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Electrocardiographic Pattern among Heart Failure Patients at Kampala International University Teaching Hospital, Ishaka, Uganda

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ABSTRACT

The prevalence of cardiovascular diseases is increasing rapidly in Sub-Saharan Africa. A multicenter prospective cohort study of 1,006 patients with acute heart failure in a Sub-Saharan Africa Survey showed that 814 patients had ECGs readings among which 97.7% had abnormalities. There is paucity of data on ECG abnormalities among heart failure patients in many developing countries, Uganda inclusive. A cross sectional study was conducted at KIU-TH between January and March 2020 which recruited 122 heart failure patients. Questionnaires were administered to respondents to obtain factors associated with ECG abnormalities. A 12-lead ECG machine was used to obtain ECG findings. Data were analyzed using bivariate and multivariate logistic regression analyses to establish the association between each independent variable and the ECG abnormalities. The mean age of study respondents was 62.4 ± 20 years and 54.9% of the respondents were females. The main ECG abnormalities were left ventricular hypertrophy (29.5%), left bundle branch block (12.4%) and right bundle branch block (11.4%). The prevalence of abnormal ECG among heart failure patients was very high. Respondents aged above 50 years, smokers, hypertensive and those staged in NYHA functional class III and IV were at high risk of having abnormal ECG. It is recommended that ECG test should be included as a routine test in the management of heart failure patients at KIU-TH, regular refresher training in ECG should be organized for clinicians. Routine health education on the dangers of alcohol misuse and smoking to the heart and other organs, should be encouraged at triage centres of all health facilities by the Ministry of Health in Uganda.
Keywords: Electrocardiographic Pattern, Heart Failure, KIU-TH

INTRODUCTION

With more than 100 years of development, the history of electrocardiograph (ECG) has been complicated and unorganized [1]. [2], observed while dissecting a frog, that electric stimulation of frog nerves could cause muscle contraction, which he called "animal electricity". This discovery revealed the biological basis of electrophysiology. Later, the first ECG of a human being was recorded in 1869 with a siphon instrument by Muirhead in London [1]. With the introduction of chest x-ray in 1895 by Roentgen and the electrocardiograph (electrocardiogram) in 1902 by Einthoven who was inspired by the work of Waller, objective information about the structure and function of the heart was provided. Electrocardiography has played an important role in the diagnosis of heart diseases [3].

In the first half of the 20th century, the electrocardiograph no longer employed a string galvanometer to record the potential difference between the extremities resulting from the electrical activity of the heart [1]. In 1930, Wolff, Parkinson, and White reported on 11 young patients with paroxysms of tachycardia, or atrial fibrillation (AF) that had a functional bundle branch block and an abnormally short PR interval on ECG. It was subsequently described as Wolff-Parkinson-White syndrome or pre-excitation syndrome [1]. Later, in 1966, Dessertenne first described "torsades de pointes" and in 1967, the ECG characteristics of sick sinus syndrome were first proposed by Lown. However earlier in 1957, Norman Holter invented the dynamic ECG, also named Holter ECG, a portable device which enables the continuous monitoring of various

electrical activities of heart for more than 24 hours [1].

The study was done to determine the ECG pattern among heart failure patients at KIU-TH.

METHODOLOGY

Study Design

Research design is the "overall plan or strategy for conducting the research" [4]. Survey design was adopted for this study. Here, samples of the target population were chosen for study, analysis and discovery of occurrences as they were.

Study Area

This study was conducted at Kampala International University Teaching Hospital, Ishaka.

Target Population

The target population for this study were adult heart failure (HF) patients in Western Uganda. Adult HF patients are in different stages of the disease and live in different communities. Some HF patients are either undiagnosed or misdiagnosed at different places where people seek healthcare. The population of HF patients in this community is therefore very scattered and infinite.

Sample Population

The sample of the accessible population chosen for this study consisted of adult HF patients who received medical care at KIU-TH during the duration of the study and met the inclusion criteria for the study. This sample was chosen because clients report to KIU-TH for health care and the hospital has the medical staff members who can appropriately diagnose HF. In addition, facility for determining ECG and other necessary clinical investigations were readily available.

Inclusion Criteria

Criteria for being included in the study were being diagnosed to have HF, age of 12 years and above, attending clinical care at KIU-TH, Ishaka and giving written consent to participate in the study during the study period.

Exclusion Criteria

All patients were excluded from participation in the study if they had any overt mental disorders or were unable to withstand the interview, did not consent to participate or changed their mind during the study. Respondents with known allergy to the gel used in the ECG procedure were excluded from the study.

