THE FUNCTIONAL CLASS AND ELECTROCARDIOGRAPHIC ABNORMALITIES IN HEART FAILURE PATIENTS IN SOUTHERN NIGERIA: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: *Heart failure (HF)is often regarded as the end-stage of all diseases of the heart and constitutes a major cause of morbidity and mortality. Impairment of the functional status of the patient is invariably a cause of concern, as it translates to a reduced quality of life and the loss of work man hours occasioned by frequent hospitalizations. These periods of hospitalizations are quite frequently related to the occurrence of cardiac arrhythmias.*

Objectives: *To determine the prevalent electrocardiographic abnormalities and functional status of the heart failure patients in our practice, and to investigate the relationship between the presence of cardiac arrhythmias and functional class.*

Methods: *Three hundred and thirty-three (333) heart failure patients were studied, comprising of consecutively enrolled hospitalized heart failure patients. Anthropometric and biochemical data were collected, and also the functional class assessed by the New York Heart Association (NYHA) functional classification system. Electrocardiography (ECG) was performed on each patient to identify the presence of any arrhythmia.*

Results: *We found that 150 (45%) of the hospitalized HF patients were males and 183 (55%) females, and that the mean age of all the patients was 57.63± 11.46 years. Most of the HF patients were within the fifth and sixth decades of life.Most of the participants were in the NYHA stage II functional class. We also found that 97.4% of the HF patients had ECG abnormality at hospitalization. The commonest ECG abnormality was left atrial enlargement, while the commonest sustained arrhythmiawas atrial fibrillation. Sinus tachycardia was however solely able to predict a progression to an advanced NYHA class.*

Conclusion: *Patients in HF were mostly in the NYHA II class, and were relatively young. A normal ECG finding is quite rare in HF. Sinus tachycardia in the context of HF may portend a more debilitating functional status.*

Keywords: *Heart failure, functional status, electrocardiographic abnormality.*

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INTRODUCTION

Cardiovascular disease is a major contributor of the global disease burden.[1,2] Africa however has a dual disease burden, grappling with traditional communicable and infectious diseases with the added menace of an increasing burden of non-communicable diseases such as hypertension, diabetes mellitus, chronic obstructive pulmonary disease, and cancers.
Heart failure (HF) is a clinical syndrome characterized by dyspnoea, fatigue, and clinical signs of congestion leading to frequent hospitalizations, poor quality of life, and shortened life expectancy.[3]

The incidence, prevalence and aetiology of heart failure (HF) are variable and influenced by the definition of heart failure used and the relevant causes unique to the individual countries. However, irrespective of countries and the socio-economic status, there are common epidemiologic factors.[4] As such, aging, hypertension, diabetes, obesity and increased body mass index (BMI) are major risk factors of HF.

About 6.2 million American adults had HF in 2013-2016; and patients who were newly hospitalized for HF were almost evenly distributed into those with reduced ejection fraction (EF) and those with preserved ejection fraction. The American Heart Association (AHA) 2019 Heart Disease and Stroke Statistics also reported that as of 2018, 3994 Americans were on the waiting list for heart transplant.[5]

Despite advances in medical treatments and improved prognosis congestive heart failure(CHF) is associated with significant mortality. HF is one of the leading primary diagnoses for hospitalization with an estimated 1 million patients discharged in 2010. The total cost of HF for 2012 was $30.7 billion.[6]

The prevalence of HF increases sharply with age. In patients younger than 40 years, the prevalence is only1%; in patients 80 years or older, it is 20%.[7]

There is a paucity of data on the prevalence of HF in developing countries because of the lack of population-based epidemiological surveys. A recent report from Sub-Saharan Africa, revealed that acute HF was essentially a disease of the young and middle-aged; and mainly caused by preventable and treatable causes such as hypertension (78.5%), dilated cardiomyopathy (7.5%), and rheumatic heart disease (RHD) (2.4%).[8]

HF hospitalizations are increasing, and many of these may be related to cardiac arrhythmias, such as atrial fibrillation, premature ventricular contractions (PVCs), and intra-ventricular conduction delays. Indeed, periods of cardiac decompensation are often related to cardiac arrhythmias.

Sudden cardiac death (SCD) which is a major cause of mortality is often as a result of malignant ventricular arrhythmias.[9]

The electrocardiogram (ECG) has many established applications useful for the diagnosis, management, and follow-up of patients with congestive heart failure. ECG

may reveal ventricular arrhythmias, evidence of previous myocardial infarction, left ventricular hypertrophy (LVH), all types of atrial arrhythmias, intra-ventricular conduction blocks, right ventricular hypertrophy, or merely sinus tachycardia. A completely normal electrocardiogram is very uncommon in patients with chronic HF.[10] A recent study conducted in Port Harcourt, Southern Nigeria showed a widespread use of ECG in private hospitals (83.2%)[11], which highlights the extensive penetration in its deployment in medical practice.

