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Original Article

Factors Influencing Electrocardiogram Interpretation among Nurses at Public Tertiary Hospitals in Dar es Salaam, Tanzania

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Keywords:

Electrocardiography, Nursing, Knowledge, Practice, Arrhythmia.

ABSTRACT

Background: Cardiovascular disease is a leading cause of death worldwide, accounting for nearly one-third of global deaths. Electrocardiography is a common procedure used in the diagnosis of cardiac disorders. Knowledge of electrocardiogram interpretation is important to nurses as they can play an important role in preventing complications that may occur in patients who have cardiac problems. Little is known about nurses' knowledge of ECG interpretation. **Broad objective:** To assess factors influencing ECG interpretation among nurses at public tertiary hospitals in Dar es Salaam, Tanzania. **Methodology:** A cross-sectional study was done where 371 nurses were recruited using simple random sampling. Data were collected using self-administered questionnaires and entered into SPSS version 23 and analysed by using both descriptive and inferential statistics. Analysed data presented in tables and pie charts. **Results:** Most of the registered nurses (73.9%) were females. The most prevalent age range was between 30 and 34years (74.1%) with low knowledge, while 21.4% nurses with an age ranging from 25-29 years had good knowledge. Nearly half of nurses who attended ECG training were observed to have low knowledge (49.5%). However, only 34.2% of nurses who had no ECG training had moderate knowledge on ECG interpretation. Age was found to be positively associated with ECG interpretation among nurses, where nurses aged between 25-29 years old had moderate knowledge on ECG interpretation (*p-value= 0.002*). **Conclusion:** ECG interpretation among nurses can be determined by various factors like ECG training, working experience, working unit, level of knowledge, workload and availability of hospital resources. Training on ECG interpretation is needed among nurses who are working in critical areas to improve their knowledge and practice of ECG. **Recommendations:** The hospital should provide nurses with regular and standardized on job ECG training. The hospital should provide an environment where nurses have access to learning materials and other resources for self-learning. Nurses should be motivated to learn basic ECG as part of their nursing practice.

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Similar studies may be considered for the improvement of knowledge and practice on ECG interpretation.

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INTRODUCTION

Worldwide, non-communicable diseases (NCDs) are the leading cause of death, accounting for 73.4% of all deaths, led by cardiovascular diseases (CVDs), with ischemic heart disease (IHD) being the most frequent cause of cardiovascular death(Yuyun *et al.*, 2020). Cardiovascular diseases (CVDs) are the third leading cause of death worldwide. In 2017, CVDs caused an estimated 17.8 million deaths worldwide, corresponding to 330 million years of life lost and another 35.6 million years lived with disability. Cardiovascular diseases alone are responsible for 13% of the total NCD deaths in Tanzania, and adults aged 25–64 years are highly affected (Roman, Martin and Sauli, 2019).

An Electrocardiogram (ECG) is an advanced recording method of the bioelectric signal originating in the heart that provides valuable information about the activity of the human heart and is used to measure the rate, rhythm, and regularity of the heartbeat, and analyse the position, thickness, and size of the heart chambers. By examining changes from a normal ECG, health care providers can identify a multitude of cardiac disease processes (Chege, 2018).ECG shows a series of waves that relate to the electrical impulses that occur during each beat of the heart. It's an important tool used for the initial evaluation of patients presenting with cardiac problems. It is considered the first diagnostic tool in chest pain, and it also provides objective information about the structure and function of the heart (Mayapur, 2018).

A correct interpretation of ECG, particularly in life-threatening scenarios, influences the decisions for appropriate actions to be taken in patient care. Doctors and nurses need to acquire the skills of 12-lead ECG placement and interpretation (Kerbage, 2017). Nurses play an important role in preventing complications that may occur in patients who have cardiovascular conditions, and therefore, having knowledge of ECG interpretation is important to identify heart problems and take appropriate action. Nurses should acquire ECG knowledge during on-the-job training and formal nursing training(Aurélio and Saffi, 2018). However, there are limited studies done in Tanzania related to nurses' knowledge towards ECG interpretation. Therefore, this study aims to find out factors influencing ECG

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interpretation among nurses working at Jakaya Kikwete Cardiac Institute, Muhimbili Orthopedic Institute and Muhimbili National Hospital.

