ACCURACY OF ECG INTERPRETATION AMONG DOCTORS WORKING AT THE EMERGENCY MEDICINE DEPARTMENT OF A TERTIARY HOSPITAL IN TANZANIA

Emmanuel Wilson Mmbando, MD

MMed (Emergency Medicine) Dissertation
Muhimbili University of Health and Allied Sciences
October, 2024

Muhimbili University of Health and Allied Sciences

Emergency Medicine Department

FACTORS ASSOCIATED WITH PROVISION OF PAIN MANAGEMENT AMONG ADULT TRAUMA PATIENTS PRESENTING TO THE EMERGENCY DEPARTMENT OF THREE TERTIARY HOSPITALS IN TANZANIA; A CROSS SECTIONAL STUDY

By

Emmanuel Wilson Mmbando

A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Medicine (Emergency Medicine) of

Muhimbili University of Health and Allied Sciences
October, 2024

CERTIFICATION

The undersigned certifies that they have read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: **"Accuracy of ECG Interpretation Among Doctors Working at the Emergency Medicine Department of a Tertiary Hospital in Tanzania,"** in (partial) fulfillment of the requirements for the degree of Master of Medicine (Emergency Medicine) of Muhimbili University of Health and Allied Sciences Dar es Salaam, Tanzania.

_____

Dr. Said S Kilindimo MD, MMed (SU), FCEM(SA), FCICM(Apollo)

(Supervisor)

Date: _____

_____

Dr. Alphonce N. Simbila, MD, MMed Emergency Medicine (MNH)

(Co-Supervisor)

Date: _____

_____

Dr. Evelyne Mapunda, MD, MMed Emergency Medicine (MNH)

(Co-Supervisor)

Date: _____

DECLARATION AND COPYRIGHT

I, **Emmanuel Wilson Mmbando**, hereby declare that this **dissertation** is entirely original and has not been submitted to any other university for consideration for any kind of degree award.

Signature…….. **Date** ……

In terms of intellectual property, this dissertation is protected by copyright under the Berne Convention, the Copyright Act of 1999, and other international and state laws. It cannot be duplicated in any form or by any means, except brief excerpts used in fair dealing, research or private study, critical scholarly review, or discussion with attribution, without the express written consent of the Directorate of Postgraduate Studies, representing the author and Muhimbili University.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my family, whose unwavering support has been instrumental in the completion of this dissertation. First and foremost, I thank my beloved wife, Dr. Marim, for her endless encouragement and patience, and my daughter, Ivanna, for bringing joy and motivation into my life during this challenging journey.

I extend my heartfelt thanks to my supervisor, Dr. Said Kilindimo, Head of the Emergency Medicine Department at MUHAS, for his insightful guidance, continuous support, and invaluable expertise. His leadership has been a cornerstone in the successful completion of this work. I am also deeply grateful to my co-supervisors, Dr. Alphonce N. Simbila and Dr. Evelyne Mapunda, for their consistent support, constructive feedback, and dedication, which have significantly enriched my research. Sincere gratitude is extended to Prof. Ellen Weber for her invaluable advice and unwavering support.

Furthermore, I would like to acknowledge my colleagues who participated in this study. Their willingness to contribute and their cooperation made this research possible, and for that, I am truly thankful.

Lastly, I wish to extend my appreciation to my classmates and friends for their support and camaraderie throughout this period. Their encouragement has been a source of strength and motivation, helping me navigate through the various phases of this research.

DEDICATION

To my parents, my wife Dr Mariam Elsias, and my daughter Ivanna Emmanuel

ABSTRACT

Background: Electrocardiograms are widely used for diagnosing heart diseases, including myocardial ischemia, metabolic disturbances, and life-threatening arrhythmias. In the Emergency Medicine Department, the utilization and evaluation of electrocardiograms (ECGs) are vital for diagnosing and planning the treatment of patients with critical conditions. However, Errors in interpretation can cause significant morbidity and mortality, while over-interpretation can lead to unnecessary treatments, increasing costs and hospital stays.

Objective of the study: To determine the accuracy of ECG interpretation among doctors working at the Emergency Medicine Department in a tertiary hospital, in Tanzania.

Methodology: The study was conducted at Muhimbili National Hospital's Emergency Department in Tanzania (March-April 2024) and involved Emergency Medicine Residents and General Practitioners with specified experience. Participants provided consent, completed a survey, and interpreted ten anonymized ECGs. Accuracy was assessed on rate, rhythm, QRS axis, P wave, T wave, PR interval, QT interval, and primary diagnosis. Two specialists reviewed the ECGs, and a marking scheme was developed. Data were summarized using SPSS, calculating frequencies, percentages, means, standard deviations, medians, percentiles, and 95% confidence intervals.

Results: The average ECG interpretation score among doctors in the Emergency Medicine Department was 59.4%. Mean scores for general practitioners, 1st, 2nd, and 3rd-year residents were 50.96%, 54.18%, 66.06%, and 66.43%, respectively. Bifascicular Block and Acute Pericarditis were the most challenging diagnoses. Overall, 51% of respondents reported good confidence, while 35.3% reported moderate confidence. There was a moderately strong positive correlation (rho = 0.532) between ECG scores and self-reported confidence.

Conclusion: Enhanced ECG training and confidence-building are crucial for improving diagnostic accuracy and patient outcomes. Targeted training programs should be immediately implemented.

Commented [L1]: This is more of recommendation

TABLE OF CONTENT

CERTIFICATION....i
DECLARATION AND COPYRIGHT.... ii
ACKNOWLEDGEMENT iii
DEDICATION iv
ABSTRACT v
TABLE OF CONTENT vi
LIST OF TABLES ix
LIST OF FIGURES....x
LIST OF ABBREVIATIONS xi
OPERATIONAL DEFINITIONS OF TERMS.... xii
CHAPTER ONE 1
1.0 INTRODUCTION....1
1.1 Background 1
1.2 Problem Statement 3
1.3 Conceptual Framework 5
1.4 Rationale....7
1.5 Overall Research Question....8
1.5.1 Research Questions....8
1.6 Objectives....9
1.6.1 Broad Objective....9
1.6.2 Specific Objectives 9
CHAPTER TWO....10
2.0 LITERATURE REVIEWS 10
2.1 ECGs interpretation accuracy among doctors working in the emergency medicine department....10
2.2 Commonly Missed ECG Diagnoses in Emergency Medicine 10
2.3 Level of training of emergency doctors and error rates in interpreting ECGs....11

2.4 Level of confidence and ECG interpretation accuracy among doctors working in the emergency medicine department....12
CHAPTER THREE....14
3.0 METHODOLOGY....14
3.1 Study design....14
3.2 Study setting....14
3.3 Target Population....15
3.3.1 Accessible population:....15
3.3.2 Study population....15
3.4 Sampling Technique....15
3.5 Selection criteria....15
3.5.1 Inclusion criteria....15
3.5.2 Exclusion criteria....16
3.6 Variables of interest....16
3.7 Outcome variables....16
3.8 Variables....17
Independent variables....17
Dependent variables....17
3.9 Sample Size....17
3.10 Data Collection....17
3.11 Data analysis....19
3.12 Ethical considerations....20
CHAPTER FOUR....21
4.0 RESULTS....21
CHAPTER FIVE....28
5.0 DISCUSSION....28
CHAPTER SIX....32
6.0 LIMITATIONS, CONCLUSION AND RECOMMENDATIONS....32
6.1 Limitations....32

6.2 Conclusion....32
6.3 Recommendations....33
REFERENCES....34
APPENDICES....38
Appendix I: Informed Consent Form (English Version)....38
Appendix II: Questionnaire....41
Appendix III: Approval for ethical clearance....44
Appendix IV: Introduction Letter....46

LIST OF TABLES

Table 1: Background information.....22

Table 2: Scores of ECG interpretation among doctors working at the Emergency Medicine Department (EMD.....23

Table 3: Mean score per ECG 24

Table 4: Differences in mean scores across levels of EMD training.....27

LIST OF FIGURES

Figure 1: Conceptual framework of the study. 5

Figure 2: Mean score of ECG interpretation at different levels. 23

Figure 3: Self-reported confidences on ECG interpretation 25

Figure 4: 26

LIST OF ABBREVIATIONS

AMI:	Acute Myocardial Infraction
APP:	Advanced practice practitioner
CVD:	Cardiovascular Diseases
ECG:	Electrocardiogram
EMD:	Emergency Medicine Department
GBD:	Global Burden of Disease
GPs:	General Practitioners
HCAHPS:	Hospital Consumer Assessment of Healthcare Providers and Systems
HIC:	Higher Income Countries
ICU:	Intensive Care Unit
IRB:	Institutional Review Board
LMIC:	Low- and Middle-Income Countries
MD:	Medical doctor
MNH:	Muhimbili National Hospital
MNH-EMD:	Muhimbili National Hospital-Emergency Medicine Department
MUHAS:	Muhimbili University of Health and Allied Sciences
PGY:	Post-Graduate Year
SSA:	Sub-Saharan Africa
USA:	United States of America
WHO:	World Health Organization

OPERATIONAL DEFINITIONS OF TERMS

Commented [L2]: Include references for these definitions

Doctors working in Emergency Medicine Department – This includes Emergency Medicine Resident and General Practitioners (Medical officers) working full time at emergency medicine departments with full-time emergency physicians on site.

