



HHS Public Access

Author manuscript

Int J Cardiol. Author manuscript; available in PMC 2018 September 15.

Published in final edited form as:

Int J Cardiol. 2017 September 15; 243: 311–317. doi:10.1016/j.ijcard.2017.05.025.

Heart Failure, Post-Hospital Mortality and Renal Function in Tanzania: a prospective cohort study

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Abstract

Objective—To determine one-year, post-hospital mortality and the predictors of mortality in Tanzanian adults with heart failure (HF) compared to other admitted adults.

Methods—In this prospective cohort study we consecutively enrolled medical inpatients admitted during a 3-month period, screened for HF and followed until 12 months after hospital discharge. Standardized history, physical examination, echocardiography and laboratory investigations were obtained during hospital presentation. The primary outcome was one-year post-discharge mortality. The secondary outcome was in-hospital mortality. Cox regression adjusted for age and sex was used.

Results—During the study period, we enrolled 558 adults; 145 had HF and 107 of these survived until discharge. Patients with HF had a higher one-year post-hospital discharge mortality than all other diagnoses (62/107 (57.9%) vs 150/343 (43.7%), respectively, HR=1.57[1.13–2.18]). In-hospital mortality was similar. Markers of renal disease were more common in adults with HF (40/107 (37.4%) and were the strongest independent predictors of post-hospital mortality: low eGFR (HR=2.94[1.62–5.31]) and proteinuria (HR=2.03, [95%CI 1.13–3.66]). No patients discharged with the combination of low eGFR/proteinuria survived to the one-year endpoint. Of note, 79/145 (54.5%) of adults admitted with HF were newly diagnosed during hospital admission.

Conclusions—Over half of adults discharged with HF died within 12 months after discharge. Adults with HF had higher post-hospital mortality compared to other medical inpatients. Markers of renal disease were the strongest predictor of this mortality. Innovative interventions are needed to reduce post-hospital mortality in adults with HF and should focus on those with renal disease.

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Disclosures

The authors have no conflicts of interest to disclose.

Keywords

global health; global disease patterns; heart failure mortality

INTRODUCTION

The global burden of heart failure (HF) is rapidly increasing.¹ Heart failure represents up to 3% of all hospital admissions and 11% of all deaths in high-income countries, with these statistics outpacing those of other chronic diseases.^{2,3} Low and middle-income countries (LMIC) likely bare an even greater burden of HF morbidity, mortality and economic impact.⁴ In sub-Saharan Africa, HF prevalence is estimated to be 5% and increasing.⁵ At our own hospital, HF represents 10% of hospital admissions and 10% of in-hospital deaths.⁶ In addition, primary healthcare resources for managing chronic diseases such as HF are severely limited in sub-Saharan Africa,^{7,8} with most service provided at hospitals instead of community health facilities.

Although the first-year post-hospital period is known to be one of particularly high risk for HF patients in the U.S. and Europe,⁹ very little is known about this critical year in LMIC.⁴ Additionally, while renal dysfunction is common and worsens mortality in adults with HF in high-income countries,^{10,11} few studies have reported LMIC predictors of poor outcomes in discharged patients. A better understanding of post-hospital outcomes for HF patients as compared to in-hospital, as well as the predictors of mortality, will be critical to designing interventions to improve long-term health in this population.

Therefore, we conducted a prospective cohort study with 12-month follow up to determine the clinical course of adults with HF in Tanzania from the time of hospital admission, through hospital discharge and then for the first year after discharge. Our objectives were: 1) to compare one year post-hospital mortality in adults admitted with HF to adults admitted with other conditions and 2) to determine predictors of post-hospital mortality in adults with HF compared to predictors of in-hospital mortality. We hypothesized that post-discharge HF mortality would be significantly higher than other admitted patients, that outcomes and predictors would differ for in-hospital and post-hospital mortality and that markers of renal dysfunction would be a significant, independent predictor of post-hospital mortality.

METHODS**Study setting**

In this prospective cohort study, we consecutively enrolled adults hospitalized on the medical wards of Bugando Medical Centre (BMC). BMC is a public hospital that serves the Lake Victoria region of northwestern Tanzania (population: 13 million). BMC is located in the city of Mwanza, the second largest urban center in Tanzania and the capital of the Mwanza region. BMC has 100 adult medical beds and ~3000 medical hospitalizations per year.

Inclusion & exclusion criteria

Adults (≥ 18 years) hospitalized in the medical ward were eligible for enrollment. Potential study participants were provided with information regarding the study within 12 hours of hospitalization. All of those who provided informed consent were enrolled. Study participants with multiple hospitalizations to BMC during the study period were only enrolled during their first hospitalization.

All patients enrolled at time of admission were included in the “All Admitted Cohort.” All patients who survived until discharge were included in the “Post-hospital Cohort.” In this manuscript, we have provided data regarding both cohorts in order to describe the entire clinical course of admitted HF patients and for the sake of comparison. Our manuscript, though, focuses on the “Post-hospital HF Cohort” due to absence of published data regarding long-term outcomes for this group as well as the greater opportunity for intervention in this group.

Study procedures

On the day of enrollment, a pre-validated, adapted, translated version of the WHO STEPS questionnaire was administered in Kiswahili by a Tanzanian study investigator. The WHO STEPS questionnaire includes questions regarding prior testing, diagnosis, and treatment for chronic diseases as well as standard protocols for physical examination.¹² Heart failure specific questions from the Framingham clinical HF criteria were added in the WHO STEPS questionnaire to screen all admitted adults for clinical HF.

After completing the questionnaire, we conducted a standardized physical examination. Blood pressures were measured by a registered nurse or doctor using a mercury sphygmomanometer according to the WHO STEPS protocol.

Laboratory analysis

At the time of hospitalization, by hospital policy, all medical inpatients were offered voluntary counseling and testing for HIV and underwent measurement of glucose, creatinine, and urine dipstick testing. Serum creatinine levels were measured using a Cobas Integra 400 Plus Analyzer (Roche Diagnostic Limited, Basel, Switzerland). An estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation¹³ (without ethnic factor) as recommended by international guidelines. Random blood glucose was measured using a finger stick sample (Ascensia Glucometer, Bayer Healthcare, Germany). A urine dipstick was used to test for proteinuria, hematuria, and pyuria (Multistix 10SG, Siemens, USA).

