

Trends and Predictors of In-Hospital Mortality among Heart Failure Patients in a Cameroonian Tertiary Care Center, 2021-2024

—Mortality Predictors in Acute Heart Failure in Cameroon

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Abstract

Background: Heart failure (HF) mortality is a critical challenge in low-resource settings like Cameroon, where predictors and trends are poorly understood. This study evaluated in-hospital mortality rates, trends, and predictors among HF patients at a Cameroonian tertiary cardiology unit. **Methods:** This retrospective cohort study analysed 757 HF admissions at Laquintinie Hospital, Douala (2021-2024). Multivariable logistic regression identified mortality predictors ($p < 0.05$), with model fit assessed via the Hosmer-Lemeshow test and area under the receiver operating characteristic curve (AUC). **Results:** Among 757 HF patients (median age 63 years, 51.3% female), hypertensive heart disease (28.5%) was prevalent, with an in-hospital mortality rate of 17.0% ($n = 129$). Multivariable analysis identified elevated Blood Urea Nitrogen (BUN) (aOR = 1.01, 95% CI: 1.01 - 1.02, $p < 0.001$), dobutamine use (aOR = 2.85, 95% CI: 1.30 - 6.25, $p = 0.009$), and admission in 2023-2024 (aOR = 1.79, 95% CI: 1.15 - 2.80, $p = 0.010$) as mortality predictors, while hypertensive heart disease (OR = 0.40, 95% CI: 0.21 - 0.77, $p = 0.006$) and higher systolic blood pressure (aOR = 0.99, 95% CI: 0.98 - 1.00, $p = 0.009$) were protective. Calcium channel blockers ($p = 0.102$), RAAS inhibitors ($p = 0.100$), and beta-blockers ($p = 0.129$) were not significant. Model fit was robust (Hosmer-Lemeshow $p = 0.811$, AUC = 0.769). **Conclusions:** In-hospital HF mortality was

high, driven by elevated BUN, dobutamine use, and later admission years, potentially reflecting increased patient acuity or resource constraints. Hypertensive heart disease and higher systolic blood pressure were protective. Interventions to enhance diagnostic access (e.g., echocardiography, ECG), and address systemic healthcare barriers are critical. Prospective studies are needed to investigate rising mortality trends and optimize HF management in Cameroon.

Keywords

Heart Failure, In-Hospital Mortality, Risk Factors, Cameroon, Sub-Saharan Africa

1. Introduction

1.1. Background

Cardiovascular diseases have been reported as the second most significant cause of non-communicable disease (NCD) burden in Sub-Saharan Africa, contributing 22.9 million disability-adjusted life years (DALYs), or 15.1% of the total NCD burden [1]. Heart failure has emerged as a dominant form of cardiovascular disease in Africa [2].

HF is a clinical syndrome resulting from various underlying causes, rather than a distinct disease on its own. The reported incidence of heart failure (HF) in Europe and the U.S. ranges from 1 to 9 cases per 1,000 person-years, varying by population and diagnostic criteria [3]. In Latin America and the Caribbean, HF prevalence is estimated at 1% [4]. Limited population-based data exist for Sub-Saharan Africa, with recent studies from Cameroon and other SSA countries providing insights into HF outcomes but lacking detailed in-hospital mortality predictors specific to resource-constrained tertiary settings [5] [6]. In hospital prevalence studies, HF is reported to be responsible for 9.4% - 42.5% of all medical admissions and 25.6% - 30.0% of admissions into the cardiac units [7]. Overall mortality from heart failure (HF) is reported at 16.5%, with the highest rates observed in Africa (34%) and India (23%), moderate rates in Southeast Asia (15%), and the lowest in China (7%), South America (9%), and the Middle East (9%) [8].

In sub-Saharan Africa (SSA), HF leads to high death rates, with 29% to 58% of patients dying within a year and 8% to 26% dying during hospital stays [9]. A review in 2020 suggested that this high mortality is driven by several factors, including genetic traits in SSA populations that increase risks of high blood pressure and heart muscle thickening, as well as a higher prevalence of HF with reduced ejection fraction (HFrEF), a type associated with greater mortality [9]. Patients in SSA also face additional health challenges like heart valve issues, kidney disease, anemia, lung problems, infections, and severe HF symptoms at diagnosis [9]. Limited access to proven treatments, such as guideline-directed medical therapy (GDMT) and heart devices like Implantable Cardioverter-Defibrillators (ICDs),

further worsens outcomes [5] [6] [9].