MATERIALS AND METHODS

Study Design, Settings and Population

Descriptive cross section study design using a quantitative approach was used to assess factors influencing ECG interpretation among nurses when looking at data from a population at one specific point in time(Rahimpour *et al.*, 2021). This was carried out in three tertiary hospitals, JKCI, MNH and MOI. Both of these hospitals are located at municipality of Dar es Salaam. These are among the tertiary and teaching hospitals in Tanzania. The study involved all registered nurses with more than twelve months of employment working in the Emergency department, Intensive care units, coronary care unit, Coronary Catheterization department, Outpatient department, and wards to a respective institutes, JKCI, MNH and MOI.

Tertiary Hospitals	**Total number of nurses**	**Proportion**	**Required sample size**
Jakaya Kikwete Institute	130	130*0.649	84.3
Muhimbili National Hospital	360(EMD,ICUs)	130*0.649	233.6
Muhimbili Orthopedic Institute	100(EMD,ICU)	100*0.649	64.9
TOTAL	585		382.6

Sample Size

The sample size was calculated by using the formula of Cochran's formula for sample size (1963).

$$N=\frac{Z^2P(100-P)}{E^2}$$

n= required sample size

E=Marginal of error set at 5%

Z= Standard normal deviation corresponding to 95% confidence interval (1.96)

P= Proportion of nurses with moderate knowledge on ECG interpretation, 52% (Werner, Kander and Axelsson, 2016)

Therefore,

$$n=\frac{(1.96)^2.52(100-52)}{5^2}$$

n=383

The required sample size was 383 from three tertiary hospitals, but the study recruited 371 nurses.

Sampling Procedure

In this study, data was collected from respondents in the tertiary hospitals at JKCI, MNH and MOI by using simple random sampling. The technique targeted the study population by using clusters sampling technique because it provided an equal chance of recruiting eligible respondents into the study during data collection (Seiya, 2020). The proportion of the study respondents to be selected for the study depends on the number of nurses in each hospital, based on the information obtained from the director of nursing services. The proportion of the study respondents included in the study is illustrated in the table below

From the incident rate, sample size/Total population

383/585=0.649

Therefore, the sample size for each area was 84 from JKCI, 64 from MOI and 233 from MNH.

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Sampling Method

The study employed a simple random sampling technique as a non-probability sampling method whereby the study participants was obtained randomly by using a lottery method, and everyone had an equal chance of being selected(Zangirolami-Raimundo, Echeimberg and Leone, 2018). A researcher generated a sampling frame once by using the list of all nurses working in ICUs, CCU, EMD from JKCI, MNH and MOI and general wards for JKCI, which was given by leaders and selected participants randomly by using the odd or even numbers. The process was repeated with other prospective participants until the required sample size was reached. The sample size differs because the general wards for JKCI were included because it is the only National Cardiovascular Institute in the country, and apart from the ICUs and CCU, these wards are also equipped with cardiac monitors in every room for patient monitoring, and all nurses are supposed to have knowledge of ECG interpretation. Second, the total number of nurses in the specific units differs from every Institute which sample size were taken.

RESULTS

Socio-demographic Characteristics of the Participants

Participants' response rate in this study was 371(97%). About 165(44.5%) of participants were aged between 30-34 years. The majority of 274 (73.9%) participants were females, and nearly one-third of participants, 118 (31.5%), had working experience between 6 and 10 years. More than half, 220 (59.3%) of participants had previous ECG training, with 217(58.5%) had on job training on ECG. (Table 1).