Sample Size Determination

Sample size was calculated using a formula for single population proportion with correction for finite population [5]. That is:

$n = N^*X / (X + N - 1)$ (Equation 1)

Where:

N= population size, estimated at 160 HF patients attending the Internal Medicine Department (Both MOPD, Inpatients Department and Private ward) at KIU-TH from January 2019 to March 2019 (Unpublished data).

X = $Z_{\alpha/2}^2 * p * (1-p) / MOE^2$,

$\mathbf{Z_{\alpha/2}}$ = critical value of the Normal distribution at $\alpha/2$ for α of 0.05= 1.96,

p= proportion of ECG abnormalities among HF patients in Uganda (Mulago, Kampala): 37.1% [6].

MOE= margin of error considered at 5%,

$X = (1.96^2 \times 0.371 \times 0.629) / 0.05^2 = 358$

Substituting, $n = 160*358 / (358 + 160 - 1) = 111$

To cater for attrition, an additional 10% was added to the sample size which gave a sample size of 122 heart failure patients.

Sampling Techniques

This study employed cluster, purposive and convenience sampling techniques. Cluster sampling was used to categorize places where adult HF patients are usually seen in groups. These places are healthcare units; hence each healthcare unit in Bushenyi District was categorized as cluster. The study focused on adult patients with HF. Adult HF patients receive healthcare from different healthcare facilities and each healthcare facility that provide such care in Bushenyi District was considered as a cluster where adult HF patients could readily be seen. Cluster sampling technique divides a population into relatively smaller groups (clusters) and some of the clusters randomly selected as the sample. All members of the chosen cluster are studied. It is used to select groups rather than individual members where a sampling frame cannot be constructed. The technique was chosen because it saves time and money, and it is suitable if a sampling frame cannot be obtained. In this study, a sampling frame is not obtainable because not all adult HF

patients attend healthcare facilities and some who attend are misdiagnosed by healthcare workers.

Purposive sampling technique was adopted for selecting the cluster sample. In purposive sampling, one consciously chose who to include in the sample. KIU-TH was chosen as the cluster for this study because it is the only tertiary healthcare facility in Bushenyi District. In addition, it provides services to HF patients who visit on their own volition and those who are referred from other lower healthcare units. KIU-TH has sufficient human resource for health and facilities for proper diagnosis of HF. This study focused on gathering information from HF patients only. Purposive sampling technique selects "typical" and useful cases only, it saves time and money. These factors guided the adoption of purposive sampling for selection of KIU-TH as a good cluster for this study.

The convenience sampling technique was adopted for selecting individual respondents in the chosen cluster. Convenience sampling technique consist of selecting, on first come first served basis, those who happen to be available. This sampling technique is used for pilot or exploratory studies and in infinite populations when it is not possible to determine the sampling frame. It collects data at the spur of the moment without rigidity of procedure. It takes advantage of those who happen to be there at the moment of unexpected events. Hence, the convenience sampling technique was chosen for this study where respondents were consecutively enrolled until the desired sample size was attained. Respondents were enrolled into the study as they were diagnosed at the hospital entry points (MOPD, Accident and Emergency Department). Those who were admitted, but missed at the entry points, were enrolled from the Medical, Private and Semi-Private Wards. Every patient who met the selection criteria was eligible to participate.

Data collection

Data Collection Instruments

Questionnaire

The study used questionnaires as the main tool for data collection (Appendices D & E). The choice of questionnaire as the main data collection tool was guided by the study objectives. The main aim of the study was to determine the clinical characteristics and factors associated with ECG abnormalities among HF patients. A questionnaire is a collection of items to which a respondent is expected to react to [4]. It is used for collection of many information over a short period of time and it is suitable for studying large literate populations in limited time and where the required information can easily be described in writing. The questions contained in the questionnaire focused on study objectives that explored sociodemographic factors (age and gender); behavioral factors (smoking and alcohol use); medical factors (type of heart failure, medication and NYHA classification at enrollment) and comorbidities (Hypertension, diabetes mellitus, COPD and obesity) among adult HF patients.

