Addis Ababa University

School of Information Science and School of Public Health

Health Informatics Program

Research Project: Improving the Use of ICT Based Blood Tests of Pre and Post Analytical Medical Laboratory Practices to Enhance Patient Satisfaction in St. Paul's Hospital, Addis Ababa, Ethiopia

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Acronym

IOM	Institute of Medicine
TTP	Total testing process
OPD	Outpatient department
IRB	Institution review board
SPSS	Statistical Package for Social Sciences
ICT	Information Communication Technology
GYN	Gynecology
Obs.	Obstetrics
EHNRI	Ethiopian Health and Nutrition Institute
LIS	Laboratory Information System
WHO	World Health Organization

Abstract

Background: *Quality improvement is the practice of continuously assessing and adjusting performance using statistically and scientifically accepted tools and procedures. More than 60-70% of the most important decisions on admission, discharge, and medication are based on laboratory test results. In laboratories most of their attention has been directed toward detecting and correcting defects in the analytical portion of the testing process, such that analytical mistakes now account for <10% of all mistakes. Ross and Boone found that mistakes made in laboratory testing were 46% in pre analytical, 7%, in analytical and 47 % in post analytical phases. The greatest impact for overall improvement would be to focus on pre- and post-analytic services where most errors occur. In most large clinical laboratories, test results are produced from and stored in the LIS. In these laboratories, test data may be entered manually into the LIS or automatically transferred to the LIS from automated systems. In case of manually entry of the test data into the LIS there are chances of transcription errors. For eg, an accurate and reliable result reported on the wrong patient, using the wrong value, and/or with the wrong units [eg, mg/L instead of mg/day]After the failarty of (Smart Care) St' Paul's Hospital with the help of John Hopkins University introduced PolyTAK for the laboratory Purpose only*

Objective: *To assess ICT based Pre and post analytical Medical laboratory practices at St. Paul's Hospital Addis Ababa, Ethiopia*

Methodology: *Institutional cross sectional descriptive study design was conducted to assess Pre and post analytical Medical laboratory practices through ICT at St Paul's Hospital from May 05, 2014-22, 2014. Quantitative and qualitative data collection methods were used. Pretested structured questionnaire and Check list was used to collect the necessary data. By using Convenience sampling technique Nine hundred sixty data was collected during the studied period. Data was entered in to Microsoft excel sheet and exported to SPSS version 20.0 for analysis. And descriptive statistics has been used to see the frequency of errors.*

Result: *A total of Nine hundred sixty data were collected for the evaluation of occurrence of error in pre and post analytical laboratory practices from all OPD. Of these Majorities of them from Medical 334(34.8%), Surgical 165(17.2%) and 156(16.3%) were Gynecology. Out of all the required information Patient Hospital Number and Name were written in all forms (100%), the Patient age and Sex were present on 91.9% and92% of the request papers respectively. The patient's Clinical Data was not stated on 683 (71.1%) forms, while the date of request was not present on 102(10.6%) of forms. The location of the patient was missing on 87(9.1%) forms. the name and/or Signature of the physician ordering the test was not provided on 363(37.8%) of forms also the date of the test ordered was present on 89.4 % forms. Concerning the Phlebotomy Practices there was a high frequency of error on Patient identification 24(2.5%) and 13(1.4%) were lost. From the post analytical practices 5(0.5%) had error while the result transferred from paper to the LIS database. Whereas during creation 9(0.5%) of test request in to the database unrelated test request with the request paper were created whereas 24(2.5%) of the total request were repeatedly created and from the total, 13(1.4%) were lost.*

Conclusion and recommendation: *In general our study showed there were higher frequencies of gap on pre and post analytical practices that should be solved there for the organization should focus to improve Data quality, documentation, and Information flow of the clients*.

Key words: *ICT, pre analytical, Post analytical, Error*

1. Introduction

The World Health Organization (WHO) recognizes quality laboratory services as key to improving global health and reaching Millennium Development Goals (1). Daily laboratory activity is an essential part of the comprehensive patient care, and consists of various actions that should be optimized and standardized to provide laboratory reports that might be ultimately useful for the clinical decision making. As the number and complexity of laboratory analysis are constantly increasing, it is crucial that laboratory errors are reduced to the least possible rate.

Quality improvement is the practice of continuously assessing and adjusting performance using statistically and scientifically accepted procedures. According to the current definition of the US Institute of Medicine (IOM) healthcare quality is the degree to which health services increase the likelihood of desired health outcomes and are consistent with current professional knowledge. (2)

Use of clinical laboratory test results in diagnostic decision making has become an integral part of clinical medicine. More than 60-70% of the most important decisions on admission, discharge, and medication are based on laboratory test results. With this high degree of influence, the quality of laboratory testing and reporting is of utmost importance. (3)

Specimen collection is the first phase of interaction between the patient and the laboratory. Appropriate counseling should be done before specimen collection and consent taken whenever needed. Attention should be paid to patient's sensibilities during the entire process. It is therefore considered an important step of good clinical laboratory practice and is referred to as "pre analytic control". (4)

Laboratory testing, a highly complex process commonly called the total testing process (TTP). The majority of errors in TTP originate in the pre-analytical phase, being due to individual or system design defects. In order to reduce errors in TTP, the pre-analytical phase should therefore be prioritized. The automation of the pre-analytical phase is therefore a means to preventing errors. In a paper on this issue, the use of automated pre analytical robotic workstations

effectively reduced the labor associated with specimen processing, and reduced the number of laboratory errors occurring on sorting, labeling, and aliquotting specimens; it was also found to improve the integrity of specimen handling throughout the steps of specimen processing (5)

The medical record is the most important practice tool used by physicians, regardless of specialty. because it supports and enhances the care that our patient receives. it is also a legal document that details the care you provide to your patients and acts as are cored of your billing practices(6)

In order to improve implement these quality improvement, The Government of Ethiopia through health management improvement reform program has introduced EMR (smart care) from these St' Paul's one of the beneficiary Organization .How ever this project were failed throughout the country. But after the failarty of (Smart Care) St' Paul's Hospital with the help of John Hopkins University introduced PolyTAK for the laboratory Purpose only.

2. Literature review

Errors in the post-analytical phase of laboratory medicine, particularly in incorrect interpretation of laboratory results, have been estimated to be at least 20% of all errors ascribable to laboratory professional staff. (7)

The most relevant features of studies on laboratory errors are their scarcity and their heterogeneous nature. The total testing process is typically divided into three main phases (pre-, intra- and post-analytical), exploration of the beginning and end of the loop reveals that currently, pre- and post-analytical steps are more error-prone than intra-analytical processes. In particular, in the pre-analytical phase, the existence of a pre-pre-analytical phase (i.e., procedures performed neither in the clinical laboratory nor under the direct control of laboratory personnel) must be recognized. This phase starts with test request, patient and specimen identification, blood drawing, sample collection and handling, and ends with the transportation of specimens to the laboratory. One of Importance of the pre-analytical phase is Misuse of laboratory services through inappropriate laboratory test requesting. (8)

Laboratory quality management plans, with pre-analytic, analytic, and post-analytic components, are key elements in ensuring patient safety. While all three components are important for ensuring patient safety, the greatest impact for overall improvement would be to focus on pre- and post-analytic services where most errors occur. The topic of patient safety has taken a front seat in the continuing debate on the reform of the American health system. The new attention to the topic is not unwarranted. With estimates of over 100 million Americans being affected by a medical mistake at a cost of $200 billion a year, patient safety and quality issues need to be addressed system wide.(8)

The post-analytic mode of practice requires that interpretive comments be added to laboratory reports when appropriate to ensure that clinical practitioners fully understand the full potential of the test results. Implementing such pre-analytic and post-analytic practices not only opens up channels of communication with health care providers, often practicing in remote locations, but provide for establishing valuable guidelines to assure specimen quality that may impact on the accuracy of test results, and encourages the use of informative interpretive comments on laboratory reports that can significantly impact patient care.(9)

