Research Article

# Identification of the types of preanalytical errors in a hematology laboratory: 1 year study at ESIC hospital, Chennai

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## Abstract

**Objective:** To evaluate the common causes of preanalytical errors in a fully automated hematology laboratory. **Methods:** Laboratory staff was instructed to record the rejected samples and the causes of such rejections of ward and outpatient samples collected in both wards and laboratory. **Results:** Of the 53344 samples received for hematological tests during the one year period from 1.1.2016 to 31.12.2016, 181 samples were rejected for analysis. This accounted for 0.3% of samples collected for hematological tests. The reasons for rejections with their incidences are as follows: Insufficient samples –35.3 %, Clotted sample –25.7 %, Wrong registration –15.0 %, Double registration –11.6 %, Inappropriate container –5.5 %, Sample spillage – 3.9 %. **Conclusion:** The overall percentage of rejection in our hematology laboratory is 0.3 % and insufficient sample is the most common cause for rejection. Adequate training, regular maintenance of a record of errors and periodic auditing will result in effective reduction of such errors and hence improvement in the overall performance of laboratory works.

**Keywords:** Preanalytical error, Hematology lab, Sample rejection

## Introduction

Remarkable advances in automation, technology and testing methods have transformed the way of analysis in hematology laboratories. Errors occurring in the whole testing process heavily influence the results. There is heterogeneous information on the error rate within the whole laboratory testing process (from 0.1% to 9.3%) [1]. Moreover, the frequencies and types of mistakes differ between one facility and another and between one time period and another. Process analysis has demonstrated that laboratory errors occur primarily in the preanalytical phase, influencing patient outcomes and costs. Compliance with systems of quality management, such as certification and accreditation, requires accurate procedures for identifying the processes that are more susceptible to errors [2]. Sample processing errors are classified in to preanalytical, analytical and post analytical. The preanalytical phase includes all the events that happen before processing the samples in the analysers. The common preanalytical errors include inadequate sample, clotted sample, transportation delays, wrong registration, double registration, inappropriate sample container and spillage of sample due to improper capping of the sample containers. Though, most of these errors are beyond the control of the working laboratory, the credibility of the results is at stake due to these errors. The labs have to be responsible for the incorrect and inconsistent reporting that can arise due to such preanalytical errors.

The aim of this article is to list and analyse the prevalence of different preanalytical errors that arise during sample processing in the hematology laboratory during a 1 year period.

## Materials and Methods

Our hospital, ESIC Medical College & PGIMSR is a tertiary care hospital catering to persons insured under

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the ESI scheme. This is 400 bedded hospital which provides all the specialty and super specialty services. The hematology laboratory is equipped with LH 5 part autonalyser, ABX Micros 3 part part autoanalyser, Therma linear automated ESR analyser and other ancillary equipments for sample processing. The entire laboratory is automated with laboratory information system with every equipment being interfaced with the computers, with removal of the need for manual entry of values thereby reducing the incidence of post analytical errors to 0 %. Inpatient phlebotomies are done by ward staff whereas blood samples from outpatients are collected at centralized collection centre by persons trained for phlebotomy. The samples were collected by closed collection system using vacutainers.

The ward samples collected in the ward are delivered by the ward staff and from the collection area are delivered by the laboratory support staff to the working laboratory.

A total of 53344 samples were received by our hematology laboratory during the study period of January 2016 – December 2016. Out of these, 36012 samples were from OP patients and 17332 samples were from inpatients.

**Inclusion criteria:** All the samples (both inpatient & outpatient) referred for hematological analysis were included.

**Exclusion criteria:** Samples for other tests viz, Biochemistry & Microbiology were excluded for the study.

Once, when the samples are received in the laboratory, the laboratory staff incharge of receiving the samples will check for the suitability of the sample for processing. In every case of rejected sample, the ward staff or the phlebotomy staff are informed and a repeat sample is requested.

The preanalytical variables evaluated included inadequate samples, wrongly registered samples (Name and insurance number mismatch or names written in the request form and sample container discrepancy), inappropriate containers, presence of clot in the sample, Improperly corked containers with blood spillage. Such samples will be rejected after stating the reason for rejection in the LIS. The software also enables us to look at the list of rejected samples with the reasons stated for any specified period with segregation of patients in to OP and IP. The data generated is reviewed on a monthly basis and analysed using SPSS 17.0.

## Results

Out of the 53344 blood samples received for hematological analysis in our laboratory over a period of one year, the preanalytical errors were 181 which accounts for 0.3 % of the total number of samples. The distribution of different types of errors was then tabulated and calculated (Table 1). The majority of the rejected samples were due to sample inadequacy, which accounted for 35.3 % causes for rejection and 66% of such samples were collected from the wards by the ward staff. This was closely followed by clotted sample which accounted for 28.7 % of rejected samples and 92% of such samples were collected in the wards. The remaining causes like wrong registration, double registration, inappropriate container and blood spillage accounted for 15.0 %, 11.6%, 5.5% and 3.9 % respectively.