1.2. Study Rationale and Objectives

The advent of new treatment regimens like Sodium-Glucose Co-transporter-2 (SGLT2) inhibitors which offer a survival advantage [10], and adjustments in models of care for HF post Covid-19 [11] suggest that mortality rates from HF may differ significantly from older reports.

We therefore sought to determine the intra-hospital mortality rate from HF in Cameroon and explore the factors associated with it. This study, involving patients from a diverse population with restricted access to advanced cardiac care, would provide a critical lens on HF outcomes in resource-constrained environments and inform equitable healthcare strategies. This study aims to quantify in-hospital mortality rates and identify specific clinical and therapeutic predictors in a Cameroonian tertiary center, building on prior SSA registries to inform targeted interventions in resource-limited settings.

2. Methodology

2.1. Study Design, Period and Setting

This was a retrospective cohort study of patients admitted with heart failure (HF) from January 2021 to December 2024. The study was conducted at a Laquintinie Hospital Douala, a second level hospital in Cameroon serving a socioeconomically diverse population with limited access to advanced cardiac care. Data were extracted from medical records and patient charts in the cardiac unit.

2.2. Participants

Eligible participants were patients with a clinical diagnosis of HF admitted during the study period. Patients with incomplete data on outcome or not hospitalised for an acute episode of heart failure as primary diagnoses were excluded. Participants were followed from admission until death or discharge.

2.3. Sampling and Sample Size

The sample size was calculated to detect predictors of in-hospital mortality, assuming a 34% mortality rate from regional heart failure studies in sub-Saharan Africa [8]. To ensure model stability and prevent overfitting, we aimed for an events-per-variable (EPV) ratio of 10 based on recommendations for logistic regression, as outlined in statistical literature [12]. Targeting 10 predictors, a minimum of 100 mortality events was required, necessitating at least 340 patients ($100/0.34$).

2.4. Variables

The primary outcome was in-hospital mortality, defined as death during hospitalization. HF diagnosis was confirmed using ESC 2021 criteria, incorporating clinical symptoms, and/or echocardiography or biomarker data where available,

to minimize misclassification [13]. Covariates assessed included age, sex, comorbidities (hypertension, kidney disease, anemia, via laboratory tests), and use of recommended medications including renin-angiotensin-aldosterone system inhibitors, beta-blockers, mineralocorticoid receptor antagonists, or sodium-glucose co-transporter-2 inhibitors.

2.5. Data Sources and Collection

Data were sourced from hospital medical records, echocardiography reports, and laboratory results. Trained personnel used standardized protocols to extract data, with 10% of records cross-checked for accuracy. Data were collected using a structured tool that included: 1) demographic information (such as age, sex, marital status, and place of residence); 2) clinical parameters (including ejection fraction categorized as HFrEF <40%, HFmrEF 40% - 49%, and HFpEF ≥50%, systolic blood pressure, and oxygen saturation); 3) laboratory results (such as haemoglobin levels and blood urea nitrogen [BUN]); 4) prescribed medications (including RAAS inhibitors) before admission, during admission and at discharge; and 5) outcomes (mortality and length of hospital stay). Patients with missing outcome data were excluded from analysis. Potential confounding by socioeconomic factors was addressed by adjusting for relevant covariates such as marital status in the analysis.

2.6. Bias

Missing key severity markers such as NYHA class, natriuretic peptides, and ejection fraction (EF) for 45% of patients introduces potential biases. NYHA class was not routinely documented due to inconsistent practices, risking misclassification bias and underestimating mortality risk (bias toward null). Natriuretic peptides were unavailable due to limited diagnostic resources, causing confounding bias by omitting a key prognostic factor, potentially over- or underestimating covariate effects. Missing EF data for 45% of patients, due to scarce echocardiography access, introduces selection bias, as tested patients may differ (e.g., wealthier or sicker). This may underestimate mortality risk in severe cases (e.g., undiagnosed HFrEF), biasing results toward the null. Mitigation included MICE imputation, covariate adjustment (e.g., age, comorbidities), and ROSE for class imbalance. Residual confounding persists, necessitating future studies with robust diagnostic data.

