Supplemental Material

Title: **Descriptive Epidemiology and Short-Term Outcomes of Heart Failure Hospitalization in Rural Haiti**

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Supplement Methods

Hospital referral zones

Patients were grouped into proximity-based geographic zones based on self-reported addresses and UHM's regional referral structure (**Table S1**). Patients in zone 1 (primary catchment area) generally receive all primary care at UHM. Patients in zone 2 (secondary catchment area) generally receive primary care from another facility and UHM is the closest regional hospital. Patients in zone 3 may present to a regional hospital closer to them, but may be referred to UHM for specialty care. Zone 4 patients live outside the standard referral catchment area of UHM but self-present to UHM. Though the referral structure has been designed as part of hospital planning, the majority of patients self-present to a hospital of their choice.

Electronic chart extraction

A list of patients meeting the inclusion criteria – along with demographic and care utilization data – were exported from the UHM electronic medical record (EMR). The electronic data export included basic demographics including age at the time of primary admission and address (to the level of the communal section). When a physician enters a brief consultation note in the EMR, the encounter is recorded with a date and time stamp. Physician-entered diagnoses are coded using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). Care utilization data including dates and times of admission, discharge, subsequent clinic visits, and repeat hospitalization dates were included in the data export. All variables involving dates, such as length-of-stay and number of days between hospital discharge and follow-up clinic visit, were calculated using the electronically entered dates.

Paper chart extraction

The paper medical records were reviewed in November 2014. One co-investigator (GFK) extracted clinical information from the following sources (when available): admission note, progress notes, discharge summary, death certificate (if applicable), electrocardiogram, and laboratory results. Comorbidities such as history of hypertension and diabetes are based on patient self-report at the time of admission and were not systematically verified by clinician staff. Random glucose was not systematically recorded for the study. Patients generally do not know if they have had a prior myocardial infarction. When available, symptom severity indicated by the New York Heart Association classification[1] was extracted. Discharge medication lists were manually extracted from discharge summaries.

Study data were collected and managed using Research Electronic Data Capture (REDCap, Vanderbilt University, Nashville, TN) electronic data capture tools hosted at Boston University.[2] REDCap is a secure, web-based application designed to support data capture for research studies, providing an interface for validated data entry, procedures for importing data from external sources, and automated export procedures to common statistical packages. Validation rules, range checks, and consistency checks were used to ensure data entry quality. Data entered into the electronic database were not verified by another co-investigator.

Clinical echocardiography data extraction

A cardiologist (GFK) performed clinical echocardiograms using SonoSite MicroMaxx (SonoSite, Inc., Bothell, WA) portable ultrasound machines. Standard two-dimensional echocardiographic measurements[3] and reports were entered into a clinical echocardiogram database housed in REDCap[2] at the time of the diagnostic procedure. Left ventricular mass was calculated using the cube formula.[3] Cardiologist echocardiograms were stored on the hospital's digital radiology system. When the visiting cardiologist was not at UHM, general and internal medicine

physicians performed basic echocardiograms to aid in the diagnosis of HF and inform clinical care.[4] However, the basic echocardiogram data were not electronically stored for review by a cardiologist and were not included in the present study.

Data merging

Data from three sources were merged to produce the final combined study dataset: (1) exported data from the UHM EMR, (2) data extracted from paper charts, and (3) electronically coded echocardiogram data. The patient's hospital EMR identification number was used to link the 3 data sources. After the merged database was assembled, a unique study identification number was generated for all study participants and all identifiers were deleted. Only the study PI had access to the final dataset.

Patient follow-up at facilities other than UHM

We linked clinic visit data from a nearby health center – in Lascahobas commune – to explore if patients presented to another local ZL-supported clinical site for follow-up after discharge.