An important component in the management of HF is to determine the extent to which the cardiac function has been compromised. The New York Heart Association (NYHA) classification is widely used to indirectly assess the functional status of the HF patient by categorizing patients based on their limitations of carrying out routine physical activity.[12, 13]The NYHA classifies patients with HF into 4 categories (I, II, III, IV), with higher class indicating more severe symptoms, limitation in physical activity, and worse health. Determination of functional class is important in predicting outcomes in HF, including hospitalization and mortality.[14, 15]

The first goal of this study was to assess the prevalent electrocardiographic abnormalities and functional status of the congestive heart failure patients in our clinical practice at the time of hospitalization. The second goal of the study was to investigate the correlation, if any between the presence of rhythm abnormalities and functional status, assessed by NYHA class. Our null hypothesis for this study was that the presence of arrhythmias would not significantly contribute to a more advanced functional class.

METHOD

Study population

The study was approved by the Research ethics committee of the University of Port Harcourt Teaching Hospital (UPTH). Written informed consent was obtained from all participants before enrolment in the study. Adult patients aged 18 years and over with a clinical diagnosis of CHF and managed in the medical wards between September 2019 and March 2020 were recruited for the study. The clinical diagnosis of CHF was based on the Framingham criteria[16] and patients who were newly diagnosed with HF based on this criterion were recruited for the study. Patients meeting any of the following criteria were excluded: used drugs that influence QT duration within two weeks of enrolment used class I or class III anti-arrhythmic drugs, patients with hypo- or hyperthyroidism, with severe liver or kidney dysfunction. This was a retrospective observational study, conducted in medical wards at the University of Port Harcourt Teaching Hospital, in Port Harcourt, Nigeria.

Information such as age, sex, waist circumference (WC), blood pressure, pulse pressure (PP), serum electrolytes, urea, creatinine, glycated haemoglobin levels, were recorded for each patient using a standardized questionnaire.

Standard resting 12-lead body-surface ECG

was recorded for each patient on the day of recruitment using a Carl Novel AK-6 ECG recorder (GmbH Germany), with a paper speed of 25mm/s and a gain set of 10mm/mv to ensure a clear, stable baseline with no interference. The Sokolow-Lyon and Cornell's criteria[17] were adopted for the definition of LVH. The ECG analysis was carried out by a team of cardiologists who had been trained and were experienced in ECG analysis. Their ECG analyses were also subjected to periodic auditing and feedback.

On the day the enrolment, each patient was categorized independently by two investigators as class I, II, III, or IV according to NYHA guidelines as previously described[12,13].

Statistical analysis

Data was analysed using SPSS software version 17.0. Data were expressed as mean± standard deviation and frequencies as percentage. Continuous variables were compared with the Student's t-test, or one-way analysis of variance (ANOVA) as considered appropriate. Proportions or categorical parameters were compared with the Chi-square or the Fischer's exact test. To assess whether certain arrhythmias would predict the likelihood of being classified in a higher NYHA class, a generalized ordinal logistic regression model was fitted; with the potential confounder of age, included. All tests were considered to be statistically significant at the p-value <0.05.

RESULTS

Three hundred and thirty-three (333) heart failure patients were studied, out of which 150 (45%) were males and 183 (55%) females, giving a male: female ratio of 1: 1.22. The mean age of all patients was 57.63± 11.46 years. The age range of the study participants was 19-87 years. The mean age of the female participants was 57.91±11.80 years, while the age for the male population was 57.29±11.05 years (p=0.618).

Among the heart failure patients, 85 (25.6%) were in the NYHA stage I, 140 (42.2%) in NYHA stage II, 41(12.3%) in NYHA stage III, and 66 (19.9%) in NYHA stage IV functional class.(Fig. 1)

Most, (68.2%) of the HF population were within the fifth and sixth decades of life.

The functional status of the population did not appear to be affected by gender (X^2=0.380, p=0.944). The ECGs were abnormal in 97.4% of the patients.

Table 1 shows the prevalence of arrhythmias and other ECG abnormalities in the study population. The most common ECG abnormalities found in this study population were structural abnormalities, i.e. left atrial enlargement (45.95%) followed by left ventricular hypertrophy (44.4%). Atrial fibrillation was the most common rhythm abnormality observed in the study (15.3%). Table 2 shows the prevalence of ECG abnormalities the population of HF patients according to the NYHA staging.