Study Definitions

Clinical HF was defined as the simultaneous presence of at least 2 major Framingham HF criteria or 1 major criterion in conjunction with 2 minor criteria. Patients with clinical HF underwent echocardiography. Echocardiographic confirmation of HF was determined by ejection fraction <50% and/or diastolic dysfunction. These criteria are consistent with current HF study definitions in low and middle income countries.⁵ Study subjects with diagnoses other than HF were classified as “controls”.

Echocardiography

Echocardiography was performed using a GE VIVID 7 Pro by an expert echocardiographer following American Society of Echocardiography guidelines. LV systolic function was assessed by apical biplane method of discs (modified Simpson's rule). Patients with EF less than 50% were classified as having systolic dysfunction and LV diastolic dysfunction was diagnosed by the presence of a reduced e' ($e' < 9$ cm/s) and/or an increased E/e' ratio > 15 . Dilated cardiomyopathy (DCM) was defined by the presence of all-chamber or isolated LV dilatation and global hypokinesia in the absence of features of hypertensive heart disease or any other apparent cause of global dilatation and hypokinesia (ie regional wall motion abnormality). Ischemic cardiomyopathy was defined by depressed LV ejection fraction with supportive ECG findings and/or presence of regional wall motion abnormality. Hypertensive HF was defined by symptoms of HF, documented high blood pressure and ECHO finding of LVH or concentric remodeling (e.g. increase in relative wall thickness with normal LVMI), with either systolic or diastolic dysfunction, or both. Valvular HF was defined by HF secondary to primary underlying valvular abnormality (e.g. RHD with classic elbow shaped appearance or degenerative valve disease). HF secondary to HIV infection was defined in patients with HIV with a cardiac condition causing dilated HF. Other conditions, such as hypertrophic obstructive cardiomyopathy and endomyocardial fibrosis, were determined by an expert echocardiographer using ASE guidelines. All diagnoses of HF and determination of HF etiologies were confirmed by two blinded, independent physician reviewers. In the case of disagreement between these two physician reviewers, a certified cardiologist was consulted for final diagnosis.

Discharge diagnoses

Diagnoses were determined at the time of discharge. Since December 2008, our hospital has used a standard list of recommended discharge diagnoses adapted from the WHO's International Classification of Diseases version 10 (ICD-10). Heart failure patients were discharged with medical outpatient management according to hospital guidelines when determined in "stable discharge condition" by clinical staff. Hospital guidelines for heart failure were specifically written to include medications that are available in the pharmacy of our hospital including beta blockers and ACE inhibitors. Some medications which would be considered part of "optimal treatment" are not available in Tanzania such as digoxin and neprilysin inhibitors.

HF patients were discharged with optimal medical outpatient management when determined in "stable discharge condition" by clinical staff. This treatment regimen is routinely available in the study outpatient setting. Of note, palliative care in the study setting is provided as an inpatient service only; therefore, no patients were discharged for end-of-life care.

Follow-up of study participants

Three mobile phone numbers were obtained from all participants at discharge. Follow-up phone calls were made at one, three, six, and 12 months. During each call, a standard set of questions were asked in Kiswahili including vital status and primary care clinic attendance. These questions were asked directly to the study participant whenever possible, and alternate

phone numbers were used only if the study participant was unavailable or unable to communicate information clearly.

Measures

The primary study outcome was death after hospital discharge. Mortality was classified as in-hospital if it occurred during the index hospitalization and post-hospitalization if it occurred in the year that followed, not including, the index hospitalization.

Data analysis

Data were entered into Microsoft Excel and analyzed using STATA version 11 (StataCorp, College Station, Texas, USA). Categorical variables were described as proportions (percentiles), and continuous variables were described as means (interquartile ranges). For all cross-sectional analyses, a chi-squared test was used for comparing categorical variables and a Wilcoxon rank sum test was used for continuous variables. All available data was included in all calculations. No explanatory variable was missing more than 7 patients except for the urine dipstick results. A two-sided p-value of <0.05 was regarded as statistically significant in all analyses.

Cox regression models adjusted for age and sex were used for all survival analyses to compare outcomes between groups and to determine predictors of in-hospital and 12-month mortality. We adjusted for age and sex since these were thought to be the most important possible confounders for HF outcomes and predictors. Kaplan-Meier survival curves were used to display incident mortality. Study participants who were lost-to-follow-up were censored at the last contact date.

We estimated that one fifth of study participants had HF, that post-hospital mortality would be 50% in the HF group vs 25% in patients admitted with all other diagnoses. Given these assumptions, and allowing for a 10% loss-to-follow-up, we calculated that including 275 consecutively discharged adults would give us $>90\%$ power to detect this 25% absolute difference in 12-month, post-hospital mortality.

Ethical issues

Ethical approval was obtained from the ethics committees of BMC (IRB number BREC/001/18/2008), the Tanzanian National Institute of Medical Research and Weill Cornell Medical College. All study participants were informed about the study by a nurse or doctor fluent in Kiswahili and provided written informed consent before participation. Participants also consented to receiving phone calls at either their own mobile phone number or the mobile phone numbers that they provided for friends and relatives. All study procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

RESULTS

Enrollment

During the study period from October to December 2014, 670 total patients were admitted to the medical wards of our hospital. All patients were acutely ill and none were admitted for elective reasons. Forty-seven patients admitted with acute infectious diseases (malaria, urosepsis, acute tuberculosis and meningitis) were ineligible for the study. Of the remaining 623, 35 patients were excluded: 12 patients were <18 years of age, 17 patients died prior to enrollment and 6 patients refused informed consent. Therefore, a total of 588/623 (94.4%) of patients were enrolled. Of these 588, 29 (4.6%) and 45 (7.7%) were lost-to-follow up after 6 and 12 months, respectively. Nine of 145 (6.2%) HF and 36/443 (8.1%) of control patients were lost to follow-up in the first year after discharge.

Of the 588 study subjects enrolled, 145 (22.4%) were diagnosed with HF and 443 (75.3%) did not have HF. The in-hospital mortality rates were 38/145 (26.2%) in the HF group and 100/443 (22.6%) in the control group.

Therefore, 107 adults with HF and 343 control subjects continued in the Post-hospital Cohort. A total of 45 HF patients and 193 control patients survived until 365 days post-discharge.

Baseline Characteristics

The characteristics of the two study groups (HF and controls) are described for both the Post-hospital Cohort and All Admitted Patients Cohort in Table 1.