The post-analytical procedures performed within the laboratory include verifying laboratory results, feeding them into the laboratory information system, and communicating them to the clinicians in a number of ways (in particular, by producing a report and making any necessary oral communications regarding ‘‘alert’’ or panic results). In this step, the most common mistakes, accounting for 18.4–47% of total laboratory errors, are: wrong validation, results that are delayed, not reported or reported to the wrong providers, and incorrect results reported because of post-analytical data entry errors and transcription errors. (9). Communication within the practice and between the practice and another location can be subjected to communication gaps and errors tha leads to patient harm(10)

In the post-analytical phase performed outside laboratory control (post-post-analytical phase), the clinician receives, reads and interprets the results, and makes a decision on the basis of information from the laboratory and other sources. There is evidence that laboratory information is only partially utilized: The post-analytic mode of practice requires that interpretive comments be added to laboratory reports when appropriate to ensure that clinical practitioners fully understand the full potential of the test results (11). a recent report demonstrates that 45% of the results for urgent laboratory tests requested by the Emergency Department of one hospital were never accessed, or were accessed far too late. (10)

Application of Total Quality Management concepts to laboratory testing requires that the total process, including preanalytical and postanalytical phases, be managed so as to reduce or, ideally, eliminate all defects within the process itself. Indeed a “mistake” can be defined as any defect during the entire testing process, from ordering tests to reporting results.(12)

Study done on the frequency and types of mistakes found in the “stat” section of the Department of Laboratory Medicine of the University-Hospital of Padova by monitoring four different departments (internal medicine, nephrology, surgery, and intensive care unit) for 3 months. Among a total of 40,490 analyses, we identified 189 laboratory mistakes, a relative frequency of 0.47%. The distribution of mistakes was: pre analytical 68.2%, analytical 13.3%, and post analytical 18.5%. Most of the laboratory mistakes (74%) did not affect patients’ outcome. However, in 37 patients (19%), laboratory mistakes were associated with further inappropriate

investigations, thus resulting in an unjustifiable increase in costs. Moreover, in 12 patients (6.4%) laboratory mistakes were associated with inappropriate care or inappropriate modification of therapy. The promotion of quality control and continuous improvement of the total testing process, including pre- and post analytical phases, seems to be a prerequisite for an effective laboratory service. (12)

Quality and accountability are the focus of current concern in laboratory medicine. Mounting evidence indicates that reliability cannot be achieved in a clinical laboratory through the mere promotion of accuracy in the analytical phase of the testing process. Laboratory personnel's have long realized the importance of monitoring all steps in laboratory testing to detect and correct defects. However, most of their attention has been directed toward detecting and correcting defects in the analytical portion of the testing process, such that analytical mistakes now account for <10% of all mistakes. Ross and Boone found that mistakes made in laboratory testing were distributed as follows: pre analytical 46%, analytical 7%, and post analytical 47%). (12)

A study done In 2008 to 2009, Chawla and colleagues performed a 1-year study in the clinical chemistry laboratory on the frequency of pre-analytical errors observed in both inpatients and outpatients. For the inpatients, a pre-analytical error rate of 1.9% was reported. The variable receiving the highest frequency rating was specimen hemolysis at 1.10%. For the outpatients, the error rate was 1.2%, and the variable with the highest frequency rating was insufficient volume for testing. Some of the other common sources of pre-analytical error are the following: ordering tests on the wrong patient, ordering the wrong test, misidentifying the patient, choosing the inappropriate collection container, or labeling containers improperly. (13)

In an article by Plebani and Piva, the authors give a comprehensive overview on the ongoing efforts for improving actual consensus on the definition and notification of laboratory critical values, and for evaluating their contribution to improve clinical outcomes and patient safety. The article also provides some highlights on a valuable experience of automated notification, which is a reliable tool for improving the timeliness of communication and avoiding potential errors for which accreditation programs require read-back of the results. (13)

Medical laboratory staff may not collect all or any samples for examination. However, laboratories are still responsible for ensuring that samples received are not compromised.

Personnel records including training and qualifications should be reviewed and collection techniques by the laboratory's own staff should be witnessed. Wherever the collection work is performed, the collection sites should be evaluated when accrediting medical laboratories and all the typical collection sites should be covered during the whole accreditation cycle. (14)

A study conducted in Ghana on hematology laboratory request paper evaluation by Edeghonghon Olayemi and Rebecca Asiamah-Broni shows the patient's age and sex were missing in 25.6% and 32.7% of the formats respectively. About half (50%) of the request forms did not have the patient's location. No clinical detail was provided on 22.7% of the forms. Doctors were most of the time sign on the formats and provide a name but they all failed to provide an address or a contact telephone number (15)

A study conducted by **Adegoke** O. A., Idowu A. A. and Jeje O. A. in Nigeria. a total of 2,115 request forms were examined of these completeness of request papers the patient name were well written on all forms (100%).where as Patient Hospital number, patient age(date of birth)and, Sex were accounts (95.6%),(86.4%),(98.8%)and(98.8%) respectively. Whereas the patient clinical data were well written in 92.2%, Physician name 95.7%, and the location of ward/OPD indicated in 99.7 %.(16)

A 1 year cross sectional study in University hospital of Verona, Italy, showed that, a total of 423,075 routine venous blood specimen (71,922 from out patients; 17%) were received in the 5 more representative sections of the laboratory (130,806 for clinical chemistry testing, 113,699 for hematologic testing 61,301 for coagulation testing, 59,403 for electrophoresis and specific protein testing and 57,866 for immunology testing) according to the above specified criteria 3154 (67.4%) pre- analytic errors were identified and recorded in the 1 year observation period they observed a significant difference in the error rate between in patients and out patients (0.82% Vs 0.73%,) current data on laboratory error rate most un suitable samples resulted from hemolysis (18.1%) insufficient quantity (16.8%) and clotting (13.4%) (17)

Cross sectional study conducted in Verona hospital, Italy on the prevalence and type of pre analytical problems for in patients sample in coagulates laboratory form January 2005 to

December 2006, 65,283 routine and stat test requests for complete first line coagulation tests (APTT, PT and fibrinogen) pre- analytical problem were identified in 5.5% of the specimens. The more frequent problems could be referred to sample not received in the laboratory following doctor's order (49.3%) hemolysis (19.5%), clotting (14.2%) and in appropriate volume (13.7%). The investigation demonstrates a high prevalence of pre analytical problems affecting samples for coagulation testing.(18)

Cross sectional study in East Tallinn. Estonia showed that the number of hemolyzed samples was reduced by 29.3% (from 2008 in 2009 to 1427 cases in 2010) and the number at clotted samples by 14.440 (from 460 to 401 cases) for the whole hospital. In surgery clinic the number of clotting was reduced by 20.6%. as 77-80% of these hemolzed samples came from emergency department they estimated if to be a good effect. In internal diseases clinic the number of hemolysis was reduced by even 36.8% and the number of clotting was reduced by 10.5%. In women's clinic the number of hemolysis was reduced by 17.4% and the number of clotting rise by 1% the poor result is due to the difficult sample collection procedure of premature new born. (19)

Study done in Ankara University Ibni Sina Hospital, Pre- analytic errors were observed in the Central Laboratory Clinical Biochemistry Unit at. The most common pre-analytic error was incorrect patient information being entered into the hospital information system (16.5% and 23.5% for the morning and night shift, respectively). The second most common pre analytic error was discordance between test requests on the forms and what was entered into the hospital information system (10.1% and 7.1% for the morning and night shift, respectively) Inadequate volume of blood (3.2% and 2.9% for the morning and nigh shift, respectively) was the next most common pre- analytic error. The statistical differences between morning and night shifts were significant ($P<0.001$) for hospital information system patient errors. (20)

Across-sectional study conducted in India clinical Biochemists laboratory from January to March 2011 showed that, the screening of 1,513 lab requests forms done to assess the pre analytical errors affecting the laboratory results. No diagnosis was provided on 61.20% of forms. Type of spacemen was not mentioned in 61.60% of the forms and 89.25% of all forms were illegible. Critical results were encountered in 17.30% of patients and of these76.60% were not

communicated due to incomplete forms. Physician's name were missing in 13.1% of the forms and these were not signed by them in nearly 13.4 %(21)