General Practitioners - Medical doctors with a first degree in medicine (MD) who completed a one-year internship and were allowed to practice Medical Council of Tanzania.

Resident Doctor - Medical doctor with a first degree in medicine (MD) currently in training for a master's degree in emergency medicine.

Cardiovascular diseases (CVD)- defined as a group of disorders of the heart and blood vessels. These conditions include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism.

Electrocardiogram - is the actual graphical representation or recording of the electrical activity of the heart over some time.

Electrocardiography refers to the process or technique used to record the electrical activity of the heart over a period leading to the creation of an electrocardiogram.

Rate - In the context of an electrocardiogram (ECG), "rate" refers to the heart rate, which is the number of heart beats per minute.

Rhythm- In the context of an electrocardiogram (ECG), "rhythm" refers to the pattern of electrical impulses generated by the heart and recorded by the ECG machine. The ECG tracing displays these electrical signals as waves and complexes, including the P wave, QRS complex, and T wave.

Axis-In an electrocardiogram (ECG), the "axis" refers to the overall direction of the electrical activity of the heart as represented on the ECG tracing which provides valuable information about the orientation of the heart's electrical forces within the body.

Emergency Department (ED) - is a medical facility within a hospital that provides immediate medical care to patients who present with acute illnesses or injuries to ensure timely assessment and treatment of medical emergencies.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Cardiovascular diseases (CVD) are among the major causes of mortality on a global scale, especially among individuals with comorbidities such as diabetes mellitus or chronic kidney disease. Addressing the prevention, early detection, and effective management of these conditions poses significant challenges in the modern era. (1).

Electrocardiograms are a commonly used diagnostic procedure to identify various heart conditions, such as myocardial ischemia, metabolic disturbances, or life-threatening arrhythmias. (2,3).

Patients with these emergency conditions are seen at the Emergency Medicine Department. The use and analysis of electrocardiograms (ECGs) play a crucial role in diagnosing and devising treatment plans. (4). Emergency physicians, by accurately identifying conditions like myocardial infarction in the Emergency Department (ED), are recognized for enhancing patient outcomes, especially for those requiring urgent life-saving interventions, through early reperfusion to promote favorable results. (5).

Interpreting an electrocardiogram (ECG) requires a thorough understanding of anatomy, electrophysiology, and pathophysiology. It also involves the skills of recognizing visual patterns and applying diagnostic reasoning. (3). The subjective interpretation of the ECG at the emergency department often exhibits significant variability, which can result in higher-than-expected rates of false activation of the cardiac catheterization laboratory, reaching up to 36% and several studies have indicated that as much as 72% of inappropriate activations were attributable to misinterpretations of the ECG. (6). Errors in interpreting electrocardiograms (ECGs) related to critical cardiac incidents can lead to substantial morbidity and mortality. Conversely, the misinterpretation of an ECG as indicating a life-threatening cardiac event may result in unnecessary therapies and procedures increasing treatment costs and hospital stays. (7-8).

Therefore, Emergency Physicians need to acquire expertise in ECG interpretation when assessing patients. Interpreting electrocardiograms (ECGs) is a vital skill that medical trainees and residents, particularly those in the Emergency Department (ED), need to develop. (9).

There are various methods for interpreting ECGs that can be acquired through training and elective learning opportunities. (4,10).Furthermore, there are significant variations in the clinical experience of interpreting ECGs among emergency medicine residency programs worldwide (11).

Tanzania is a nation in the process of development, and the field of Emergency Medicine is an evolving specialty, with the initial group of locally trained Emergency Physicians graduating approximately 10 years ago. Currently, staffing in the emergency medicine department mostly consists of emergency medicine specialists, residents, and general practitioners. At Muhimbili National Hospital, immediate medical management is primarily carried out by Emergency Medicine residents and general practitioners who are stationed on duty without specialist or consultant input. To comprehend the possible need for further educational improvements and on-the-job training, it is essential to assess the accuracy of ECG interpretation among general practitioners and trainees specializing in emergency medicine within the emergency department. To achieve this objective, the researcher conducted a study to examine the accuracy of ECG interpretation among physicians working in the emergency medicine department at Muhimbili National Hospital in Tanzania.

1.2 Problem Statement

Globally, non-communicable diseases (NCDs) account for the majority of deaths, constituting 73.4% of all fatalities. In sub-Saharan Africa (SSA), NCDs are the second most prevalent cause of death, contributing to 2.6 million fatalities, representing around 35% of all deaths (30). The electrocardiogram (ECG) serves as the primary diagnostic tool, and it plays a critical role in diagnosing acute coronary events and other non-cardiac conditions. Emergency physicians must possess the essential skill of interpreting ECGs accurately and promptly, especially for high-risk cases involving metabolic, cardiac, toxicological, and electrolyte imbalances, as timely analysis can be lifesaving. (21). Several studies examining cases of missed presentations of acute myocardial infarction (AMI) in the emergency medicine department have highlighted that a key factor leading to errors in patient management is the inability to interpret electrocardiograms (ECGs) accurately (6). Diverse approaches are available for instructing ECG interpretation, including both obligatory training and elective learning opportunities before entering the emergency medicine department. Moreover, there are significant differences in the clinical exposure to ECG interpretation among physicians in the EMD. (11).

In our locality, Electrocardiograms (ECGs) in the emergency medicine department (EMD) are typically ordered by attending physicians, who are also the primary interpreters of these ECGs. However, when necessary, consultation with colleagues or more senior personnel within the shift may be sought, with the ultimate decision resting with the attending physician. Occasionally, situations may arise where a misunderstanding between two physicians working in the emergency department regarding a certain ECG finding occurs, necessitating consultation with a cardiologist to resolve the issue. Despite the availability of various training and workshops, both in-person and online, focused on ECG interpretations, there exists a notable absence of formal assessment mechanisms to gauge the accuracy of our interpretations in our locality. In some parts of Africa, Jager et al. (2010) determined that the average overall score for ECG interpretation among physicians in the emergency medicine department was 46.4%. This lack of formal assessment makes it challenging to obtain data regarding prevalent errors encountered in ECG interpretation within our locality, identify parameters posing difficulties in

interpretation, or understand the challenges faced by physicians, doctors, and residents in this domain.

Consequently, there is a compelling need to establish structured frameworks for assessing the accuracy of ECG interpretations, enabling the identification of common errors, challenging parameters, and obstacles encountered by healthcare professionals in interpreting ECGs effectively. Therefore, this study was set to determine the accuracy and confidence of MNH-EMD residents and registrars in the interpretation of ECGs of common ED diagnoses.

1.3 Conceptual Framework

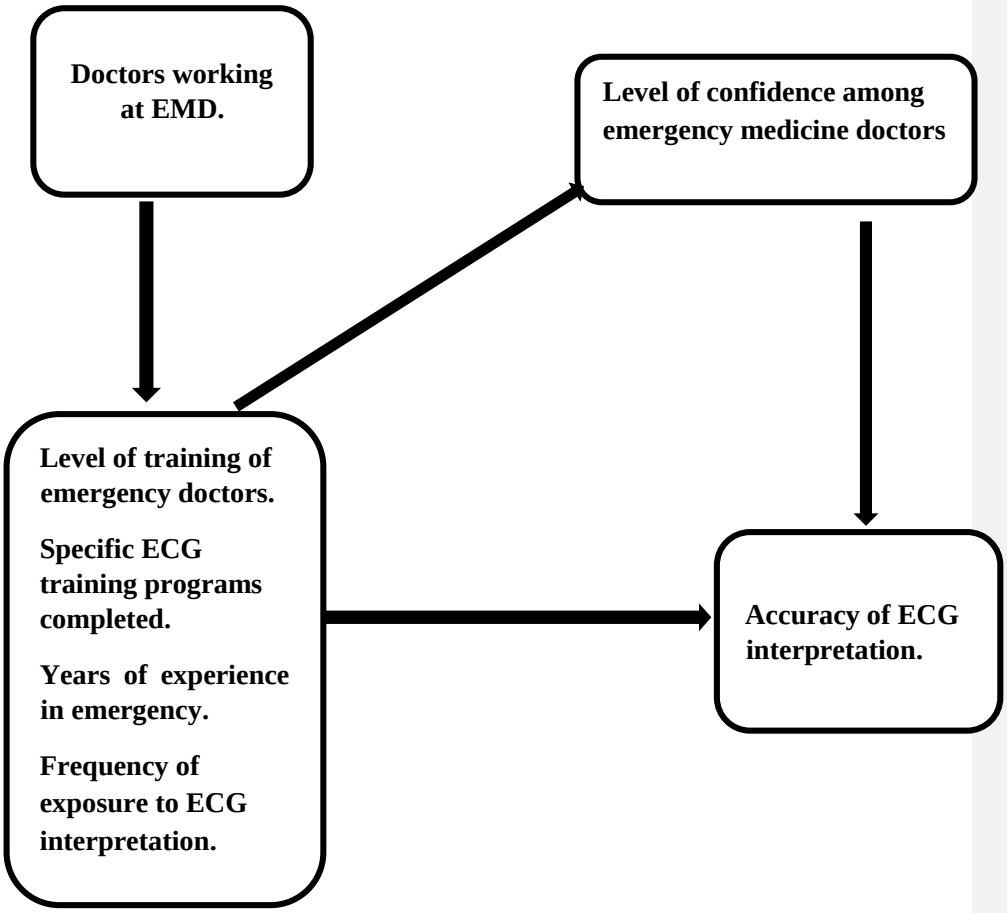


Figure 1: Conceptual framework of the study.