2.7. Statistical Methods

The study developed a logistic regression model to predict in-hospital mortality using a robust methodology. Normality of variables was assessed with the Shapiro-Wilk test, and descriptive statistics (medians, interquartile ranges, percentages) summarized baseline characteristics and mortality rates due to non-normal distributions. Univariable logistic regression identified factors associated with mortality ($p < 0.250$ and clinical relevance) for inclusion in the multivariable model. The dataset was pre-processed by renaming columns for clarity and ensuring appropriate data types. Missing data were handled using Multiple Imputation by

Chained Equations (MICE), generating five datasets, with the first used for analysis; imputation assumptions were based on observed variable distributions, and sensitivity analyses confirmed robustness. To address moderate class imbalance (17% mortality), the Random Over-Sampling Examples (ROSE) technique was applied to balance discharge and death outcomes, as it improved model sensitivity for detecting mortality events in preliminary analyses. Predictor selection involved univariate screening, multicollinearity assessment (removing variables with Pearson's $|r| > 0.7$ or variance inflation factors [VIF] > 5 ; all included variables had VIF < 5), and stepwise regression (forward/backward selection via AIC). Clinically relevant interaction terms were cautiously included. Adjusted odds-ratio estimates and standard errors in multivariable model were pooled across all imputed datasets, Model performance was assessed via AUC, sensitivity, specificity, and Hosmer-Lemeshow test. Missing data imputation and sensitivity analyses were conducted to ensure robustness. Model performance was evaluated using AUC, Gini coefficient, accuracy, sensitivity, specificity, and the Hosmer-Lemeshow test ($p > 0.05$ indicating good calibration). Calibration was visualized using calibration plots, and model robustness was tested via bootstrap validation (1000 iterations). Analyses were conducted using SPSS v26 and R v2025.05.0 + 496.

2.8. Ethical Considerations

The study was approved by the Regional Ethics Committee for the Littoral under reference N 2024/CE/CRERSH-LITTORAL and informed consent was waived for retrospective data.

3. Results

3.1. Participants

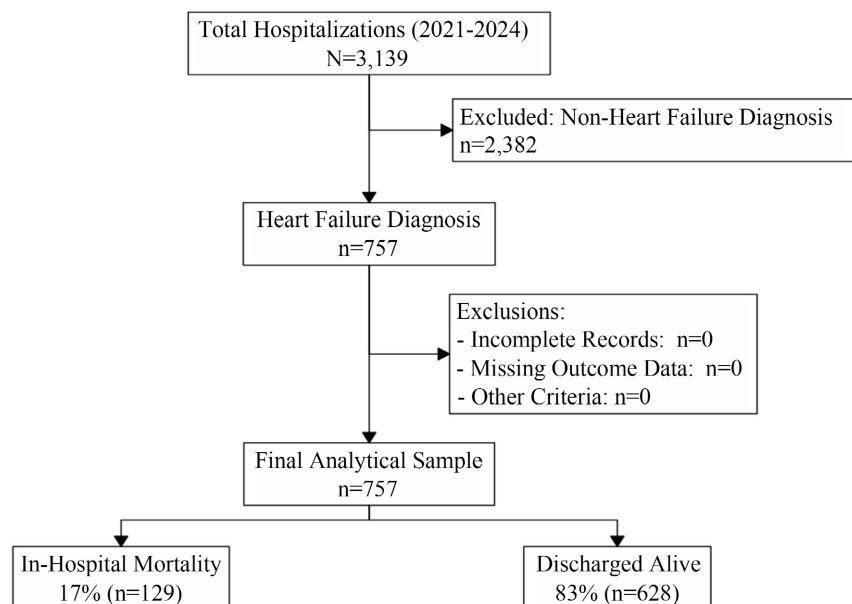


Figure 1. Flowchart of participant recruitment and study inclusion.