Study conducted at the Lgbinedion University Teaching Hospital Okada, Nigeria in 2012.Showed that a total of 2,362 laboratory request forms sent to laboratory department. Data mostly omitted was patient's age, observed in 48.3% of request forms reviewed. Complete documentation was only observed in respect to patients name and signature of attending physician. The name of the attending physician, however, was missing in 19.8% of forms audited. Information regarding patient's gender and location (ward) in the hospital was absent in 1.1%, and 20.1% cases respectively. 151(6.4%) of audited forms were void of working diagnosis, while type of clinical sample was not documented in 2.7% of laboratory request forms evaluated. (22)

A survey done in Toronto, Canada showed that of test ordering accuracy, 2.9% of test orders, representing 6,538 tests from 577 institutions were not completed of those not processed by the laboratory 42% were incorrectly entered into the computer and 13% of their question was improperly completed. When paper requisitions are filled out illegibly, it may result in the wrong test being performed. (23)

A study conducted by Shams, Sedigheh et. al. Children's Medical center in 2008. A total of 375 of 425 complaints were related to delay in reporting test results. 50 cases of erroneous result complaints; Also 72% of delayed reports and 34% of complaints of unaccepted results were caused in post-analytical phase (i.e. after test was performed). "Failure to input the results in computer" was the main reason (37%)."Lost results "(25%) and transcription error (22.6%), "absence of laboratory request form" (9.8%) and "wrong method of filing" (4.2%) were the other observed causes. (24)

Miscommunication can happen between physician and laboratory personnel especially while reporting the results verbally and could lead to critical situations. Transcription error: In most large clinical laboratories, test results are produced from and stored in the LIS. In these laboratories, test data may be entered manually into the LIS or automatically transferred to the

LIS from automated systems. In case of manually entry of the test data into the LIS there are chances of transcription errors. For eg, an accurate and reliable result reported on the wrong patient, using the wrong value, and/or with the wrong units [eg, mg/L instead of mg/day]. (25)

Paper-based test requests in themselves pose a risk because they may be completed only partially, placed in the wrong collection box, or simply lost. Computerized order entry systems (COES) replace the paper-based test request by allowing the ordering information to be directly fed into a computer. This type of system is often combined with the electronic delivery of the test result, sometimes accompanied by a digital signature. A this eliminates many sources of error, above all those connected with paper-based information, such as transcription error and lost requests or results (26)

Data loss can be caused by many things ranging from computer viruses to hardware failures to file corruption to fire, flood, or theft (etc). If you are responsible for business data, a loss may involve critical financial, customer, and company data. If the data is on a personal computer, you could lose financial data and other key files, pictures, music, etc that would be hard to replace (27)

The medical record is apt to contain more personal information than any other single document. It contains not only sensitive health care information, but also demographic, sexual, behavioral, dietary, and recreational information. Because of the vast amount of highly sensitive information in the medical record, patients have the expectation that the information therein will be held in privacy. That loss of personal privacy is the greatest concern of over a quarter of our population.(28)

LIMS is a software which helps you getting access to the lab resources (tools licenses, tools booking), Running the tools (instructions, recipes, SPC), Archiving the experimental results (logs, batch register), LIMS is also used for administration of laboratory (managing of users, tools, licenses, runs, economy, processes). (29) Traditionally, laboratory information management systems (LIMS) have been viewed as an analyst-side tool, which took the place of a physical notebook. However, with the increase in both evidence volume and legal scrutiny (and potential refutation) of the results comes added scope, yielding LIMS implementations which

tend to either underperform or become unwieldy and cumbersome in their attempt to be everything for everybody. (30)

Good software engineers are inherently lazy and try at all costs to refrain from being innovative. Innovation takes time and is pointless when a solution already exists. Patterns are a tool used by developers to avoid having to re-invent certain solutions. A thorough set of patterns, for use with a LIMS, could significantly increase productivity, speed up implementation, and help reduce the amount of innovation required when developing a LIMS (31)

3. Statement of the problem:

Because of the volume of laboratory testing and high frequency of medical errors to laboratory testing, there is a need for improved quality in the area.

Development of technology, Automatization and quality control of analytical processes has contributed to reduce significantly the rate of errors in the analytical phase; nevertheless, potential errors still can arise from the extra-analytical phases. In laboratory medicine, multiple studies have shown that the majority of errors or gaps in quality take place in the pre analytic and post analytic phases of the total testing pathway

Lab errors, as and when detected call for sample rejection. Any rejected sample calls for repeat sample collection and analysis leading to delayed reports, and additional costs to the lab, besides impacting service quality and customer satisfaction. It is also possible that some lab errors could even go undetected and thereby could adversely affect the patients' health due to incorrect treatment protocol Consequences of lab errors, therefore, have implications on finances, service quality, and additional training inputs to lab staff. In short, lab errors cut the profitability margin of the laboratory, and therefore minimizing lab errors is a major task in lab management(32).

When errors are categorized into general process categories, frequent pre analytic errors involve inadequate sample collection, inappropriate sample transportation, and incorrect test requests for patients. Frequent categories of post analytic errors include lose of the result, transcription error, delays in receiving reports, error in interpretation. Additionally, documentation and the connection between health care quality and communication is an issue of critical importance, especially in laboratory medicine. Poor communication among health care providers is the root cause of most medical errors, including sentinel events. Much attention has been directed at quality initiatives within the analytic phases of testing in the laboratory with quality control programs. (33)

Recent years have seen a significant improvement in our perception of the importance of patient safety and the need to reduce medical errors. As they are part of the overall healthcare system, clinical laboratories are prone to medical errors. A body of evidence demonstrates that, currently, the pre- and post-analytical steps of the laboratory testing process are more error prone than the analytical steps. (34)

In general there is a gap in implementing quality services in pre and post analytical medical laboratory practices. One of Importance of the pre-analytical phase is Misuse of laboratory services through inappropriate laboratory test requesting. Frequently in post analytic phases there are errors include lose of the result, transcription error, delays in receiving reports, and error in interpretation. To improve patient satisfaction needs to reduce occurrence of error in pre and post analytical Phases. In most large clinical laboratories, test results are produced from and stored in the LIS. In these laboratories, test data may be entered manually into the LIS or automatically transferred to the LIS from automated systems. In case of manually entry of the test data into the LIS there are chances of transcription errors. For eg, an accurate and reliable result reported on the wrong patient, using the wrong value, and/or with the wrong units [eg, mg/L instead of mg/day. Also Poor communication among health care providers is the root cause of most medical errors

4. Objectives

4.1 General Objective:

To Improve the Use of ICT based Blood tests of Pre and post analytical practices to enhance patient satisfaction in St. Paul's Hospital

4.2 Specific Objectives

- To describe the level of implementation of the existing ICT practices for pre and post analytical phases
- To describe the magnitude of error in request paper completeness
- To Determine error in Phlebotomy Practices
- To determine the magnitude of error in post analytical practices

6. Methodology

6.1 Project Area

The Project was conducted in Addis Ababa which is the capital city of Ethiopia, in saint Paulo's Hospital millennium medical college particularly in Laboratory department, from May 09 to 22 2014. It is teaching and referral Hospital located in western part of Addis Ababa Gulele sub city. The hospital built by Emperor Haile selassie in 1969 with the help of the Germen Evangelic church; with the aim to serve under privileged people. A medical college was established in 2007. This Hospital Serves on average 700 patient's daily. The Hospital has 340 beds. The laboratory gives service on average 300 patients daily including private wing.

6.2 Study Design and period

Cross sectional Faculty based Descriptive study design was conducted to assess ICT based pre and post analytical laboratory practices. in St. Paul's Hospital Millennium Medical College laboratory from May 9 to 22/ 2014

6.3 Source population

The source of population was all laboratory testes requested at St. Paul's Hospital Millennium Medical College.