Compared to control subjects, HF subjects were more female (66/107 (61.7%) vs 188/343 (51.6%), $p=0.02$, respectively) and older (50.8 vs 44.7 years, $p=0.004$). Other notable differences were significantly: lower educational status, more known hypertension, more history of renal disease, more patients taking anti-hypertensive medication, more obesity in the HF group. Of note, HF subjects had a statistically greater number of patients with low eGFR (25/107 (23.4%) vs 33/343 (9.7%), $p<0.0001$) but a similar prevalence of proteinuria compared to controls (25/107 (23.6%) vs 79/343 (23.0%), $p=0.99$). Additionally, significantly fewer HF patients were HIV infected (12/107 (11.2%) vs 92/343 (26.8%), $p=0.03$). Of adults with HF, 57/107 (53.3%) were newly diagnosed at the time of hospital admission. Additionally, only 41/107 (38.3%) were currently prescribed any HF medication prior to admission.

At admission, 79/145 (54.5%) of adults with HF were newly diagnosed. Additionally, only 57/145 (39.6%) were currently prescribed any HF medication prior to admission. The most prevalent individual Framingham major and minor criteria present were cardiomegaly and dyspnea on exertion, respectively. Prevalence of all Framingham factors was similar in HF patients not surviving to hospital discharge (Table 1).

Heart Failure Mortality

In the Post-hospital Cohort (Figure 1A), mortality was significantly higher in HF participants as compared to controls, 62/107 (57.9%) vs 150/343 (43.7%) respectively

(HR=1.57[1.13–2.18]), $p=0.007$ by Cox regression adjusted for age and sex). Between HF subtypes, mortality in the year after discharge was not significantly different, $p=0.480$.

By comparison, in-hospital mortality was not significantly different between adults with HF and control patients (38/145 (26.2%) vs 100/443 (22.6%), respectively ($p=0.564$ (Figure 1B)). In-hospital mortality was also similar between HF subtypes ($p=0.227$).

In total, 100 (69.0%) of the 145 enrolled HF participants died within one year of hospital admission compared to 250 (56.4%) of the 443 enrolled control participants (HR=1.45[1.13–1.85]), $p=0.004$). Of these 100 deaths in the HF group, 38/100 (38.0%) occurred in-hospital and 62/100 (62.0%) occurred in the first year after hospital discharge.

Factors Associated with Heart Failure Mortality

All variables listed in Table 1 were analyzed as possible predictors of post-hospital and in-hospital mortality.

The only significant independent predictors of post-discharge mortality after adjusting for age and sex were eGFR ($< \text{or} \geq 45 \text{ mL/min/1.73m}^2$) (HR2.94[1.62–5.31], $p<0.0001$ and proteinuria (HR=2.03[1.13–3.66]), $p=0.018$) (Figure 2). Additionally, the combination of proteinuria and low eGFR (eGFR $<45 \text{ mL/min/1.73m}^2$) was strongly associated with HF mortality as compared to controls (HR=1.59[1.25–2.16], $p<0.0001$) with none of the patients with the low eGFR/positive proteinuria combination surviving at the one-year post-discharge time point.

By comparison, Cox regression analysis adjusted for age and sex (Supp Table 1) revealed nine significant predictors of HF mortality in the in-hospital period: heart rate >120 bpm, severe hypotension, low glomerular filtration rate, pleural effusion, proteinuria, sex, diastolic and systolic blood pressure and acute pulmonary edema: (HR[CI]: 3.89[1.61–9.30], 3.85[1.72–8.0], 3.25[1.55–6.70], 3.07[1.38–6.80], 2.03[1.1–3.8], 1.93[1.01–3.70], 0.98[0.97–0.99], 0.59[0.36–0.9], 0.366[0.16–0.82] respectively.

Heart Failure Etiology

Heart failure etiologies and mortality are described in Figure 3. Hypertensive heart disease was the most prevalent HF subtype (45/107 (42.1%)) followed by rheumatic (11/107 (10.3%)), cor pulmonale (11/107 (10.3%)), alcoholic dilated (7/107 (6.5%)), ischemic (6/107 (5.6%)), peripartum and idiopathic cardiomyopathy (5/107 (4.7%)), HIV dilated and tamponade (4/107 (3.7%)), other valvular (3/107 (2.8%)), VSD/ASD and high output (2/107 (1.9%)) and EMF and restrictive cardiomyopathy (1/107 (0.9%)). Total burden of all-cause dilated HF was 21/107 (19.6%) and of all-cause valvular was 14/107 (13.1%). Heart failure etiology prevalence of the All Admitted Cohort was generally similar to those surviving to discharge.

Renal Function in Heart Failure Subgroups

Baseline characteristics of patients with and without low eGFR are described in Supp Table 2. In the Post-hospital Cohort, more adults with HF had an eGFR $< 45 \text{ mL/min/1.73m}^2$ compared to all other diagnoses (40/107 (37.4%) vs 64/343 (18.7%), $p<0.0001$). Subgroup

analysis of HF patients surviving to hospital discharge showed statistically similar rates of low eGFR, proteinuria and the combination of low GFR/proteinuria across all sub-groups (Supp Table 3A).

For comparison, in the All Admitted Cohort, significantly more of the HF population admitted had a low eGFR as compared to all other diagnoses (67/145 (46.2%) vs 99/443 (22.3%), $p < 0.0001$) and more patients with low eGFR/positive proteinuria (30/145 (20.7%) vs 50/443 (11.3%), $p = 0.01$) as compared to controls. Within the HF group there was a significant difference in number of patients with low eGFR between subgroups, with hypertensive HF having the largest proportion of low eGFR (38/62 (61.3%))(Supp Table 3B). Proteinuria, and the combination of low eGFR/positive proteinuria, were evenly distributed across HF subgroups ($p = 0.154$ and 0.329 , respectively).

DISCUSSION

More than half of adults discharged with HF in stable condition from a typical public hospital in Africa had died within 1 year. Greater than 40% of these had died within 6 months. The risk of post-hospital mortality for adults with HF was 70% greater than control adults discharged with other medical conditions and is 3-fold greater than the 20% mortality reported for adults admitted with HF in high-income countries.¹⁴⁻¹⁶ This is the first published data to describe the long-term clinical course of African adults admitted and discharged with HF compared to those with other medical conditions. From prior, uncontrolled studies it is difficult to determine if poor post-hospital outcomes for adults with HF was specific to this condition or generally true for all adults discharged from hospitals in Africa. Other recently published data from SSA confirm that long-term outcomes are poor for outpatients with HF as well.¹⁷ There is an urgent need for interventions to improve the long-term health of adults with HF in Africa.