Conceptual framework

The central concept of this framework was the " ECG Interpretation accuracy among doctors working at Emergency Medicine Department," representing the main focus of the study which aimed at understanding and evaluating the ECG Interpretation accuracy among doctors working at emergency medicine department. The stated accuracy was influenced by several independent variables, including the level of training of emergency doctors. The hypothesis posited that higher levels of training may positively influence the ECG interpretation accuracy. Another independent variable was the level of confidence among doctors working in the emergency medicine department in ECG interpretation. The assumption was that higher confidence levels may correlate with increased accuracy, and these confidence levels may also be affected by years of experience in emergency medicine, completion of specific ECG training programs, and the frequency of exposure to ECG interpretation. This positive influence on confidence may, in turn, have a direct effect on the ECG interpretation accuracy among doctors working in the emergency medicine department.

1.4 Rationale

The accuracy of ECG interpretation in the emergency department holds significance, as ECGs are frequently employed as a diagnostic tool in assessing patients with chest pain, breathing difficulties, palpitations, and other cardiovascular and metabolic diseases. (31).

Accurate interpretation of ECGs can help emergency department physicians identify life-threatening conditions such as cardiac arrhythmias acute myocardial infarction and pulmonary embolisms and initiate timely and appropriate treatment.(20).

Despite the significance of the diagnostic test and various recommendations on ECG interpretation education (12) To evaluate the potential need for further improvements in education, it was beneficial to determine the proficiency of physicians and trainees in accurately interpreting ECGs.(1)

On the other hand, inaccurate or delayed ECG interpretation can lead to missed diagnoses, inappropriate treatment, and adverse outcomes for patients.(12) Hence, it was essential to evaluate the ECG interpretation accuracy at the emergency medicine department to identify areas for improvement and implement interventions to enhance the quality of care.

By systematically evaluating and optimizing ECG interpretation practices, emergency department staff members can improve patient outcomes and reduce the poor outcomes of cardiovascular disease.

This study therefore sought to determine the accuracy and confidence of MNH-EMD residents and registrars in the interpretation of ECGs with common ED diagnoses. The findings of this study will serve as a foundation for creating an ECG training curriculum tailored for residents.

1.5 Overall Research Question

Among doctors working at the emergency medicine department in a tertiary hospital in Tanzania what is the accuracy of interpreting ECGs ?

1.5.1 Research Questions

1. In doctors working in the Emergency Medicine Department of a tertiary hospital in Tanzania, what is the average percentage score of ECG interpretation?
2. Among emergency medicine doctors in a tertiary hospital in Tanzania, what are the missed emergency diagnoses in the interpretation of pre-selected ECGs compared to the standard diagnosis?
3. In emergency medicine doctors in a tertiary hospital in Tanzania, what is the level of confidence in interpreting ECGs with pre-identified emergency diagnoses?
4. In emergency medicine doctors in a tertiary hospital in Tanzania, is there an association between the level of confidence and the accuracy of interpreting ECGs with pre-identified emergency diagnoses?
5. In emergency medicine doctors in a tertiary hospital in Tanzania, is there an association between the level of training and error rates in interpreting ECGs with pre-identified emergency diagnoses?

1.6 Objectives

1.6.1 Broad Objective

To determine ECG interpretation accuracy among doctors working at the Emergency Medicine Department (EMD) in a tertiary hospital, in Tanzania.

1.6.2 Specific Objectives

1. To determine the average percentage score of ECG interpretation among doctors working at the Emergency Medicine Department (EMD) in a tertiary hospital in Tanzania.
2. To identify missed emergency diagnoses among the pre-selected ECGs by emergency medicine doctors in tertiary hospitals, in Tanzania.
3. To determine the level of confidence among emergency medicine doctors in interpreting ECGs with pre-identified emergency diagnoses in tertiary hospitals, in Tanzania.
4. To determine the association between the level of confidence and accuracy of interpreting ECGs with pre-identified emergency diagnoses among emergency medicine doctors in tertiary hospitals, in Tanzania.
5. To determine the association between the level of training of emergency doctors and error rates in interpreting ECGs with pre-identified emergency diagnoses in tertiary hospitals in Tanzania.

CHAPTER TWO

2.0 LITERATURE REVIEWS

2.1 ECGs interpretation accuracy among doctors working in the emergency medicine department

Electrocardiogram (ECG) interpretation is a critical skill in everyday clinical practice, particularly in emergency medicine. (12).

In one of the studies, it was revealed that across all training levels, EMD physicians demonstrated a median accuracy of 54% in ECG interpretation, with an interquartile range of 40%-66%. (13) Another study found that the overall mean accuracy of ECG interpretation was 52% whereas for junior doctors, the mean accuracy was 42%, and for senior doctors, it was 65% (14). Likewise, a study done in Australia reported an overall mean accuracy in ECG interpretation by Emergency medicine physicians to be 56.6%. Senior trainees achieved an accuracy of 67.5%, while others achieved 49.6%.(4) Other studies in USA and France demonstrated a median accuracy of between 40%- 60% among the EMD residents and Residents in emergency medicine and internal medicine did not show a significant difference in overall competence in ECG interpretation. (15-16) . In Africa, similar findings were shown. They determined that the average overall score for ECG interpretation was 46.4% among physicians in the Emergency Medicine Department whereby the junior group scored an average of 42.2%, but the senior group scored 52.5%. (10)

2.2 Commonly Missed ECG Diagnoses in Emergency Medicine

This literature review aims to identify and analyze the most frequently missed electrocardiogram (ECG) diagnoses in Emergency Medicine departments based on findings from relevant studies.

The study was done to investigate and identify common errors in interpreting electrocardiograms (ECGs) within the Emergency Department (ED) setting. Repolarization abnormalities, ventricular hypertrophy, and hemiblock were noted as the most frequent errors in the interpretation of ECGs in the ED.(17). Likewise, in the USA a study highlighted the

misinterpretation of repolarization abnormalities and ventricular hypertrophy as acute myocardial ischemia by both emergency medicine and internal medicine residents, but this study did not specifically mention hemi-blocks in the highlighted misinterpretations.(7)

In another study assessing the agreement between the interpretations of abnormal ECGs by emergency physicians and cardiologists, they disclosed that atrial fibrillation was the most overlooked dysrhythmia in the Emergency Department (ED), ischemia/infarct in the anterior wall was also frequently missed (18). Similarly, in the USA the findings revealed that the frequently overlooked diagnoses included ST-segment elevation myocardial infarction (misdiagnosed by 8%) and dysrhythmias, notably ventricular tachycardia (misdiagnosed by 11%). Furthermore, complete heart block was misdiagnosed by 58% among both emergency and internal medicine residents. (15) These studies provide valuable insights into specific ECG diagnoses that may elude timely recognition in emergency settings.

2.3 Level of training of emergency doctors and error rates in interpreting ECGs

The literature findings suggest an association between the level of training of emergency doctors and their error rates in interpreting electrocardiograms (ECGs). Three studies were examined, each shedding light on this relationship.

In the USA it was found that third and fourth-year postgraduate residents (PGY-3/4s) exhibited a notably higher success rate at 74.6% incorrect interpreting an ECG, surpassing first-year (PGY-1s) residents at 63.2%, and second-year (PGY-2s) residents with an average of 69.0%. (20) Similarly, In Iran, a study done on Emergency Medicine residents found that the ECG interpretation score significantly differed across various years of residency in which there was a notable progression from 64.1% accuracy in the first year to 96.2% in the second year and 98.6% in the third year. (19) In Australia, study findings echoed a similar pattern where the report indicated an average accuracy of 52% in ECG interpretation. Among junior doctors, the mean accuracy was 42% and senior doctors exhibited a higher accuracy at 65%, further emphasizing an improvement in ECG interpretation skills with increasing experience. (14) Likewise in Africa, in a study done in South Africa junior participants demonstrated an overall average ECG interpretation accuracy of 42.2%, while the senior group exhibited an accuracy of

52.5%, indicating a significant advancement in skills between the two groups. (10), This underscores the positive correlation between training progression and enhanced ECG interpretation proficiency.

However, some studies reveal a different result. The study in the USA on ECG Interpretation by Emergency Physicians and Advanced Practice Practitioners found advanced practice practitioners (APPs) and first-year post-residency physicians exhibited comparable sensitivity and specificity. (21) Likewise, a study done in eight Arabic countries reported a noteworthy correlation was found between ECG interpretation and the year of medical residency, with fourth-year residents achieving the highest scores (mean = 9.24), but participants in the third and second years were more likely to have sufficient ECG knowledge compared to first-year residents. (22)Also a study done in France on ECG interpretation among residents in the Emergency Department produced a unique different finding, indicating an average overall score of 40%. Nevertheless, there was no significant distinction in scores observed between first-year and second-year postgraduate residents. (16)

2.4 Level of confidence and ECG interpretation accuracy among doctors working in the emergency medicine department.

The association between confidence level and accuracy in interpreting test results is a critical aspect of medical decision-making and diagnostic proficiency. Several studies have explored this relationship in various medical contexts.