Table 1: Socio-demographic Characteristics of Study Participants

Variable		Frequency (n=371)	Percentage (%
Age	20-24 years	2	0.5
	25-29 years	112	30.2
	30-34 years	165	44.5
	35-39 years	92	24.8
Sex	Male	96	25.9
	Female	274	73.9
Education level	Certificate	22	5.9
	Diploma	195	52.6
	Bachelor	118	31.8
	Master	36	9.7
Working experience	1-5years	110	29.6
	6-10 years	117	31.5
	11-15 years	113	30.5
	Above 15 years	31	8.4
Working area	ICU	137	36.9
	CCU	10	2.7
	General wards	147	39.6
	EMD	68	18.3
	Cathlab &ECG lab	9	2.4
Attended ECG training	Yes	220	59.3
	No	151	40.7
Years since last ECG course	<2years	50	13.4
	2-5years	120	32.6

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Variable		Frequency (n=371)	Percentage (%
	>5years	50	13.4
	No course	151	40.7
ECG resources	On job training	180	48.5
	Other resources	40	51.5

Knowledge of Nurses on ECG Interpretation

In determining the level of nurses' knowledge regarding ECG interpretation, the participants were asked to answer questions, which consisted of 15 true/false questions regarding the nurses' knowledge of ECG. The lowest score of correct answer was on atrial fibrillation, 80(21.5%), and the highest score was on ST elevation in lateral myocardial infarction appear in leads I, AVR, V5201 (54.1%). (Table 2).

Table 2: Knowledge of Nurses on ECG Interpretation

statement on ECG(n=371)	true/false	Correct answer		Incorrect answer	
		n	%	n	%
The P wave represents right and left atrial repolarisation	F	100	26.9	271	73
The QRS complex represents right and left ventricular depolarisation	T	97	26.1	274	73.8
The T wave represents ventricular repolarisation	T	182	49	189	50.9
The T wave is one of the negative waves in the ECG	F	109	29.3	270	72.7
Normal PR interval between 0.12and 0.20 sec	T	197	53	180	48.5
In a normal ECG, V1 and AVR leads are negative waves	T	101	27	270	72.7
Pathologic Q waves are a sign of previous myocardial infarction	T	105	28.3	266	71.6
Atrial fibrillation could be regular rhythm	F	80	21.5	291	78.4
ST elevation in inferior myocardial infarction appears in leads V1-V6	F	170	45.8	201	54.1
ECG can detect hypertrophy(LVH)	T	177	47.7	194	52.2
ST elevation in lateral myocardial infarction appears in leads I,aVRV5, V6	T	201	54.1	170	45.8
ST depression in the ECG indicates ischemia myocardial	T	111	29.9	260	70
ST elevation in anterior myocardial infarction appears in leads II, III, and aVF	F	190	51.2	181	48.7
RSR pattern appears in V1-V2 and V3 in right bundle branch block rhythms	T	90	24.2	281	75.7
The T long wave and the QRS wide wave are seen	F	110	29.6	261	70.3