6.4 Study population

Test requested from OPD at St. Paul's Millennium Medical College laboratory during the study period.

6.5. Inclusion and Execution criteria

All tests for clinical chemistry, Hematology, serology, Hormonal and coagulation test from outpatient department (OPD) requests included during the study period. and other than the above mentioned will be excluded

6.6. Sample size

A total of Nine Hundred sixty tests were used; that were conveniently accessible within the study Period from May 9 to 22/ 2014 St. Paul's Hospital OPD within the study period.

6.7 Sampling technique

Convenience sampling technique was used to collect the pre and post analytical phases

6.8 Data collection tools

Quantitative method: structured Questionnaire and data collection work sheet was used to collect quantitative information. The study describes errors in laboratory request paper, Sample collection practices; and also error in data creation, data entry, result transcription, and frequency of lost results during routine hour. The data was collected by senior Laboratory personnel

Qualitative method: Structured observation check list was prepared to collect information about the process of pre and post analytical work flow. Which include about the convenience of the sample collection area, the person who collects the specimen, availability of LIS in each laboratory section, way and timing of transportation of the spacemen, practice and type of backup system, and. The check list was filled by the principal investigator

6.9 Data collection procedure

The data was collected by two trained senior laboratory Technologist and principal investigator. The data collectors were trained for one-day about how to use the check list, work sheets eligibility criteria. Data was collected by using the standardized Questionnaire, check list and work sheet. The information provided on each request form was recorded in a spread sheet and evaluated using SPSS version 20. A frequency distribution table was created to summarize the data and observed data are described in detail.

6.10 Data quality control

Data collection check list and data collection work sheet was pre- tested before the actual data collection in the selected hospital to ensure the validity of the study tool. After the data collection tool was pre -tested appropriate modification made to standardize the data collection work sheet. The collected data was checked for completeness by principal investigator.

7. Ethical consideration

The study was done after getting ethical clearance from the ethical clearance committee of Addis Ababa University School of information science and Public health Research committee. A letter informing the facility administrators were written from the department of Health Informatics.

Informed written Permission was obtained from St. Paul's Millennium Medical College Institution review board (IRB) and staff of laboratory department Information about the study was given to all lab personnel and clinicians; in addition all information that will necessary for the management and further improvement of the laboratory were given to the respective health institutions.

8. Operational definition

Errors: Non-conforming results with "statistical meaning".

Pre analytical errors: Occurrence of error at pre analytic Phase. It includes; Patient requisition, Creation of patient/client data, Patient/client identification, Patient/client preparation, Specimen collection, Specimen transport and handling, Specimen processing, Specimen storage

Post analytic errors: Post-analytical procedures performed within the laboratory. Includes; review of patient/client results, Posting or transcription of patient/client results, Maintenance of patient/client results, notification to the physician of critical values,

Quality: Ability of a service to satisfy the needs and expectations of the customer

Proper mixing of Blood sample of Hematology test: Inverting up and down gently 3 to 4 times

Phlebotomist: The person who trained in Blood sample collection

Client: all individual involved in the study including sick and Healthy (Pregnant Women)

Critical Values: These are results that exceed or are below the reference range that has been establish for each laboratory, these results involve immediate medical attention

Hematoma: is a localized collection of blood outside the blood vessels

Hemolysis: Invitro destruction of Red Blood Cells

Best Practices: Practices integral to the provision of laboratory medicine services that increase the probability of beneficial patient outcomes, considering scientific evidence and, when needed, expert opinion that support the IOM quality aims (25)

A **data backup:** is the result of copying or archiving files and folders for the purpose of being able to restore them in case of data loss (29)

9. Scope of the project: 9

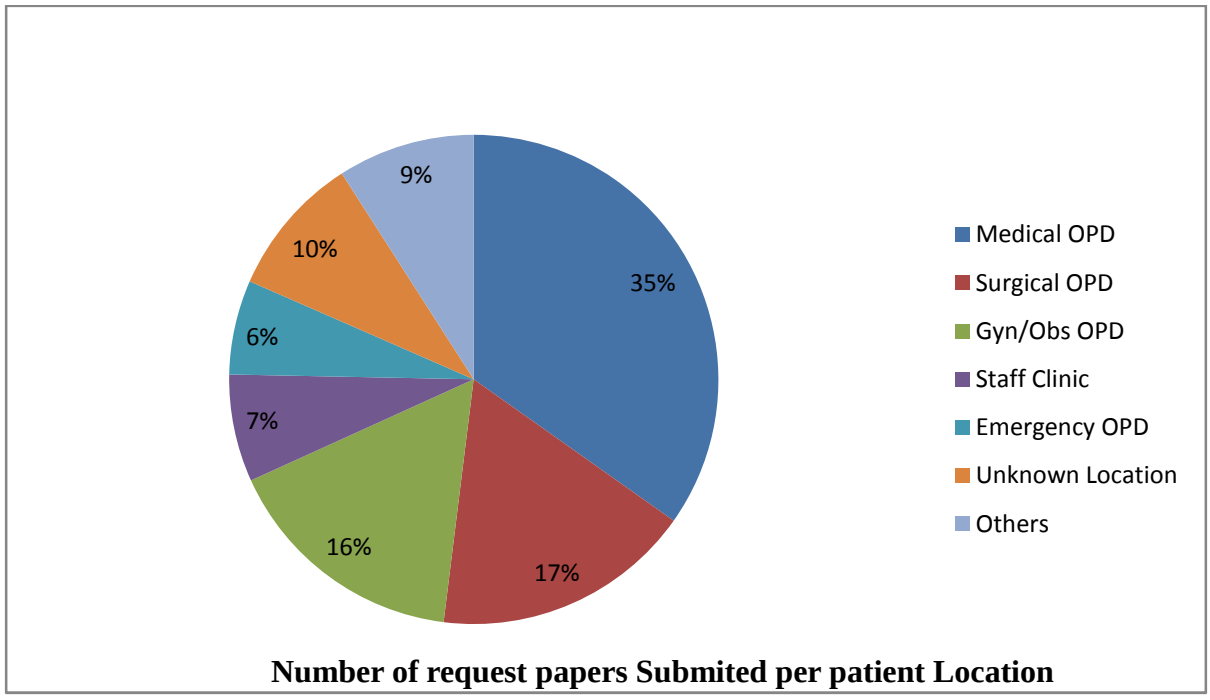
The project covered factors that will affect the quality service delivery in ICT based pre and post analytical laboratory practices. To have base line this study perform gap analysis, and then based on the result, I had tried to implement and take plan of action for best possible solutions, finally recommendation were written to the organization for the continuity and follow-up of the practice of improvement. It is conducted at St Paul's Hospital Laboratory from May 9 to 22/ 2014 G.C. It is expected to be covered by 14,922 Birr.

10. Significance of the Project

Application of Quality improvement concepts to laboratory testing requires largely pre analytical and post analytical error management, so as to reduce or, ideally, eliminate all errors within the process itself. Solutions for these errors will improve utilization of laboratory services and reduce diagnostic and treatment errors and delays; which are safe, timely, efficient, effective, equitable and patient-centered

11. Result

A total of Nine hundred sixty data were collected for the evaluation of occurrence of error in pre and post analytical laboratory practices. Of these majority of the request papers are sent from Medical, Surgical and gynecology/obstetrics OPD were 34(34.8%), 165(17.2%), 156(16.3%) respectively. Whereas staff clinic 68(7.1%), emergency 60(6.3%), Unknown location 90(9.4%) and others 87(9.1%).