**Table 1: Preanalytical error tracking, based on specimen acceptability, over a one year observational period in the six most representative sections of a hematology laboratory.**

| Reason for rejection | IP | OP | Total | % |
|---|---|---|---|---|
| Sample insufficient | 42 | 22 | 64 | 35.3 |
| Clot | 48 | 4 | 52 | 28.7 |
| Wrong registration | 15 | 12 | 27 | 15.0 |
| Double registration | 10 | 11 | 21 | 11.6 |
| Inappropriate container | 9 | 1 | 10 | 5.5 |
| Sample leakage | 7 | 0 | 7 | 3.9 |
| Total number of haematology samples: 53344<br>Out patients:36012, Inpatients: 17332<br>Number of rejected samples:181 | | | | |

## Discussion

Escalating technology has led to many advancements in the field of laboratory medicine and diagnostics transforming manual, cumbersome and error prone testing methods to fully automated techniques with drastic reduction in the incidence of errors in the laboratory. However, a laboratory cannot function independently as its working is dependent on the referring clinics, requisition forms, blood collecting staff etc; Cumulative evidences state that reliability cannot be achieved in a clinical laboratory through mere promotion of accuracy in the analytical process of testing. The phases before the sample reaches the laboratory (preanalytical) and the phase after the sample is analysed (post analytical) are equally important. The preanalytical phase is challenged with many shortcomings like improper filling up of request forms with illegible handwriting, improper blood collection by the staff and improper mixing up of blood with the anticoagulant etc; The health care system should be more diligent in applying scientific knowledge to reduce the errors in this phase, which is very essential for the quality of the work done by the laboratories [3].

There are varied informations on the error rates within the whole lab testing procedure (0.1% to 9.3%). Plebani and Carraro observed in their study that the great majority of errors result from problems in the pre and post analytical phases [4].

In our study, inadequate sample accounted for the most common cause of rejection. Every analytical process requires a fixed volume of serum or plasma for analysis. The use of vacutainers and closed system of blood collection has made blood collection efficient and easy. The analysis of patient distribution from the table clearly states that the inadequate sample collection is more often from ward patients from whom samples were collected by the ward staff. Post analysis enquiries and observation of collection procedure in the wards, revealed the lack of staff training, difficult sampling as in pediatric patient, patients with chronic, debilitating diseases, patients on chemotherapy with thin veins and reluctancy in using vacutainer collection among some of the ward staff. Inadequate samples will result in low sample anticoagulant ratio and can thus influence the analysis. Also autoanalysers will result in partial aspiration of the samples causing errors in the analytical phase. Hence, intense training of all the staff involved in blood collection, teaching them the importance of adequate sample collection and periodic observation of their collection procedures will certainly reduce such inadequate samples being a common cause for rejection in clinical laboratories.

The second most common cause of rejection in our laboratory was clotted sample, which was again common in samples collected from ward patients. Post analysis observation of collection procedure in the wards revealed inadequate training and lack of knowledge about the proper mixing procedure that should follow blood collection. Permitting blood samples that contain clot of any size will result in blockage of the tubings of the analysers and will also result in erratic values. In the centralized collection area, immediately after collection the sample tubes are rotated with a hemomixer which is not available in the wards. Adequate training of all the staff involved in blood collection about proper mixing of blood with the anticoagulant will result in bringing down the incidence of sample rejection due to clot formation.

Like the above mentioned two causes of rejection, inappropriate container and improper capping of the containers
resulting in spillage of blood happened with higher incidence in ward samples due to lack of proper training and lack
of knowledge about using the closed system of blood collection respectively. Though these two causes account for a minor fraction of rejected samples, 5.5% & 3.9% respectively, the incidences of sample rejection due to these two causes will also be reduced significantly with adequate training of the staff and periodic observation.

Wrong registration and double registration accounted for 15.0% and 11.6% causes for rejection. Post analysis observation showed that these were due to discrepancies in the names written on the request forms and on the samples received and failure of proper communication between the ward staff during their duty change over respectively. All the samples collected in the centralized collection areas will be labelled with barcodes generated during computerized registration for out patients. Hence, manual writing of names over the containers is completely avoided. Whereas, in ward collections the containers are labelled with the names of the patients before collecting blood sample and hence

there are chances of wrong labelling with wrong identification. Proper training and periodic observation of the procedures will bring down the incidences of such causes for sample rejections.

Earlier studies on preanalytical errors in clinical laboratories by Bonini et al, Jones et al and Iman J Shultz et al also show similar significant differences between ward and out patient samples with more errors arising from samples collected in the ward patients by ward staffs [5,6,7].

Every case of rejected sample demands a repeat sample which will not only result in delay in processing the samples and delivering the reports but will also result in increase in man hours and wastage of consumables like, syringes, containers etc;

Phlebotomy is an integral part of laboratory work. Any wrong practices followed during this phase will obviously impair the quality of the results, no matter how much care is given to the analytical and post analytical phases. Adoption of quality control in all the phases and not merely the analytical phases and regular audits is necessary to improve the overall quality of laboratory work [8,9].

## Conclusions

The quality of laboratory work is dependent on all the steps involved in sample processing beginning from requesting for the tests till the interpretation of the results. The reason for incorrect phlebotomy practice includes lack of awareness or possibly a heavy workload. The adoption of ideal phlebotomy practices is mandatory for ensuring quality laboratory services. This is the reason phlebotomy has been considered a separate area of improvement for medical technicians in developed countries. A practice of maintaining and periodic analysis of a record of the errors at all the stages of analysis and following effective corrective and preventive measures will help us in achieving accuracy in our laboratory reports.

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