A study done to assess self-reported proficiency in ECG interpretation reported that 45% of the health professionals expressed discomfort with the independent interpretation of ECG and self-reported confidence levels averaged 0.83 ± 0.53 on the provided scale the results underscore notable deficiencies in the proficiency of healthcare professionals in interpreting ECGs. (23)

In the USA research conducted revealed a significant correlation between increased workforce confidence in delivering patient care and elevated ratings from patients regarding their overall healthcare experience. Conversely, decreased levels of workforce confidence correlated with diminished patient ratings. Hospitals positioned in the top 25%, exhibiting positive workforce

perceptions, achieved an 11.7% higher score on the HCAHPS overall rating compared to those in the bottom 25%. (24) Likewise, another study on ECG interpretation reported that 53.9% of the participants who rated their eligibility for electrocardiogram interpretation as moderate demonstrated a significant relationship between ECG interpretation competency and self-assessment. (25) Similar Observation was reported studies in the USA by two studies where in the first study radiologists who reported being very confident were 1.32 times more likely to have correctly recalled the patient than those reporting neutral confidence and in the other study on ECG interpretation at EMD a positive correlation existed between competence in ECG interpretation and self-rated proficiency ($r = 0.386$), as well as certainty ($r = 0.428$). Therefore, overall competence was significantly associated with self-reported proficiency and certainty, respectively. (26), (15) Contrastingly, a study carried out in the USA shows no discernible association between pretraining confidence levels and competence but following training majority of students (88%) reported an enhancement in confidence and was found to be correlated with demonstrated competence after training. Notably, younger medical students initially exhibited lower confidence scores before training, but they demonstrated a comparable likelihood of achieving competence after completing the training,(27) Likewise, a study conducted in Wales clinical skills assessments unveiled a diverse range of competence levels among PGY1s. Interestingly, no apparent correlation was noted between the self-assessed confidence ratings of PGY1s and their objectively assessed competencies. (28)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design

This was a hospital-based cross-sectional observational study that investigated emergency medicine residents and general practitioners working in the emergency department. It was conducted from March to April 2024.

3.2 Study setting

This study was conducted at the Muhimbili National Hospital (MNH) Emergency Medicine Department situated in Dar es Salaam, Tanzania. EMD MNH, operational for the past 11 years, represents the country's first fully equipped Emergency Medicine department. Muhimbili National Hospital, a government-owned tertiary-level facility located in the heart of Dar es Salaam, serves as a crucial healthcare institution. The Emergency Medicine Department at Muhimbili National Hospital (EMD MNH) attends to approximately 65,000 patients annually.

The department focuses on stabilizing critically ill patients, overseeing their care for a maximum of 24 hours, and then deciding the appropriate next steps, which may include inpatient care, intensive care, outpatient clinics, or medical evacuation for additional diagnostic assessment and treatment.

EMD MNH serves as an educational hub for emergency medicine rotations linked with Muhimbili University of Health and Allied Sciences (MUHAS), providing opportunities for students in the medical and nursing disciplines, along with residents from various specialties.

As of now, the department is equipped with 24 general practitioners, 22 first-year emergency medicine residents, 16 second-year emergency medicine residents, and 15 third-year emergency medicine residents.

At the Emergency Medicine Department (EMD) of Muhimbili National Hospital (MNH), approximately 20 Electrocardiograms (ECG) are conducted daily. The physician is responsible for ordering the ECG and is initially tasked with interpreting the results. In case assistance is required for ECG interpretation, the ordering physician may consult a colleague on shift. Additionally, the Emergency Medicine (EM) specialist plays a role, and if a disorder is diagnosed that necessitates cardiologist consultation, a cardiologist will be consulted for further discussion and management of the patient.

3.3 Target Population

All Emergency medicine residents and general practitioners working in the Emergency Medicine Department in Tanzania

3.3.1 Accessible population:

All Emergency medicine residents and general practitioners working at EMD MNH

3.3.2 Study population

All Emergency medicine residents and general practitioners working at EMD MNH during the study period.

3.4 Sampling Technique

All Emergency Medicine residents and general practitioners working at Muhimbili National Hospital Emergency Department during the study period were consecutively enrolled in the study. Every resident and general practitioner was approached and invited to provide their consent for participation.

3.5 Selection criteria

3.5.1 Inclusion criteria

All Emergency medicine residents and general practitioners working at MD-MNH consented to participation during the study period.

3.5.2 Exclusion criteria

- Visiting Residents and General practitioners from other Universities, departments, or hospitals were not approached.

3.6 Variables of interest

The primary aim of this research was to evaluate the accuracy of electrocardiogram (ECG) interpretation among doctors working in the Emergency Medicine Department of a tertiary hospital in Tanzania.

3.7 Outcome variables

- Primary Outcome
  In this study, the accuracy of ECG interpretation among doctors working in the Emergency Medicine Department was assessed as a primary outcome.
- Secondary outcome
  These are factors associated with the outcome of interest, which include;
  - Missed emergency diagnoses among the pre-selected ECGs by emergency medicine doctors in a tertiary hospital, in Tanzania.
  - The level of confidence among emergency medicine doctors in interpreting ECGs with pre-identified emergency diagnoses in a tertiary hospital, in Tanzania.
  - The association between the level of confidence and the accuracy of emergency medicine doctors in interpreting ECGs with pre-identified emergency diagnoses in a tertiary hospital, in Tanzania.
  - The association between the level of training of emergency doctors and error rates in interpreting ECGs with pre-identified emergency diagnoses in a tertiary hospital, in Tanzania

3.8 Variables

Independent variables

- Years of experience in emergency medicine.
- Specific ECG training programs completed.
- Frequency of exposure to ECG interpretation.
- Level of training of emergency doctors.
- Level of confidence among emergency medicine doctors

Dependent variables

- Accuracy of ECG interpretation
- Association between level of confidence and accuracy of ECG interpretation.
- Identification of missed emergency diagnoses.
- Error rates in interpreting ECGs.

3.9 Sample Size

The sample size was based on the total number of individuals (residents and general practitioners) that were eligible to be in the study.

Currently, the Department has 24 general practitioners, 22 first-year residents, 16 second-year residents, and 15 third-year residents.

In total of 77 participants were involved in the study.

3.10 Data Collection

Data collection occurred during each emergency medicine department teaching session, which took place twice a week for residents. For general practitioners, data was collected during their clinical shifts. Participation was optional, and participants were required to sign a consent form before they proceeded to complete the survey.

Participants initiated the procedure by completing a self-administered survey that included demographic information and an assessment of their confidence in interpreting ECGs in the emergency medicine department, utilizing a five-point Likert scale. The survey was directly

supervised by the study coordinator or an appointed representative. To safeguard confidentiality, all completed forms were anonymized before undergoing evaluation.

The primary diagnosis for the ten ECGs was determined in the following manner:

The ten Electrocardiogram (ECG) diagnoses used in this study were obtained from our database in MNH EMD. These ECG diagnoses were selected based on the top ten diagnoses of clinical importance that were likely to impact patient management plans. Then ten ECGs from ECG banks having pathognomonic features of the selected top ten diagnoses were chosen to be used in this study. The selection process spanned one year. The chosen diagnoses and ECGs were thoroughly discussed by a panel of emergency medicine specialists for inclusion in the study.

The list of primary diagnoses for the ten ECGs was as follows:

1. Inferior ST elevation myocardial infarction
2. Atrial flutter
3. Right bundle branch block with left anterior hemiblock (bifascicular block)
4. Pericardial effusion/tamponade
5. Third-degree atrioventricular block
6. Antero-septal ST elevation myocardial infarct
7. Wolf-Parkinson-White syndrome
8. Right heart strain
9. Pericarditis
10. Hyperkalemia

ECG Interpretation:

Following the survey, participants were tasked with analyzing ten de-identified electrocardiograms (ECGs), and in a day participants interpreted three ECGs and recorded their interpretations on a standardized data form. Points were given for accurately identifying the rate, rhythm, QRS axis, primary diagnosis, and any significant additional findings in the ECG. Each ECG was paired with a relevant clinical scenario, featuring concise descriptions of the clinical presentation, gender, and age, as applicable to each ECG. There was no specified time

constraint for the completion of the interpretation of ECGs provided. ECG sample and a data form that had been filled out in advance were supplied to serve as a reference.

Scoring System:
Two senior emergency physicians independently assessed the electrocardiograms (ECGs). These evaluators were trained in the primary ECG diagnosis and provided with definitive answers from the ECG bank for the selected ECGs. The identity of individual participants was kept confidential from the evaluators.

Each ECG was assigned a score out of ten. A total of 6 points was granted for correctly identifying the primary diagnosis, 3 points if it was mentioned as an additional finding, and 0 points if not mentioned at all, 4 points for correctly identifying the rate, rhythm, and QRS axis. The average of the two scores from the two emergency medicine physicians was utilized as the final mark.

In instances where there was a divergence of more than three points in any score between the evaluators, the ECG was referred to a cardiologist for a conclusive opinion, and the cardiologist's final score was taken. Both markers remained unaware of each other's assessments.

3.11 Data analysis

The primary outcome of this study was the overall accuracy of ECG interpretation by physicians working at EMD in recognizing the primary diagnosis.

Participants were categorized into four groups according to their advancement in emergency medicine training. These groups included general practitioners stationed in the Emergency department, as well as emergency medicine residents in their first, second, and third years of training. This classification was compared based solely on the primary diagnoses provided by the participants in each category.