Number of request papers Submited per patient Location

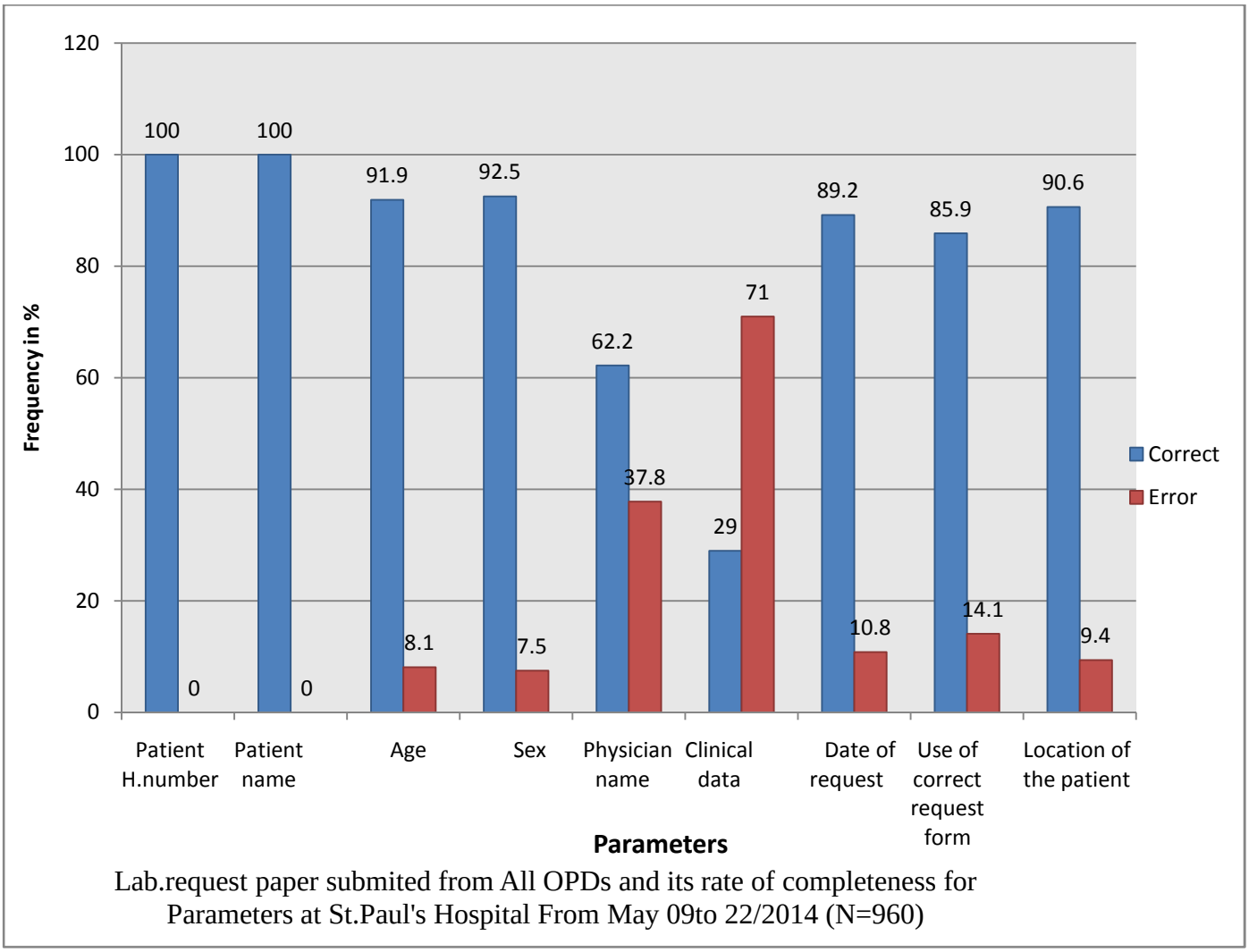
Table 1: Laboratory request forms and their completeness rates the parameters submitted to the laboratory, from all out patient department (N=960) at St. Paul's Hospital Millennium Medical College, Addis Ababa; Ethiopia. From May 09 to 22, 2014

Parameters	Completnes	Frequency	Percentage
Patient ID number	Done	960	100
	Not done	-	0
Patient name	Done	960	100
	Not done	-	0
Age	Done	882	91.9
	Not done	78	8.1
Sex	Done	888	92.5
	Not done	72	7.5
Physician name and/or signature	Done	597	62.2
	Not done	363	37.8
Clinical data	Done	278	29
	Not done	682	71
Date of request	Done	856	89.2
	Not done	104	10.8
Correct request	Done	825	85.9
	Not done	135	14.1

A total of nine hundred sixty request forms were studied Out of all the required information Patient Hospital Number and Name were written in all forms (100%), Patient age and Sex were present on 91.9% and92% of the request papers respectively.

The patient's Clinical Data was not stated on 683 (71.1%) forms, while the date of request was not present on 104(10.8%) forms. The location of the patient was missing on 87 (9.1%) forms.

With respect to physician information; of the name and/or Signature of the physician ordering the test, 37.8% of them committed error. The date of the test was ordered was not present on 10.8 % forms.



Lab.request paper submited from All OPDs and its rate of completeness for Parameters at St.Paul's Hospital From May 09to 22/2014 (N=960)

Table 2:Laboratory request forms and their completeness rates of the parameters submitted to the laboratory from Medical outpatient department. N=334 at St. Paul's Hospital Millennium Medical College, Addis Ababa; Ethiopia. From May09 to 22, 2014

Parameters	Completeness	Medical		Frequency	Percent
		OPD 1	OPD 2		%
Patient Hospital number	Not done	-	-	0	0
	Done	83	251	334	100
Patient name	Not done	-	-	0	0
	Done	83	251	334	100
Age	Not done	31	7	38	11.4
	Done	52	244	296	88.6
Sex	Not done	18	8	26	7.8
	Done	65	243	308	92.2
Physician name and/or	Not done	33	97	130	38.9
signature	Done	50	154	204	61.1
Clinical data	Not done	69	155	224	67.1
	Done	14	96	110	32.9
Date of request	Not done	10	15	25	7.5
	Done	73	236	309	92.5
Correct request Paper	Not done	19	23	42	12.6
	Done	64	228	292	87.4

A total of 334 data were collected from two medical OPD; to evaluate the completeness rate (the magnitude and types of error) on laboratory request forms; specifically on Patient demographic data and other patient information, submitted to the laboratory at St. Paul's Hospital Millennium Medical College. From; May 9 - 22, 2014. As a result patient Hospital number, Name of the patient and the location of OPD was not missed (100%) at all request papers. Others demographic data such as, Age, and sex were not stated on 11.4%, and 7.8% of request forms. Also no clinical detail is provided on 67.1% of the requests papers. And 38.9% of the physicians didn't put their name and/or signature of the request papers. The date of the request and use of correct request forms were missed in 7.5% and 12.6% of the requests.

Table 3:Laboratory request forms and their completeness rates for the parameters submitted to the laboratory from Surgical outpatient department. N=165(Surgical 1=12, Surgical 2=153) at St. Paul's Hospital Millennium Medical College), 2014 Addis Ababa; Ethiopia. From May09 to 22, 2014

Item	Completeness	OPD 1	OPD 2	Frequency	Percent %
Patient Hospital number	Done	12	153	165	100
	Not done	-	-	-	0
Patient name	Done	12	153	165	100
	Not done	-	-	-	0
Age	Done	10	151	161	97.6
	Not done	2	2	4	2.4
Sex	Done	12	149	161	97.6
	Not done	-	4	4	2.4
Physician name and/or	Done	10	115	125	75.8
signature	Not done	2	38	40	24.2
Clinical data	Done	8	45	53	32.1
	Not done	4	108	112	67.9
Date of request	Done	7	140	147	89.1
	Not done	5	13	18	10.9
Correct request	Done	11	131	142	86.1
	Not done	1	22	23	13.9

A total of one hundred fifty six request forms were studied from surgical OPD. That shows the information required on laboratory request forms and the percentage of laboratory forms that contained the required information. Out of all the required information only the patient's name and Hospital Number, were present in all forms.

Both the patient's age and sex were not given on 2.4% of the request forms, while physician name and/or signature were present on 75.8% of them. The date of the request 18 (10.9%) were

not written while 13.9% of the requests were not prescribed by the correct request format. Only 32.1 % of the request forms evaluated contained the clinical details of the patient.

