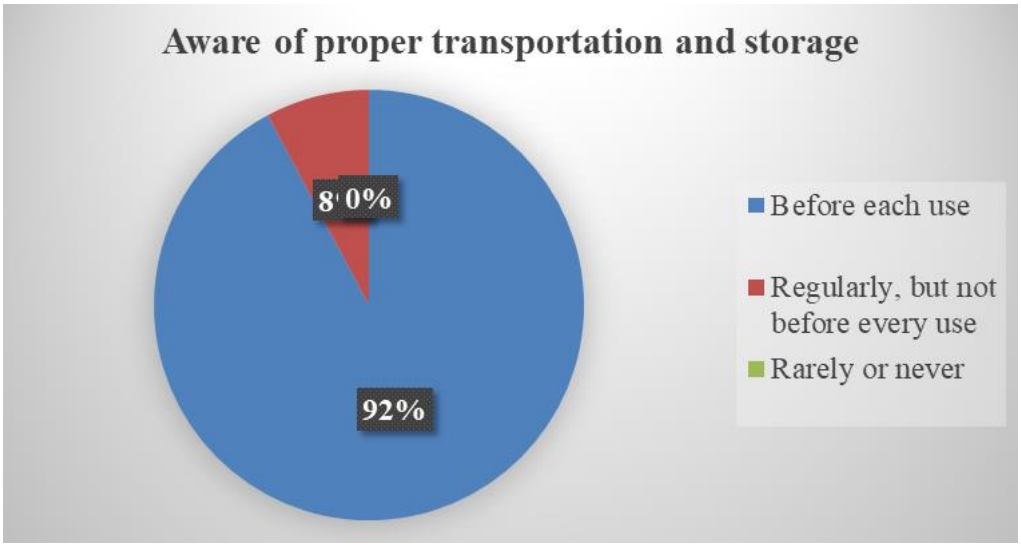

Figure.6: Distribution of the study participants in awareness of the proper transportation and storage.

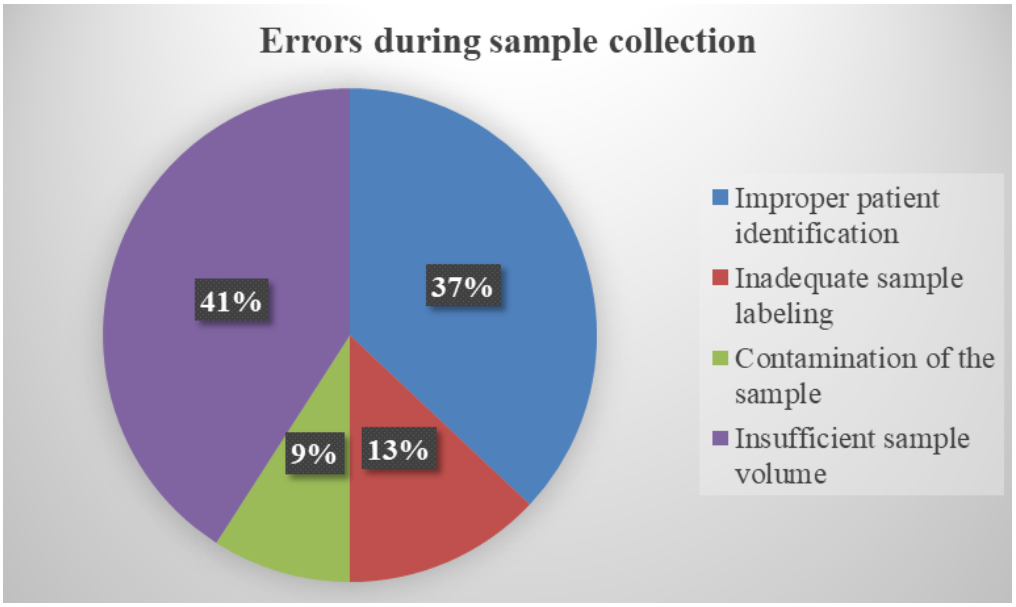

Figure.7: Distribution of the study participants in pre-analytical errors encountered most during the sample collection |process.

