PRE-ANALYTICAL ERRORS AFFECTING QUALITY OF FINAL RESULTS AT THE PATHOLOGY LABORATORY COLLEGE OF HEALTH SCIENCES, MAKERERE UNIVERSITY KAMPALA UGANDA

NAMWASE BETTY
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DECEMBER, 2018
DECLARATION

I Betty Namwase declare that this is my origin work and it has never been submitted to any institution of higher learning for the award of any degree before.

Signature:………………………… Date:……………………
APPROVAL

This research dissertation report has been submitted for examination with the approval of my university supervisor.

Signature………………………………… Date…………………………

Mr. Mwambu Bashir
University Supervisor
(Clarke International University)
DEDICATION

This report is dedicated to my little angles Gloria, Gertrude and Gilbert.
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It is a pleasure to thank the many people who have made this research possible. First and foremost, I give thanks to God the almighty who has given me the gift of life up to today and who I shall forever thank for seeing me through many difficult situations.

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DEFINITION OF TERMS

**Pre-analytical phase:** processes that start, in chronological order from the clinicians request, preparation and identification of the patient, collection of the primary sample and transportation to and within the laboratory and end when the analytical examination begin.

**Analytical phase:** set of operations having the object of determining the value or characteristics of a property qualitatively.

**Post-analytical:** processes following the analytical examination including review of results, retention and storage of clinical material, sample and waste disposal and formatting, releasing, reporting and retention of examination results.

**Quality:** ability of a service to satisfy the needs and expectation of the customer or having an accurate, timely and complete report.

**Laboratory error:** as per ISO 22367 is failure of planned action to be completed as intended or use of a wrong plan to achieve an aim.

**Quality assurance:** implies getting the right result, at the right time, on the right specimen from the right source, with results interpreted using correct reference data and at right affordable price.

**Audit:** is a quality improvement process that seeks to improve patients care and outcome through systematic review of care against explicit criteria and the implementation of change.

**Quality management system:** it’s a system which directs and controls an organization with regard to quality.

**Histology:** microscopic examination of fixed, processed and stained tissue on a slide for diagnosis.

**Biopsy:** a piece of tissue surgically removed during life for diagnostic purpose.

**Turnaround time:** the time interval between when a test is requested to the time treatment decision is made.

**Ischemia time:** time to gross sectioning and transfer of samples to cassettes.

**Warm ischemic time:** occurs during operation, after ligation of blood supply till removal of the specimen from the body.

**Cold ischemic time:** time from tissue removal to fixation in 10% formalin.

**Confidence limits:** These are upper and lower levels (ends) of confidence interval.

**Confidence interval:** Defines the variability of estimate say of a disease in certain samples. That is to say how likely the disease occurs in certain samples. It uses upper and lower limits.
ABBREVIATIONS

\%

Percentage

\(^{\circ}\)C

Degree centigrade

ASCO

American society of clinical oncologists

CAP

College of American Pathologists

CIU

Clarke International University

D.P.X

Distyrene Plasticizer Xylene

D/C

Deeper cut

FFPE

Formalin fixed paraffin embedded tissue

G

grams

H & E

Haematoxylin and Eosin stain

I.P

In patient’s number

ISO

International standards for organization

L

liters

LIMS

Laboratory information management system

Mls

milliliters

O.P

Out patient’s number

Pkt

packets

QA

quality assurance

QC

quality control

RNA

Ribonucleic acids

SHO

Senior House Officer

SLIPTA

Stepwise Laboratory Improvement Program Towards Accreditation

SOPs

Standard Operating Procedures

TAT

Turnaround time

TQI

tissue quality index

UGX

Uganda shillings

USA

United States of America
ABSTRACT

Introduction: These pre-analytical errors have been reported as the major pit hole in Pathology laboratory that affect the quality of reports as well as the management and prognosis of the patient. These errors constitute about 4-5 times of the errors compared to analytical and post-analytical processes. The work flow effectively involves three phases, pre-analytical, analytical and post-analytical in which all phases are interconnected directly or indirectly. The research study was done at the Pathology department, college of health sciences, Makerere University located in upper Mulago. The main objective of the study was to study Pre-analytical errors affecting the quality of the final results produced at Pathology laboratory. The specific objectives were to determine the rate of occurrence, commonest stage presenting with pre-analytical errors and to establish any association between pre-analytical errors and the quality of the final results produced at Pathology laboratory Makerere University College of Health Sciences.

Methodology: The study looked at 323 laboratory request forms using a descriptive prospective research design in a period of three (3) months ranging from May to Aug 2018. Data was collected using observation checklist, entered into excess, analyzed and presented using frequency tables and bar charts.

Results: The rate of occurrence of pre-analytical errors in the study was 100%. The commonest stage presenting with pre-analytical error was grossing not done by senior 316(97.83%), followed by grossing errors 312(96.59%) and the lowest was clinical summary 27(8.36%). There was no association between pre-analytical and TAT.

Conclusion and recommendations: Pre-analytical errors occur frequently in pathology lab, there a strong association between pre-analytical errors especially demographic data, clinical history and grossing. Pathology laboratory should embrace SLIPTA in order to work towards accreditation in any of the accrediting bodies. There is a desperate need of senior pathologist during grossing and there is need to do monitoring and evaluation both in laboratories and clinical.
CHAPTER ONE: INTRODUCTION

1.0 Background

Histopathology is a laboratory based science, which plays a critical role in establishing tissue based diagnosis, generally these includes infectious, degenerative and neoplastic diseases,(Roque et al 2015). It is estimated to contribute worldwide 60%-70% of all the critical decisions involving patient treatment(Badrick et al., 2017). This process of diagnosis involves a chain of highly complex procedures which requires strict quality control and quality assurance policies. The work flow effectively involves three phases, pre-analytical, analytical and post-analytical in which all phases are interconnected directly or indirectly. A mistake at any of these phases affects the end product. The process thus will ensure accurate, reliable and timely report to the patient according to the clinical laboratory improvement amendments(Rao et al., 2016; Badrick et al., 2017)

Recent studies (Rao et al., 2016) showed that pre-analytical phase are prone to errors which may affect the quality of results produced. The pre-analytical activities comprise all of the following steps starting from identifying the patient, preparing the patient, collecting the specimen, fixing, and labeling, transporting, accessioning, grossing, tissue processing, embedding, sectioning, staining, mounting sectioned slides and delivering slides to the surgical pathologists for reporting. Each successive step was used to assess errors in the previous step as explained in (Appendix I).Many pre-analytical factors including nature, concentration and volume of fixative, the type and size of the container used for submission of the specimen, the duration of fixation, a reliable clinical history on the request form, laboratory criteria for accepting and rejecting sample, daily internal quality control performance on staining tissue sections, immediate transportation to the laboratory, following SOPs, proper maintenance of equipment, well labeled sample and training of the personnel to mention some were found to affect the quality of reports and services delivered pathology laboratory hence poor outcome and prognosis(Hawkins, 2012; Paingha et al., 2015; Rao et al., 2016).The following are some of the analytical factors which include reagents storage, following expire dates first in first out, malfunction of equipment, sample mix up, undetected and lack of quality control measures(Hawkins et al., 2012). Post-analytical factors include transcription errors, and report delivery within the recommended turnaround time(Hawkins et
This study therefore was aimed at assessing the pre-analytical errors affecting the quality of Pathology laboratory.