Diagnostic characteristics of local physician HF diagnosis

Local physicians assigned a diagnosis of HF based on clinical symptoms and signs. However, the cardiologist did not agree with the local physicians in all suspected cases. The diagnostic characteristic of local clinical diagnosis was assessed in relation to the diagnosis assigned by the cardiologist using echocardiography. Of the patients evaluated by the cardiologist, the positive predictive value was calculated by dividing the number of patients in whom the cardiologist agreed with the local physicians (true positives) by the total number of patients with suspected HF (true positives + false positives). As the cardiologist did not systematically assess patients who did not have a clinical diagnosis of HF assigned by the local physicians, other diagnostic characteristics such as sensitivity and specificity cannot be calculated.

Supplement Results

Self-reported hypertension and diabetes

During the course of routine clinical care, past medical history regarding hypertension and diabetes is recorded in the clinical chart. The available surrogate for hypertension was admission blood pressure. When comparing hypertension by past medical history against a diagnostic standard of hypertension by admission vital signs (systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥ 90 mmHg), the sensitivity and specificity were 68% and 74%, respectively.

A past history of diabetes was only noted in 22 patients. The available surrogate for a diagnosis of diabetes was the prescription of glucose-lowering medications at discharge. When comparing diabetes by past medical history against a diagnostic standard of discharge diabetes medicine, the sensitivity and specificity were 79% and 96%, respectively. Because there were relatively few patients with a past history of diabetes, the positive predictive value was 50% (only half of patients with reported diabetes were treated with glucose-controlling medicines at discharge).

Characteristics of patients with and without echocardiogram

The demographic and clinical characteristics of patients with (n=81, 26%) and without (n=230, n=74%) echocardiogram are shown in **Table S3**. The patients were similar with respect to age, sex, NYHA classification, and comorbidities. Compared to patients with echocardiogram, patients without echocardiogram had higher systolic (133 mmHg vs. 145 mmHg, p=.01) and diastolic blood pressure (84 mmHg vs. 91 mmHg, p=.03). The median length of stay was longer in patients with (12 days) vs. without (10 days) echocardiogram (p=.04).

Echocardiographic measures

Echocardiographic measures of the patients with formal echocardiograms are shown in **Table**

S4. Of patients with cardiomyopathy by echocardiography, mean left ventricle ejection fraction was very low at 22.1% (±standard deviation 7.6%) compared with 53.0%±16.9% for those with other causes of HF. Cardiomyopathy patients also had greater left ventricular end diastolic dimensions (54mm±13mm vs. 43mm±16mm], p<.01) and mass (141g±59g vs. 85g±60g, p<.01).

Patient follow-up at facilities other than UHM

Eighteen of the discharged HF patients lived in Lascahobas (zone 2) and served by the nearby ZL-supported health center. Seven of these 18 patients were linked to the UHM clinic within 30 days, with only one of the other 11 Lascahobas patients having a clinic visit at the Lascahobas health center after discharge from UHM, occurring 96 days later. No patients from any other neighboring communes were seen in the Lascahobas health center after UHM discharge.

Supplement Table S1. List of communes within the Primary, Secondary, and Tertiary zones of University Hospital Mirebalais. All other Communes in Haiti are considered outside of the referral zones. Population per 2012 estimates.[5]

Department	Commune
Zone 1: Primary catchment, population = 165,118	
Centre	Mirebalais
Centre	Saut d'Eau
Centre	Savanette
Zone 2: Secondary catchment, population = 184,291	
Artibonite	La Chapelle
Centre	Boucan Carré
Centre	Lascahobas
Ouest	Cornillon
Zone 3: Tertiary catchment, population = 2,189,873	
Artibonite	Desdunes
Artibonite	Dessalines
Artibonite	Gonaïves
Artibonite	Grande Saline
Artibonite	Petite Rivière de L'Artibonite
Artibonite	Saint-Marc
Artibonite	Saint-Michel de L'Attalaye
Artibonite	Verrettes
Centre	Belladères
Centre	Cerca Cavajal
Centre	Cerca La Source
Centre	Hinche
Centre	Thomassique
Centre	Thomonde
Ouest	Arcahaie
Ouest	Cabaret
Ouest	Croix-des-Bouquets
Ouest	Fonds Verettes
Ouest	Thomazeau
Zone 4: Outside the UHM referral zone, population = 7,873,929	

Supplement Table S2. Heart failure diagnoses for study inclusion (defined by clinical providers and entered in the EMR).