Standard Weight scale

Electronic weighing scale with high precision strain gauge sensor system (Clikon model) was used for measuring the weight of each respondent. The weight was measured to the nearest 100 grams with each respondent not wearing heavy cloths and standing bare-footed on the weighing scale in an upright position. Electronic weighing scale with high precision strain gauge sensor system was used in order to obtain accurate weight measurements by completely eliminating errors that could arise from use of manual weighing scales. Such errors may arise from observer position and variability in gauge strain with repeated use over time.

a. Standard Height pole

Portable standard height pole mounted vertically against a wall was used for height measurement. Each respondent's height was measured with the respondent standing upright, backing the height pole and his/her buttocks touching the height pole/wall. Care was taken to ensure that the lateral angles of the respondent's eyes were at the same level with the middle of the pinna. The height was read off with the horizontal piece directly touching the vertex of each respondent's head. The portable standard height pole was chosen because it gives better results than other crude locally used methods. Its results are comparable with results generated from anywhere with similar tool.

b. Sphygmomanometer

Manual sphygmomanometer with appropriate cuff sizes wrapped around the arms for each patient was used for the measurement of respondents blood pressure.

c. Stethoscope

Stethoscope 3 M Littmann ® Classic II SE was used for the cardiovascular examination during data collection.

d. Pulse Oximeter

The blood oxygen saturation and the pulse rate of each respondent were taken by using a fingertip pulse oximeter model MP-1000C with a measurement range of 77% to 99%. It has the advantages of small size, low power consumption, easy operation and being easy to carry (https://tp-wireless.com/a/chanpinfangan/healthcare/2020/06113/548, consulted on 27/06/2020).

e. ECG Machine

The "DRE/True ECG Plus machine" was used as for determining the ECG in each respondent. It is an excellent cost-effective portable ECG machine with an internal storage upgrade up to 200 ECGs, card reader, SD card and a flash drive. The machine has automatic measurement and interpretation for adults and pediatrics (https://www.dremed.com/dre-true-ecgl-singnle-channel-ecgekg/id/1974, consulted on 7/12/2019).

Validity and reliability of the data collection instruments

Inclusion and exclusion criteria were strictly adhered to questionnaire. Pre-testing of the questionnaire was conducted among five adult HF patients at Ishaka-Adventist Hospital and the outcomes guided the adjustment of some questions. That contributed towards improvement of both validity and reliability of the final questionnaire used for this study. Validity was further strengthened by content and context experts who reviewed the instrument and confirmed that each construct was correctly measured. Experts in the field rated each items on the questionnaire on the scale of relevance: very relevant (4), quite relevant (3), somewhat relevant (2) and not relevant (1). Validity was determined using Content Validity Index (CVI).

CVI = items rated ≥ 3 by both judges/Total number of items in the questionnaire (equation 2).

The questions rated three and above were 42 out of 51; hence CVI = 42/51 = 0.8235 = 82%.

The data collectors ensured that the questionnaires were filled correctly by allowing enough time for the filling-in of questions. The questionnaires were in both English and local language for ease of communication. With the help of translators, unfamiliar technical terms were explained to the respondents consistently. The ECG was done according to the SOP and the interpretation was done by the principal investigator. The supervisors verified interpretation of each ECG finding and final confirmation of the ECG findings was done by the cardiologist to ensure reliability.

Data processing, Analysis and Interpretation

Data from completed questionnaires were arranged, summarized and entered into the Microsoft Excel version 2010 and then exported to STATA version 14.2 for analysis. The baseline characteristics of respondents were analyzed using means for continuous variables with normal distribution and proportions for categorical variables.

Privacy and confidentiality

Identification of respondents was done by means of numerical codes to ensure anonymity and confidentiality. Details of respondents were kept under lock and key for privacy and confidentiality purposes throughout the course of research. There were no disclosure of information of respondents to the public without their consent.

RESULTS

Table 1. Baseline Characteristics of Study Respondents (N = 122)

Variable	N = 122
Sociodemographic characteristics	
Female, n (%)	67 (54.9)
Age, mean (SD)	62.4 (±20)
Age categories (years), n (%)	
< 20	6 (4.9)
20-29	3 (2.5)
30-39	6 (4.9)
40-49	16 (13.1)
50-59	19 (15.6)
60-69	18 (14.7)
70-79	25 (20.5)
≥ 80	29 (23.8)
Greater Bushenyi, n (%)	107 (87.7)
Peasant farmer, n (%)	54 (44.3)
No formal education, n (%)	63 (51.7)
Behavioral characteristics	
Smoking history, n (%)	44 (36.1)
Alcohol use history, n (%)	
Never	85 (69.7)
Not harmful alcohol use	15 (12.3)
Hazardous drinking	22 (18.0)
Medical characteristics	
Duration of heart failure, n (%)	
< 1 year	67 (54.9)
> 1 year	55 (45.1)
Medication: ARBs / ACEIs, n (%)	56 (45.9)
Hypertension, n (%)	60 (49.2)
BMI, Mean (SD)	23.3 (±5.2)
BMI categories, n (%)	
Underweight	24 (19.7)
Normal	53 (43.4)
Overweight	28 (23.0)
Obesity	17 (13.9)
NYHA functional class, n (%)	
NYHA I-II	38 (31.1)
NYHA III-IV	84 (68.9)

The mean age of the respondents was 62.4 ± 20 years. Table 1 shows that the majority 67 (54.9%) of the respondents were females. The majority 107 (87.7%) were from great Bushenyi, 63 (51.6%) of them had no formal education; 44 (36.1%) were smokers and 37 (30.3 %) had history of alcohol use. About half of them were hypertensive 60 (49.2%) and 55 (45.1%) had a duration of HF of more than a year. The angiotensin receptor blockers or angiotensin converting enzyme inhibitors were the base of medication (45.9%). The majority 84 (68.9%) of respondents were decompensated and staged in NYHA class III and IV at enrollment while 45 (36.9%) of respondents were obese or overweight.