Rhythm abnormalities, such as sinus tachycardia (p<0.001), pathological Q waves

(p=0.001), and poor R wave progression (PRWP) (p=0.003) were more common in the higher NYHA classes. Obviously, this does not suggest that the presence of these arrhythmias leads to a worse functional class. Structural cardiac abnormalities were more common in the lower NYHA classes, although these were not statistically significant.

The correlation between sinus tachycardia, pathological Q waves, PRWP, and functional class was studied with aim of assessing the independent influence of the presence of arrhythmias. Sinus tachycardia was associated with a 9-fold increase in the likelihood of being in a higher NYHA class (OR 9.01 (95%CI 2.630-30.911, p<0.001). The presence of pathological Q waves or PRWP were however not predictive of a higher NYHA class.

The aetiologies of HF in the study population are shown in Figure 2, with hypertension being the most prevalent (49.9%), followed by hypertension with diabetes (48.1%), rheumatic heart disease (0.6%), idiopathic dilated cardiomyopathy (0.6%), ischaemic heart disease (0.6%), and congenital heart disease (0.3%).

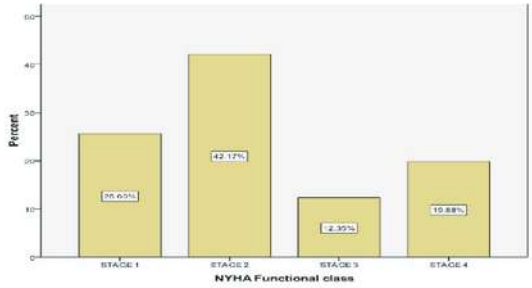

Figure 1: The NYHA functional class of the study population

Table 1: Prevalence of arrhythmias and other ECG abnormalities in the study population

ECG Abnormality	Percentage
Sinus bradycardia	1.03
Low voltage complexes	0.52
Pathological Q waves	3.09
Sinus tachycardia	6.7
Left atrial enlargement	45.95
Junctional rhythm	1.55
T wave inversion	22.52
ST depression	5.13
Poor R wave progression	6.67
ST elevation	20.72
Left ventricular hypertrophy	44.4
Sinus arrhythmia	2.17
First degree AV block	6.52
RBBB	8.7
LAFB	1.03
LBBB	7.21
AF	15.3
PVCs	11.7
VT	2.2
Prolonged QT	6.52

RBBB= right bundle branch block; LAFB= left anterior fascicular block; LBBB= left bundle branch block; AF= atrial fibrillation; PVCs= premature ventricular contractions; VT= ventricular tachycardia.

Table 2: ECG abnormalities according to NYHA functional staging

ECG Abnormalities	NYHA 1 Frequency (%)	NYHA 2 Frequency (%)	NYHA 3 Frequency (%)	NYHA 4 Frequency (%)	p-value
Sinus tachycardia	**0**	0	0	9 (17.3)	**<0.001***
Path. Q waves	**0**	0	0	6 (11.5)	**0.001***
Junctional rhythm	**0**	0	0	1 (1.9)	**0.055**
LAE	**44 (51.8)**	54 (38.6)	44 (51.8)	35 (53)	**0.135**
ST elevation	**17 (20)**	37 (26.4)	17 (20)	8 (12.1)	**0.107**
T wave inversion	**25 (29.4)**	25 (17.9)	7 (17.1)	18 (27.3)	**0.133**
ST depression	**0**	4 (5.6)	0	6 (11.5)	**0.040***
PRWP	**0**	2 (2.8)	0	9 (17.3)	**0.003***
LVH	**38 (44.7)**	62 (44.6)	38 (44.7)	32 (48.5)	**0.690**
1st degree block	**0**	6 (20)	0	0	**0.004***
Atrial fibrillation	**7 (8.2)**	28 (20)	7 (8.2)	9 (13.6)	**0.118**
PVCs	**14 (16.5)**	20 (14.3)	14 (16.5)	4 (6.1)	**0.042***
VT	**0**	2 (6.7)	0	0	**0.238**
ProlongedQTc	**0**	0	0	4 (9.8)	**0.305**