This retrospective cohort study included 757 patients hospitalized for heart failure (HF) at Laquintinie Hospital in Douala, Cameroon, from 2021 to 2024 as shown in **Figure 1**. Eligible patients were identified from hospital records with a confirmed HF diagnosis, admitted between January 2021 and December 2024. No patients were excluded due to missing outcome data (in-hospital mortality). The cohort was distributed across admission years: 18.0% (n = 136) in 2021, 26.9% (n = 204) in 2022, 24.3% (n = 184) in 2023, and 30.8% (n = 233) in 2024.

3.2. Baseline Characteristics (Sociodemographic and Clinical)

The median age was 63 years (IQR: 51 - 74), with 51.3% female (n = 388) and 48.7% male (n = 369). Most patients resided in Douala (87.5%, n = 643), and 47.6% (n = 360) were married, while 21.5% (n = 163) were single, 23.0% (n = 174) widowed, and 6.6% (n = 50) unreported as shown in **Table 1**. Professionally, 32.8% (n = 248) were unemployed or retired. Prevalent comorbidities included hypertension (48.6%, n = 368), chronic heart failure (34.2%, n = 259), diabetes mellitus (16.9%, n = 128), and history of lung pathology (8.6%, n = 65) as shown in **Table 2**. Routine cardiovascular medications included ACE inhibitors (12.9%, n = 98), beta-blockers (11.9%, n = 90), and calcium channel blockers (16.5%, n = 125). At admission, median systolic blood pressure was 137 mmHg (IQR: 114 - 162), with 4.6% (n = 35) having hypotension (SBP <90 mmHg) as shown in **Table 3**. Diagnostic procedures included echocardiography (54.4%, n = 412) and ECG (46.5%, n = 352). Common HF aetiologies were hypertensive heart disease (28.5%, n = 216), dilated cardiomyopathy (12.9%, n = 98), and Cor pulmonale (9.1%, n = 69) as shown in **Table 4**. Median ejection fraction was 39% (IQR: 26 - 60) and HF subtypes were distributed as follows: HFpEF (36.9%, n = 152), HFmrEF (10.2%, n = 42), and HFrfEF (52.9%, n = 218).

3.3. Outcomes

In-hospital mortality was 17.0% (n = 129), with rates of 11.8% (2021), 15.2% (2022), 19.0% (2023), and 20.2% (2024). Among the 628 patients discharged alive, 74.0% (n = 560) had authorized discharges, 6.9% (n = 52) were discharged against medical advice, and 2.1% (n = 16) were transferred. The median hospitalization duration was 8 days (IQR: 5 - 12) as shown in **Table 5**.

3.4. Univariate Analysis of Significant Predictors

Univariate logistic regression identified predictors significantly associated with in-hospital mortality (p < 0.05). Admission in 2023-2024 (vs. 2021-2022), cerebrovascular accident, chronic liver disease/hepatitis, hypotension (SBP <90 mmHg), elevated blood urea nitrogen (>60 mg/dL), Cor pulmonale, and high-output heart failure increased mortality risk. Conversely, leucocytosis was observed in 22.0% (n = 93/424) of patients (20.4% alive, n = 74/363; 30.6% deceased, n = 19/62), and anemia (Hb <12 mg/dL) in 60.0% (n = 273/455) (58.5% alive, n = 227/388; 68.7% deceased, n = 46/67). Hypertensive heart disease, and hypertensive

crisis were linked to lower mortality. Dobutamine use increased mortality, while beta-blockers and RAAS inhibitors reduced it.