The post-hospital period is particularly important for adults with HF in Africa because many adults are first diagnosed with HF during their index hospital admission. In our study, >50% of study subjects admitted with HF were newly diagnosed at the time of admission. Three-fourths of study subjects with HF improved during hospitalization and were discharged in stable condition. A similarly high prevalence of new diagnosis at the time of hospital admission has been reported for other diagnoses such as HIV, hypertension and diabetes.^{6,18} The delay in diagnosis in HF until the time of the index hospital admission is likely related to the limitations in resources for diagnoses of HF at lower level health facilities.^{7,8} Therefore, as supported by evidence from the U.S.,^{19,20} we have identified the post-hospital period as a critical window of interventional opportunity for improving HF outcomes in Africa.

Markers of renal disease (i.e. positive proteinuria and low eGFR) were the only independent predictor of mortality in both the in- and post-hospital periods. These data extend the findings of a recent study of predictors of post-discharge, two-month HF mortality²¹ reported renal function as an important predictor of mortality. Other data support the strong relationship between renal disease and short-term post-hospital mortality in adults with HF in Africa.^{17,21} Interestingly, proteinuria was a strong predictor of mortality. This is an

especially interesting finding given recent data from the U.S. showing proteinuria is a strong, independent predictor of HF mortality.²² These findings are of dual importance: 1) we believe this group represents an important first-step in intervention of the high HF mortality in SSA, and 2) our data suggest that renal dysfunction in this population may be identifiable with low-cost screening tools (i.e. urine dipstick for proteinuria).

These data have similarities and differences as compared to previous heart failure trials in HIC settings. Compared to major clinical trial of HF in the U.S. and Europe, our study subjects were younger (52 vs. 65 years), more female (56% vs. 29%) and had less presumed ischemic heart disease (6.2% vs. 52%).²⁴⁻²⁸ These differences in population should be taken into account when efforts are made to generalize clinical trial results from HIC to Africa and indicate a need for clinical trials conducted in Africa. We also report a mortality rate of 65% in the first year post-discharge, a number in-line with that of very early HF trials in HIC settings,²⁸ but much higher than that of those more recently published.²⁹ This is encouraging and suggests that HF outcomes can be improved in LMIC settings. Additionally, we report a 7% loss-to-follow-up rate, which is higher than that of HIC HF trials but is similar to that of previous SSA HF cohorts (7.0% vs 6.9% and 13.8%).^{17,30}

There are limitations to the current study. Most notably, whether the reported mortality associated with renal dysfunction is a result of intrinsic renal disease or secondary to heart failure is unknown. Future studies should include either patients with known baseline renal function or repeat measures of renal function post-discharge.

In summary, we report that 60% of adults discharged from our hospital with HF had died within 1 year. The risk of post-hospital mortality was 70% higher than adults discharged from the same hospital with other diagnoses and 3-fold higher than adults admitted with HF to hospital in high-income countries. Readily available markers of renal disease (such as urine dipstick for protein) are a common and independently predict post-hospital stay mortality. Therefore we conclude that developing and testing interventions to improve post-hospital outcomes for adults admitted with HF will be critical to improve the long-term health of adults with HF in Africa. Clinical this population should address renal disease as important prognostic indicators and possibly a target for intervention in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We would like to thank Professor Kien Mteta, the Director General of Bugando Medical Centre, for his administrative support in this study.

Funding

This project was supported by National Institutes of Health (NIH) Research Training Grant R25 TW009337, funded by the Fogarty International Center, the NIH Office of the Director, the National Institute of Mental Health, and the National Institute of Diabetes and Digestive and Kidney Diseases. Additionally, This study was supported by grants from the National Institutes of Health Fogarty Foundation (TW000018 and K01 TW010281-01) and the National Institute of Allergy and Infectious Diseases (K24 AI098627).