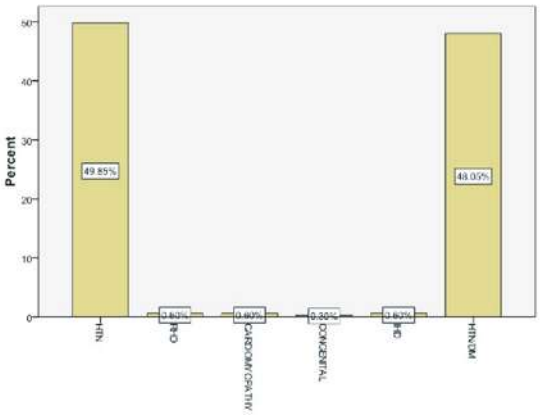

Figure 2: Etiology of heart failure in the study population

DISCUSSION

Our study found out that 97.4% of the ECGs examined were abnormal. This finding is consistent with the reports by Karaye[18] in Kano, Nigeria, and Owusu *et al.* Kumasi, Ghana[19]; this also affirms that a completely normal electrocardiogram is very uncommon in patients with chronic HF.[10]

The commonest ECG abnormality found in our study population was LAE (45.95%), followed by LVH (44.4%). This was in contrast to the finding by Karaye and Sani[18] who reported LVH as the commonest ECG abnormality, followed by LAE. Owusu *et al*[19] also found left ventricular hypertrophy as the commonest ECG abnormality in their study population.

The reasons behind the contrast in the results might be related to the differences in aetiologies of populations sampled. A large proportion (48%) of our population had a background history of diabetes mellitus, and this might have influenced the outcome. The relationship between left atrial remodelling and type 2 diabetes mellitus (T2DM) is well established[20]; and several studies have shown that changes in LA size and function were associated with adverse cardiovascular events like atrial fibrillation, stroke, diastolic dysfunction and LV failure.[21,22]

Atrial fibrillation was the most common arrhythmia found in our study (15.3%). Karaye and Sani (16%)[18], Owusu *et al* (8.9%)[19], also reported AF as the most common arrhythmia in their study population of HF patients. This finding was in concert with established clinical postulations that AF is the commonest sustained arrhythmia.[23]The identification of AF is of importance in HF because it can cause thromboembolism, stroke, worsen HF status,

and increase mortality.

The greatest proportion of our participants (42.2%) was in the NYHA II at the time of hospitalization. This was in contrast to the finding by Akpa and Iheji in Southern Nigeria who reported that 57.5% of hospitalized heart failure patients were in the NYHA III class[24] and Ojji*et al* in Northern Nigeria who also reported a similar finding, with 40.7% of their hospitalized HF patients being in NYHA III at the time of admission.[25] While the findings by the other investigators revealed that the HF patients presented late, the earlier presentation by the patients in our study cohort may reveal a positive shift towards early health-seeking behaviour among our hypertensive patients, as a result of persistent advocacy by healthcare practitioners and the present ease of accessing medical information[26], or it may be the outcome of the establishment of a specialized heart failure clinic in the hospital.[27]

Alternatively, it may simply be a reflection of the inter-operator variability that exist in the use of the NYHA classification in assessing the functional status of HF patients.[28]

Most of the HF patients were within the fifth and sixth decades of life, which is similar to the pattern reported by Akpa and Iheji[24] and other investigators in the African continent.[18] The relatively younger age of occurrence of HF among Africans when compared to their Caucasian cohorts is related to the earlier occurrence of hypertension with its complications among the African population.[29]

We found that arrhythmias like sinus tachycardia, PRWP, and pathological Q waves were more common among patients in NYHA IV class (Table 2). The ordinal logistic regression model established that sinus tachycardia was able to predict 9-fold likelihood of progression of heart failure in the study population. The present study confirmed the existence of a strong association between increased prevalence of sinus tachycardia and advanced NYHA class. Since an advanced NYHA class is associated with increased rates of re-hospitalization[24], and in-hospital mortality[15] it becomes imperative to note that sinus tachycardia in the context of HF is not innocuous. Interestingly, an analysis of the study of the effects of a β-blocker on the rate of re-hospitalization of elderly HF patients (SENIORS study), showed that there was a reduction in mortality and hospitalization for heart failure in patients with sinus tachycardia when treated with β-blockers. This is important because resting heart rate is an independent predictor of cardiovascular morbidity and mortality in patients with HF irrespective of underlying ejection fraction.[30]

CONCLUSION

We found that HF patients in the Southern part of Nigeria were relatively young, and are perhaps starting to present to hospitals at an earlier NYHA functional class. This may be due to a better health-seeking behaviour on account of easier accessibility to medical information, often with the click of a button.

We also determined that HF without an abnormal ECG is a rarity, while sinus tachycardia in the HF patient may not be benign and might portend the progression to an advanced NYHA class. A more robust prospective study is however required to elucidate this important observation.

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