The information was put into the Statistical Package for Social Science (IBM SPSS version 25, IBM, LTD, Carolina, USA) for analysis. Categorical data was assessed through the calculation

of frequencies and percentages, while numerical data had means and standard deviations (or medians and percentiles) computed. Furthermore, a 95% confidence interval was established for the mean scores.

For the comparison of categorical data among diverse groups, the Fisher's exact test or Chi-Square statistic was applied. To assess mean values disparities between groups, the t-test was utilized, while the Kruskal-Walli's test was employed if median values are compared, contingent on the data distribution. Correlation coefficients were employed to examine the connection between confidence ratings and the precision of ECG interpretations. A significant level of 0.05 was maintained throughout the data analysis.

3.12 Ethical considerations

Approval for the ethical aspects of this study was sought from the MUHAS Institutional Review Board (MUHAS IRB). Participation in the study was contingent upon obtaining consent from all participants, and their engagement in the assessment was entirely voluntary.

All data were recorded in a Microsoft Excel® database and securely stored on a password-protected computer. The results of the ECG assessments were shared with the physicians in the emergency medicine department upon the conclusion of the project.

CHAPTER FOUR

4.0 RESULTS

A total of 74 assessments, each containing a bundle of ten ECGs with different diagnoses, were distributed to the participants. All 74 assessments were returned (100%) and fully completed (100%).

Demographic characteristics

Of the 74 participants, majority were emergency residents 49(66.2%) followed by general practitioners 25(33.8%).Among the emergency residents; many were second-year residents 18(24.3%). The median number of years since graduation suggests a relatively early-career cohort. Slightly over half of trainees (55.4%) received ECG training during medical school; additionally, 48 % stated they had learned through internet-based sources, 21.6% in an ECG workshop, and 16% in formal teaching after medical school. About half of trainees (51.4%), rated their self-assessed ECG interpretation competency as good. The number of ECGs read per week varied, with 33.8% reading between 3 to 5 ECGs per week and 35.1% reading between 6 to 10 ECGs per week. Trainees' ECG teaching adequacy in the emergency department rotation, only a few said it was poor; the majority said they relied on self-study, 13% said it was moderate, and 29.7% said it was good but can improved.29.7% believe that the teaching is good and can be improved. (Table 1)

Table 1: Background information

Variable	Frequency (n)	Percent (%)
Emergency medicine training level		
First year residence	17	23.0
Second year residence	18	24.3
Third year residence	14	18.9
General practitioner	25	33.8
Self – assessment of ECG interpretation competency		
Week	9	12.2
Moderate	26	35.1
Good	38	51.4
Very Good	1	1.4
Years since graduation (years)		
< 3	2	2.8
3 – 5	33	45.8
>5	37	51.4
Median years since graduation (IQR)	6 (4, 7)	
Previous specific ECG training		
Medical school	41	55.4
ECG workshop	16	21.6
Formalized teaching	12	16.2
Internet based	36	48.6
Mostly self-study	50	67.6
Approximately number of ECG you read/ week		
< 3 ECGs	5	6.8
3 – 5 ECGs	25	33.8
6 – 10 ECGs	26	35.1
>10 ECGs	18	24.3
Believe ECG teaching is adequate in ED rotation		
Poor teaching	2	2.7
Excellent teaching	40	54.1
Moderate	10	13.5
Good but can improve	22	29.7

Scores of ECG interpretation among doctors working at the Emergency Medicine Department (EMD)

The mean score for ECG interpretation among the doctors included was 59.4 SD 10.8 out of a possible 100. The mean scores and standard deviations for the 1st, 2nd, and 3rd-year emergency medicine residents increased with experience: 54.2% SD 14.3, 66.1% SD 9.9, and 66.4% SD 8.4, respectively. The general practitioners (GPs) achieved a mean score of 50.96% SD 10.7. (Table 2)

Table 2: Scores of ECG interpretation among doctors working at the Emergency Medicine Department (EMD

Training Level	1st year	2nd year	3rd year	GP	Average mean score
Mean	54.18	66.06	66.43	50.96	59.4
Std. Deviation	14.32	9.861	8.355	10.73	10.8

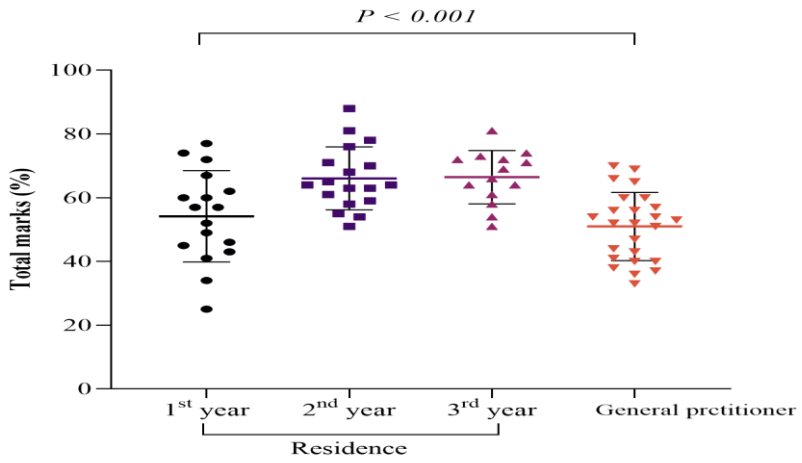


Figure 2: Mean score of ECG interpretation at different levels.

Mean score per ECG

The lowest mean scores were observed for Bifascicular Block (ECG 3) and Acute Pericarditis (2.4 SD 1.8 and 3.7 SD 2.2 respectively), indicating these were the most challenging diagnoses for participants, with moderate variability in their scores.

Participants were most accurate in identifying **Inferior STEMI** and **Anteroseptal STEMI**, as reflected by the highest mean scores (9.122 and 8.514, respectively) and relatively low standard deviations, indicating consistent performance. High standard deviations of 3.46,3.21,3.69 and 3.92 for diagnoses of **Atrial Flutter with Variable Blocks**, Massive pericardial effusion, Right heart strain (Pulmonary Embolism), and **Severe Hyperkalemia respectively** suggest significant differences in participants' interpretation skills for these conditions.

Table 3: Mean score per ECG

ECG Number	ECG Diagnosis	Mean score out of ten per ECG	Std. Deviation
1	Inferior STEMI	9.1	1.9
2	Atrial Flutter with a variable blocks	6.3	3.5
3	Bifascicular block	2.4	1.8
4	Massive pericardial Effusion	6.9	3.2
5	Complete Heartbock	5.9	2.8
6	Anteroseptal STEMI	8.5	2.6
7	Atrial Fibrillation (WPW)	4.3	2.3
8	Right heart strain (Pulmonary embolism)	5.0	3.7
9	Severe Hyperkalemia	6.0	3.9
10	Acute Pericarditis	3.7	2.2

Self-reported confidences on ECG interpretation at emergency medicine department.

Overall confidence on average, 51% of respondents across all groups reported good confidence in ECG interpretation, while 35.3% reported moderate confidence. Among emergency residents, confidence levels improved with the year: no first-year residents reported good confidence, 61.1% of 2nd-year residents reported good confidence while 78.6% of 3rd-year residents in EM reported good confidence. No 2nd or 3rd-year resident reported weak confidence, although 47.1% of first-years reported weak confidence. Very good confidence was only reported by 4% of GPs (and not another specialty, with 64% of GPs reporting good confidence. (Figure 3)

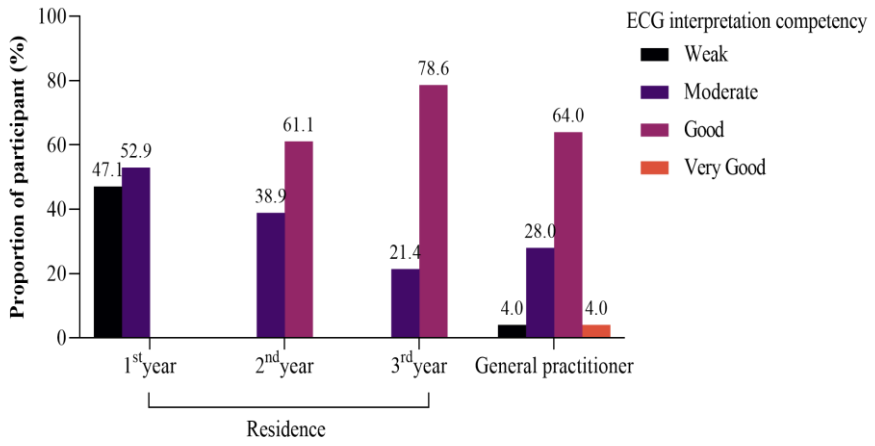


Figure 3: Self-reported confidences on ECG interpretation

Correlation between the ECG score and the self-reported confidence levels of ECG interpretation at EMD.

The correlation between the ECG score and the self-reported confidence levels (weak, moderate, good, and very good) can be seen in the attached figure. The Spearman's rank coefficient (rho) is 0.532, with a p-value of less than 0.001, indicating a moderately strong positive correlation between the two variables. This suggests that as the ECG score increases, self-reported confidence tends to increase as well.