Heart Failure Diagnoses	ICD-10 code
Cardiomyopathy due to human immunodeficiency virus	B33.2
Rheumatic mitral stenosis	I05.0
Rheumatic heart disease, not mitral stenosis	I09.1
Rheumatic heart disease, unknown type	I09.9
Hypertensive heart disease with HF	I11.0
Ischemic cardiomyopathy	I25.5
Isolated right HF	I27.9
Dilated cardiomyopathy	I42.0
Endomyocardial fibrosis	I42.3
Alcoholic cardiomyopathy	I42.6
Idiopathic cardiomyopathy	I42.8
Congestive HF exacerbation	I50.9
HF, not otherwise specified	I50.9
Peripartum cardiomyopathy	O90.3
Ventricular septal defect	Q21.0
Atrial septal defect	Q21.1
Tetralogy of Fallot	Q21.3
Congenital heart disease	Q24.9

Table S3. Demographic and clinical presentation characteristics for patients with and without echocardiogram*

Characteristic	n with available data†	Echo		No Echo		p‡
N (%)	311	81	(26.0)	230	(74.0)	
Age at admission, years	311					
Mean ±sd		49.9	±17.7	53.4	±18.7	.15
≤ 40 years, n (%)		28	(34.6)	63	(27.4)	.22
Sex: Women, n (%)	311	50	(61.7)	136	(59.1)	.68
Catchment area, n (%)	311					.03
Zone 1 (Primary)		32	(39.5)	68	(29.6)	
Zone 2 (Secondary)		5	(6.2)	44	(19.1)	
Zone 3 (Tertiary)		26	(32.1)	73	(31.7)	
Zone 4 (Outside referral zones)		18	(22.2)	45	(19.6)	
NYHA class n (%)	156	(n=40)		(n=116)		.95
Class II		1	(2.5)	2	(1.7)	
Class III		10	(25.0)	29	(25.0)	
Class IV		29	(72.5)	85	(73.3)	
Comorbidities (self-reported)						
Hypertension, n (%)	263	29	(43.9)	96	(48.7)	.50
Diabetes, n (%)	267	2	(3.0)	20	(10.0)	.08
HIV, n (%)	269	0	(0)	7	(3.5)	.12
Habits						
Smoking, current or past, n (%)	267	12	(18.5)	57	(28.2)	.12
Alcohol, current or past, n (%)	209	6	(11.5)	37	(23.6)	.06
Vital Signs						
Systolic BP, mmHg, mean ±sd	275	133	±30	145	±37	.01
Diastolic BP, mmHg, mean ±sd	275	84	±19	91	±25	.03
Heart rate, beats per minute, mean ±sd	275	111	±30	107	±25	.31
% Oxygen saturation, mean ±sd	273	94	±9	94	±8	.64
ECG						
Atrial fibrillation, n (%)	232	3	(5.4)	11	(6.3)	.81
Prior infract (Q wave), n (%)	232	3	(5.4)	12	(6.8)	.70
Laboratory						
Sodium, mmol/L, mean ±sd	175	139	±8	140	±7	.25
Potassium, mmol/L, mean ±sd	182	4.8	±1.3	4.6	±1.0	.22
Blood urea nitrogen, median [Q1,Q3]	176	14	[11,32]	16	[11,30]	.62
Creatinine, mg/dL, median [Q1,Q3]	211	0.9	[0.7,1.3]	1.0	[0.7,1.7]	.23
Hemoglobin, g/dL, mean ±sd	269	11.0	±2.5	10.4	±2.8	.12
Length of stay, days, median [Q1, Q3]	311	12	[8, 18]	10	[7, 17]	.04

Abbreviations: BP, blood pressure; HIV, human immunodeficiency virus; ECG, electrocardiogram; Q1, 25th percentile; Q3, 75th percentile.
*Data shown are N (%), mean (± Standard Deviation), or median [Q1, Q3].
†Characteristics obtained through review of paper charts were either not available or incompletely obtained for some patients. Data are computed from non-missing values when indicated.
‡ p values shown are from a comparison of women and men: t-test (comparison of means), Chi-square exact test (comparison of proportions), or Wilcoxon rank sum test (comparison of medians).