Table 4:Laboratory request forms and their completeness rates for the parameters submitted to the laboratory from Gynecology/obstetrics outpatient department. N=156(OPD 1=89, OPD 2=67) at St. Paul's Hospital Millennium Medical College, Addis Ababa; Ethiopia. From May09 to 22, 2014

Item	Information	OPD 1	OPD 2	Frequency	Percent %
Patient ID number	Done	67	89	156	100
	Not done	-	-	0	0
Patient name	Done	67	89	156	100
	Not done	-	-	-	0
Age	Done	64	87	151	96.8
	Not done	3	2	5	3.2
Sex	Done	60	85	145	92.9
	Not done	7	4	11	7.1
Physician name	Done	46	62	108	69.2
and/or signature	Not done	21	27	48	30.8
Clinical data	Done	25	13	38	24.4
	Not done	42	76	118	75.6
Date of request	Done	58	78	136	87.2
	Not done	9	11	20	12.8
Correct request	Done	56	75	131	84
	Not done	11	14	25	16

Information regarding evaluation of completeness of request forms from gynecology and obstetrics department; a total of 156 request papers were examines of these Patient Name and Hospital number were not missed at all. Whereas patient demographic information such as Name, Age, Sex were 99.4%, 96.8%and 92.9% respectively.30% of the clinicians were committing error in completing their name and signature. Most of the clinicians (75.6%) were not indicating the clinical data. But the error on the date of request and use of correct request forms were 12.8% and 16% respectively.

Table 5: Phlebotomy practices and the rate of errors by Phlebotomist; on Patients who gave blood sample for Hematology test (N=244) in St Paul's Hospital Millennium Medical College Addis Ababa, Ethiopia, from May09 to 22, 2014

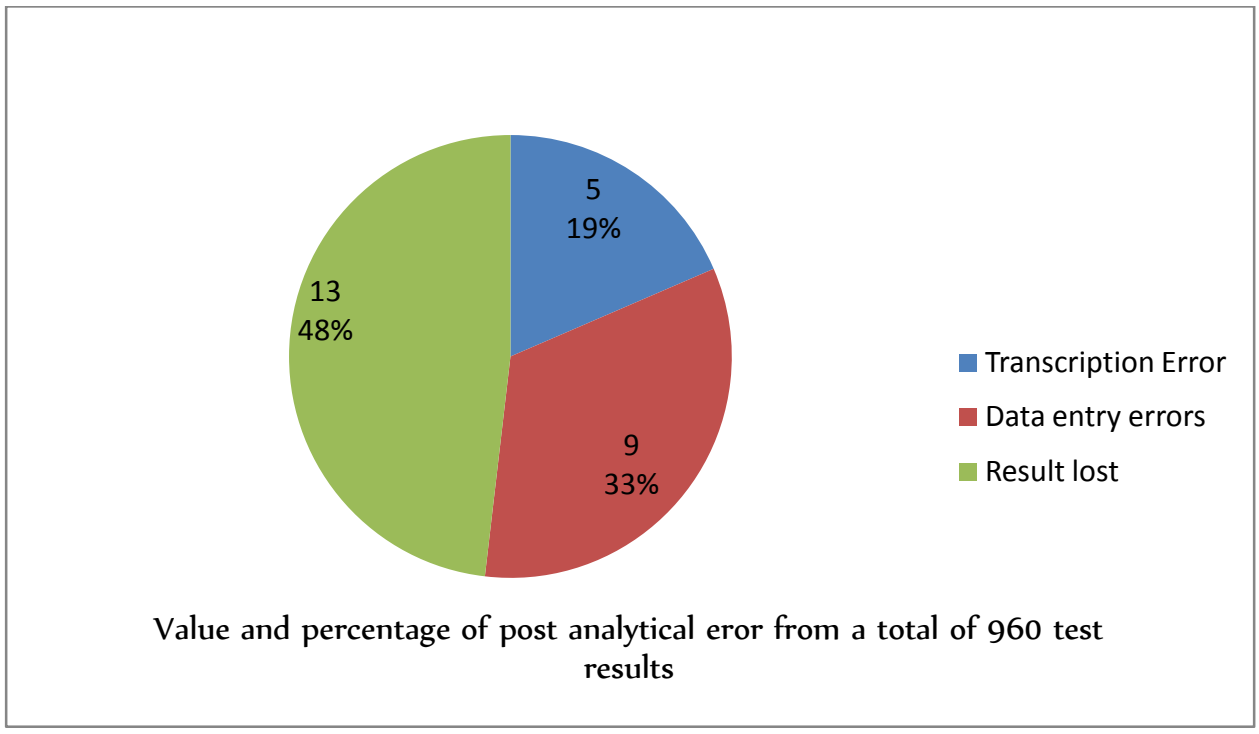
Phlebotomy practices	Frequency of Error	Percent%
Patient identification	70	28
Tourniquet usage while blood drawing	31	12.8
Proper mixing for Blood samples with anti-coagulant	136	56
Appropriate use of test tube is done	-	0
Proper Vain selection for blood sample drawing	25	10.3
Volume of blood sample	30	16.5

A total of 243 Phlebotomy practice were observed on patients who gave hematology blood sample; of this 70(28%) of the practices was not follow the patient identification procedure. Tourniquet is applied while blood drawing > one minute on 30(12.8%) of the patients and 25(10.3%) of vein selection procedure incorrect. After drawing of the sample the phlebotomist were used appropriate test tube in all samples (100%), but they didn't mix properly with the anticoagulant for 136(56%) of the samples. also 25(10.3%)the volume of blood sample were not proper.

Table 6: Post analytical types of error occurred and their frequency (N=960) in St Paul's Hospital Millennium Medical College Addis Ababa, Ethiopia, 2014

Post-analytical errors	Frequency	Percent%
Transcription errors	5	0.5
Data entry errors	9	0.9
Result lost	13	1.4
Repeated data creation in the database	24	2.5
Total	**51**	**5.3**

A total of nine hundred sixty six data were collected for the evaluation of post analytical practices of these 5(0.5%) had error while the result transferred from paper to the LIS database. Whereas during creation 9(0.9%) of test request in to the database unrelated test request with the request paper were created and 24(2.5%) of the total request were repeatedly created. from the total 13(1.4%) were lost.



Value and percentage of post analytical eror from a total of 960 test results

Daily laboratory activity is an essential part of the comprehensive patient care and consists of various actions that should be optimized and standardized using deferent ICT tools to provide laboratory reports that might be ultimately useful for the clinical decision making. In general the medical laboratory shall have a well organized space, facilities and equipment to give quality services for the customers.

Patient Reception area

Patient data has been created at the reception site; the data clerk sometimes not creating all the necessary patient information and test request rather some of them were missed. Mainly focusing on hospital number, test type and the location of the clinician, But regarding Age and sex if did not filled by the physicians they solve the problem by asking the patient itself or by comparing with the card holed by the patient. Otherwise; they leave unrecorded. This was due to different factors the major one was lack of understanding, about the use of full information of the patient demographic data, the other one was test selection challenges included; multiple or confusing test names for the same test, diverse testing panels with the same name, internationally unaccepted use of abbreviations by some clinicians.

Phlebotomy room

The room was well organized with phlebotomy materials; sample collection and receiving principles and procedures. Even though the room was enough for the phlebotomy practice there was no waiting area at all for the patients, as a result there is always over crowded over the area. The room did not supported with LIS. There were four sample collectors; of these two of them have diploma in laboratory technology, but they haven't take proper Phlebotomy training after joining the hospital, the rest two had taken short training once for the phlebotomy practices despite having diploma or above in laboratory technology. Sample were delivered in to all laboratory sections in average within 15 minutes by responsible individual this is a good practice; but sample transporter did not take any training yet how sample is handle and transported; instead oral instruction was given from the department head.

The lab have written specimen rejection criteria and there is in place over the phlebotomy room and all laboratory sections. Even though the Lab has documented collection manual; reviewed consistently. Regarding urgent and oral requests there was procedure in place.

General Laboratory

Laboratory information software has been working only for the laboratory; that is the physician requesting the test on paper. Mostly there was sudden and irregular interruption of the system for Laboratory information system software; but electric supply was mostly support with generator.