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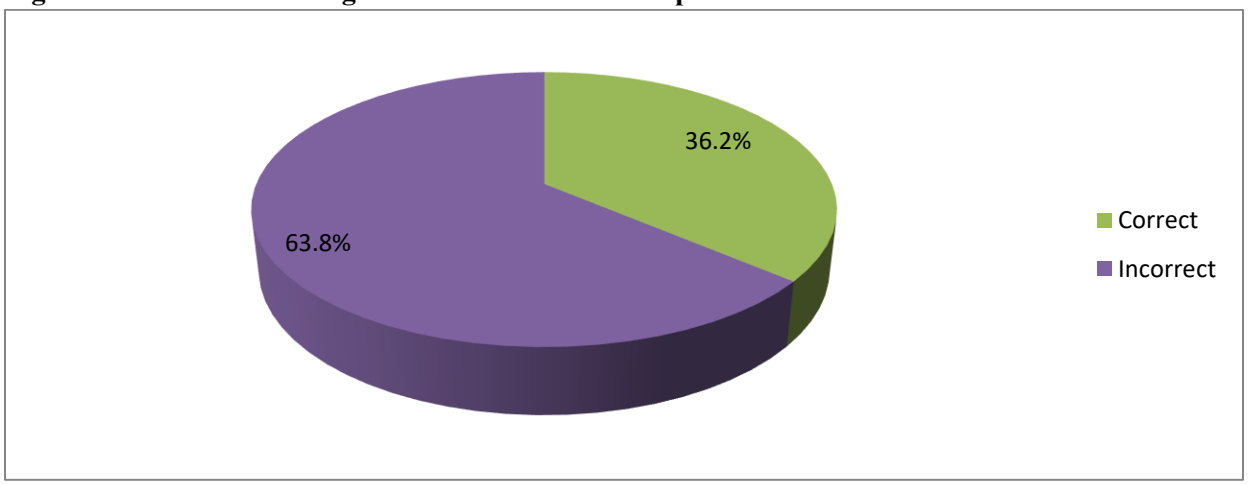
Figure 1: Overall Knowledge of Nurses on ECG Interpretation

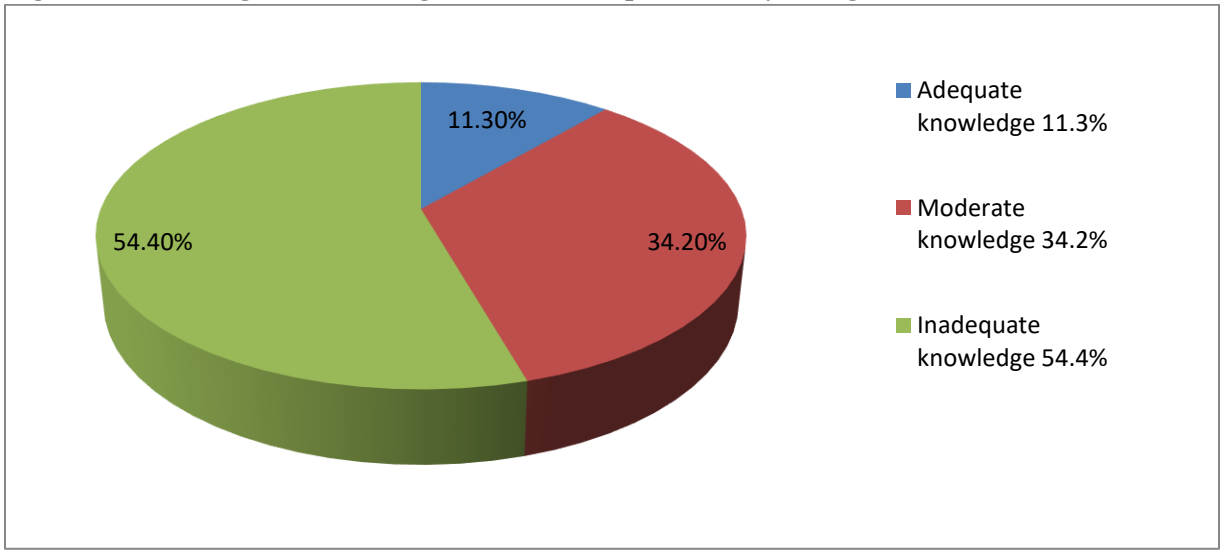


Level of knowledge was also categorised into three scores, adequate knowledge (13-15scores), Moderate knowledge (9-12score) and inadequate knowledge (below8) and finally the scores were analysed to get percentages on each category(Yaser, Tahboub and Yılmaz, no date)(Darikynti, 2019). Nearly half of the participants, 202 (54.4%), had low knowledge on ECG interpretation, whereas only 42(11.3%) of nurses had good knowledge (Table 3).