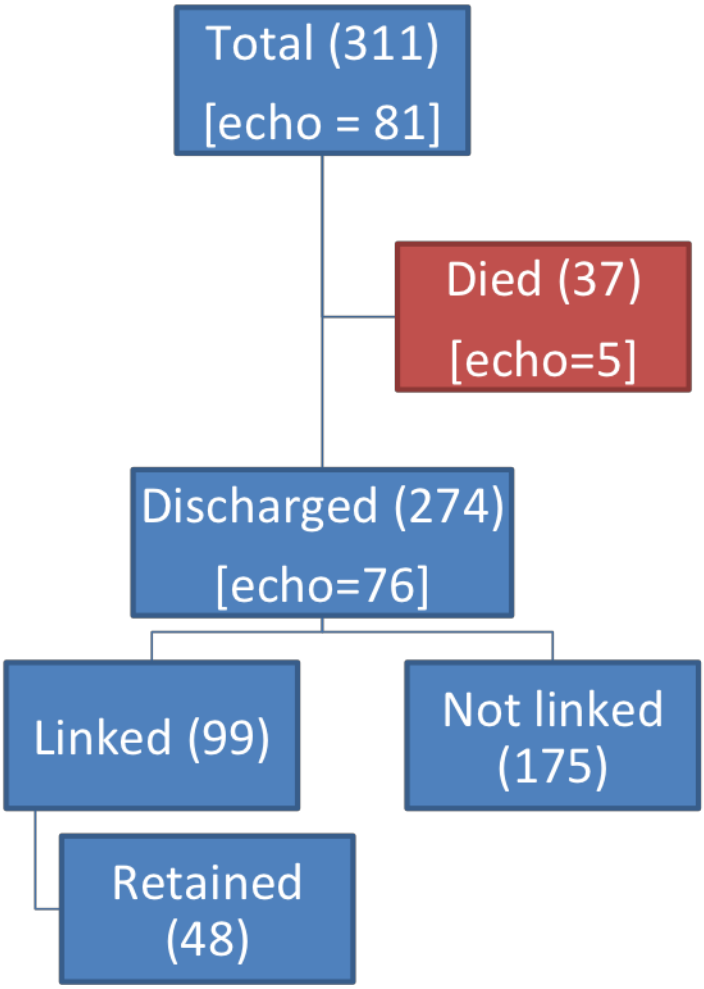
Supplement Table S4. Echocardiographic measures by HF category

Measure	Total (n=81)		Cardiomyopathy (n=52)		All other causes (n=29)		*P**
LV ejection fraction, %	33.2	± 18.9	22.1	± 8	53.0	± 16.9	<0.01
Interventricular septum width, mm	8	± 3	8	± 2	9	± 4	0.06
LV end diastolic dimension, mm	50	± 15	54	± 13	43	± 16	<0.01
LV end systolic dimension, mm	41	± 16	48	± 12	28	± 14	<0.01
LV Posterior wall width, mm	9	± 3	8	± 2	9	± 3	0.10
LV mass, grams	121	± 65	141	± 59	85	± 60	<0.01
Aortic root dimension, mm	27	± 12	28	± 12	25	± 12	0.26
Left atrial dimension, mm	38	± 13.9	40	± 12	35	± 17	0.15
Pulmonary artery systolic pressure, mmHg (n=69)	43	± 12	39	± 10	49	± 13	<0.01

Patients with cardiologist echocardiogram, n=81/311, 26.0%
Data shown are mean ± standard deviation.
*P values shown from t-test comparing cardiomyopathy and all other causes.
Abbreviation: LV, left ventricle.

Supplement Figure legend

Supplement Figure 1: Flow diagram showing the number of patients at each stage of the care cascade and the number with available echocardiography and discharge medication data.



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