1.1 Problem statement
Pre-analytical errors have been reported as the major cause of errors in Pathology laboratory. They constitute about 4-5 times of the errors compared to analytical and post-analytical processes (Paingha et al 2015; Rao et al., 2016) (Piran, et al 2016). These errors might lead to a poor quality results, and such errors can be irreversible during analytical and post-analytical processes. Furthermore, such errors are associated with a prolonged turnaround time, which may directly affect patients management in general and those with cancer in particular (Warner, et al 2017). However no study has been done to assess pre-analytical errors in Pathology laboratory Makerere University College of Health Sciences Uganda.

1.2 Justification/Significance
According to sources from Pathology department, the number of pre-analytical errors is on the increase. This has led to so many quality issues as reported by patients and clinicians in the feedback messages. Identification of such factors will therefore help in improvement of the quality of service in Pathology laboratory.

1.3 Research question
1. At what frequency do pre-analytical errors occur in Pathology laboratory Makerere University College of Health Sciences?
2. What pre-analytical errors occur in Pathology laboratory?
3. Is there any association between pre-analytical errors and the quality of the final results produced at the Pathology laboratory?

1.4 General objective
To study Pre-analytical errors affecting the quality of Pathology laboratory services as seen in the department of pathology, Makerere University College of Health Sciences.
1.5 Specific objective
1. To determine the frequency of occurrence of pre-analytical errors at the Pathology laboratory Makerere University College of Health Sciences.
2. To determine the commonest stage presenting with pre-analytical errors occurring at the Pathology laboratory Makerere University College of Health Sciences.
3. To establish any association between pre-analytical errors and quality of the final results produced at Pathology laboratory Makerere University College of Health Sciences.

1.6 Conceptual framework

**Pre-analytical Errors**
- Poor fixation
- Inadequate patient identification
- Mix-ups
- Thinner sections
- Poor H and E stain
- Thicker sections
- Grossing
- Appropriateness of container used

**Effects on analytical errors**
- Turnaround time
- Re-biopsying
- Incomplete request form
- Re-grossing
- Embedding
- Sectioning
- Floating out
- Slide sign out

**Effects on post-analytical errors**
- Mis-identification
- Poor treatment out come
1.7 **Explanation of conceptual frame work**

Pre-analytical errors can affect the outcome of patient diagnosis either through analytical stage or direct impact on the challenge on the post-analytical stage. The bad practice such as poor fixation, poor H and E stain and inadequate specimen, thick or thinner sections can affect the reading of the stained tissue sections. While other pre-analytical errors like mix up and inadequate patient identification can be correctly identified at times, this may affect the treatment outcome if not properly identified and corrected.
CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

2.1 The rate of occurrence of pre-analytical errors in the Pathology laboratory

2.1.1 in high income countries

There are several factors leading to the occurrence of pre-analytical errors. These can be the set up of a facility and cost involved. Therefore the nation’s wealth might play a vital role in controlling the errors prone to laboratory phases. In the United States of America (USA), (Hawkins, et al 2012) reported the rate of occurrence of pre-analytical errors across to range between (31% to 69%). This was similar to several reports that were carried out across USA and Europe where the prevalence of pre-analytical errors ranged between (46%-68%)(Carraro and Plebani, 2007; Plebani, et al 2009; Peter et al., 2010; Roque, et al 2015). However (Hung et al., 2015) reported a higher prevalence (84.5%) in Taiwan as compared to the ones done in USA and Europe. The commonest errors reported were due to inaccurate process of specimen, lack of standardization SOPs for collection, transportation, and specimen storage. These showed that pre-analytical errors are still a major problem in laboratory based diagnosis hence inaccurate patient’s management and unfavorable outcomes.

2.1.2 Middle income countries

Studies done in South Africa(Carraro and Plebani, 2007) and Nigeria Nutt, Zemlin and Erasmus, 2008; Hung et al., 2015) reported that pre-analytical errors account for 68.2% of the laboratory errors which is in tandem with (Peter et al., 2010; Roque et al., 2015) in (USA) and Europe who reported that most testing errors ranged between (46%-68%). Furthermore a similar studies done in Pakistan reported pre-analytical errors at a rate of (46% to 62.8%) as highlighted by Neelam et al., 2012, Angeleset al., 2014 and (Usman, et al 2015). This is also similar to the study of Italian stat laboratory which found that the pre-analytical errors were due to lack of standardization protocols for defining and measurement of pre-analytical variables Lippi G, Guidi GC, Mattiuzzi C, Plebani M. Preanalytical variability: the dark side of the moon in laboratory testing, ClinChem Lab Med 2006; 44:358–65).
2.1.3 Low income countries

Information regarding pre-analytical errors is scarce in low income countries; however a study done in Tanzania, (Mwakyoma, 2009) found that 90% of the request form was incomplete, as far as clinical history is concerned. Mislabeling of container 85%, illegible labeling of the specimen container 75%. These rates are too high as compared to the rest of the high and middle income countries where the labs are accredited and beyond star four (4), therefore these high rate of pre-analytical errors have been attributed to the low level of accreditation, and lack of standardization of the protocols in low income countries and this includes most laboratories in sub Saharan Africa not excluding Uganda.

2.2 To assess the commonest stage presenting with pre-analytical errors in pathology laboratory

2.2.1 Fixation

Inadequate volume of fixative and poor fixation like use of water, detergent or normal saline instead of 10% formalin, and concentrated formalin >10%, may lead to autolysis, hardening of the tissue which can directly affect the morphology hence limiting proper histopathology interpretation and diagnosis, these puts the clinician in dilemma with regard to further treatment in case the whole lesion have been completely excised. Furthermore, molecular analysis is also affected by the aforementioned factors since such studies depends on accuracy of proteins expressed in the tissue as highlighted in the(TQI), which allow global assessment of protein status based on quantitative measurement of a small number of selected, informative epitopes (Sharif et al., 2007; Rao et al., 2016).

2.2.2 Sample transportation

Inappropriate packaging and the nature of the specimen container may distort the anatomical landmarks as well as displacement of the specimen which might results into spillage of the fixative and sometimes loss or drying of precious specimen during transportation. To ensure the sample integrity the safety for the carrier, community and receiving laboratory have to be well equipped with safety measures. Sample collection and its submission in 10% formalin is the ideal recommended preservative, within the required time frame and temperature interval of 25°C ISO 15189 clause 5.4.5, (Sharif et al., 2007; Rao et al., 2016). The container might have to be cut in case of plastic or broken if it’s a glass bottle. The personnel are put to risk
and small pieces of glass may be embedded with the specimen in the cassettes causing damage to the microtome blade during sectioning (Rao et al., 2016).

