ORIGINAL ARTICLE

Frequency of Pre-Analytical Errors in a Tertiary Hospital Clinical Laboratory, North-Central Nigeria

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ABSTRACT

Background: The generation of accurate and reliable laboratory results is the main objective of any clinical laboratory service. The total testing process is broadly divided into pre-analytical, analytical and post-analytical phases. There are several errors, both human and technical that can affect the quality of laboratory results at any phase of the total testing process. At the pre-analytical phase, errors could occur during filling of request forms, sampling, transportation and storage of samples.

Objective: To determine the frequency of the various pre-analytical errors that can affect the quality of laboratory results in Bingham University Teaching Hospital Jos, North Central Nigeria.

Methods: We examined request forms, specimen collection, transportation and storage from both out- and in-patients over a period of three months. Ethical clearance was obtained from the Research and Ethics Committee of the hospital.

Results: A total of 11,109 out-patient and 4,178 in-patient forms and specimens were examined. The most common errors recorded from the specimens for out-patients and in-patients were inadequate labeling (50.9% and 44.6%, respectively) and lack of collection time (54.1% and 46.4%, respectively). Other errors were late submission (40.9%) and lack of patient preparation (65.1%).

Conclusion: Errors were recorded in all activities involved in the pre-analytical phase with the most frequent ones being inadequate labeling of specimens, poor filling of request forms and lack of patient preparation. There is need to have regular trainings and/or seminars with healthcare stake holders involved in the pre-analytical phase of laboratory testing process with a view to improving the quality of laboratory results.

INTRODUCTION

The generation of accurate and reliable laboratory results is the main objective of any clinical laboratory service. There are several errors, both human and technical that can affect the quality of laboratory results at any phase of the total testing process. Errors may arise from the clinicians who order the tests, the patients who give the specimen, the ward attendants who are sometimes involved in transporting specimens, the equipment and methods used to perform the tests, the laboratory staff or during the delivery of the result. However several quality control measures are normally put in place to overcome these errors in order to produce reliable results.

The total sample testing process is broadly divided into pre-analytical, analytical and post-analytical phases. This study focuses on the pre-analytical phase which involves all activities occurring prior to the actual performance (analytical phase) of the test in the laboratory. These activities include: specimen test ordering, patient preparation, sample collection, sample labeling and transportation to the laboratory. It also includes storage of samples for those tests that will not be performed immediately.

The pre-analytical phase is a very important phase because it deals with the delivery of a quality specimen to the work bench for analysis. However, it is more difficult to control and therefore more error prone as most of the activities occur outside the laboratory; also many people are involved-the doctor, the patient, the phlebotomist, the laboratory assistant and probably the ward attendant. Studies have shown that most errors that lead to unreliable laboratory results occur during the pre-analytical phase.[1,3] On the other hand, the rate of analytical errors has been drastically reduced with the introduction of new, improved equipment and techniques in the last few decades[1,2]

In this study we examined the frequency of the various pre-analytical errors that can affect the quality of laboratory results in

Bingham University Teaching Hospital, Jos, North-Central Nigeria.

METHODOLOGY
This is a prospective study conducted at Bingham University Teaching Hospital (BUTH) Jos, North-Central Nigeria over a period of 3 months, from 1st April to 30th June 2015. The hospital is a 250 bed facility with a monthly turn-over of 300 to 500 in-patients and an average of 5,000 attending the out-patient departments, comprising General Out Patient Department(GOPD), Medical Out-Patient Department(MOPD), Surgical Out-Patient Department(SOPD), Paediatric Out-Patient Department (POPD) as well as the Antenatal and Gynaecology Clinics.

Ethical clearance (BHUTH/HREC/RE/SNO/00054) was obtained from the Research and Ethics Committee of the Hospital. A written informed consent was obtained from the participants. There was no grant or any financial support for this study and there is no conflict of interest.

The study covered 3 units of the Clinical laboratory namely Chemical Pathology, Haematology, Medical Microbiology and Parasitology. Altogether these units receive an average of 6,418 request forms and specimens per month.
Pre-analytical errors were defined based on ISO 15189 prescribed standards for Pre-examination Procedures for Medical laboratories[4]
Data on errors that occurred during test ordering and specimen collection were obtained by the examination of filled request forms along with the specimens from the General out-patient department, Clinics and In-patients at the reception during the period of study. The phlebotomy room was visited to directly observe the process of blood collection and administer questionnaire to the staff involved in sample collection. In addition, questionnaires were administered to laboratory staff to evaluate storage facilities in the laboratory, and to capture errors that could occur during transportation and lapses in patient preparation.

The data was then collated and transformed into frequency tables.

RESULTS
A total of 11,109 and 4,178 Out-patients and In-patient request forms with samples were examined and errors recorded are presented in the frequency tables below.

Table 1. Frequency of Errors Detected From Request Forms

Error(missed information)	Frequency (%)	
	Out-patients	In-patients
Name not indicated	0 (0)	1 (0.02)
Age not indicated	4,262 (38.4)	950 (22.7)
Sex not indicated	3,023 (27.2)	798 (19.1)
Hospital number not indicated	291 (2.6)	76 (1.8)
Test ordered not indicated	510 (4.6)	38 (0.9)
Date ordered not indicated	328 (3.0)	114 (2.7)
Time of collection not stated	6,957(62.6)	1,862(44.6)
Requesting Physician not stated	1,457(13.1)	152 (3.6)
No clinical information Stated	5,864(52.8)	1,558 (37.3)
Contact (ward/clinic) not indicated	546 (4.9)	39 (0.9)
Total	**23,238**	**5,588**

