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RESEARCH ARTICLE

PRE-ANALYTICAL ERRORS IN SAMPLE COLLECTION AND THEIR IMPACT ON LABORATORY RESULTS

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Abstract

Clinical laboratory investigations are an essential component of modern medical practice. It is estimated that approximately 60–70% of clinical decisions related to diagnosis, treatment, and patient monitoring are influenced by laboratory test results. The laboratory testing process is broadly divided into three phases: pre-analytical, analytical, and post-analytical. Among these, the pre-analytical phase is considered the most error-prone.The pre-analytical phase includes all procedures performed before the actual analysis of the specimen, such as patient identification, test request, patient preparation, sample collection, labeling, transportation, and storage. Errors occurring during this phase may significantly affect the accuracy of laboratory results, even if the analytical process is performed correctly.Pre-analytical errors may result in falsely increased or decreased values, sample rejection, repeated sampling, delayed diagnosis, unnecessary treatment, increased workload for laboratory staff, and compromised patient safety. Therefore, identification and control of pre-analytical errors are crucial for ensuring laboratory quality and reliability of test results.

Introduction:-

Review of Literature:-

Several studies have emphasized that pre-analytical errors constitute the largest proportion of laboratory errors. Lippi et al. reported that approximately 65% of laboratory errors occur in the pre-analytical phase, with hemolysis being the most common cause. Hemolysis leads to false elevation of analyses such as potassium, lactate dehydrogenase (LDH), and aspartate aminotransferase (AST). Plebani highlighted that patient identification and labeling errors are among the most dangerous pre-analytical errors, as they can result in reporting of results to the wrong patient, leading to serious clinical consequences. Bonini et al. observed that insufficient sample volume and inappropriate use of anticoagulants significantly affect hematological and coagulation parameters. Carraro and Plebani found that pre-analytical errors increase sample rejection rates and delay turnaround time, thereby affecting

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clinical decision-making.Narayanan concluded that regular training of phlebotomists and strict adherence to standard operating procedures can reduce pre-analytical errors by more than 40%.

Aim and Objectives:-

Aim:-

To study pre-analytical errors in sample collection and evaluate their impact on laboratory results.

Objectives:-

1. To identify common pre-analytical errors in clinical samples
2. To determine the frequency of various pre-analytical errors
3.To assess the impact of these errors on laboratory parameters
4. To recommend strategies to reduce pre-analytical errors Chapter

Materials and Methods:-

Study Design:-

Observational cross-sectional study.

Study Area:-

Central Clinical Laboratory, Tertiary Care Hospital.

Sample Size:-

200 clinical samples

Inclusion Criteria:-

- Blood and urine samples received for routine investigations
- Samples collected from OPD and IPD patients

Exclusion Criteria:-

- Repeat samples from the same patient
- Samples rejected due to analytical instrument failure

Types of Samples:-

- EDTA blood samples
- Citrated blood samples
- Plain serum samples
- Urine samples

Data Collection:-

Each sample was observed for pre-analytical errors such as:

- Hemolysis
- Insufficient volume
- Clotted sample
- Wrong container
- Improper labeling
- Delayed transport

Statistical Analysis:-

Data were analyzed using percentages and presented in tables and graphs.

Results:-

A total of 200 samples were analyzed in the present study:-

Table 1: Distribution of Samples (n = 200).

Type of Sample	Number	Percentage
EDTA Blood	80	40%
Plain Serum	70	35%
Citrated Blood	30	15%
Urine	20	10%
Total	200	100%

Table 2: Frequency of Pre-Analytical Errors

A. Type of Error	Number	Percentage
B. Hemolysis	C. 45	D. 22.5%
E. Insufficient volume	F. 30	G. 15%
H. Clotted sample	I. 25	J. 12.5%
K. Wrong container	L. 20	M. 10%
N. Improper labeling	O. 15	P. 7.5%
Q. Delayed transport	R. 10	S. 5%
T. No error	U. 55	V. 27.5%

Table 3: Impact of Pre-Analytical Errors on Laboratory Results

W. Type of Error	X. Affected Parameters	Observed Impact
Y. Hemolysis	Z. Potassium, LDH, AST	AA. Falsely increased values
BB. Insufficient volume	CC. CBC	DD. Inaccurate cell counts
EE. Clotted sample	FF. PT, APTT	GG. Invalid coagulation results
HH. Wrong container	II. Calcium, Glucose	JJ. Erroneous values
KK. Delayed transport	LL. Glucose	MM. Falsely decreased levels