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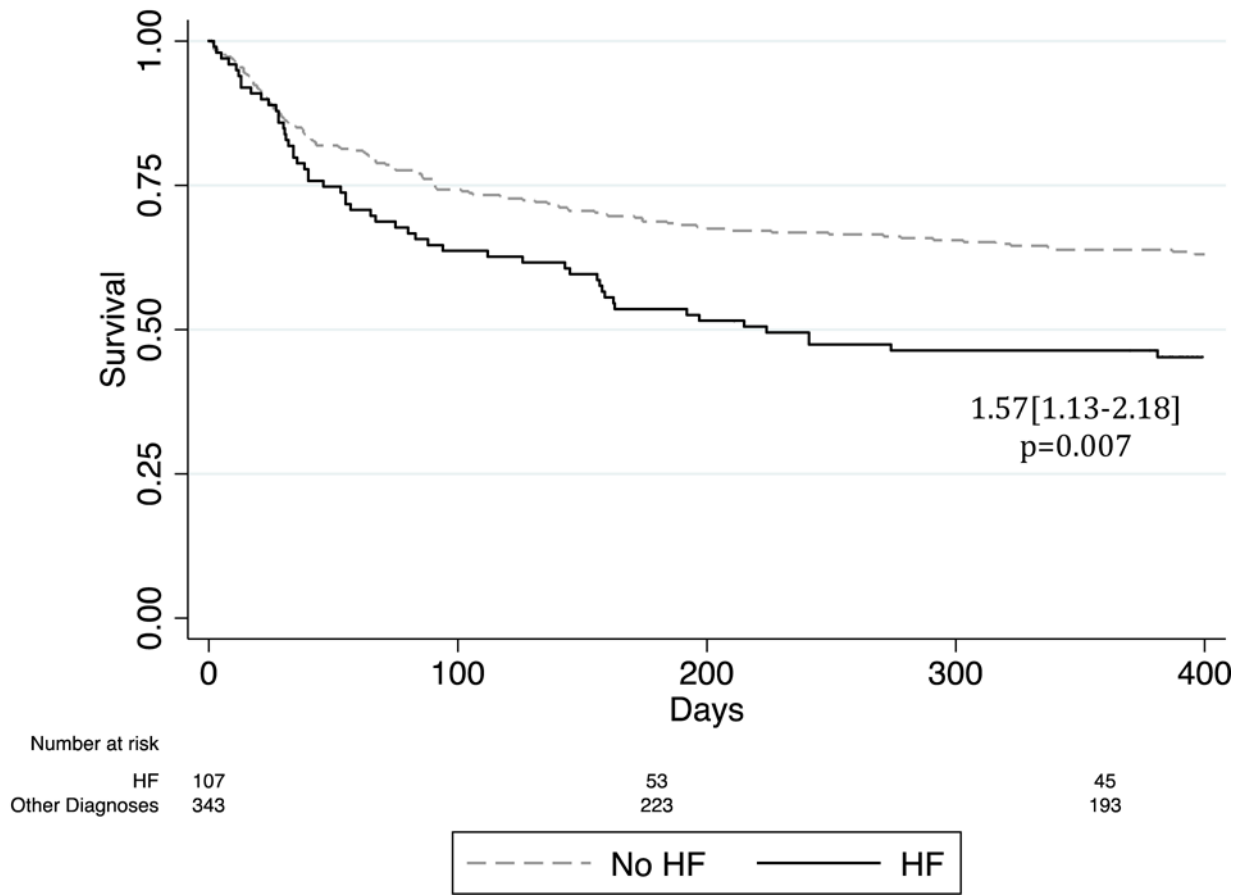
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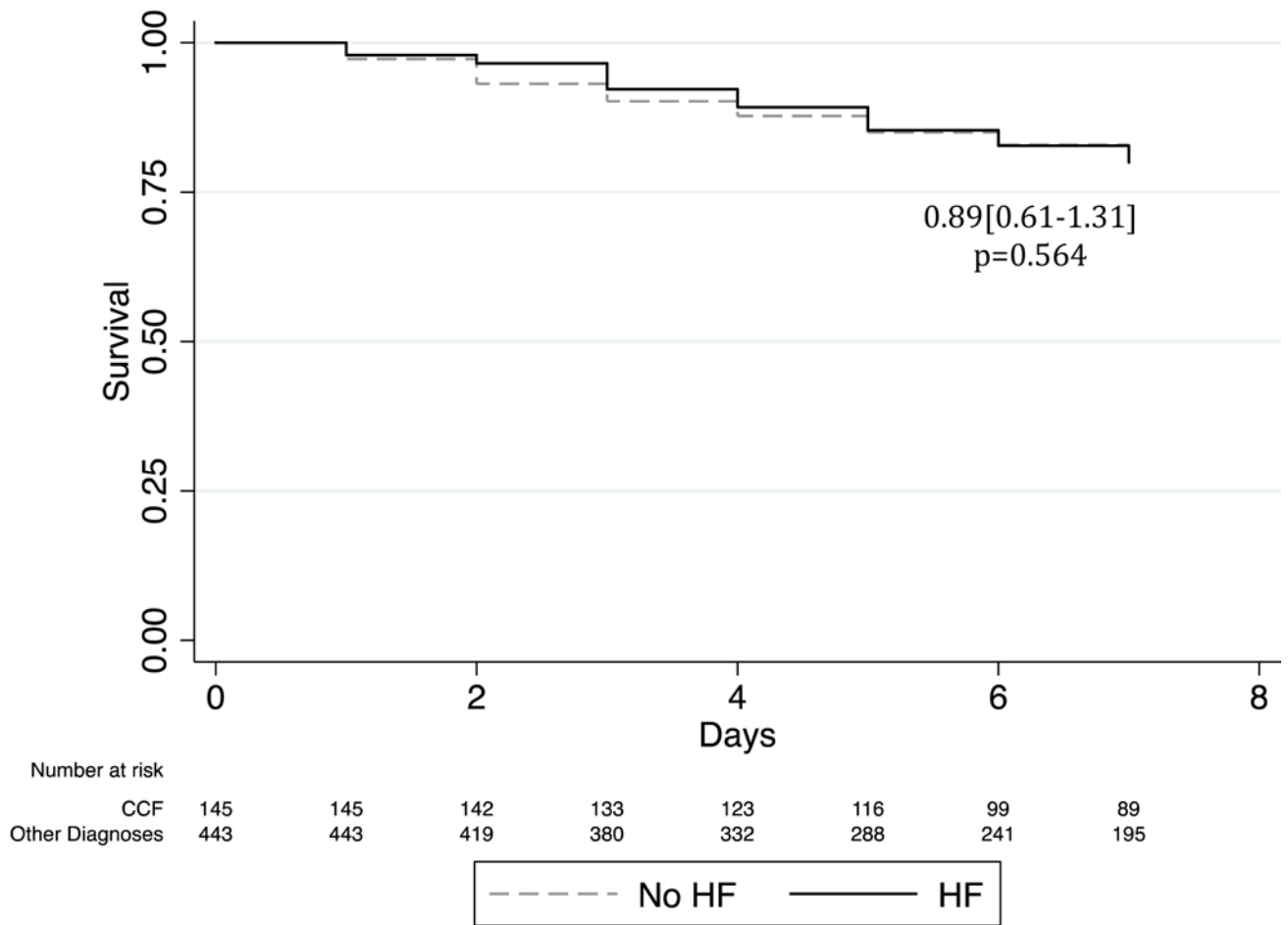
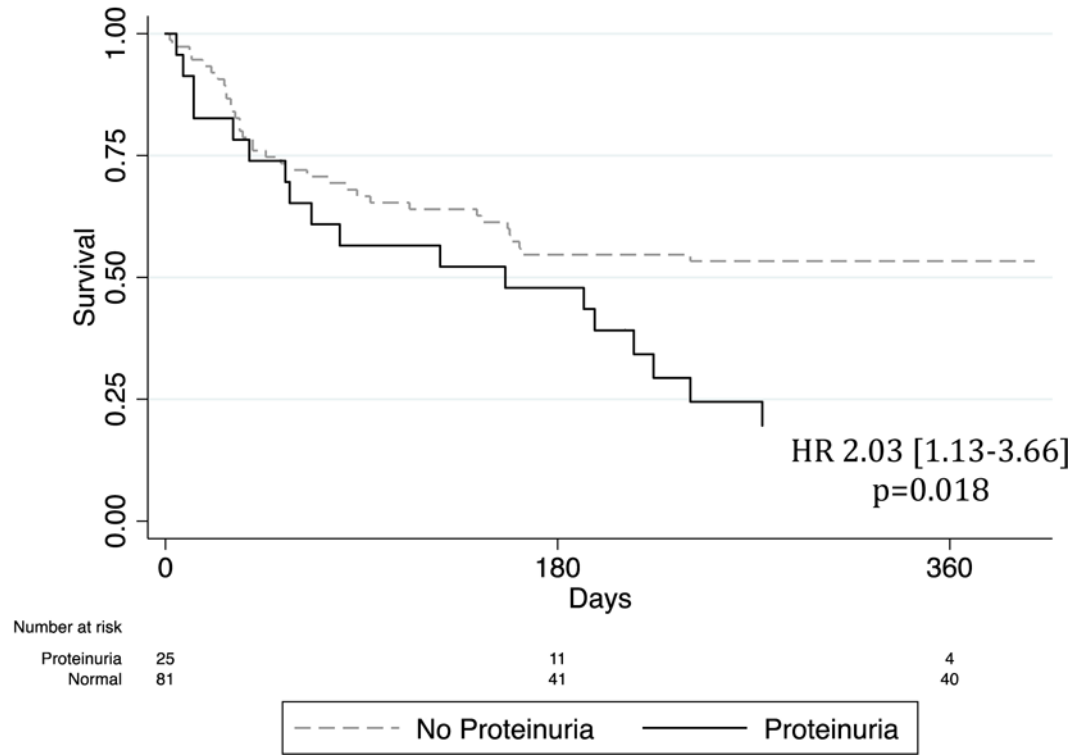