There is standard operating procedure for all test types. The laboratory has written policy regarding incomplete request orders by the clinicians but it was not implemented during the study period. Even though written communication protocols (SOP) was available within Laboratory; stile there was communication gaps with the physician due to lack of implementation. Communication with laboratory professionals is of particular concern because it is the least frequent among the various ordering and interpretation tactics used in dealing with the challenges. However, when clinicians did consult with laboratory professionals, the majority found it useful. Overuse, underuse, and misuse of laboratory tests may be reduced and patient care improved, if the methods deemed “useful” by the survey respondents can be available to more physicians.

Post analytical Phase

All of testes have reference interval, if reference intervals not written on the result difficult for the clinicians to interpretation and sometimes leads to Wrong dissections. because deferent test kites have their Owen reference range.

All test results are documented within the data base, when result is released only date and time of the first creation of patient information is displayed on the paper. Time of confirmation is not available. Backup of the data is not implemented.

12. Discussion

Pre analytical

Many Researches indicates Pre and post analytical Practices are more prone to errors than analytical Phase. In this study, the study assessed the magnitude of pre and post analytical errors, and the information flow from pre analytical to Post analytical Phase.

The main finding of our study shows, of the total nine hundred sixty request paper collected for evaluation, the Patient Hospital number and patient name available on all the formats (100%). The result indicated on the patient name is comparable to a similar study done by Adegoke O, Idowu A, and Jeje O [16]. This is because all request papers were first registered at reception area and given a barcode of all the tests to be analyzed; so that patients can give sample for the phlebotomists having this barcode on hand.

Among the total request papers evaluated, patient's Age and Sex were showing an error of 78(8.1%) and 72(7.5%) respectively. In line with our findings a high frequency (25.6% and 32.7%) of errors were reported from Ghana [15]. Whereas the clinical data of the majority of the request papers (71%) were not written. In line with this finding there was a report of lower frequency (22.7%) from Ghana [15].This will be because of most Physicians considers as "Witting clinical data will create bias for the laboratory personnel".

Other parameters such as the Clinician name and the patient location (OPDs) were missed in363 (37.8%) and 87(9.1%) of the request formats respectively. This finding is higher than reports of study done in Nigeria by Edeghonghon Olavemi and Rebecca Asiamah-Broni Which was 4.3% and 0.3% respectively; this defferece may be due to Patient Load and/or negligence [16]. Each test has its own request paper. 135(14.1) % of the test were requested by incorrect request papers.

A total of 334 data were collected from Medical OPD. Of these the Patient Hospital number and name were not missed at all. This was similar with the rest of OPDs included in the study at St. Paul's Hospital. On the other hand age (11.4%) and sex (7.8%) of the patient was not written from Medical OPD. Whereas from Surgical OPDs (2.4%) for age and sex and gynecology /Obstetrics (3.2%) of age and (7.1%) of sex were not written.

Physician name and signature were ignored in a great number of request papers. Medical (38.9 %), Surgical (24.2%), and gynecology /Obstetrics OPD (30.8 %).As we can see the errors committed in medical OPD was higher than the rest OPDs. Surprisingly the patient clinical data were not written in majority of request papers, which accounts for (67.1%) in medical, (67.9%) in Surgical, and (75.6%) in gynecology /Obstetrics OPDs. In normal circumstances when the patients load increase the rate of committing error can also increase. But in this case even though the numbers of requests sent to the laboratory were lower in Medical OPD the error was higher.

The date of request form and the use of correct request papers found almost in similar ranges; in Medical (4.4%), in Surgical (2.4%), and gynecology /Obstetrics (2.6%)OPDs.

A total of 243 patients came to phlebotomy area with Hematology request paper were involved. Before the patient gives Blood samples the Phlebotomist should identify the patient by asking his /her name and comparing it with the name on the request paper. But there was a large number (28%) of patient identification were not done by the phlebotomists. The possible justification for this error is that most critical patients will not bring the request directly to the Phlebotomist instead attendants will bring the request papers and by mistake Phlebotomist will draw blood samples from the attendants.

After drawing blood samples Phlebotomists were expected to mix gently by inverting 3to 4 times for hematology analysis to avoid error on test result. In this study 136(56%) of the samples were not properly mixed as stated on the SOPs. Applying Tourniquet while blood drawing should not be greater than one minute according to the SOPs as this will form hematoma and lead to hemolysis of blood samples [21]. On 30(12.8%) of patients tourniquet was applied over one minute.

To avoid the pain and to have enough blood sample the preferable vain should be selected. While selecting Venipuncture Site Antecubital vein location varies slightly from person to person; however, two basic vein distribution arrangements referred to as the “H-shaped” and the “M-shaped” patterns are seen most often. The “H-shaped” pattern is so named because the most prominent veins in this pattern- the cephalic, cephalic median, median basilic, and basilic veins- are distributed on the arm in a way that resembles a slanted H. The most prominent veins of the M pattern- the cephalic, median cephalic, median basilic, and basilica veins- resemble the shape

of an M. The H-shaped pattern is seen in approximately 70% of the population [22]. In this regard 25(10.3%) of the patients vein selection procedure was incorrect.

Different test tubes have deferent chemicals in them; we have to choose test tubes according to the types of tests we are going perform. If we use test tubes randomly the chemicals will affect the type of test we need. In our study we found phlebotomist was used appropriate test tube in all samples (100%). The volume of blood sample for hematology should be 2 to 4ml [21]. But the volume of blood sample in our investigation were not proper in 25(10.3%) of samples for hematology.

Post analytical

The post-analytical procedures performed within the laboratory include verifying laboratory results, feeding them into the laboratory information system, and communicating them to the clinicians (7)

Specimen requests must include patient identifiers and demographic data, as well as tests requested and clinical diagnosis; if appropriate. If there is a mismatch between the patient and the patient information entered into the computer or written on to a paper request test results can be issued on the wrong patient.

A total of nine hundred sixty six data were collected of these 5(0.5%) had error while the result transferred from paper to the LIS database. A similar study done in Ankara University Ibni Sina Hospital, indicate 10 % of the data were created wrongly in to the database. Whereas during creation of test request in to the database also 9(0.9%) of them were unrelated test request this is also lower error than study done in Ibini Sana Hospital sometimes This deference will be due to sample size and patient load.(16)

From the total 960 test results, 13(1.4%) were lost. Also unreadable test request written by paper were sent to the lab. the data clerk will confused with tests that have similar spellings, the other one is when they type in harry they wrongly select the request. 24(2.5%) of the total request were repeatedly created.

14. Solutions and actions

There is opportunity for improvement in the organization, but to improve the quality service, performance gap analysis need to be performed. A gap analysis will establish how big the gap is between current performance and desired performance.

In this study the major findings or gaps were isolated and immediate and plan of action were taken by communicating with the stakeholders at different levels. After analyzing and sorting the major Problems; discussion was made with the Department Head and The quality officer of the laboratory. Based on the result immediate action was taken for those can be solved by department levels and plan of action for those cannot be solved at that level. Concerning the completeness of request papers; except Patient Name and Hospital number, all parameters had an error. Particularly the clinical data and Physician name or/and signature for the OPDs, Short notice were prepared concerning the importance of completing the parameters on the requesting papers and informal communication were done with the nurses who are assisting the physician and also discussion had been done with the Physician at time of morning session.

Phlebotomy area was one of those who need immediate and planned action. The major problems were the absence of patient waiting area, the room was not communicating with other laboratory sections by LIS, the phlebotomist have not take any Phlebotomy and LIS training after employed to the Hospital and. Based on the solution preferred was; concerning the patient waiting area communication was done with the department head with the issue and the management have a plan to solve this problem in the future. For the phlebotomy practice, dealing with the Head and Quality Officer of the department, training was prepared for one-day and the training was given to the Phlebotomist.