3.5. Multivariable Analysis

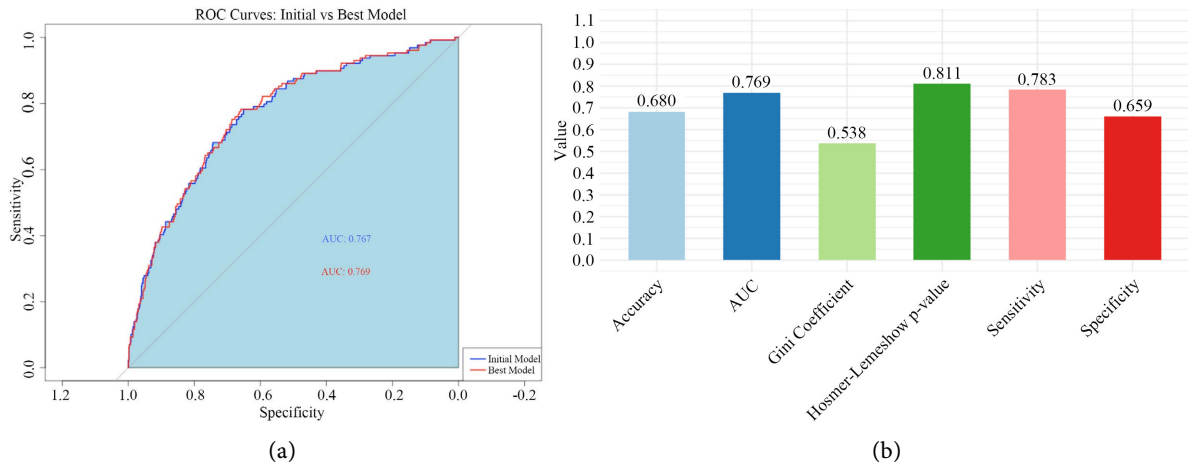


Figure 2. Receiver operating characteristic curve and performance metrics of the stepwise model.

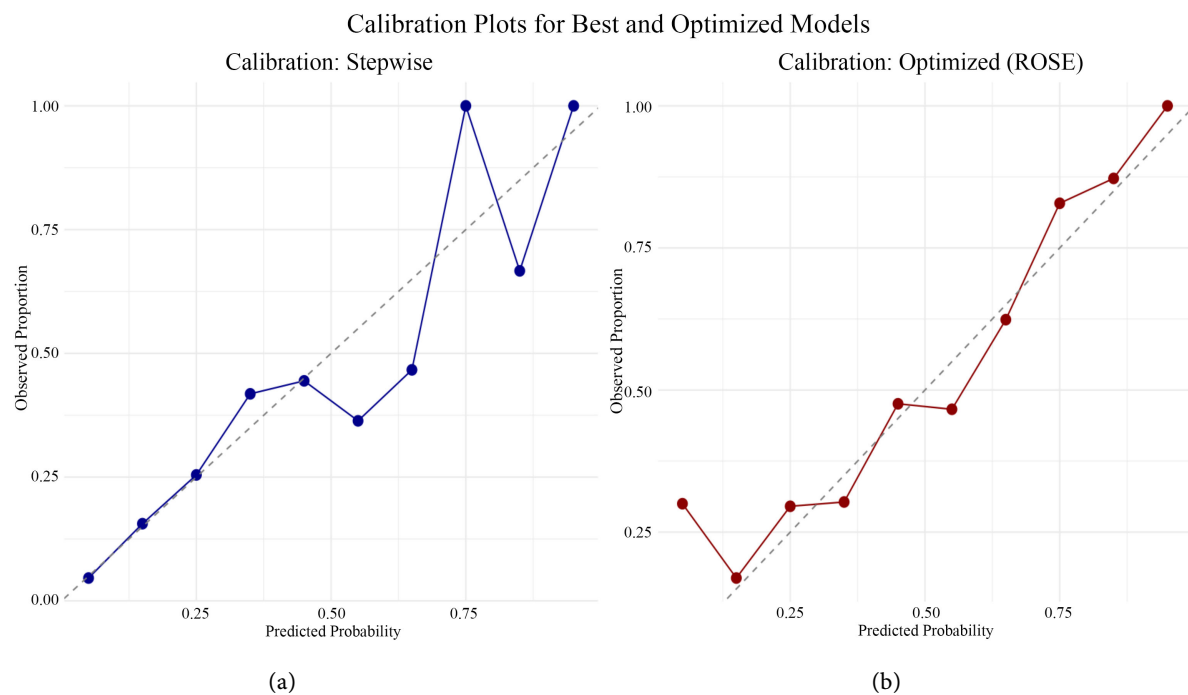
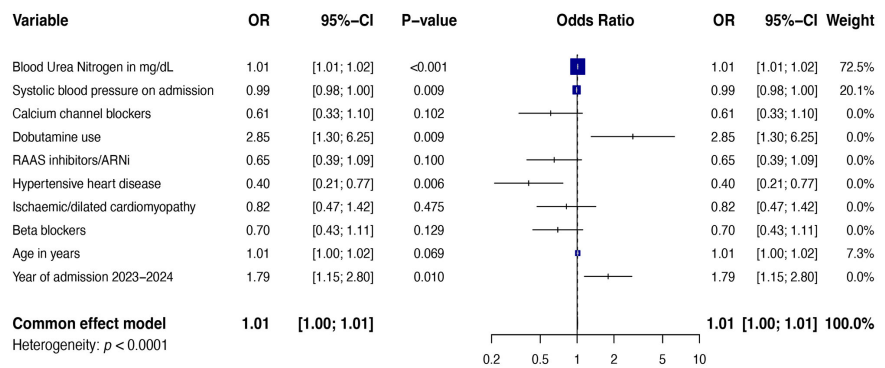