2.2.3 Incomplete laboratory request form
This is a communication tool between clinicians and pathologist; therefore Laboratory request form must be accompanied with specimen in a container with identifying information which tally with the request form. Ideally the request form should include patient’s demographic data, details of hospital, including ward, a unique identifying number, particulars of requesting clinician, patient’s clinical history, nature of specimen, site where it was harvested, date and time when the procedure was done. A request form with inadequate information may lead to difficulty in establishing the diagnosis hence poor patient outcome (Sharif et al., 2007; Hawkins, et al 2012; Rao et al., 2016).

2.2.3.1 The demographic data
Include full name, date of birth, hospital number and patient location. Demographic data helps in differential diagnosis, some diseases affects only a certain age groups, gender and occupational exposure. Marital status and number of sexual partners may increase the risk of cervical cancer. In the breast cancer trends the demographic assist in identifying the exact risk groups commonly affected the disease(Sharif et al., 2007; Perry et al., 2008).

2.2.3.2 Place of origin
Certain diseases affects people in a well defined geographic areas, knowing the person’s place of origin may help in diagnosing the nature of disease he/she is suffering from. Exposures to certain environmental factors may cause disease eg; those living around mountainous areas suffer from goiter, due to lack of iodine in their soils hence compensatory enlargement of the thyroid gland.

2.2.3.3 Clinical information
The clinical information includes; the nature of the complaints, its duration, the nature of previous management given, and previous investigations carried out. The adequacy of clinical history is considered a minor problem in a high income countries, and it was reported at a rate of 6.1% in USA (Burton et al., 2001) but Nakhleh and Zarbo found and 2.4% (Sharif et al., 2007), and this was lower as compared to 34% reported in Nigeria. Availability of
clinical history enables the pathologist to reach the definitive diagnosis and to list a possible differential diagnosis of the disease in question.

2.2.4 Accessioning errors
Here specimen is critically assessed by a qualified laboratory technician with guidance of standard operating procedure (SOPs). Technician checks all the parameters as mentioned above, those that fulfill the criteria are entered in the laboratory information system, coded with the laboratory unique number which is given consecutively. Then specimen progresses to grossing. Identification error may also affect the quality of histopathology results, leading to mix-up of the patient/specimen. This occurs when the specimen is labeled with incorrect patient identifier, no specimen in the container, inconsistency between the specimen and request form, no request form submitted, incomplete request form, and registration error (Lopes et al., 2015) (Layfield et al., 2010) (Howanitz et al., 2001); Rao et al., 2016) (Nakhleh, et al., 2016)

2.2.5 Grossing errors
It requires taking a representative samples for processing and keeping the remaining specimen for further consultation. Identification error, erroneous labeling of the tissue cassettes, erroneous cutting of the specimen, loss of specimen, contamination of specimen, specimen, premature loading of specimen, specimen mix-up and inaccurate selection of samples may all occur during grossing, and these may lead to a serious and unfavorable outcomes. (Lopes et al., 2015) (Nakhleh, et al 2015; Rao et al., 2016)

2.2.6 Tissue processing errors
After grossing is done, the tissues will be taken through a series of laboratory procedures which includes; loading of the tissue into an automatic tissue processor with various grades of dehydrating, clearing and impregnated in molten laboratory paraffin wax, followed by embedding, tissue sectioning, staining, cover slipping, sorting of the slides and reporting (Nakhleh, 2015; S and Beatriz, 2015; Rao et al., 2016)

2.2.7 Embedding and blocking out in the same tissue cassette
It involves dispensing molten laboratory paraffin wax in a suitable embedding mould then embed the tissue inside the paraffin wax by use of warm pair of forceps, cut surface facing
the bottom. Then cover using the same tissue cassette you used for processing, which gives tissue support to be cut on the microtome. Errors may be due to not prior cleaning the forceps which may be contaminated, not opening one tissue cassette at a time then mix-up tissues, lacking experience in good orientation of tissue, exchange of specimen, poor quality paraffin wax, specimen was wrongly positioned and then end up losing the tissue rated at 4.5% in the United States (Lopes \textit{et al.}, 2015)(Nakhleh, 2015; Rao \textit{et al.}, 2016)

\subsection*{2.2.8 Trimming and sectioning}
This involves the use of microtome blade fixed on the microtome, and trimming off the excess paraffin wax to exposing tissue embedded in the tissue block cut at 5-45microns. Then put on block of ice to get a uniform consistence between the tissue and wax. Lastly serial sections are made by use of sharp blade at 2-4 microns. Errors due loss of specimen, contamination due to incorrect tissue embedded in given patient paraffin block at the time of grossing, thickness errors, damaged sample, identification error of the block, mislabeling slides, prior slide labeling, mismatching of block and slide. These lead to a laboratorian being requested to section a deeper cut, thinner section due to poor technical skills rated at 23% in the United States by (Nakhleh, 2015; S and Beatriz, 2015; Rao \textit{et al.}, 2016)

\subsection*{2.2.9 Floating out}
This involves the floating the serial sections on warm water bath of about 45°C, then picked up on microscopic slide. Placed in hot air oven such that the tissue sticks to the slide and excess wax melted off. During this pick up the technician may create an error and picks wrong tissue leading to misdiagnosis between two patients. Another error when the water surface is not carefully cleaned with a piece of paper. Error due over use of water in the water bath without changing it and use of low level of water in the water bath may lead to tissue artifact and mix-up (Lopes \textit{et al.}, 2015)(Nakhleh, et al. 2015; Rao \textit{et al.}, 2016).

\subsection*{2.2.10 Staining and cover slipping}
Slides with tissue sections are de-paraffinized, rehydrated, stained in haematoxylin and eosin stain then dehydrated and cleared by use of alcohol and xylene. Slides are cover slipped by adding a drop of depex then cover using a cover slip. Errors may arise due to insufficient time for de-waxing, loss of reactivity with the stains, poor staining, detachment of section from the slide, breakage of slides, misuse of stains, incorrectly mounted slides, failure of filtering
reagents and stains, previous minute staining fragments may break off the tissue section and mount themselves on the tissue sections being stained, causing misinterpretation of patient results. Errors can arise due to failure of checking for contaminants in the reagents and staining as result of poorly processed tissues. These errors lead to better staining and inadequate haematoxylin or eosin rated to 1.5% in the United States and Italy (Morelli et al., 2013; Nakhleh, 2015; (Lopes et al., 2015); Rao et al., 2016)

2.2.11 Slide sign out
Stained microscopic slides are paired with request form that has gross description. Slides are also matched with the log sheet of the technician to ensure that all sides have been completed and presented to the pathologist for analysis. Here errors of exchange of slides, broken slides, un delivered slides, error of number reported on the slide label, specimen in decalcification not presented, mistaken request form, mix-up of slides are the commonest occurrences of a wrong slide put on a wrong request form rated at 35% in the United States (Lopes et al., 2015)(Nakhleh, 2015; Rao et al., 2016)

2.3 The effects of pre-analytical errors and the quality of results produced in the pathology laboratory
2.3.1 Turnaround time
Patient’s outcome may be affected by a prolonged turnaround time (TAT). The TAT is a key monitor of the overall function of the laboratory service and is considered a critical element of quality because of the impact on clinical management of patients (Raouf, et al 2005). The internal TAT is measured from the time the laboratory receive the specimen to the time the final report is authorized excluding external laboratory TAT. Furthermore having a short TAT in clinical laboratory is a clinician satisfier and is an important indicator of efficiency in any clinical laboratory (Howanitz et al., 2001)(Valenstein, et al 1996; Hawkins, 2007)Truchaud et al 1997.
TAT for most Stat clinical laboratory tests are two (2) working days for routine surgical pathology cases Howanitz et al 1992, Zarbo et al 1996, Howanitz 1991. Yet Volmaret al noted up to five (5) working days for routine specimen. For those specimens that require special handling their TAT takes up to thirteen (13) working days.
Unmonitored TAT delays laboratory operations, patient results as well as clinical decision and interventions which sometimes results leads to a poor prognosis.