Table 3: Knowledge of Nurses on ECG Interpretation

Level of knowledge	Frequency (n=371)	Percentage (%)
Adequate knowledge	42	11.3
Moderate knowledge	127	34.2
Inadequate knowledge	202	54.4
Total	**371**	**100.0**

Figure 2: Percentage of Knowledge on ECG Interpretation by Categorisation Score



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Association between Socio-Demographic Characteristics and Knowledge on ECG Interpretation

The analysis showed that different socio-demographic factors had a significant association with ECG interpretation among nurses, such factors include age (p-value= 0.002), working experience (p-value= 0.000), education level (p-value 0.000), as well as training on ECG (p-value=0.001). (Table 4).

Table 4: Association between Socio-Demographic Characteristics and Knowledge on ECG Interpretation

Variable		Level of knowledge			
		Adequate	**Moderate**	**Inadequate**	**P-value**
		(13-15 scores)	**(9-12 scores)**	**(below8 scores)**	
Sex	Male	10(10.4)	29(30.2)	57(59.3)	
	Female	32(11.7)	98(35.7)	144(52.5)	0.510
Age	20-24 years	0(0)	1(50)	2(0.6)	
	25-29 years	24(21.4)	32(28.6)	112(30.2)	
	30-34 years	10(3.9)	56(21.9)	189(74.1)	
	35-39 years	8(7.0)	38(33.3)	68(59.6)	**0.002**
Working experience	1-5 years	17(15.4)	27(22.7)	66(60)	
	6-10 years	15(12.8)	58(49.5)	44(37.6)	
	11-15 years	10(8.8)	29(25.7)	74(67.2)	
	>15 years	0(0)	13(41.9)	18(16.3)	**<0.001**
Working unit	ICU	23(16.8)	49(35.8)	65(47.4)	
	CCU	0(0)	4(40)	6(60)	
	G/wards	13(8.8)	52(35.4)	82(55.8)	
	EMD	4(5.9)	20(29.4)	44(64.7)	
	Cathlab	2(22.2)	2(22.2)	5(55.5)	0.151
Education level	Certificate	0(0)	4(18.1)	18(81.8)	
	Diploma	10(5.1)	103(52.8)	82(42.0)	
	Bachelor	25(21.2)	13(11.0)	80(67.8)	
	Masters	7(19.4)	7(19.4)	22(61.1)	**<0.001**
ECG training	Yes	36(16.3)	75(34.1)	109(49.5)	
	No	6(3.5)	52(34.2)	93(61.2)	**0.001**

Practices of Nurses on ECG Interpretation

Multiple-choice questions of eight ECG scenarios were used to assess the nurses' practice of ECG interpretation. Participants were required to provide one correct answer. The total score of correct answers was computed to obtain percentages. The results indicated that the most frequently known items from scenario questions were interpretation and recognition of Bradycardia240 (64.7%) and Heart block 207(55.8%). (Table 5)