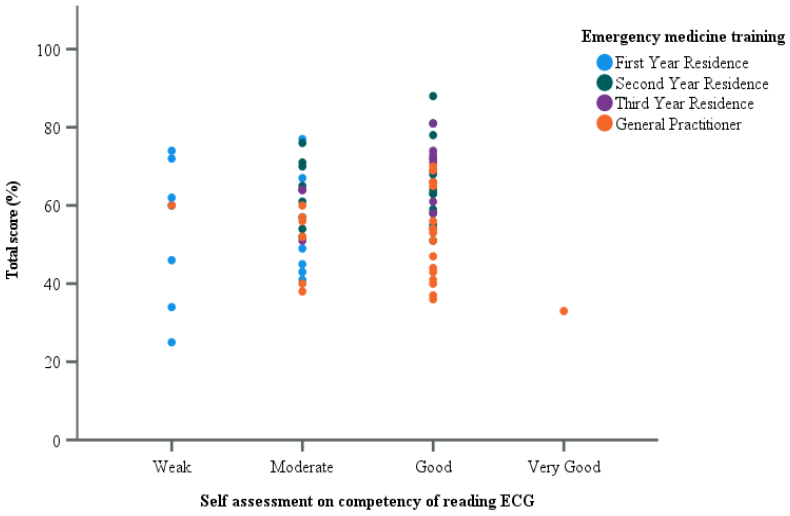


Figure 4:

Spearman’s rank coefficients (rho) = 0.532, $p < 0.001$

Mean ECG scores across Vs level of ED training.

The table shows significant differences in ECG interpretation scores across ED training levels. First-year residents scored significantly lower than second-year (-11.88, 95% CI: -21.75 to -2.01, p=0.012) and third-year residents. Significant score differences were also noted between first and third-year residents, second-year residents and GPs, and third-year residents and GPs. No significant differences were found between first-year residents and GPs, or between second and third-year residents. Overall, ECG interpretation scores increased with training level, with GPs scoring the lowest and third-year residents scoring the highest.

Table 4: Differences in mean scores across levels of EMD training

	Mean Difference	**95% CI of difference**	**p-value**
1st year vs 2nd year residence	-11.88	-21.75 to -2.01	0.012
1st year vs 3rd year residence	-12.25	-22.78 to -1.72	0.016
1st-year residence vs GP	3.216	-5.96 to 12.39	0.793
2nd year vs 3rd year residences	-0.3730	-10.77 to 10.02	0.9997
2nd-year residence vs GP	15.10	6.06 to 24.12	< 0.001
3rd year vs GP	15.47	5.73 to 25.21	< 0.001

CHAPTER FIVE

5.0 DISCUSSION

The study aimed to evaluate the accuracy of ECG interpretation among doctors working in the Emergency Medicine Department at a tertiary hospital in Tanzania.

Various studies have examined how ECGs are evaluated in emergency medicine departments (EMDs) and the accuracy of ECG interpretation in these settings. In this study, the mean score for ECG interpretation among doctors working in the EMD was 59%. When compared to other studies one study revealed that across all training levels, EMD physicians demonstrated a median accuracy of 54% in ECG interpretation. (13) Another study found the overall mean accuracy of ECG interpretation to be 52%, with junior doctors achieving a mean accuracy of 42% and senior doctors achieving 65%.(14)Similarly in a study conducted in Australia, the overall mean accuracy of ECG interpretation by emergency medicine physicians was reported to be 56.6%. Senior trainees achieved an accuracy of 67.5%, while others achieved.49.6 %. (4) The similarities in accuracy rates across different studies may be attributed to the standardized training protocols and similar challenges faced in ECG interpretation across various regions. Common factors such as the complexity of ECG interpretation, the frequency of ECG use in emergency settings, and the critical nature of accurate interpretation may contribute to these consistent accuracy rates. A different result was observed in South Africa, where the average mean score for ECG interpretation among physicians in the EMD was 46.4%. The junior group scored an average of 42.2%, while the senior group scored 52.5 %. (10) The differences in these results may be attributed to various factors, such as the relative maturity of EMDs in these different regions. For instance, at the time of the study in South Africa, the EMD was only six years old, while in Tanzania, the current EMD has been established for more than ten years, indicating advancements in training and experience.

This study provides valuable insights into the relationship between training levels and ECG interpretation proficiency among doctors in the Emergency Medicine Department. The findings highlight significant differences in mean scores across different training levels. In this study the

comparison between 1st year and 2nd year residents shows a mean difference of -11.88 with a 95% CI of -21.75 to -2.01 and a p-value of 0.012, indicating a statistically significant difference in scores. Similarly, significant differences in mean scores were found between year and 3rd year resident 2nd year residents and general practitioners, and 3rd year residents and GPs. In our study, we observed a pattern where experience and training progression led to better ECG interpretation accuracy among emergency medicine residents.

This pattern is consistent with findings from other countries. In the USA, third and fourth-year residents (PGY-3/4s) demonstrated a success rate of 74.6% in ECG interpretation, significantly higher than first-year residents (PGY-1s) at 63.2% and second-year residents (PGY-2s) at 69.0%. (20) Similarly, in Iran, ECG interpretation accuracy improved dramatically from 64.1% in the first year to 96.2% in the second year and 98.6% in the third year. (19) Australia's and South Africa's findings mirrored this trend, with junior doctors showing a mean accuracy of 42%, while senior doctors achieved 65% for Australia and the junior group scored an average of 42.2%, while the senior group scored 52.5% for South Africa. (14,10)These studies highlight a universal trend as residents gain more experience and training, their ability to accurately interpret ECGs improves significantly. This consistency across different regions underscores the importance of progressive training and experience in developing clinical skills.

Also, this study revealed no statistical difference in ECG interpretation scores between general practitioners and first-year residents. This finding may be attributed to the fact that first-year residents typically spend their initial semester focused on basic sciences, with limited participation in clinical practice at EMD. In contrast, research from the USA showed that advanced practice providers (APPs), akin to general practitioners in our settings, performed exceptionally well in ECG interpretation where they demonstrated sensitivity and specificity levels comparable to physicians in their first year out of residency. (21) This notable performance similarity could be explained by the extensive experience many APPs have accumulated over more than ten years in EMD while in this study majority of the general practitioners were relatively early-career cohort.

Diagnosing various ECG abnormalities poses distinct challenges for emergency medicine department (EMD) doctors, influenced by factors such as the prevalence of conditions in different settings, the level of training, and individual experience in interpreting ECGs. This study identified bifascicular block and acute pericarditis as particularly challenging diagnoses. Additionally, high standard deviations of 3.46, 3.21, 3.69, and 3.92 for diagnoses of Atrial Flutter with Variable Blocks, Massive Pericardial Effusion, Right Heart Strain (Pulmonary Embolism), and Severe Hyperkalemia, respectively, suggest significant differences in participants' interpretation skills for these conditions. Similarly in one of the studies repolarization abnormalities, ventricular hypertrophy, and hemiblock were frequently noted as problematic aligning with our finding that Bifascicular Block and Acute Pericarditis were difficult for participants in our study repolarization abnormalities and ventricular hypertrophy were not studied (17), also in another study assessing the agreement between the interpretations of abnormal ECGs by emergency physicians and cardiologists, they disclosed that atrial fibrillation was the most overlooked dysrhythmia in the Emergency Department (ED). (18)

Conversely, participants were most accurate in identifying Inferior STEMI and Anteroseptal STEMI, as reflected by the highest mean scores (9.122 and 8.514, respectively) and relatively low standard deviations, indicating consistent performance. Different from this study a study done in the USA reported that conditions such as ST-segment elevation myocardial infarction (STEMI) and ventricular tachycardia are commonly misdiagnosed 8% misdiagnosis rate for STEMI and an 11% rate for ventricular tachycardia with, reflecting the variability and challenges noted in our study for certain high-stakes diagnoses suggesting regional differences in training and clinical exposure. (15) Some ECGs' diagnosis was not highlighted in our study, which may reflect differences in the focus of training programs and the prevalent clinical conditions in different regions. Focused instruction in emergency electrocardiography could improve EMD doctor’s recognition of some life-threatening ECG patterns.

Several studies have shown that higher levels of confidence among physicians in clinical practice lead to better performance in interpreting investigations and performing procedures. Confidence enhances decision-making skills, reduces hesitation, and improves the accuracy of

diagnostic interpretations. In this study on average over half of respondents across all groups reported good confidence, while many (35.3%) reported moderate confidence in ECG interpretation. Similar findings were reported by a study done in Mayo Clinic USA where 45% of health professionals expressed discomfort with the independent interpretation of ECGs. (23)

In this study, it was found that confidence levels in ECG interpretation improve significantly from general practitioners to 3rd-year residents, with a marked increase in the proportion of individuals reporting good confidence. Similarly, a USA study showed no initial association between confidence and competence, but post-training, 88% reported increased confidence correlated with competence. Additionally, younger medical students initially had lower confidence, which increased post-training, matching competence levels. (27) This suggests training and experience boost confidence and competence, a trend mirrored in our findings.