Table 2. Frequency of Errors Detected from Specimen

Error	Frequency (%)	
	Out-patients	In-patients
Inappropriate container	154 (1.4)	0 (0)
Inadequate labeling	5,652(50.9)	1,862(44.6)
Inadequate specimen	864 (7.8)	190 (4.6)
Excess specimen	108 (0.9)	114 (2.7)
Quality of sample-(spillages, clots, lysis)	468 (4.2)	76 (1.8)
No time of collection indicated	6,012 (54.1)	1,938 (46.4)
Name of technician not written on the sample bottle	108 (0.9)	41 (1.0)
Total	**13,366**	**4,221**

Table 3. Time Taken from Collection to Submission of Specimen (Urine, stool, sputum, swabs, semen) n=1,764

Time	Frequency	%
<20min	772	43.8
20-40min	159	8.9
41-60min	111	6.4
>60min	722	40.9
Total	1764	100

Test Ordering/Patient Preparation (n=1,764)
One thousand, five hundred and eighty three (89.7%) requests were ordered by clinicians and the remaining 181 (10.3%) were ordered by other health care workers. Only 616 (34.9%) were given instructions on how to collect and handle the specimen, the remaining 1148 (65.1%) were not instructed

Blood Sample Collection
Venipuncture for blood samples was carried mainly by laboratory Technicians and Medical laboratory student interns. There was no trained Phlebotomist.

Transportation
In-patients samples were transported in large kidney dishes and the staff wore hand gloves while out-patients brought their samples either openly, in polythene bags or inside their bags or their pockets. There were no preservatives added to the specimen

Storage
Serum/plasma was separated immediately and stored in multipurpose refrigerators for tests that could not be performed immediately. Power sources to the laboratory include National grid, diesel power generating plant and electrical current inverters

DISCUSSION
A total of 23,238 errors were committed on the 11,109 out-patient forms that were examined, giving an average of 2 errors per form; while 5,588 errors were committed on the 4,178 in-patient forms, an average of one per form. There were more errors on the out-patient forms probably due to the high

patient turn over in the out- patient departments. The pattern and frequency of the errors for both out- and in-patients were similar. The most frequent errors include: no recorded time of sample collection, no clinical information, no age recorded and no gender indicated (Table 1). These are very vital information needed for result interpretation.[4] Age classifications such as adult, child and neonate were often used instead of the patients' actual age. This is not usually relevant in result interpretation. The adult age group for example has a wide range (18yrs and above) and very variable in terms of physiology, disease epidemiology and pathophysiology.[5]

Fifty three percent and 37% of out- and in-patient forms respectively had no input for patients' clinical information. This is similar to studies by Firdushi *et al*. and Zelalen *et al.* who reported 62.4% and 97.8%, respectively.[6,7] These studies also showed frequent omission of time of sample collection as 70.15% and 100% of out- and in-patient forms respectively.[6,7] The most common errors recorded from the specimens for out-patients and in-patients (Table 2) were, inadequate labeling (50.9% and 44.6%, respectively) and lack of collection time (54.1% and 46.4%, respectively)

Although about 90% of the requests were ordered by clinicians in our study, it was observed that in some busy clinics such as Antenatal and Diabetic Clinics, request forms were often filled by the Nurses who may not be conversant with the patients' clinical details. There was frequent omission of patients' gender probably because this could be inferred from most names in our environment; however there are a few unisex names and therefore it is always necessary to provide information on the patient's sex.

The name of requesting Clinician was absent in 13.1% and 3.6% of out-patient and in-patient forms respectively, similar to the 15.5% reported by Paingha *et al*. from Bayelsa, South-South Nigeria.[8] Many specimens did not have the name or hospital number of patients as well as date and time of collection (Table 1)

Blood samples were collected in the laboratory for all out-patients by laboratory staff. The same category of staff went to the wards to collect specimens from in-patients which they promptly deliver to the workbench. This may explain why there was frequent inadequate labeling and omission of the time of collection since they immediately allocate a laboratory number to the form and the specimen. It may also account for the low number of errors in the use of specimen containers and in dispensing the right quantity of specimen.

However for specimens such as urine, stool, sputum, swabs and semen which were taken and transported by the patients themselves, it is important to indicate the time of collection in order to determine the freshness or otherwise of the sample at reception. Table 3 showed that a remarkable number of these specimens (40%) were submitted more than an hour after collection. At this time deterioration would have started and pathogens expected to be seen at microscopy, or cultured would have died, more so that preservatives such as boric acid or Cary-Blair medium were not used.[5] For semen, motility and morphology of spermatozoa are affected if sample submission is delayed for more than an hour.[9]

Patients' preparation was poor, only 34.5% were instructed on what to do before collection of specimen. This is a very important pre-analytical measure to ensure a quality specimen is obtained for analysis. The high rate of error recorded might be attributable to the large number of patients to a very limited number of doctors available especially in the outpatient departments.[10] Another possible reason that could account for this frequent error is that many clinicians assume that the laboratory staff will give the patient instructions when they get to the laboratory while the laboratory staff also assume that the patients have been adequately instructed or prepared for the test by the Clinicians.

Samples that were not meant for immediate analysis were processed soon after reception and stored in multipurpose refrigerators or freezers. The multipurpose freezers are powered from the national grid and stand-by power generating plant. The inverters are used only for light duty equipment. However, the quality of these samples whenever they are required for analysis may not be guaranteed because of the frequent opening and closing of the freezers which is a subject of further study

CONCLUSION
Clinicians pay little attention to the filling of laboratory request forms and give poor education and preparation to patients going for laboratory test. These errors can negatively impact the quality of the result and patient management. There is a need to have regular trainings and/or seminars with all healthcare stake holders involved in the pre-analytical phase of the testing process with a view to minimizing pre-analytical errors.

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