The second objective of this study was to determine the ECG pattern of HF patients at KIU-TH, Ishaka. To achieve this objective, a cost free ECG was done for each respondent. The ECG findings were interpreted by the principal investigator and reviewed for confirmation the supervisors of the study. The data obtained were analyzed under the question “what is the ECG pattern among heart failure patients at KIU-TH, Ishaka?” The results are presented in Table 2.

Table 2. ECG Pattern of Heart Failure Patients at KIU-TH

ECG pattern	N =122 n (%)
Normal ECG findings	17 (13.9)
Abnormal ECG findings	105 (86.1)
Major abnormalities only (n = 66)	
LVH with ST abnormalities	16 (15.2)
Left Bundle Branch Block	13 (12.4)
Right Bundle Branch Block	12 (11.4)
Other arrhythmia (SVT, VT, VP)	9 (8.6)
Atrial fibrillation	7 (6.7)
Isolated ischemic abnormalities	7 (6.7)
Third degree AV-Block	1 (0.9)
Q wave myocardial ischemia	1 (0.9)
Minor abnormalities only (n = 30)	
LVH without ST abnormalities	9 (8.6)
First and second degree AV-Block	6 (5.7)
Atrial premature beat	5 (4.8)
Right atrium enlargement	4 (3.8)
Non-specific ST-abnormalities	4 (3.8)
Ventricular premature beat	2 (1.9)
Major and minor abnormalities (n = 9)	
LVH with ST abnormalities + Left atrial enlargement	4 (3.8)
Atrial fibrillation + atrial premature beat	3 (2.9)
LVH with ST abnormalities + ventricular premature beat	2 (1.9)

SVT = Supra-Ventricular Tachycardia, VT = Ventricular Tachycardia, VP = Ventricular Preexcitation.

Table 2 describes the ECG pattern among HF patients. The majority 105 (83.1%) of study respondents had abnormal ECG and 17 (13.9%) had normal ECG findings. Nine (8.6%) respondents had both major and minor abnormalities, 66 (62.8%) respondents had only major abnormalities and 30 (28.6%) of them had only minor abnormalities. The main abnormalities found in the study were LVH with or without ST changes (23.8%), LBBB (12.4%) and RBBB (11.4%).

DISCUSSION

The main ECG abnormalities found during the study were LVH with or without ST changes (29.5%), LBBB (12.4%) and RBBB (11.4%). Nine (8.6%) respondents had both major and minor abnormalities, 66 (62.8%) respondents had only major abnormalities and 30 (28.6%) of them had only minor abnormalities. The pattern of ECG abnormalities found in this current study are similar to the study of [7] in India for who the main ECG abnormalities were LVH (42.9%), LBBB (19.4%), left atrial enlargement (25.8%) and atrial fibrillation (9.1%). [8] in Sub-Sahara in 2014 found that the commonest pattern of the ECG abnormalities were RBBB and Ischemic changes; and [8,9,10,11,12,13] in Brazil during their observational retrospective study reported that complete Left Bundle Branch Block was the commonest electrocardiographic abnormality. In Ghana, [10] found in their study that the main ECG abnormalities were LVH (43.7%), left axis deviation (39.6%), LBBB (19.2%) and left atria enlargement (25.6%). These similarities could be explained by the anatomy and the physiology of the heart which are the same for all human being and when the heart is failing, the consequences are the same despite the origin of the patient. [11,12,13] however got different pattern of ECG abnormalities compared to the

current study. They got a high prevalence of left ventricular hypertrophy in 77.5% of cases compared to 29.5% in this study. The discrepancy could be related to differences in the criteria used for defining ECG abnormalities. In addition, 78% of their respondents were hypertensive compared to 49.2% in this study. Thus, the presence of higher percentage of LVH can be attributed to higher percentage of hypertensive in the population studied by Karaye and Sani.

CONCLUSION

Left ventricular hypertrophy, left bundle branch block and right bundle branch block were the most common abnormalities among study respondents.

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