Minimum TAT begins with surgeons skills of taking a representative biopsy, ensuring adequate and prompt fixation of biopsy, submission in a right container and accompanied by well written request form (Atanda et al., 2013).

Specimen handling is an important factor and it is commonly associated with prolongation of TAT (Nakhleh et al., 2006). The following factors were found to contribute to a prolonged TAT in laboratories, these includes; specimen rejection, failure to transport the specimen on time, and lack of other crucial material needed for tissue processing.

The size of the specimen can affect the TAT either negatively or positively. Large specimens takes a longer fixation time, its grossing is complex, it produces a large number of tissue blocks, and slides as compared to small biopsies (Volmar et al., 2015). TAT can be lengthened by use of special handling techniques such as overnight fixation, decalcification, re-cuts, re-embedding of poorly oriented sections, re-grossing, special histochemical stains, immunohistochemical stains, and other molecular studies. Studies Hede K, 2008, Nkoyet et al., 2010 showed that cold ischemic time and protein degradation within the tissue can cause (10% to 20%) false negative results for estrogen in breast cancer to avoid this, guidelines established by the American society of clinical Oncologist (ASCO) and College of American Pathologist (CAP) to evaluate estrogen, progesterone and HER2 in breast cancer, limiting cold ischemic time to sixty minutes (60 minutes) Wolff et al 2006, Hammond et al 2010, (Goodson and Moore, 2002), Vaught et al 2011, Vaught et al 2012 and Hicks et al 2011. Cold ischemia time is especially important in breast surgical pathology, prolonged fixation affect retrieval of estrogen and progesterone expression. Quality of the histological sections depends on adequate fixation on the tissues as well as antigen retrieval for immunohistochemical stains are poor on poorly preserved tissues thus tissues which are vital may end up being useless requiring re-biopsy or leads to death due to unexplained delay in specific diagnosis (Sharif et al., 2007; Rao et al., 2016), McInnes E, 2005.

**Mis-placement of specimen**

Is a critical malpractice. These situations increase non-value added works, reduce health care quality and confidence of patient to hospitals, damage hospitals reputation and results to greater patient compensation.
**Specimen re-biopsying**
Increase cost and delay in hospital stay. This is when an inappropriate specimen is sampled. This may affect the quality of results and turnaround time causes unnecessary delay in diagnosis and treatment (Carraro et al., 2007, 2007; Hung et al., 2015; Rao et al., 2016).

**2.3.2 Difficulty in interpretation**
Failure to interpret results may necessitate re-sampling or re-grossing, incomplete laboratory request form, poorly fixed specimen, poorly processed tissues, improperly embedded tissue, thick/thinner sections, improper staining protocols, mismatch of stained slide for examination and faulty microscope may all lead to interpretation difficulties and delays in patient care in general, and patients with cancer in particular (Badrick et al., 2017; Burnett et al., 2004).
CHAPTER THREE; METHODOLOGY

3.1 Study design
The study was a cross-sectional prospective laboratory based study covering cases from May 2018 to August 2018. The study assessed pre-analytical errors affecting quality of the final results of Pathology laboratory.

3.2 Study area
The research was carried out in the department of Pathology, School of Biomedical Sciences, Makerere University. Pathology department comprises of two laboratories private and general service laboratories. Pathology department is one of the departments in the College of Health Science located on Mulago hill together with Mulago national referral hospital, Uganda cancer institute and Uganda heart institute see Appendix III. Pathology department is a national referral laboratory offering general and specialized quality pathology service. It receives all patients’ specimen for Pathological examination from all over Uganda.

3.3 Study population
The study population comprised of consecutively selected request forms accompanying the specimen during the study period.

3.4 Sample size determination
The sample size was estimated using Kish Leslie formula below.

\[ N = \frac{Z^2 \times P \times (1-P)}{d^2} \]

where \( N \) - sample size, \( Z \) - statistic for level of confidence, \( P \) - expected proportion, \( d \) - precision (Daniel, 1999).

\( Z = 1.96 \) for level of confidence of 95%.

\( P = 70\% \) according to the studies done in South Africa (Nutt et al., 2008)

\( d = 0.05 \)

Therefore \( N = \frac{1.96^2 	imes 0.70 	imes (1-0.70)}{0.0025} = 323 \) laboratory request forms.

Therefore, a total of **323** laboratory request forms were collected.
3.5 Sampling procedure
The samples delivered to the department of Pathology were consecutively sampled until the required sample size was obtained. The details such as information in the request form, the type of specimen container and fixative used, the type and nature of specimen, the date of taking, delivery and accession was assessed per case as explained in (Appendix II).

Laboratory procedure
Accessioning dates were assessed; grossing errors identified, which included morphology, container faults, size of tissue specimen to container ratio and tissue specimen to fixative. Date and time of loading tissue to tissue processor was noted. The quality of processing reagent was assessed including the quality of wax. The date of cutting tissue section (microtomy) which included quality of the microtome blades and the machine. The date of servicing the microtome machine including other equipment e.g. balance was recorded. Quality of the stains (preparation and expired date), volume used was assessed. The type of slides, coverslips, DPX were assessed. The errors that arose from sorting stained slides and forms were looked into. The date of presenting the slides for analysis was recorded as explained in (Appendix II).

Study variables

3.6 Dependent variable
Quality of the final results produced at Pathology laboratory.

3.7 Independent variable
Pre-analytical errors which include poor fixation, inadequate patient identification, mix-ups, appropriateness of container used, person performing grossing, mislabeling of cassettes, mislabeling of slides, shallow cuts, thicker sections, poor H and E stain

3.8 Selection criteria
3.8.1 Inclusion criteria
All Pathology request forms received during the study period.
3.8.2 Exclusion criteria
All torn Pathology request forms and those that are illegible damaged were excluded from the study.

3.9 Data collection tool
3.9.1 Prevalence of errors
An observation standardized checklist as per ISO 22367 was used to assess correctness of samples received in the laboratory. The patient request forms were assessed for completeness of filling as described in external laboratory activities (appendix II). Accessioning correspondence of the sample and request form was observed. Incompletely filled request were checked and recorded for any pre-analytical error such as, demographic data, date biopsy taken, hospital, ward, patient IP or OP number, location, requester’s name, clinical history.

The quality of grossing errors were assessed on grossing description and recorded like mix-ups, container faults, ratio of specimen to container and specimen to fixative, mislabeling of cassettes, wrong specimen submitted, autolytic tissue, re-grossing and poor fixation.