Figure 1. Kaplan Meier survival curve of HF patients as compared to all others admitted. Cox regression adjusted for age and sex. (A) Incidence of post-discharge mortality in the Post-hospital Cohort. (B) Incidence of in-hospital mortality in the All Admitted Cohort.

(A)



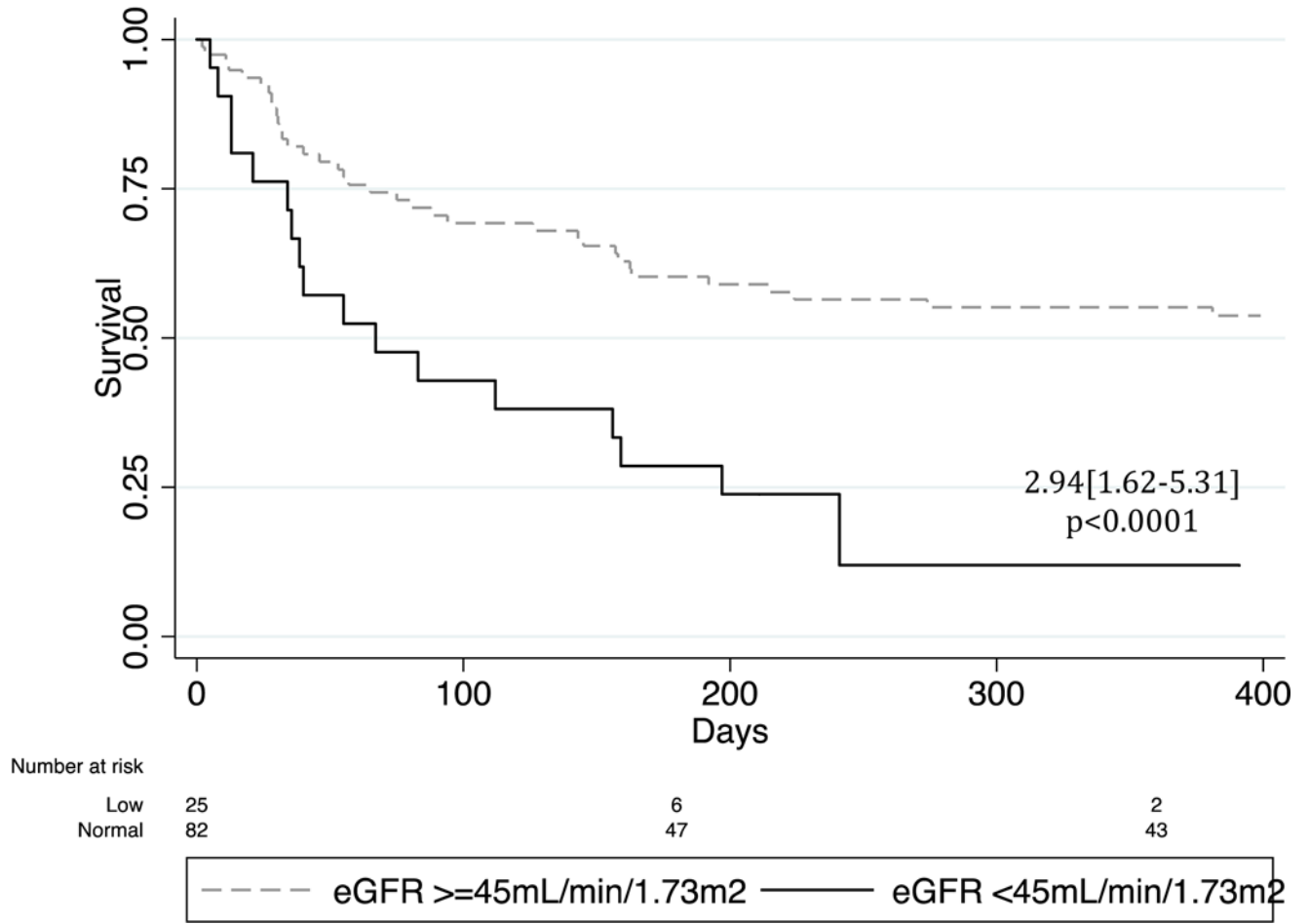
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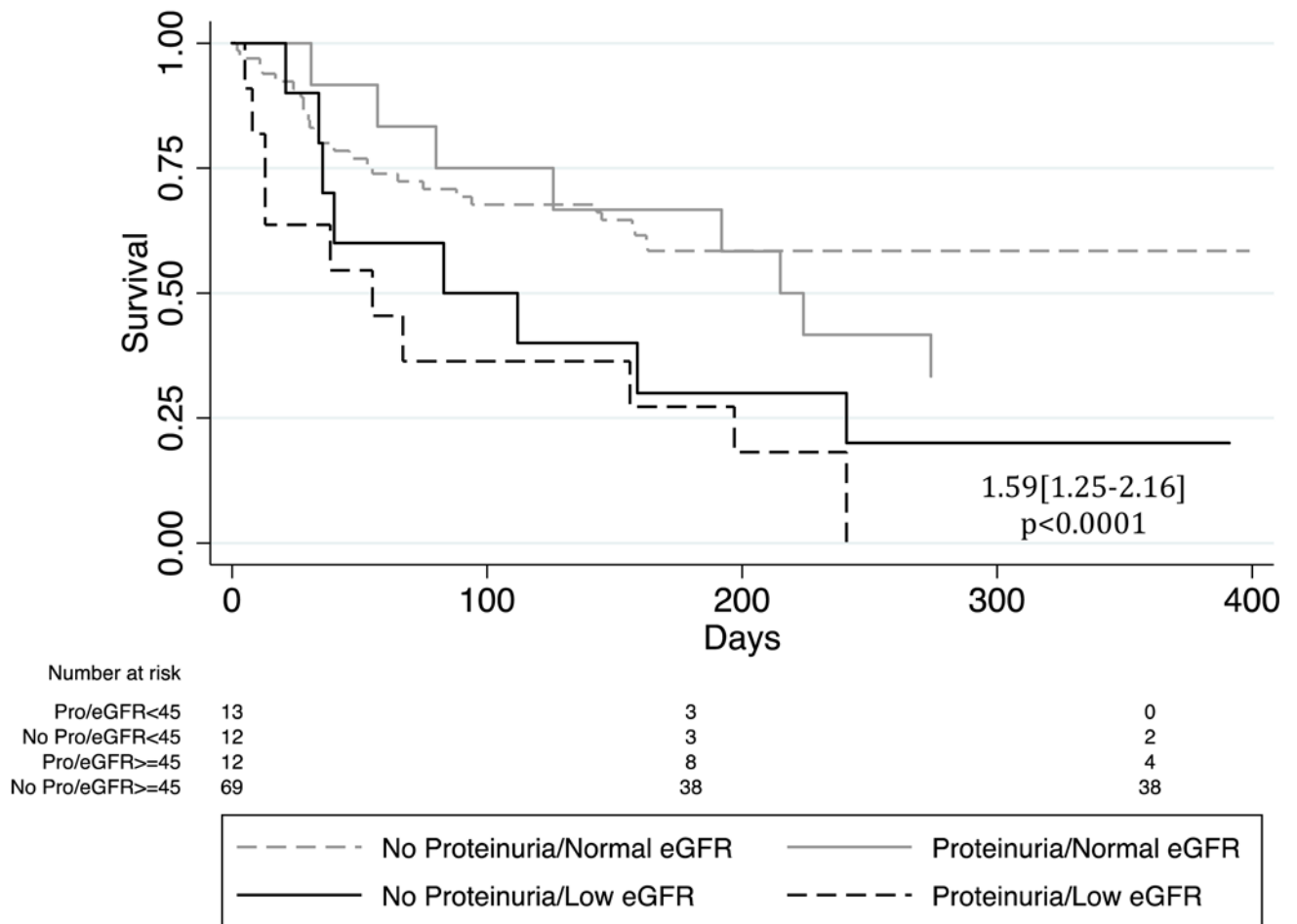