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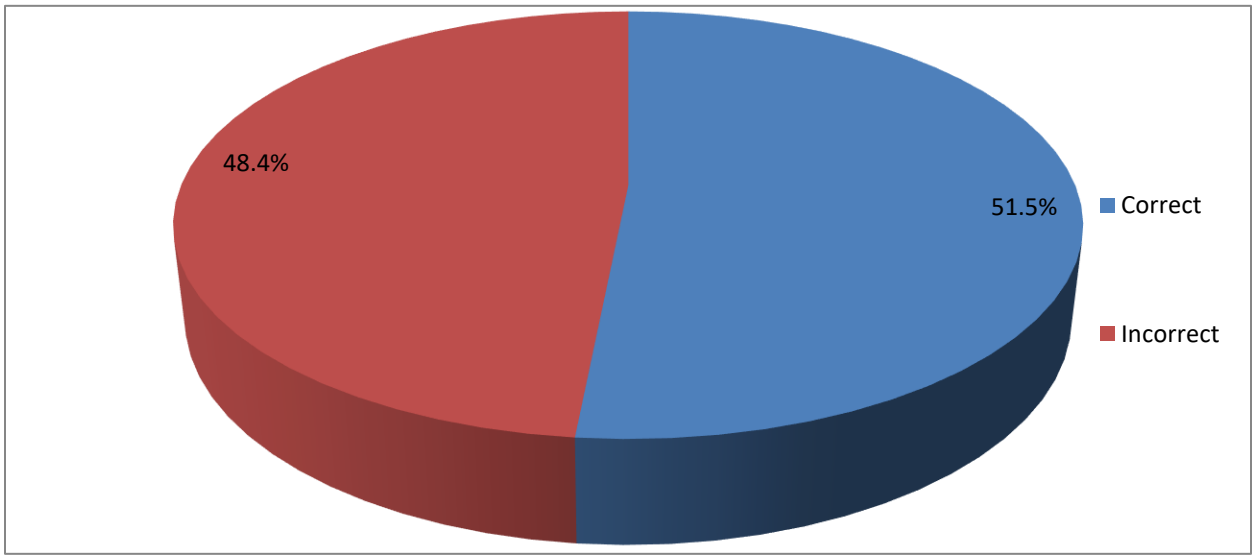
Table 5: Practices of Nurses on ECG Interpretation

Scenario of ECG interpretations	True interpretations	Correct answer	
		n	%
You perform an ECG and observe this rhythm. What do you think it might be	Atrial flutter	170	45.4
You perform an ECG and observe this rhythm. How would you act?	Ask for help without leaving the patient alone because it is a ventricular fibrillation	169	45.6
A patient comes to the emergency department due to respiratory distress. He has 140 beats per minute. You perform an ECG and observe the results. What could be the problem?	Atrial fibrillation	146	39.4
A hospitalised patient who had surgery due to an Acute myocardial infarction, his vital signs are unstable. You perform an ECG and observe the following	Ventricular tachycardia	198	53.3
You performed an ECG to patient who has chest pain that appeared after leaving an important meeting two hours ago. He is 52 years of age and hypertensive, and a few months ago, he was diagnosed with Diabetes Mellitus II. The ECG is as follows	Myocardial infarction	199	53.6
A 24-year-old male comes to the emergency department. He is athletic and slim. He reports feeling a pricking sensation in the left area of his chest since he finished doing exercise (3 hours earlier). You perform an ECG and observe the following.	Bradycardia	240	64.7
A 30-year-old woman comes to the emergency department reporting palpitations, chest tightness and dyspnea. You perform an ECG and observe the following	Heart block	207	55.8
What pathology do you think the patient with this ECG has?	No pathology	200	53.9

Figure 3: Nurses' Practice on ECG Interpretation



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The total frequencies of correct and incorrect answers were 51.5% and 48.4%, respectively.

Association between **Socio-Demographic Characteristics** and **Practices** of **Nurses** on ECG **Interpretation**

The analysis showed that years of experience in the current unit had an association with the practice of nurses on ECG interpretation (p=0.044). (Table 6).

Table 6: Association between socio-Demographic Characteristics and Practices of Nurses on ECG Interpretation

Variables		Practice on ECG interpretation		P-value
		Correct answers	Incorrect answers	
Age	20-24years	20	33	
	25-29years	46	33	
	30-34years	93	96	
	>35 years	10	40	0.52
Gender	Male	47	49	
	Female	122	152	0.26
Education level	Certificate	13	9	
	Diploma	85	110	
	Bachelor	52	66	
	Masters	19	17	0.42
working experience	1-5 years	47	63	
	6-10 years	53	64	
	11-15years	52	61	
	>15years	17	14	0.69
Working unit	ICU	62	75	
	CCU	6	4	
	Wards	65	82	
	EMD	34	34	
	Cathlab	2	7	0.48
Years of the current unit	1-3years	64	93	
	4-6years	56	75	
	7-10years	42	28	
	>10 years	7	6	**0.04**
ECG training	Yes	99	121	
	No	70	81	0.43
ECG resource	On job training	100	120	
	Other resources	81	70	0.71

Factors Influencing ECG Interpretation among Nurses

The majority 340 (91.6%),302(81.4%),256(69%),260(70.1) of the participants responded that availability of facilities in the settings, Previous training, Working unit and Working experience were the major factors that facilitate ECG interpretation, respectively. (Table7).