The quality of tissue processing was assessed on sectioning and reporting then those failing were reported as errors such as deeper cut, thinner and thicker sections, tearing, re-orientation and scores of tissue, and those that passed were reported as no error detected.

The quality of staining to sign out were assessed from pathologist’s report for the non-conformity to the stained tissue section quality such as pigments, better H and E stain, mix-ups. The total number of all the pre-analytical errors recorded were divided by the total number of patient requisition form included multiplied by one hundred (100) to get the percentage error. Then the individual pre-analytical errors were categorized in the same formats’ explained in (Appendix II).

3.9.2 Assessment of the commonest errors
Particular errors were recorded and segregated. The number of errors were recorded on the appendix II checklist and calculated individually from the total errors to get the proportions of occurrence. Review of detail on request form completion and corresponding gross description and microscopy test report were able to determine errors for grossing, tissue processing, embedding, sectioning, floating out, and slide sign out. Since labeling is manually
done the unique identifier given at reception counter book were matched with the one on the request form. The errors were documented on the collection data sheet (See Appendix II)

3.9.3 Effects of pre-analytical errors and the quality of final results produced at Pathology laboratory
The effects of the errors observed were assessed by the outcomes that included the pathologist’s comment which includes deeper cut, thinner section, better H/E, review and re-sampling and TAT calculated from date of accessioning to date the report is accomplished as presented in this chapter. A percentage increment for errors verses those without errors were documented.
Wrong results dispatched were assessed by mis-identification and requester’s disagreement and seeking for second opinion of the report dispatched. The errors were documented on the collection data sheet. The above mentioned individual effects of pre-analytical errors were calculated from the total errors to get the percentage effects and frequencies presented as seen in Appendix II.

3.10 Data analysis
Information gathered were recorded on hard copy and transferred to spreadsheet Excel version 2007 then exported to Stata SE, version 10 and Anonymous Open Source Epidemiologic statistics for Public Health Version 2.2.1 (http://www.openepi.com/Menu/EpiMenu.htm). Data analyzed were presented as follows: bar graphs and table form.

Prevalence of pre-analytical errors
This was categorized by getting individual percentages to show the distribution pattern.

Commonest errors
This was analyzed by taking proportions of specific individual percentages from the sub categories of distribution pattern to get the commonest errors from the total number of errors.

Effects of pre-analytical errors and the quality of final results produced at the Pathology laboratory
This was analyzed qualitatively to capture data of time spent in days from when the specimen is received in the Pathology laboratory to when the Pathology report is interpreted by a
Pathologist. Then calculated the proportions of odds ratio (OR), confidence interval (CI) and P-values.

3.11 Data Presentation
Results got were presented in the form of frequency table and bar graphs

3.12 Quality control
Each observation checklist was thoroughly checked for completion, consistency and accuracy during the process of data collection before leaving that particular pathology request form. These were reviewed by a qualified and experienced consultant Pathologist and research supervisor.

3.13 Ethical consideration
Prior to commencement of the study, approval was granted from my supervisor through the Faculty Administrator institute of Allied Health Sciences of Clarke International University. There after I obtained an introductory letter from the Faculty Administrator of the institute of Allied Health Sciences of Clarke International University (see Appendix XI). The permission to use Pathology department archives was obtained from Department of Pathology Research and Ethics Committee (see Appendix XI).
CHAPTER FOUR: RESULTS

4.0 Introduction
We studied 323 laboratory requests that were received in the pathology department Makerere from different levels of health units including National Referral Hospital, regional referral hospitals, district referral hospital, health centers II to IV and clinics. These were from both public (government) and non-government hospitals/health facilities (for profit and not for profit). We considered facilities from different regions like Central, Western, Eastern, Southern and Northern which are located either in urban or rural areas.

4.1 The rate of occurrence of pre analytical errors and the commonest stages
The occurrence of errors was recorded by the presence of errors in at least one stage of the pre analytical phase. The prevalence of errors was 100%. More errors were observed under grossing not being done by senior Pathologist, [316(97.83%)] followed by errors in appropriate grossing [312(96.59%)], the demographic data [262 (81.11%)], date biopsy taken [242(74.92%)], appropriateness of the container [145(44.89%)] and filling clinical summary [27(8.36%)] the least to present with errors as seen in the figure 1 below. It was observed that no single stage of pre-analytical errors had SOPs.

Figure 1: The rate of occurrence of errors in different pre-analytical stages
While some variables such as Clinical summary, indication of date biopsy taken, and the person who did grossing were assessed by a single parameter, epidemiological data, container appropriateness and appropriateness of grossing were assessed by a number of parameters. In the latter category, the presence of any error for a single parameter indicated an error for the entire stage.

For completeness of epidemiological data, parameters assessed included age with 11/323 (3.41%) errors, sex with 7/323 (2.17%) errors, unit with 17/323 (5.26%) errors, level of health unit 17/323 (5.26%) region with 16/323 (4.95%) errors, location with 17/323 (5.26%) errors, patient id with 126/323 (39%) errors, ward with 78/323 (24.15%) errors, address with 182/323 (56.35%) errors, and date biopsy sent with 108/323 (33.43%) errors as seen in figure 2bellow.

![Common errors for demographic data](image)

*Figure 2: Presentation of errors occurring during capture of demographic data*

For container appropriateness, parameters assessed included data on container faults whether leaking, squeezed or both 144/323 (44.58%) were leaking, specimen to container ratio where 252/323 (78.02%) had errors the ratio being either excessive 2/323 (0.62%) or small 250/323 (77.40%). Also specimen fixative ratio was assessed with 259/323 (80.19%) being inappropriate (<1:10) and with the fixative type, fewer errors were observed at 6/323 (1.86%) as seen in figure 3bellow.
For completeness of grossing, performance of the following parameters was assessed including sample morphology with \( \frac{79}{323} \times 24.46\% \) length not taken, where \( \frac{160}{323} \times 49.54\% \) weight was not taken, with \( \frac{306}{323} \times 94.74\% \) and sample mix up where none had been mixed up as seen in figure 4bellow.
4.2 Outcome assessment

Correlation between the intensity of pre analytical errors per particular sample was done with the TAT to assess their effect. We were able to calculate TAT for 110 samples. A correlation was done between the number of stages presenting with errors (Table 1) and the TAT. The table 1 below shows the association between pre-analytical errors and the outcome, from the table, it is obvious that pre-analytical errors especially presence or absence of demographic data, clinical history, and whether or not the grossing was done by a senior has adverse effect on the quality of results produced by pathology lab.