This study found a moderately strong positive correlation ($rho = 0.532$, $p < 0.001$) between ECG scores and self-reported confidence levels in ECG interpretation at EMD, indicating higher scores align with increased confidence. Similar results were observed in the USA, where competence in ECG interpretation positively correlated with self-rated proficiency ($r = 0.386$) and certainty ($r = 0.428$). (15) Another study reported that 53.9% of participants who rated their ECG interpretation ability as moderate showed a significant relationship between competency and self-assessment. (25) This suggests that self-reported confidence is a reliable indicator of proficiency, as seen in multiple studies across different settings. The consistency in findings highlights the importance of confidence in clinical practice, linking it to improved diagnostic accuracy.

CHAPTER SIX

6.0 LIMITATIONS, CONCLUSION AND RECOMMENDATIONS

6.1 Limitations

Study participants, knowing the test wouldn't affect grades, may have relaxed, potentially reducing effort and unintentionally impacting their performance.

This study was a questionnaire-based design, which is not an optimal simulation of real doctor-patient encounters. Resident physicians lacked expanded clinical histories, detailed physical examinations, and access to past ECGs, which are important diagnostic aids.

The study's ECG traces focused on major abnormalities, which are more apparent, but real-life cases can be more complex.

These ECGs reflect common conditions, but it is possible that residents' results could vary with different ECGs.

Additionally, due to the relatively small size of the class, there were a limited number of Students enrolled.

6.2 Conclusion

This study found that the overall accuracy of ECG interpretation in the emergency medicine department was generally low, with a mean score of 59%. However, accuracy improved with higher levels of training. General practitioners and first-year residents had lower scores, while second and third-year residents performed better. Although third-year residents outperformed second-year residents, the difference was not statistically significant, this trend reflects international trends where training enhances accuracy. This improvement can be attributed to academic training, classroom sessions, and practical experience in an academic emergency medicine environment.

The study also revealed that self-reported confidence among participants was moderately good and increased with training. There was a notable correlation between confidence levels and accuracy of ECG interpretation, underscoring the importance of training in building both competence and confidence. Recognizing the organizational and environmental differences is crucial for tailoring educational strategies for emergency medicine department doctors.

Our findings emphasize the need to address deficiencies among general practitioners and first-year residents, guiding future educational initiatives. Enhanced training in emergency electrocardiography is vital for improving diagnostic accuracy and patient outcomes in emergency medicine settings.

6.3 Recommendations

1. Development of ECG clubs which would allow interaction between cadres and improve the interpretation
2. Emergency medicine doctors should keep on relying on their skills of interpretation and develop a guide on ECG learning caters to emergency department.
3. A study should be conducted other departments so as find out the depth of the problem and address it accordingly.
4. Based on the study findings more emphasis should be kept in the general practitioners training on ECG interpretation.
5. Developing a formal curriculum in the Emergency Medicine Department (EMD) can enhance resident physicians' ability to recognize ECG evidence of life-threatening cardiac events.

REFERENCES

1. Martínez-Sellés M, Marina-Breysse M. Current and Future Use of Artificial Intelligence in Electrocardiography. Vol. 10, Journal of Cardiovascular Development and Disease. MDPI; 2023.

2. Knoebel SB, Fisch C. ACC ANNIVERSARY SEMINAR Evolution of the Clinical Electrocardiogram. Vol. 14, JACC.

3. Wood G, Batt J, Appelboam A, Harris A, Wilson MR. Exploring the Impact of Expertise, Clinical History, and Visual Search on Electrocardiogram Interpretation. http://dx.doi.org/101177/0272989X13492016 [Internet]. 2013 Jun 27 [cited 2023 Dec 25];34(1):75–83. Available from: https://journals.sagepub.com/doi/10.1177/0272989X13492016

4. Hoyle RJ, Walker KJ, Thomson G, Bailey M. Accuracy of electrocardiogram interpretation improves with emergency medicine training. EMA - Emergency Medicine Australasia. 2007 Apr;19(2):143–50.

5. Orvad H, Savage L, Smith T, Hamiduzzaman M, Schmidt D. Not all stemi patients receive timely reperfusion: Considerations for rural emergency departments. J Multidiscip Healthc. 2021;14:3103–8.

6. Degheim G, Berry A, Zughaib M. False activation of the cardiac catheterization laboratory: The price to pay for shorter treatment delay. JRSM Cardiovasc Dis. 2019 Jan;8:204800401983636.

7. Trzeciak S, Erickson T, Bunney EB, Sloan EP. Variation in patient management based on ECG interpretation by emergency medicine and internal medicine residents. American Journal of Emergency Medicine. 2002;20(3):188–95.

8. Ferguson B, Geralds J, Petrey J, Huecker M. Malpractice in Emergency Medicine—A Review of Risk and Mitigation Practices for the Emergency Medicine Provider. Journal of Emergency Medicine. 2018 Nov 1;55(5):659–65.

9. Barthelemy FX, Segard J, Fradin P, Hourdin N, Batard E, Pottier P, et al. ECG interpretation in Emergency Department residents: An update and e-learning as a resource to improve skills. European Journal of Emergency Medicine. 2017;24(2):149–56.

10. De Jager J, Wallis L, Maritz D. ECG interpretation skills of South African Emergency Medicine residents. Int J Emerg Med. 2010 Dec;3(4):309–14.

11. Bilello LA, Pascheles C, Gurley K, Rappaport D, Chiu DT, Grossman SA, et al. Getting to the heart of the issue: Senior emergency resident electrocardiogram interpretation and its impact on quality assurance events. Clin Exp Emerg Med. 2020 Sep 1;7(3):220–4.

12. Antiperovitch P, Zareba W, Steinberg JS, Bacharova L, Tereshchenko LG, Farre J, et al. Proposed In-Training Electrocardiogram Interpretation Competencies for Undergraduate and Postgraduate Trainees. J Hosp Med [Internet]. 2018 Mar [cited 2023 Dec 25];13(3):185–93. Available from: https://pubmed.ncbi.nlm.nih.gov/29154379/

13. Cook DA, Oh SY, Pusic M V. Accuracy of Physicians' Electrocardiogram Interpretations: A Systematic Review and Meta-analysis. Vol. 180, JAMA Internal Medicine. American Medical Association; 2020. p. 1461–71.

14. Cruz MF, Edwards J, Dinh MM, Barnes EH. The effect of clinical history on the accuracy of electrocardiograph interpretation among doctors working in emergency departments. Medical Journal of Australia. 2012 Aug;197(3):161–5.

15. Berger JS, Eisen L, Nozad V, D'Angelo J, Calderon Y, Brown DL, et al. Competency in electrocardiogram interpretation among internal medicine and emergency medicine residents. American Journal of Medicine. 2005 Aug;118(8):873–80.

16. Barthelemy FX, Segard J, Fradin P, Hourdin N, Batard E, Pottier P, et al. ECG interpretation in Emergency Department residents: An update and e-learning as a resource to improve skills. European Journal of Emergency Medicine. 2017;24(2):149–56.

17. Snoey ER, Housset B, Guyon P, Elhaddad S, Valty2 J, Hericord1 P. Analysis of emergency department interpretation of electrocardiograms. 1994.

18. Westdorp EJ, Gratton MC, Watson WA. Emergency department interpretation of electrocardiograms. Ann Emerg Med. 1992 May 1;21(5):541–4.

19. Nejati A, Talebian MT, Zamani MM, Toliat A, Ghasemzadeh R, Saeedi M, et al. Evaluation of Emergency Medicine Residents Competencies in Electrocardiogram Interpretation. Vol. 52, Acta Medica Iranica. 2014.

20. Hartman ND, Wheaton NB, Williamson K, Quattromani EN, Branzetti JB, Aldeen AZ. A Novel Tool for Assessment of Emergency Medicine Resident Skill in Determining Diagnosis and Management for Emergent Electrocardiograms: A Multicenter Study. In: Journal of Emergency Medicine. Elsevier USA; 2016. p. 697–704.

21. Hoang A, Singh A, Singh A. Comparing physicians and experienced advanced practice practitioners on the interpretation of electrocardiograms in the emergency department. American Journal of Emergency Medicine. 2021 Feb 1;40:145–7.

22. Rakab A, Swed S, Alibrahim H, Bohsas H, Abouainain Y, Abbas KS, et al. Assessment of the competence in electrocardiographic interpretation among Arabic resident doctors at the emergency medicine and internal medicine departments: A multi-center online cross-sectional study. Front Med (Lausanne). 2023;10.

23. Kashou AH, Noseworthy PA, Beckman TJ, Anavekar NS, Angstman KB, Cullen MW, et al. Exploring Factors Influencing ECG Interpretation Proficiency of Medical Professionals. Curr Probl Cardiol. 2023 Oct 1;48(10):101865.

24. Owens KM, Keller S. Exploring workforce confidence and patient experiences: A quantitative analysis. Patient Exp J. 2018 Apr 25;5(1):97–105.

25. Amini K, Mirzaei A, Hosseini M, Zandian H, Azizpour I, Haghi Y. Assessment of electrocardiogram interpretation competency among healthcare professionals and students of Ardabil University of Medical Sciences: a multidisciplinary study. BMC Med Educ. 2022 Dec 1;22(1).

26. Carney PA, Bogart TA, Geller BM, Haneuse S, Kerlikowske K, Buist DSM, et al. Association between time spent interpreting, level of confidence, and accuracy of screening mammography. American Journal of Roentgenology. 2012 Apr;198(4):970–8.

27. Clanton J, Gardner A, Cheung M, Mellert L, Evancho-Chapman M, George RL. The relationship between confidence and competence in the development of surgical skills. J Surg Educ. 2014;71(3):405–12.