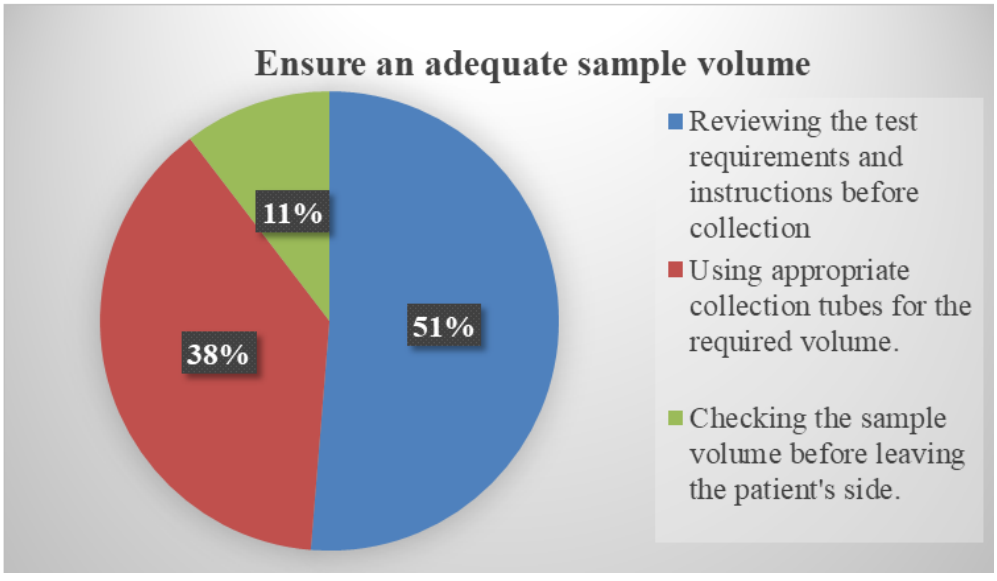

Figure 8: Distribution of the study participants to ensure an adequate sample volume collected.

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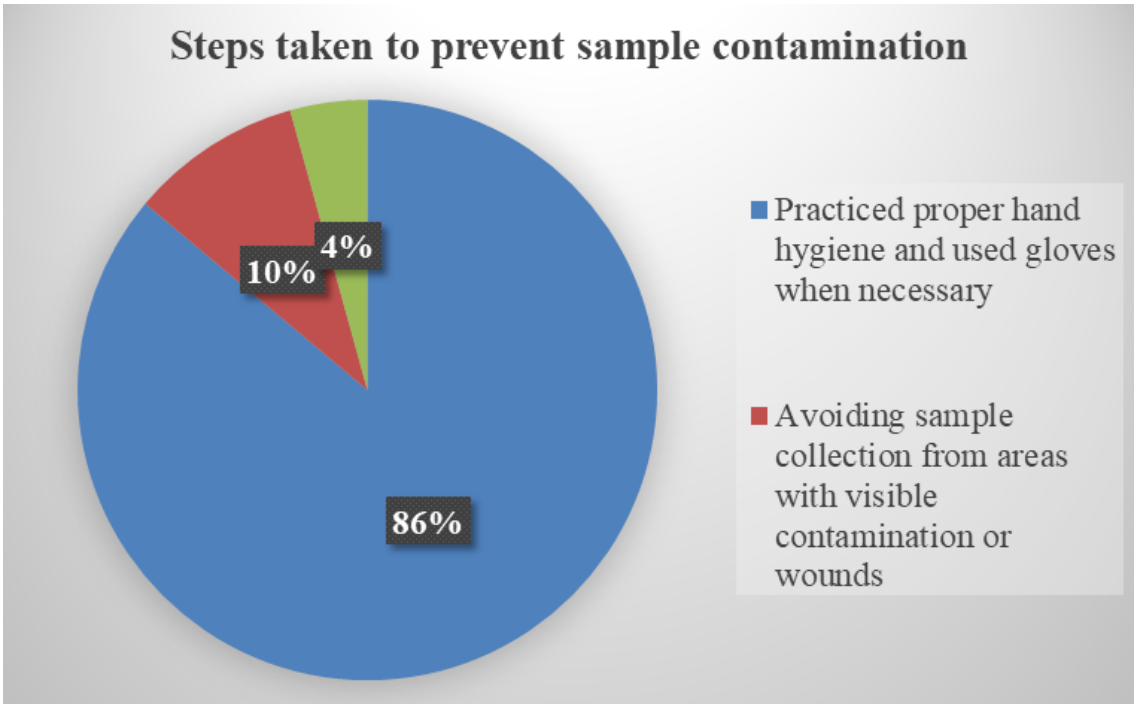