Table 1: Showing a multivariate analysis between pre-analytical errors and outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Outcome</th>
<th>Number</th>
<th>Percentage (%)</th>
<th>TAT</th>
<th>OR</th>
<th>(95%)CI</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Data</td>
<td>No error</td>
<td>262</td>
<td>81.1</td>
<td>6</td>
<td>5.0</td>
<td>1.56-16.3</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>61</td>
<td>18.9</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Biopsy Taken</td>
<td>No error</td>
<td>242</td>
<td>75.0</td>
<td>7</td>
<td>2.13</td>
<td>0.60-7.07</td>
<td>0.113</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>81</td>
<td>25.0</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Summary</td>
<td>No error</td>
<td>27</td>
<td>8.4</td>
<td>15</td>
<td>0.04</td>
<td>0.01-0.10</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>296</td>
<td>91.6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>No error</td>
<td>145</td>
<td>44.9</td>
<td>7</td>
<td>0.70</td>
<td>0.22-2.20</td>
<td>0.270</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>178</td>
<td>55.1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Took long time to gross</td>
<td>No</td>
<td>312</td>
<td>96.6</td>
<td>6</td>
<td>40.9</td>
<td>12.4-144.7</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>11</td>
<td>3.4</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grossing done by Senior</td>
<td>No</td>
<td>316</td>
<td>97.8</td>
<td>10</td>
<td>98.9</td>
<td>35.7-303.9</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>7</td>
<td>2.2</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grossing done by Junior</td>
<td>No</td>
<td>259</td>
<td>80.2</td>
<td>17</td>
<td>1.4</td>
<td>0.50-3.70</td>
<td>0.236</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>64</td>
<td>19.8</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grossing done by Senior and Junior</td>
<td>No</td>
<td>320</td>
<td>99.1</td>
<td>15</td>
<td>88.3</td>
<td>24.2-423.1</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3</td>
<td>0.9</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not identified</td>
<td>No</td>
<td>71</td>
<td>22.0</td>
<td>7</td>
<td>0.24</td>
<td>0.07-0.77</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>252</td>
<td>78.0</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER FIVE: DISCUSSION OF RESULTS

4.0 Introduction
In this study 323 histology request forms were prospectively studied for presence or absence of pre-analytical errors. We categorized the pre-analytical phase into six (6) stages because of the subcategories existing in the pre-analytical phase. The stages included completeness of the epidemiological data, indication of the date the biopsy taken, availability of the clinical summary, appropriateness of the specimen container, appropriateness of grossing and whether grossing was appropriately done by the senior/junior pathologist. Any error that occurred was recorded. Four of the stages were assessed by multiple parameters. Completeness of the demographic data was assessed by the absence of any of the parameters that included age, sex, health unit, level of health unit, region, location, patient Id, ward, address and date biopsy sent. Appropriateness of the specimen container was assessed by its inappropriateness whether fixative was (leaking, specimen squeezed in container and specimen squeezed and leaking), the ratio of specimen to container was assessed by its inappropriateness whether ratio was (adequate, inadequate or excessive), the ratio of specimen to fixative was assessed by its inappropriateness of (1:10 or <1:10) and appropriateness of the type of fixative used whether specimen was put in (formal saline, diluted or concentrated fixative and normal saline as a fixative). Completeness of grossing which included taking the weight, measurement of length and morphology which included (colour, shape and consistency). Whether grossing was appropriately done by the senior/junior, junior and not identified by the person who grossed.

4.1 The rate of occurrence of pre-analytical errors at the Pathology laboratory Makerere University College of Health Sciences
Indeed the recent studies (Rao et al., 2016) found that pre-analytical phase are prone to errors which may affect the quality of results produced. The 100% prevalence of errors obtained in this study could be explained by the lack of laboratory information system (LIMS) in place, not conducting continuous medical education to Pathologists, laboratory personnel and clinician, lack of continuous established quality improvement program that focuses on improving the processes in this laboratory and personnel competency assessment. The lack of SOPs at the different stages in pathology department such as specimen accessioning, tissue processing, embedding, sectioning, floating out, staining, mounting and signing is also a
factor to consider. This explains the importance of SOPs in the laboratory. This finding is almost similar to that study done in Tanzania were pre-analytical errors showed 90% of the request form were incomplete, as far as clinical history is concerned (Mwakyoma, 2009) but differ from findings in United States of America and Europe where pre-analytical errors were so lower at(46%- 68%)(Carraro and Plebani, 2007; Plebani, et al 2009; Peter et al., 2010; Roque, et al 2015). Similar studies Pakistan reported a lower pre-analytical errors at a rate of 46% to 62.8 (Neelam et al., 2012, Angeles et al., 2014 and Usman et al., 2015)). Major significance between rate of occurrence of pre-analytical errors in this study and Tanzania study as compared to United States of America, Europe and Pakistan was attributed to the low level of accreditation of Pathology laboratory and lack of standardization of the protocols for defining and measuring pre-analytical variables which is scarce in low income countries and this includes most laboratories in sub Saharan Africa not excluding Uganda. In the United States of America, Europe, Pakistan and South Africa the SOPs are strictly followed and even the quality of training and competence is high and use laboratory information management system (LIMS) and there are beyond star four (4) which is lacking in Uganda and Tanzania Lippi G, Guidi GC, Mattiuzzi C, Plebani M. Preanalytical variability: the dark side of the moon in laboratory testing. ClinChem Lab Med 2006; 44:358–65).

4.2 The commonest stage presenting with pre-analytical errors occurring at the Pathology laboratory Makerere University College of Health Sciences

In this study, we found that pre-analytical errors commonly occur at a highest rate when the grossing is not done by a senior (97%). This could explain the reason why majority of the sample associated errors were observed in grossing (96.59%) in this study. At a micro analysis, we observe that during grossing, areas where a senior pathologist is needed like morphology examination, taking the length and weight (figure 5) were more affected compared to mix-ups were it was easy to sort immediately and work continues. Suggestions in this study that seniority could heavily affect the grossing are backed up by the what was reported by Layfield et al., (2010). In their study (Layfield et al., 2010), they reported a similarly high prevalence (88%) who also attributed it to performance of grossing by only Laboratory assistants. In the curriculum for Senior House Officers (SHOs) at Makerere University, they are mandated to perform grossing but under the observation of a senior pathologist together with technician. In this case, having had most grossing done by juniors could be explained by the busy schedule of the senior pathologists at the department yet are
few about twelve (12) in number, yet also there are fewer Pathology laboratories to provide the population coverage. These Pathologists also handle research, teaching, project writing and give diagnostic services. In United States and United Kingdom in the recent surveys observed that anatomic Pathologist to patient population was (1:1,000,000) or (1/50) ratio (Adesina A, Chumba D, Nelson AM, et al., 2013).

A retention strategy (for graduating pathologists) with support from the principal’s Office College of Health Sciences together with the dean School of Biomedical Sciences) could be adopted at the Pathology department to improve on this quality indicator. Poor performance of grossing has been reported to affect the appropriateness of examination reports 70% (Nutt, Zemlin and Erasmus, 2008) and urgent intervention may be needed. Pathology staff should conduct continuous medical education to adopt new knowledge and skills as they become available and share and discuss with colleagues.