The other one was the post analytical practices. The baseline study showed there was a gap of practicing standard way of data access, storage and reporting the result. The laboratory Information Software was unrestricted for all profiles. There was a problem on accountability of access. Plan of action was taken to communicate and solve the problem with the responsible individual from EHNRI. Concerning LIS the Hospital have a deal with EHNRI. And for those laboratory staffs by planning the way how the problem is solved. Discussion was made on the repeated creation of patient data, how to minimize errors in transcription and how to prevent lose of patient

15.1. Strengths

As our knowledge this study is the only study which tried to identify the magnitude of errors on ICT based blood tests of pre and post analytical phases of laboratory investigations.

And also the study demonstrated the possible solutions for the sources of errors on both phases of laboratory services

The result can be used for the improvement of the laboratory services, for further study as a baseline and for the improvement of Laboratory services of similar organizations.

15.2. Limitations

There are laboratory investigations; other than blood analysis like body fluids and the likes. But because of time limitation we did not include in our investigation.

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16. Conclusion and Recommendation

The healthcare system is increasingly dependent on reliable clinical laboratory services. To support the organizational strategy; avoiding or minimizing error is the key. This can be achieved by using ICT tools and standardizing documentation and information flow that can facilitate the client's service delivery to be safe, timely, efficient, effective, equitable and patient-centered. Moreover; St. Paul's Hospital is not only giving medical services but also teaching and research center quality documentation is vital; can support teaching and research activities by retrieving deferent Knowledge from the data base.

Patient data has been created at the reception site; the data clerk sometimes not creating all the necessary patient information and test request rather some of them were missed. This was due to different factors the major one was lack of understanding, about the use of full information of the patient demographic data, the other one was test selection challenges included; multiple or confusing test request.

Incorrect or incomplete data provided to the laboratory could significantly impact on the comments and successful outcome of treatment that patient receives. The patient's demographic data is relevant because it helps in specimen identification and proper interpretation of results. In instances where samples from different subjects have the same or similar names, information such as the location of the subject, age and gender are important in identifying and sorting out both the subject and samples. Also the location/ward of the patient enables urgent results to be immediately communicated to the clinician. Despite of these in most cases there is a gap of completing Laboratory test requests by the clinicians at the study area.

Even though the room was well organized with Phlebotomy materials and documents and enough for the phlebotomy practice; there was no waiting area at all for the patients, as a result there is always over crowded over the area. The room did not support with LIS. There is also gap of Phlebotomy training for the Phlebotomist.

If there is a mismatch between the patient and the patient information entered into the computer or written on to a paper request test results can be issued on the wrong patient. Our study shows

it seems minimum number of results were lost, have transcription error and data entry error but the impact on the clients service will be huge.

In general the study showed there was large frequency of error on pre and post analytical practices that should be solved. There for the organization should focus to improve; Data quality, documentation, and Information flow of the clients

- Through giving awareness creation for the data clerk about the importance of patient data and how should be managed.
- Improving the completeness of test request parameters by clinicians through discussion With the Physicians and also continuous and smooth communication with the clinicians should be made.
- Minimizing or avoiding occurrence of error by phlebotomist through giving continuous training and follow up.
- Backup of the patient data should be done, Continuous monitoring and evaluation should be practiced for the progress. These can facilitate the client's service delivery to be safe, timely, efficient, effective, equitable and patient-centered.

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Annex I

Addis Ababa University
School of Information Science and School of Public Health,
Department of Health Informatics

Questionnaire for "Improving the quality of Pre and post- analytical medical Laboratory practices through ICT" in St. Paul's Hospital Addis Ababa Ethiopia, 2014

Hospital No _____
OPD _____
Code No _____

I. Request Paper evaluation

1. Spacemen Type
    1. Chemistry
    2. Hematology
    3. Serology
    4. Hormone
    6. Coagulation
2. Demographic information properly filled?
    - ✓ Name of the patient 1. Yes 2. No
    - ✓ Age 1. Yes 2. No
    - ✓ Sex 1. Yes 2. No
3. Hospital number
    1. Yes 2. No
4. Date of requisition.
    1. Yes 2. No
5. The clinical data
    1. Yes 2. No
6. The physician name and signature
    1. Yes 2. No
7. Use of correct request form
    1. Yes 2. No

Annex II

II. Phlebotomy Practice For those who have Hematology Test request

1. Is patient identification done appropriately by the Phlebotomist?
    1. Yes
    2. No
2. Use of glo21. One pair Glove for one patient
    2. Is changed when contaminated
    3. Used until they finish the work
    4. Used some times
    5. Not Used
3. Site selection for blood sample drawing
    1. Appropriate site is selected
    2. Used Randomly
    3. Understood as no deference
4. Duration of the tourniquet when applied for collection of blood samples
    1. Not more than 60 Second
    2. More than 6 0 Second
5. Proper mixing for Blood samples (If needed)
    1. Done
    2. Not done
6. Appropriate use of test tube is done
    1. Yes
    2. No
7. Sample Volume
    1. Proper Volume
    2. under Volume
    3. over Volume

Annex III

III. Post analytical phase Interview with responsible person and document analysis:

1. Who is verifying laboratory results (Report Validation?)
    A. Department Head
    B. Supervisor
    C. Quality Officer
    D. Other specify
2. Who is feeding the laboratory results into the laboratory information system?
    A. Lab Personnel
    B. It Professional
    C. Nurses
    D. Other
3. Way of communicating the results to physician or patient
    A. Oral
    B. Verbal
    C. Oral and verbal
    D. Poor communication
4. How dose rejected samples and/or unanalyzed test request is communicated with the physician
    A. By telephone
    B. Electronic based
    C. immediately by result collectors (Runners)
    D. the time when all result is released
5. Trend of using Backup for result
    A. Backup system is not available
    B. Paper based
    C. Electronics Based
    D. Both Paper and Electronics Based
    E. Other

Annex IV

Post analytical error identification check list

Date	Id Number	Test type	Lost samples	Data entry error	Transcription error	Repeated data creation	Remark

Annex V

Observation check list

No	Question	Yes	No	Remarks
01	Does all the necessary information written in the request paper are filed within the data base at the first contact site			
02	Does the laboratory networked with Deferent OPDs			
03	Does communication Is supported with LIS within Laboratory sample collection area			
04	Is there an Interruption of the network?			
05	Does the lab have sufficient area for reception, waiting room and sample collection room?			
06	Do all personnel performing patient blood collection have been trained in collection techniques?(Are they Phlebotomist)			
	Did all Phlebotomist receive LIS Training			
07	Are the sample collection area is safe and comfortable for collecting sample?			
08	Are there specimen collection and Receiving procedure in specimen collection area?			

09	Is there a procedure manual or other source (sops) for complete collection and handling instruction for all Laboratory specimens?			
10	Does the specimen collecting manual include instructions for all of the following elements? 1-preparation of the patient 2- Types of collection container and amount of specimen to be collected 3- Need for special timing for collection. 4-Types and amount of preservatives or anticoagulant.			
	5- Need for special handling between time of collection and time receiving by the laboratory. 6- proper specimen labeling 7- Need for appropriate clinical data			
11	Does the laboratory have a written policy regarding incomplete request ordered by the physician?			
12	Are specimens delivered to the correct work stations in a timely manner?			
13	Are procedures in place to process urgent specimens and verbal requests?			

14	Has the laboratory use standardize sample rejection criteria?			
15	Has the laboratory reviewed its specimen collection manual and phlebotomy practices to minimize unnecessary volume of blood?			
16	Is there a mechanism to provide feedback to phlebotomists on issues related to specimen quality?			
17	Is there interruption of electric power supply?			
18	Do all laboratory results have reference intervals?			
19	Does the laboratory have controlling mechanism for transcription errors?			
20	Does the laboratory have information system to communicate with clinicians?			
21	Do all laboratory results documented?			
22	Do the date and time of the specimen collection and time of report available within the data base and released results?			
23	Does backup system is available;what type of backup system is used ?			

Declaration

I hereby agreed that all works in this research thesis are done by me; by referring different literatures and books which are related to my work from internet and other sources.

Name

1._____ Signature_____