Figure 3. Calibration plots for stepwise and ROSE-Adjusted models.

The logistic regression models were evaluated for predicting in-hospital mortality, with the stepwise model selected as the best due to its superior calibration (Hosmer-Lemeshow $p = 0.811$) and balanced performance metrics as shown in **Figure 2** and **Figure 3**. The stepwise model achieved an AUC of 0.769, indicating good discriminatory ability, and a Gini coefficient of 0.538. Its accuracy was 0.680, with a sensitivity of 0.783 and specificity of 0.659, reflecting effective identification of both mor-

tality and survival cases. The model outperformed the initial (AUC = 0.767, accuracy = 0.674), refined (AUC = 0.767, accuracy = 0.674), and optimized (AUC = 0.738, accuracy = 0.679) models, which either had lower calibration (optimized: p = 0.068) or similar but less optimal metrics. The stepwise model's most potent predictors identified as statistically significant (p < 0.05), were: Blood urea Nitrogen (OR 1.01; 95% CI 1.01 - 1.02, p < 0.001); Systolic pressure on admission mmHg (OR 0.99; 95% CI 0.98 - 1.00, p = 0.009); Dobutamine use (OR 2.85; 95% CI 1.30 - 6.25, p = 0.009); Hypertensive heart disease (OR 0.40; 95% CI 0.21 - 0.77, p = 0.006)); Age in years (OR 1.01; 95% CI 1.00 - 1.02, p = 0.069), Year of admission 2023-2024 (OR 1.79; 95% CI 1.15 - 2.80, p = 0.010) were visualized in **Figure 4**. Other predictors, including age, calcium channel blockers, RAAS inhibitors/ARNi, beta blockers, and ischemic/dilated cardiomyopathy, were included but not significant.



(HF Etiology 1: Hypertensive heart disease; HF Etiology 2: Ischemic/Dilated cardiomyopathy; Year of admission 2023-2024: Ref-2021-2022).

Figure 4. Forest plot of predictors of in-hospital mortality.

Table 1. Sociodemographic characteristics in patients hospitalised for HF at LHD from 2021-2024.

Sociodemographic variables	N	Variable distribution	Alive n = 628 (%)	Death n = 129(%)	Crude OR (95% CI)	p-value
Year of admission						
2021	757	136 (18.0)	120 (19.1)	16 (12.4)	Ref	
2022	757	204 (26.9)	173 (27.5)	31 (24.0)	1.34 (0.70 - 2.57)	0.370
2023	757	184 (24.3)	149 (23.7)	35 (27.1)	1.76 (0.93 - 3.34)	0.082
2024	757	233 (30.8)	186 (29.6)	47 (36.4)	1.89 (1.03 - 3.49)	0.041
Median age in years (IQR; Q1 - Q3)	757	63.0 (51 - 74)	63.0 (50.3 - 73)	67 (56 - 75.5)	1.01 (1.00 - 1.03)	0.031
Sexe						
Male	757	369 (48.7)	312 (49.7)	57 (44.2)	Ref	
Female	757	388 (51.3)	316 (50.3)	72 (55.8)	1.25 (0.85 - 1.83)	0.256
Age group						
Less than 18 years	757	3 (0.4)	3 (0.5)	-	-	-
18 - 24 years	757	16 (2.1)	14 (2.2)	2 (1.6)	0.61 (0.14 - 2.75)	0.520
25 - 34 years	757	40 (5.3)	36 (5.7)	4 (3.1)	0.48 (0.17 - 1.38)	0.170