On the other hand, the importance of Poor performance of grossing has been reported to affect the appropriateness of examination reports 70% (Nutt, Zemlin and Erasmus, 2008) and urgent intervention may be needed. Pathology staff should conduct continuous medical education to adopt new knowledge and skills as they become available and share and discuss with colleagues.

lack of demographic data especially age, and sex is at a rate of (3.4%), (2.17%) respectively, as shown in figure 3 above, these findings are more or less in conformity with findings of another study in Nigeria by (Paingha et al. 2015) which found pre-analytical errors and lack of demographic data especially age and sex at a rate of (5.8%), (3%) respectively. The demographic information data of the patient is a media of communication between clinicians and pathologist, since specimens do not communicate. The major reason why address was not indicated compared to age, sex and region, which was indicated is that, the surgeons/clinicians do not know the significance of indicating address yet when the Pathologist is reporting, they also consider the physical place where the patient is residing like for swelling of the neck presents most with people living in high altitudes who suffer from goiter due to lack of iodine in their soils (figure 3). Furthermore some diseases present with age and sex of the patient. Significantly indicating the ward, location, sending department and level of health center all these parameters notifies to the Pathologist and epidemiological studies who are interested in data to learn the trend of occurrence of the diseases. Another reason for this is that there is no LIMS in place, heavy work load of
clinician to patient ratio, making clinician fill forms in a hurry or at later time or giving students or nurses to fill these request forms. Demographic data will lead to misinterpretation of patient’s results since analysis is correlated with patient’s age and sex (Paingha et al., 2015). Inadequate information may lead to difficulty in establishing the diagnosis hence poor patient outcome (Sharif et al., 2007; Hawkins, et al 2012; Rao et al., 2016).

Pre-analytical errors regarding not indicating the date the biopsy was taken in this laboratory rated at (74.92%). This rate is slightly lower than what (Hewitt et al., 2008) obtained at (98.2%) and much lower than (Layfield et al., 2010) who obtained (3.4%). This is attributed to the design of the laboratory request form of which some do indicate date biopsy sent others it’s missing completely, this makes the clinician taking it as option. This date is useful for charging how long the sample has been preserved in the fixative.

In this study, packaging presented with (44.89%) of pre-analytical errors. Most of these errors occurred highest in inappropriateness of specimen to fixative ratio as (80.19%), followed by specimen to container ratio being (78.02%), then container faults which included whether container is leaking, squeezed or both lastly is fixative type which had fewer errors (1.86%). This is low because the Pathology laboratory department prepares the fixative for use then distributes it out. Specimen to fixation ratio and specimen to container ratio inappropriateness was due to specimen most cases being bigger than the container used and of smaller volume than the container (figure 3 and also micrograph Appendix IV to VIII). This was attributable for the fact that there are no specific containers for specific biopsies as it is for sputum, stool and urine. Therefore clinicians just improvise. There also no SOPs for specimen collection, packaging and no emphasis on this at the different levels of medical, nursing and laboratory training schools. Appropriateness of container is due to the cadres collecting the specimen lack the knowledge of proper handling and fixation of specimen which could be highlighted in the clinician hand book. Inappropriate packaging and the nature of the specimen container may distort the anatomical landmarks as well as displacement of the specimen which might results into spillage of the fixative and sometimes loss or drying of precious specimen during transportation. To ensure the sample integrity the safety for the carrier, community and receiving laboratory have to be well equipped with safety measures. Sample collection and its submission in 10% formalin is the ideal recommended preservative (Sharif et al., 2007; Rao et al., 2016). The container might have to be cut in case of plastic or broken if it’s a glass bottle.
Lastly omission of clinical history on the laboratory request form was (8.36%). This was high than (2.4%) from United States but lower than that in Nigeria of (50%) (Atanda et al., 2013). This rate is low because at the moment the clinical history is always given but if not given, the Pathologist tends not to give the final diagnosis but continue asking the requesting clinician for clinical history before the final report is submitted. Clinical history affects the accuracy and completeness of Pathology report (Nakhleh et al., 1999).

4.3 The effect of the pre-analytical errors and the quality of results produced at Pathology laboratory Makerere University College of Health Sciences

In the study conducted by Carraro and Plebani, (2007) they found out that the overall frequency of pre-analytical errors are significantly lower than (P-value <0.05). In this study, when we analyzed the pre-analytical errors and the quality of results produced, it was found that, there was a strong association between demographic data, especially age, sex of the patients and the quality of results produced, (P-value 0.004). In this study we also found that there was a significant association between presence or absence of clinical history and the final results produced, (P-value 0.001), this finding is not in agreement with another study (Atanda et al., 2013) in Nigeria which found a strong association between pre-analytical errors and clinical history (P-value 0.2395). Furthermore, the third important error that is associated with a poor quality of results produced by pathology lab is presence or absence of a senior pathologist during grossing, in this study we found a strong association between the quality of results given and whether or not the grossing was done by a senior, (P-value 0.001) There was no significant association between date biopsy taken, submitted and packaging, (P-value 0.113), (P-value 0.270) respectively. This was in agreement with similar studies (Atanda et al., 2013) done in Nigeria with (P-value 0.892).
CHAPTER SIX: CONCLUSION, RECOMMENDATION AND LIMITATION

6.0 Conclusion
Pre-analytical errors occur frequently in pathology lab, there a strong association between pre-analytical errors especially demographic data, clinical history and grossing.

6.1 Recommendation
1. A cohort study with a larger sample size, longer study period needs to be conducted to ascertain the effect of other variables such as nature of specimen and TAT, on the final results produced at pathology lab.
2. Pathologists and laboratory personnel must have policies and procedures in place that ensure that every one follows them.
3. Refresher training courses on quality assurance for both Pathology staff and senior house officer (SHO) and clinicians. Pathology laboratory should embrace SLIPTA in order to work towards accreditation in any of the accrediting bodies.
4. Standardization of Pathology request forms.
5. Establish continuous medical education to gain new knowledge and adopt new practices as they become available to be shared and discussed with colleagues.
6. There is a desperate need of senior pathologist during grossing.
7. There is need to do monitoring and evaluation both in laboratories and clinical.
8. Establish a continuous quality improvement program that focuses on improving the processes in Pathology laboratory.

6.2 Limitations
This was a cross-sectional lab based study, important variables such as the nature of the specimen and TAT, which could have added more value to this findings were not studied.
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1929–1935.


24. Onyeaghala et al, 2013 Augustine A et al. (no date) ‘Preanalytical Factors Affecting Medical Laboratory Operations : A Look at Laboratory Request Forms in a Selected


APPENDIX I: Actual work flow of surgical pathology from pre-analytical, analytical and post-analytical phases are as follows:

- **Patient identification**
- **Selecting tissue biopsy**
- **Labeling and transport**
- **Biopsy accessioning**
- **Slide delivery for**
- **Label slide, cut section, stain and cover slip**
- **Tissue processing, embedding**
- **Grossing of tissue biopsy**
- **Collating/interpreting slides**
- **Considering ancillary test result, other**
- **Composing, transmitting**
- **Receiving interpreted**
## APPENDIX II: OBSERVATIONAL CHECK LIST