28. Barnsley L, Lyon PM, Ralston SJ, Hibbert EJ, Cunningham I, Gordon FC, et al. Clinical skills in junior medical officers: A comparison of self-reported confidence and observed competence. Med Educ. 2004 Apr;38(4):358–67.

29. Roth GA, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet [Internet]. 2018 Nov;392(10159):1736–88. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673618322037

30. Yuyun MF, Sliwa K, Kengne AP, Mocumbi AO, Bukhman G. Cardiovascular diseases in sub-Saharan Africa compared to high-income countries: An epidemiological perspective. Glob Heart. 2020 Feb 12;15(1).

31. Wathen JE, Rewers AB, Yetman AT, Schaffer MS. Accuracy of ECG interpretation in the pediatric emergency department. Ann Emerg Med. 2005 Dec;46(6):507–11.

APPENDICES

Appendix I: Informed Consent Form (English Version)

STUDY TITLE:

ACCURACY OF ECG INTERPRETATION AMONG DOCTORS WORKING AT THE EMERGENCY MEDICINE DEPARTMENT IN TERTIARY HOSPITAL TANZANIA

Introduction

Greetings, I am Dr. Emmanuel W. Mmbando, a third-year resident pursuing a master's degree in emergency medicine at MUHAS. I am currently undertaking a research study with the aforementioned title, and I kindly seek your participation and support. Your decision to participate or decline will not have any impact on your academic progress at any stage of your training. Please feel free to ask any questions at any point if you require further clarification during this study.

Aim of the study

To determine the accuracy of ECG interpretation among doctors working at the Emergency Medicine Department in a tertiary hospital, in Tanzania.

Benefits

Enhanced Patient Care:

Improved accuracy in ECG interpretation can lead to better patient care.

Correct diagnoses based on accurate ECG readings enable timely and appropriate medical interventions.

Reduced Medical Errors:

Identifying and addressing potential gaps in ECG interpretation may lead to a decrease in misdiagnoses and associated errors.

Targeted Training Programs:

The study results can guide the development of targeted training programs for emergency medicine doctors.

Optimized Resource Allocation:

This includes directing training efforts, investing in specific ECG education programs, and optimizing staffing based on identified strengths and weaknesses.

Quality Improvement in Emergency Medicine Services:

Ensuring accurate and timely diagnoses enhances the quality of care provided to patients in the Emergency Medicine Department.

Risk

There is no risk for your participation in this study.

Costs or fees for participation in this study

There will be no costs or fees required to be paid for your participation in this study.

Who can participate in this study?

This study will involve all doctors working in the Emergency Medicine Department in a tertiary hospital, in Tanzania who meet inclusion criteria, during the study period.

Consent

By signing the consent form, you agree to participate in this study. If you don't sign a consent form or you're not willing to participate in this study, it will not affect your academics. Feel free to quit your participation at any time whenever you think to do so.

Confidentiality

All information provided or documented will be held in strict confidentiality. Data stored electronically will be secured by a robust password, and any physical records will be stored in a securely locked cabinet accessible only to authorized personnel. By signing below, you confirm that you have thoroughly reviewed the aforementioned details, comprehend them fully, and willingly consent to participate in this study.

I, ……, have perused or been briefed on the contents of this document, comprehended them thoroughly, and hereby give my consent to partake in this study.

Signature of participant **Date**

……

……

Signature of investigator **Date**

……

……..

Thank you for your participation in this study. Please do not hesitate to contact me in case of any clarification.

1. Principal Investigator,
Dr. Emmanuel W Mmbando
Department of Emergency Medicine,
MUHAS,
P. O. Box 65001,
Dar es Salaam, Tanzania.
Tel: +255757414483 Email: emmammbando900@gmail.com

2. Dr Bruno Sunguya
Director of Research and Publications,
Research and Publication Committee,
Muhimbili University of Health and Allied Sciences,
P.O. Box 65001, Dar es Salaam.
Telephone Number: 2150302-6

Appendix II: Questionnaire

Survey

Kindly respond to the following inquiries by either marking the appropriate box or providing the information in the designated space.

1. Year of doctorate graduation: _____

2. Duration of service at the Emergency Medicine department: _____

3. Emergency Medicine training level (please check):
    i. First-Year Resident
    ii. Second-Year Resident
    iii. Third-Year Resident
    iv. General Practitioner
4. Approximately the number of ECGs you read in a week
    i. <3ECGs
    ii. 3-5 ECGs
    iii. 6-10 ECGs
    iv. >10 ECGs
5. Self-assessment of ECG interpretation competency:
    i. Weak
    ii. Moderate
    iii. Good
    iv. Very Good
6. Previous specific ECG training: (Select multiple options if applicable)
    i. Medical school
    ii. ECG workshops
    iii. Formalized teaching
    iv. Internet-based
    v. Self-study

7. Do you believe ECG teaching is adequate in your Emergency Medicine Rotation training?
    i. Poor - No teaching
    ii. Mostly self-study
    iii. Moderate
    iv. Good but can improve.
    v. Excellent teaching

Please elaborate on your answer: _____

8. In your opinion, how can the quality of ECG teaching be improved?

    _____

ECG Interpretation Response Form

Kindly respond to each of the 10 questions on individual pages. Ensure that each answer sheet corresponds to the number indicated in the top right corner of each ECG. The format for each response will be consistent.

Question 1

Rate: _____ /min (1)

Question 2; Rhythm: _____

Question 3; QRS Axis

i. Left Axis
ii. Right Axis
iii. Normal Axis

Question 4; Comment on P wave and T wave

_____

Question 5; Comment on segment and intervals

_____

Question 4; Primary diagnosis

_____

Question 5; Any Additional findings on this ECG:

_____

Appendix III: Approval for ethical clearance

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – RESEARCH, PUBLICATIONS AND INNOVATIONS

Ref. No.DA.282/298/01.C/2180 Date: 22/04/2024

MUHAS-REC-04-2024-2180
EMMANUEL WILSON MMBANDO
COLLEGE OF MEDICINE
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: ACCURACY OF ECG INTERPRETATION AMONG DOCTORS WORKING AT EMERGENCY MEDICINE DEPARTIMENT OF TERTIARY HOSPITAL TANZANIA

Reference is made to the above heading,

I am pleased to inform you that the Chairperson has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 22/04/2024
EXPIRATION DATE OF APPROVAL: 22/04/2025

STUDY DESCRIPTION:
Purpose:
The purpose of observational crossectional study is to determine ECGs interpretation accuracy among doctors working at Emergency Medicine Department (EMD) in a tertiary hospital, Tanzania.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2015488.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain Data Transfer Agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain Material Transfer Agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country.
8. Apply for and obtain permission to publish the results from National Institute for Medical Research. The application should be before submitting to a publisher and not concurrently through the email publications@nimr.or.tz.
9. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
10. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
11. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr. Nahya Salim Masoud,
Chairperson, MUHAS Research and Ethics Committee

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research,
Publications &
Innovations
Box 65001

Appendix IV: Introduction Letter

UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES

In reply quote;
Ref. No. HD/MUH/T.37/2021

03rd May, 2024

The Executive Director,
Muhimbili National Hospital-Mloganzila,
P.O. Box 65000,
DAR ES SALAAM

RE: INTRODUCTION LETTER OF EMMANUEL WILSON MMBANDO

We would like to inform you that the carrier of this letter is Emmanuel Wilson Mmbando with registration number HD/MUH/T.37/2021 a student at Muhimbili University of Health and Allied Science (MUHAS), pursuing Mmed Emergency Medicine.

As part of her studies, he will be doing an elective research titled **"Accuracy Of ECG Interpretation Among Doctors Working At Emergency Medicine Departiment Of Tertiary Hospital Tanzania.** he is being supervised by Dr. Said Kilindimo from MUHAS and Dr. Winnie Mdundo from Mloganzila.

The Ethical Clearance for doing the said research has been given by the University.

Kindly request your assistance and cooperation to our student.

Yours Sincerely,

Mr. Sebe Mohamed
For: DIRECTOR, POSTGRADUATE STUDIES
cc: Emmanuel Wilson Mmbando

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:https://www.muhas.ac.tz

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES

In reply quote;
Ref. No. HD/MUH/T.37/2021

03rd May, 2024

The Executive Director,
Muhimbili National Hospital,
P.O. Box 65000,
DAR ES SALAAM

RE: INTRODUCTION LETTER OF EMMANUEL WILSON MMBANDO

We would like to inform you that the carrier of this letter is Emmanuel Wilson Mmbando with registration number HD/MUH/T.37/2021 a student at Muhimbili University of Health and Allied Science (MUHAS), pursuing Mmed Emergency Medicine.

As part of her studies, he will be doing an elective research titled **"Accuracy Of ECG Interpretation Among Doctors Working At Emergency Medicine Departiment Of Tertiary Hospital Tanzania.** he is being supervised by Dr. Said Kilindimo from MUHAS and Dr. Alfonce Simbila from MNH.

The Ethical Clearance for doing the said research has been given by the University.

Kindly request your assistance and cooperation to our student.

Yours Sincerely,

Mr. Sebe Mohamed
For: DIRECTOR, POSTGRADUATE STUDIES

cc: Emmanuel Wilson Mmbando

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:https://www.muhas.ac.tz