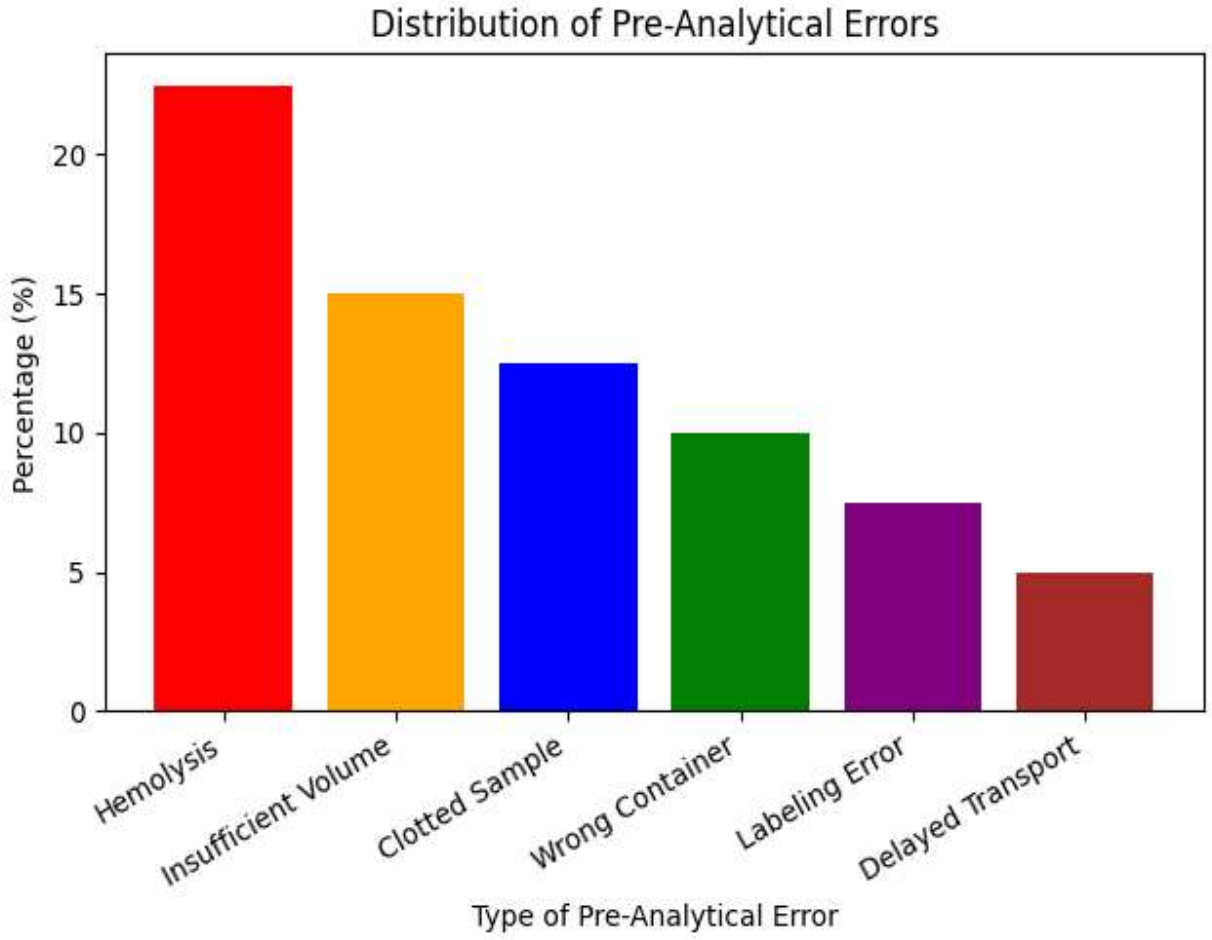
Table 4: Sample Rejection Due to Pre-Analytical Errors

NN. Reason for Rejection	OO. Number	PP. Percentage
QQ. Hemolysis	RR. 20	SS. 10%
TT. Clotted sample	UU. 15	VV. 7.5%
WW. Labeling error	XX. 10	YY. 5%
ZZ. Total rejected	4AA. 45	3BB. 22.5%
CCC.	DDD.	EEE.

Graph: Distribution of Pre-Analytical Errors:-

The above bar graph shows that hemolysis is the most common pre-analytical error,

Followed by insufficient sample volume and clotted samples.



Discussion:-

The Present Study Demonstrates That Pre-Analytical Errors Are A Major Source Of Laboratory Inaccuracies. In This Study, 72.5% Of Samples Showed One Or More Pre-Analytical Errors, Indicating That The Pre-Analytical Phase Is Highly Vulnerable To Errors. Hemolysis Was The Most Frequently Observed Error (22.5%), Which Is Consistent With Findings Reported By Lippi Et Al. And Other Studies. Improper Venipuncture Technique,

Prolonged Tourniquet Application, Use Of Narrow-Gauge Needles, And Forceful Aspiration Are Common Causes Of Hemolysis. Insufficient Sample Volume And Clot Formation Were Frequently Observed In EDTA And Citrate Samples, Leading To Inaccurate Hematological And Coagulation Results. These Findings Are Similar To Those Reported By Boning Et Al. Labeling Errors, Although Less Frequent, Pose A Serious Risk To Patient Safety, As They May Result In Reporting Of Results To The Wrong Patient. Delayed Transport Was Found To Affect Glucose Levels Due To Ongoing Glycolysis, Leading To Falsely Decreased Values. The Study Highlights The Importance Of Proper Sample Handling And Timely Transportation

Conclusion:-

Pre-Analytical Errors Constitute The Largest Proportion Of Laboratory Errors And Significantly Impact The Accuracy Of Laboratory Results And Patient Care. Hemolysis Was Identified As The Most Common Pre-Analytical Error, Followed By Insufficient Sample Volume And Clot Formation. Implementation Of Strict Standard Operating Procedures, Continuous Training Of Laboratory Personnel, And Regular Monitoring Of Quality Indicators Are Essential To Reduce Pre-Analytical Errors.

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