1. **Extra laboratory activities**

1.1 Research number ……………………………………………………………………………………

1.2. Age of client 1 Yes………2. No………3 Adult…………4. Child…………

1.3 Sex of client 1 Male………………2 Female……………3 Not indicated………………

1.4 Health Unit 1 Public (Gov’t)…… 2 NGO (Not for profit)…… 3 Others (For profit)……

1.5. Level of Health Unit 1 NRH…. 2 RRH… 3 DRH… 4 HC IV… 5 HC III… 6 HC II… 7 Clinic…

1.6 Region 1 Central…….2 Western…… 3 Northern … 4 Eastern … 5 Southern……

1.7 Location 1 Urban ……………………2 Rural ………………………

1.8 Patient OPD / IP Number 1 Yes……………………………………….. 2 No………………………………………..

1.9 Patient’s Ward 1 Yes ………………………………………….. 2 No …………………………………………..

1.10 Full Address of client 1 Yes ………………………………………….. 2 No …………………………………………..

1.11 Date biopsy taken 1 Yes ………………………………………….. 2 No …………………………………………..

1.12 Date biopsy sent 1 Yes ………………………………………….. 2 No …………………………………………..

1.13 Clinical summary 1 Yes ………………………………………….. 2 No …………………………………………..

1.14 Cadre of Clinician 1 Surgeon (Ent, Uro, Neuro, Opth, Oby, Paed, Skin, GIT, Med, Surg, Spine, plasticsurgery, ortho, Neck and head) 2 Physician … 3 Senior House Officer … 4 Nurse … 5 Others … 6 Not given …………

1.15 Prior Investigations.

1 Haematology … 2 Chemistry … 3 Microbiology … 4 Radiology … 5 None …

1.16. Investigation requested

1 Histology ………………………………………. 2 IHC ………………………………………. 3 Cytology …………..

1.17 Nature of specimen 1 Soft tissue ……….. 2 Bone tissue ……….. 3 Not indicated …………..
1.18 Size of specimen

1.19.1 Specify site of specimen taken

1.20 Identification of sample
1. Right……………….2. Wrong……………….

1.21 Presumptive diagnosis
Specify…………………………………………

1.22 Identification complete
1. Yes………………….2. No………………………

1.23 Grade error rate out of 5
Specify………………………………………………

2. Intra laboratory activities

2.1 Appropriate specimen container
1. Yes………………….2. No……………………

2.1.1 Specify the error identified

2.1.2 Ratio of specimen to container
1. Normal ) 1:10…….2. Small < 1:10…3. Excessive > 1:10

2.1.3 Volume of specimen to fixative
1. 1:10…….2. < 1:10…….3. > 1:10

2.2 Type of fixative

2.3 Date biopsy accessioned
1. Yes……………….2. No……………………

2.4 Grossing description error
1. Yes………………….2. No……………………

2.4.1 Measurements of length
1. Yes………………….2. No……………………

2.4.2 Colour, morphology and tissue consistency
1. Yes………………….2. No……………….3. Others……

2.4.3 Weight taken
1. Yes………………….2. No……………………

2.4.4 Sample mix-up
1. Yes………………….2. No……………………

2.4.5 Nature of grossed tissue
1. Incision…….2. Excision…….3. Toilet…….4. Others……
2.4.6 Grossing done by 1 Senior alone……2 Junior alone……3 Senior/Junior……4 Not identified…

2.5 Tissue processing tool (Sops) 
1 Present………………… 2 Absent…………………

2.5.1 If present what are the commonest errors identified 1 Checking reagents… 2 Refilling reagents… 3 Discarding reagents………4 Poor quality reagents… 5 Expired reagents…………

2.6 Embedding tool (Sops)
1 Present…………………2 Absent…………………

2.6.1 If present what are the commonest errors identified 1 Use of poor quality paraffin wax…. 2 Use of unwarmed forceps and mould…. 3 Poor centering the tissue in the mould…. 4 Overheating the wax, forceps and mould…. 5 Poor orienting tissue skills………6 Switching of tissues………7 Others specify……………………...

2.7 Sectioning tool (Sops) 
1 Present……………………2 Absent…………………

2.7.1 If present what are the commonest errors identified 1 Poor quality blades used……2 Microtome servicing (Sop)…. 3 Poor microtomy skills… 4 Mislabelling slides (Sop)…

5 Microtome care and maintenance (Sop)……………………

2.8 Floating out tool (Sops) 
1 Present…………………2 Absent…………………

2.8.1 If present what are the commonest errors identified 1 Contaminated water… 2 Half filled water……3 Not cleaning the water surface ……4 Poor picking skills… 5 Over heated water

2.9 Staining tool (Sops) 
1 Present…………………2 Absent……………………

2.9.1 If present what are the commonest errors identified 1 Half filled reagents…. 2 Unfiltered reagents…. 3 Expired reagents………4 Quality control of reagents/stains… 5 Poor quality reagents……

2.10 Mounting tool (Sops) 
1 Present…………………2 Absent…………………

2.10.1 If present what are the commonest errors identified 1 Air bubbles….. 2 Poor quality Depexmountant…. 2 Poor mounting skills………3 Poor quality cover slips…………

2.11 Presenting tool/ sign out (Sops) 
1 Present…………………2 Absent…………………

2.11.1 If present what are the commonest errors identified 1 Switching of forms………2 Switching of slides……

2.12 Grade the rate out of 5 Specify…………………………

35
3. Effects

3.1 Date biopsy reported
   1 Yes ........................................ 2 No ........................................

3.2 Calculated TAT
   1 Two days ................................
   2 Three days ................................
   3 Four days ................................
   4 Five days ................................
   5 Five days plus ..........................

3.3 Review /disagreement of results
   1 Agree ......................................
   2 Disagree .................................

3.3.1 If yes what is the cause of review list them ...........................................

3.4.2 Grade the rate out of 4 Specify ..................................................
APPENDIX III: A map showing college of health sciences where pathology dept. is located

APPENDIX IV: Micrograph of inappropriate specimen to container ratio <1:10 as well as specimen to fixative.
APPENDIX V: Micrograph of specimen to container ratio inappropriate < 1:10

APPENDIX VI: Micrograph of specimen to fixative ratio inappropriate < 1:10
APPENDIX VII: Micrograph of specimen to fixative ratio inappropriate < 1:10

APPENDIX VIII: Micrograph of inappropriate specimen to container ratio < 1:10 as well as specimen to fixative.
Dear Sir/Madam,

RE: ASSISTANCE FOR RESEARCH

Greetings from International Health Sciences University.

This is to introduce to you Namwase Betty, Reg. No. 2014-BMLS-FT-007 who is a student of our University. As part of the requirements for the award of a Bachelors Degree of Medical Laboratory Sciences of our University, the student is required to carry out research in partial fulfillment of her award.

Her topic of research is: Pre - Analytical errors affecting quality of pathology services at College of Health Sciences Makerere University Kampala – Uganda.

This therefore is to kindly request you to render the student assistance as may be necessary for his research.

I, and indeed the entire University are grateful in advance for all assistance that will be accorded to the student.

Sincerely Yours,

[Signature]

John Charles (PhD)
Associate Professor / Dean IAH

The International Health Sciences University
P.O. Box 7782 Kampala – Uganda
(+256) 0312 307400 email: deanahs@cu.ac.ug / jokinas@cu.ac.ug
web: www.iah.ac.ug

IHSU
INTERNATIONAL HEALTH SCIENCES UNIVERSITY
making a difference to health care

Dean’s Office-Institute of Allied Health Sciences
Kampala, Tuesday 02nd October 2018

[Stamp: Received and permitted]