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Table 7: Positive Influencing Factors on ECCG Interpretation

Variable	Frequency (%)	
	YES (%)	NO (%)
Availability of resources	**340(91.6)**	31(8.4)
Previous training	**302(81.4)**	69(18.6)
Working unit	256(69)	11(31)
Working experience	260(70.1)	112(29.9)
Self-motivation	296(79.8)	75(20.2)

The majority, 316(85.2%) of the study participants selected lack of interest*,* Lack of clinical guidelines, 218(75.7%), Lack of training on ECG, 290(78.2%) and Workload 305(82.2%), as the major hindrances for ECG interpretation. About half 205(55.3%) selected Lack of support from the management as the factor that hinders ECG interpretation. (Table8).

Table 8: Negative Influencing Factors on ECG Interpretation

Variable	Frequency (%)	
	YES (%)	NO (%)
Lack of interest	**316(85.2)**	55(14.8)
Lack of clinical guidelines	218(75.7)	90(24.3)
Lack of training on ECG	290(78.2)	81(21.8)
Workload	**305(82.2)**	66(17.8)
Lack of support from the management	166(44.7)	205(55.3)

DISCUSSION

Knowledge of Nurses on ECG Interpretation

The statistical findings of the present study revealed that about 54.4% of the staff nurses had inadequate knowledge, and 11.3% with adequate knowledge on ECG interpretation. This is contrary to the study done in India, which showed that 53% of the nurses had moderate knowledge regarding the interpretation of ECG.(Darikynti, 2019). The study done in Indonesia found that 51(75.3%) had sufficient knowledge and 17(24.6%) had insufficient knowledge on ECG interpretation(Sila, Nursalam and Asegaf, 2019). The results presented that the lowest score on knowledge questions was about the item "Atrial fibrillation", 149(39.4%). Nurses recognised that atrial fibrillation is a regular rhythm. This is similar to the results of a study conducted in Ethiopia, where more than half of the study participants (50%) were unfamiliar with the correct order of the ECG wave and intervals, 51.4% of participants incorrectly believed that atrial fibrillation could have a regular rhythm (Ababa *et al.*, 2025).

Our study showed that 36.2% of nurses had correct answers on ECG interpretation. This is contrary to the findings of the study done in Turkish which found that 69% of nurses had correct answers regarding knowledge on ECG interpretation. In our study, nurses who were working in general medical wards had low knowledge compared to nurses working in the ICU, who had good knowledge. Low knowledge in the general medical ward may be because of inadequate compared to the ICU, where patient-centred care is mostly done, and a nurse can closely monitor a patient's condition, including an ECG monitor. This is consistent with previous research done in Sweden showing a correlation between frequent ECG interpretation and increased skills among nurses working in CCU(Werner, Kander and Axelsson, 2016).

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In comparison of years of working experience as a registered nurse, currently working in a unit in a hospital and previous ECG training course with knowledge of nurses on ECG. In our study, it showed that nurses who had between 1-5years of working experience had inadequate knowledge, 60(66%), and nurses who experienced to work between 6-10 years had moderate knowledge, 58(49.5%). As shown in the comparison of years of working experience with knowledge of nurses on ECG interpretation, it is statistically significant ($p<0.05$). This is similar to the study done in Turkish, which said that nurses who had less than one year of experience had the lowest average of knowledge, and those with experience >=6 years had the highest average of knowledge on ECG interpretation.(Tahboub & Dal Yılmaz, 2019).