Figure.9: Distribution of the study participants in steps taken to prevent sample contamination.

RECOMMENDATIONS:

The following are the recommendations suggested based on the findings of the study:

- Training to be given at specific intervals for the staff includes phlebotomists, post-graduates, staff nurses, and technicians from tertiary care teaching hospitals.
- Good laboratory practices and standard operating procedures are used to maintain quality control and accuracy in laboratory testing and research.
- Enhanced educational efforts through guidelines and posters for sample collection among hospital staff to minimize errors and improve patient safety.
- Awareness and adherence to standard protocols in every department in the laboratory, including the sample collection area.

LIMITATIONS OF THE STUDY

- ✓ **Selection bias:** There may be a possibility that a certain patient population or particular types of samples are either overrepresented or underrepresented in the study,
- ✓ **Quality and Availability of Data:** The study's correctness and thoroughness are dependent on the quality and availability of data from the Hospital Records. The generalizability of the results may be diminished by incomplete or missing data.
- ✓ **Single-Center Study:** The study's capacity to be generalized to various healthcare settings with different patient demographics may be constrained by its single-center design.
- ✓ **Variability in Laboratory Procedures:** The study may run into variations in preanalytical procedures and reagent usage among various laboratory staff members or departments, which could result in discrepancies in the data.
- ✓ **Limited Timeframe:** Because the study's duration may not be extensive, it may be difficult to identify long-term trends and patterns in preanalytical mistakes and reagent prices.

FUTURE SCOPE OF THE STUDY:

Based on the findings of the study potential future scope for research could include:

- Investigating the root causes of preanalytical errors.
- Evaluating the impact of pre-analytical errors on patient outcomes.
- Analyzing the effectiveness of interventions.

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- Examining the cost-effectiveness of different reagents.
- Investigating the impact of automation on preanalytical errors.

CONCLUSION

The research on pre-analytical sampling errors in the laboratory of a teaching hospital for tertiary care emphasizes the laboratory staff's positive awareness, education, and adherence to standard procedures. The results emphasize the value of ongoing training and focused interventions to deal with particular problems, like patient identification, sample labeling, and volume. The hospital can increase the accuracy of laboratory results, which will ultimately result in better patient care and outcomes, by developing a culture of continuous improvement and adherence to best practices. Overall, the initiative offers insightful information that may be used to improve the effectiveness and caliber of laboratory services.

The research on preanalytical sample errors conducted in the lab of a teaching hospital with tertiary care offers insightful information about the attitudes and routines of laboratory employees. While identifying and proactively addressing the areas that need improvement through focused training and quality improvement programs, it is important to acknowledge and celebrate the encouraging results in terms of awareness and adherence to established norms. The hospital can increase the validity of laboratory findings by promoting a culture of ongoing learning and development, which will ultimately result in better patient care and better health outcomes

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