Figure 2. Kaplan Meier survival curves of (A) proteinuria, (B) GFR and (C) proteinuria/GFR combinations in the Post-hospital HF Cohort. Cox regression adjusted for age and sex.

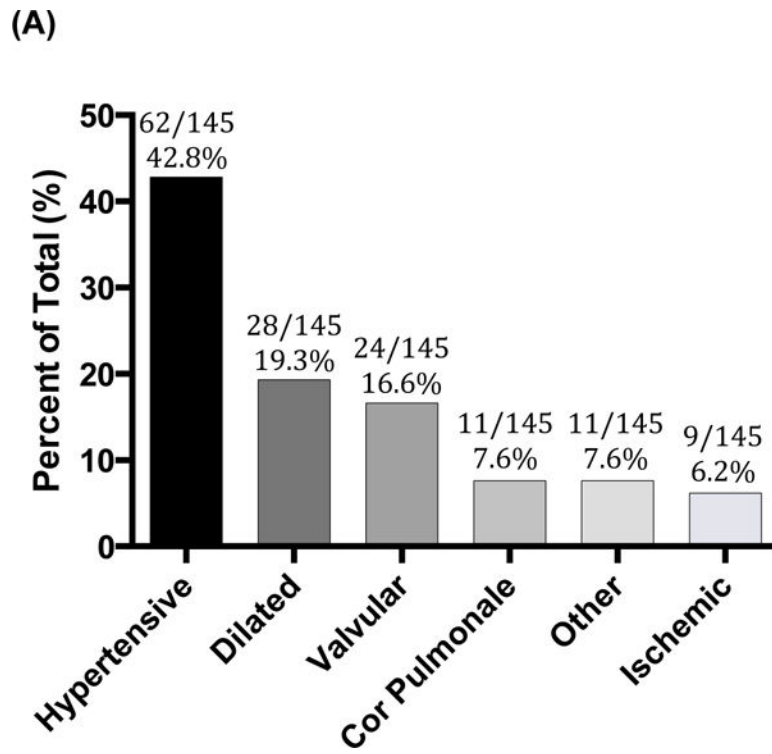


Figure 3. Likely HF etiologies in study subjects admitted with heart failure (n=145) (Figure A). Figure B illustrates the likely etiologies for those adults with dilated cardiomyopathies.

Baseline characteristics of study participants illustrating the differences between patients admitted with HF and all other patients.

Table 1

Variable (% or SD)	Post-hospital Cohort		All Admitted Cohort		p-value*	p-value*
	HF (n=107)	Controls (n= 343)	HF (n=145)	Controls (n=443)		
Demographic characteristics						
Male	41 (38.3%)	177 (51.6%)	64 (44.1%)	241 (54.4%)	0.03	0.03
Age, years#	50.8 (26)	44.7 (33)	52.0 (34)	45.9 (27)	0.004	0.001
Education						
Did not complete primary education	48 (44.9%)	114 (33.3%)	68 (46.9%)	153 (34.9%)	0.03	0.03
Completed primary education	46 (43.0%)	173 (50.6%)	57 (39.3%)	219 (49.9%)		
Completed secondary education or higher	13 (12.2%)	55 (16.1%)	20 (13.8%)	67 (15.3%)		
Occupation						
Farmer	54 (50.5%)	166 (48.5%)	75 (52.1%)	207 (47.0%)	0.18	0.06
Petty trader	21 (19.6%)	99 (29.0%)	28 (19.4%)	135 (30.7%)		
Civil servant, business, or professional	18 (16.8%)	46 (13.5%)	25 (17.4%)	61 (13.9%)		
Unemployed, retired, or student	14 (13.1%)	31 (9.1%)	16 (11.1%)	37 (8.4%)		
Medical History						
Current tobacco smoking	2 (1.9%)	16 (4.7%)	5 (3.5%)	28 (6.3%)	0.39	0.39
Current alcohol use	4 (3.7%)	26 (7.7%)	4 (2.8%)	42 (9.6%)	0.14	0.01
History of hypertension	46 (43.0%)	75 (22.0%)	61 (42.1%)	92 (20.9%)	<0.0001	<0.0001
History of kidney disease	11 (10.3%)	8 (2.3%)	17 (11.7%)	8 (1.8%)	<0.0001	<0.0001
History of diabetes	9 (8.4%)	28 (8.2%)	14 (9.7%)	30 (6.8%)	0.83	0.26
Medication Use						
Herbal or traditional medication	22 (20.8%)	66 (19.4%)	34 (23.6%)	89 (20.2%)	0.68	0.38
NSAIDs or steroids	13 (12.3%)	64 (18.7%)	16 (11.1%)	77 (17.4%)	0.18	0.07
Anti-hypertensive	41 (38.3%)	67 (19.6%)	53 (36.6%)	83 (18.8%)	0.001	<0.0001