Practices of Nurses on ECG Interpretation

Regarding the practice of nurses on ECG interpretations, the majority recognised arrhythmias of different cases for Bradycardia question 240(64.7%). This might be due to the presence of many cases in the clinical practice with such presentation, and difficulty in recognising Atrial fibrillation 146(39.4%) and Atrial flutter170(45.4%). Our study findings are contrary to the study in North Cyprus, whereby the highest score was from the ventricular tachycardia question (Alanezi, 2018), and the study done in Ethiopia, where the majority, 271(81.1%) of the study participants scored a high level of practice on the identification of asystole. On the other hand, a significant number of nurses had difficulty recognising third-degree heart block 306(91.6%), first-degree heart block 291 (88%), sinus bradycardia 288 (86.2%), atrial flutter 283 (84.7%), and atrial fibrillation 259 (83.7%) (Chamiso, Jinfessa and Jibril, 2024)

The current study findings also revealed that some social demographic variables had an association with practice on ECG interpretation, like working in the current unit-ICU/CCU, working experience and previous ECG training. These results are similar to the study done in Addis Ababa, ICU nurses demonstrated adequate knowledge levels than nurses working in the emergency room, due to ICU nurses having more frequent exposure to receiving cardiac cases, thus might contribute to having better knowledge and skill on ECG interpretation(Ababa *et al.*, 2025)

Factors Influencing ECG Interpretation among Nurses

The study showed that the availability of resources in the settings, previous training on ECG, were the major factors which influence knowledge on ECG interpretation among nurses. These factors are very important and go together to enable nurses to utilise the knowledge they have by using the facilities in their settings. The finding is similar to the study done in Indonesia and Cyprus, which showed that attending training has an impact on nurses' skills and knowledge on ECG interpretation. Hence, ECG training courses are effective in improving the nurses' ECG interpretation (Yanti, 2021).

Limitations of the Study

Data collection was conducted while the participants were gathered for education or a meeting, and some during ordinary work. The three study areas were large and scattered to the extent that some of the participants were missing due to different working shifts they had. Some of the participants were asking to have more time to fill the questionnaires, which might lead to have more chance of guessing or copying answers and may not reflect true knowledge of the study as expected. The practice of ECG interpretation was evaluated by questions and not by observing the practice in the working units.

CONCLUSIONS

Knowledge, practice and factors influencing ECG interpretation among nurses can be seen by various factors like ECG training, working experience, working unit, level of knowledge, workload and availability of hospital resources. Nurses identified

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a lack of ECG training and insufficient exposure to ECG interpretation. This study revealed that knowledge was statistically associated with working experience, previous ECG training, level of education and age, but not associated with working unit experience in the current unit, which was statistically associated with practice on ECG interpretation.

Declarations

List of Abbreviations

ACS	Acute coronary syndrome
AMI	Acute Myocardial Infarction
AV	Atrial ventricular
CAD	Coronary Artery Disease
CCU	Coronary care unit
CVD	Cardiovascular Diseases
DNS	Director of Nursing Services
ECG	Electrocardiogram
EMD	Emergency Medical Department
ICU	Intensive Care Unit
JKCI	Jakaya Kikwete Cardiac Institute
MNH	Muhimbili National Hospital
MOI	Muhimbili Orthopedic Institute
OPD	Outpatient Department
PCI	Percutaneous Coronary Intervention
SA	Sinal Atrial
SPSS	Statistical Package for Social Science

Ethical Approval and Consent to Participate

Ethical approval to conduct the study and data collection was granted by MUHAS by the ethical clearance committee with reference number MUHAS-REC-04-2022-1117. The local board authorities of Jakaya Kikwete Cardiac Institute (JKCI), Muhimbili National Hospital (MNH) and Muhimbili Orthopedic Institute (MOI) secured official letters for data collection at the study areas, with reference numbers AB.123/307/01G/83, MNH/TCUR/Perm/2022/166 and ABB.145/146/02/177 respectively.

Consent to participate in the study was obtained from all participants who were ready to participate in this study, by voluntarily giving a written consent.

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