Variable (% or SD)	Post-hospital Cohort			All Admitted Cohort		
	HF (n=107)	Controls (n= 343)	p-value*	HF (n=145)	Controls (n=443)	p-value*
Symptoms on hospitalization						
Decreased urine output	28 (26.2%)	20 (5.6%)	<0.0001	41 (28.3%)	32 (7.3%)	<0.0001
Chest pain	29 (27.4%)	43 (12.5%)	<0.0001	34 (23.6%)	53 (12.0%)	0.001
Shortness of breath	96 (90.6%)	54 (15.7%)	<0.0001	128 (88.9%)	83 (18.7%)	<0.0001
Framingham HF Criteria						
Major Criteria						
Acute Pulmonary Edema	56 (65.9%)	1 (0.3%)	<0.0001	67 (59.8%)	2 (0.5%)	<0.0001
Cardiomegaly	99 (92.5%)	60 (17.5%)	<0.0001	135 (93.1%)	85 (19.2%)	<0.0001
Neck Vein Distension	44 (41.1%)	2 (0.6%)	<0.0001	58 (40.0%)	2 (0.5%)	<0.0001
PND or Orthopnea	93 (86.9%)	18 (5.3%)	<0.0001	124 (85.5%)	27 (6.1%)	<0.0001
Pulmonary Rales	88 (82.2%)	21 (6.1%)	<0.0001	120 (83.3%)	41 (9.3%)	<0.0001
S3 Heart Sound	21 (19.8%)	11 (3.2%)	<0.0001	28 (19.4%)	11 (2.5%)	<0.0001
Minor Criteria						
Bilateral Ankle Edema	77 (72.6%)	24 (7.0%)	<0.0001	108 (75.0%)	40 (9.1%)	<0.0001
Dyspnea on Exertion	96 (90.6%)	54 (15.7%)	<0.0001	128 (88.9%)	83 (18.7%)	<0.0001
Nocturnal Cough	83 (77.6%)	21 (6.1%)	<0.0001	112 (77.2%)	29 (6.5%)	<0.0001
Pleural Effusion	18 (21.2%)	5 (1.5%)	0.58	30 (27.0%)	6 (1.4%)	0.051
Heart Rate >120 bpm (l)	7 (6.5%)	17 (5.0%)	0.58	15 (10.3%)	29 (6.5%)	0.13
Meets Framingham criteria for HF						
	104 (97.2%)	6 (1.8%)	<0.0001	140 (96.6%)	42 (9.5%)	<0.0001
Signs on physical examination						
Heart rate (bpm)	92.1 (25.0)	91.5 (23.0)	0.396	93.3 (26)	92.7 (25.1)	0.318
Systolic blood pressure (mm Hg)	127.4 (40)	123.5 (27)		125.0 (44)	123.9 (27)	
< 90	3 (2.9%)	2 (0.6%)	0.04	11 (7.7%)	7 (1.6%)	<0.0001
90–139	69 (65.7%)	259 (75.7%)		89 (62.2%)	330 (74.7%)	
140–179	28 (26.7%)	63 (18.4%)		36 (25.2%)	76 (17.2%)	
> 179	5 (4.8%)	18 (5.3%)		7 (4.9%)	29 (6.6%)	

Variable (% or SD)	Post-hospital Cohort			All Admitted Cohort		
	HF (n=107)	Controls (n= 343)	p-value*	HF (n=145)	Controls (n=443)	p-value*
Diastolic blood pressure (mm Hg)	80.5 (25)	77.1 (17)	0.03	78.5 (26)	77.3 (17)	0.375
Oxygen saturation (%)	88.7 (18)	95.1 (2)	<0.0001	88.5 (10)	94.3 (2)	<0.0001
Abdominal obesity	83 (77.6%)	219 (63.8%)	0.01	109 (75.2%)	273 (61.6%)	0.003
Body mass index (kg/m ²)						
< 18.5	14 (13.1%)	47 (13.8%)	0.15	16 (11.0%)	63 (14.3%)	0.025
18.5–24	58 (54.2%)	213 (62.5%)		79 (54.5%)	277 (63.0%)	
25–29	17 (15.9%)	52 (15.3%)		25 (17.2%)	64 (14.5%)	
30	18 (16.8%)	29 (8.5%)		25 (17.2%)	36 (8.2%)	
Laboratory investigations						
Random blood glucose (mmol/L)	7.3 (2.6)	8.0 (2.8)	0.562	7.4 (2.6)	8.0 (2.9)	0.757
Estimated glomerular filtration rate (ml/min/1.73m ²)						
<45	25 (23.4%)	33 (9.7%)	<0.0001	44 (30.3%)	56 (12.7%)	<0.0001
45	82 (76.6%)	308 (90.3%)		101 (69.7%)	384 (87.3%)	
Proteinuria by urinalysis (20)	25 (23.6%)	79 (23.0%)	0.99	43 (29.9%)	122 (28.8%)	0.80
HIV Status						
Positive	12 (11.2%)	92 (26.8%)	0.03	14 (9.7%)	129 (29.1%)	<0.0001
Negative	92 (86.0%)	251 (73.2%)		131 (90.3%)	344 (77.7%)	

* HF vs Control for respective Cohort

Maximum number of missing values was 4 for age variable