Continued

35 - 44 years	757	68 (9.0)	58 (9.2)	10 (7.8)	0.74 (0.36 - 1.51)	0.405
45 - 60 years	757	202 (26.7)	170 (27.1)	32 (24.8)	0.81 (0.52 - 1.26)	0.347
More than 60 years	757	428 (56.5)	347 (55.3)	81 (62.8)	Ref	-
Profession						
Unemployed or retired	757	248 (32.8)	202 (32.2)	46 (35.7)	1.17 (0.79 - 1.74)	0.442
Marital status						
Single	757	163 (21.5)	138 (22.0)	25 (19.4)	Ref	
Married	757	360 (47.6)	7.8)	60 (46.5)	1.10 (0.66 - 1.84)	0.703
Cohabitation	757	10 (1.3)	10 (1.6)	-	-	-
Widow (er)	757	174 (23.0)	136 (21.7)	38 (29.5)	1.54 (0.88 - 2.69)	0.128
Unreported	757	50 (6.6)	44 (7.0)	6 (4.7)	0.75 (0.29 - 1.95)	0.559
Residence						
In Douala	757	643 (87.5)	533 (87.7)	110 (86.6)	0.91 (0.52 - 1.60)	0.745

COR^a = Crude Odds Ratio.**Table 2.** Past medical history (Comorbidities and routine medications) of patients hospitalised for HF at LHD from 2021-2024.

Past medical history	N	Variable distribution	Alive n = 628 (%)	Death n = 129 (%)	COR (95% CI) ^a	p-value
<i>Comorbidities</i>						
<i>Hypertension</i>	757	368 (48.6)	309 (49.2)	59 (45.7)	0.87 (0.59 - 1.27)	0.473
Diabetes mellitus	757	128 (16.9)	109 (17.4)	19 (14.7)	0.82 (0.48 - 1.39)	0.469
Chronic heart failure	757	259 (34.2)	211 (33.6)	48 (37.2)	1.17 (0.79 - 1.74)	0.431
Coronary artery disease	757	7 (0.9)	6 (1.0)	1 (0.8)	0.81 (0.9 - 6.78)	0.846
Valvular heart disease	757	6 (0.8)	3 (0.5)	3 (2.3)	4.96 (0.99 - 25.86)	0.051
Renal disease	757	25 (3.3)	22 (3.5)	3 (2.3)	0.66 (0.19 - 2.22)	0.498
Dyslipidaemia	757	10 (1.3)	7 (1.1)	3 (2.3)	2.11 (0.54 - 8.28)	0.283
Human Immunodeficiency virus	757	28 (3.7)	24 (3.8)	4 (3.1)	0.81 (0.27 - 2.36)	0.693
History of lung pathology ^b	757	65 (8.6)	49 (7.8)	16 (12.4)	1.67 (0.92 - 3.05)	0.092
Atrial fibrillation	757	44 (5.8)	40 (6.4)	4 (3.1)	0.47 (0.16 - 1.34)	0.158
History of TB	757	36 (4.6)	26 (4.1)	9 (7.0)	1.74 (0.79 - 3.79)	0.167
Cerebrovascular accident	757	7 (0.9)	3 (0.5)	4 (3.1)	6.67 (1.47 - 30.15)	0.014
Chronic liver disease/Hepatitis	757	13 (1.7)	8 (1.3)	5 (3.9)	3.13 (1.01 - 9.71)	0.049
Gout	757	7 (0.9)	7 (1.1)	-	-	-
Cancers/dysplasia	757	11 (1.5)	8 (1.3)	3 (2.3)	1.84 (0.48 - 7.05)	0.370
<i>Routine CV medications</i>						
SGLT2 inhibitors	757	9 (1.2)	6 (1.0)	3 (2.3)	2.47 (0.61 - 10.0)	0.206
Methyldopa	757	1 (0.1)	1 (0.2)	-	-	-
MRA	757	21 (2.8)	16 (2.5)	5 (3.9)	1.54 (0.55 - 4.29)	0.406

Continued

<i>Calcium channel blockers</i>	757	125 (16.5)	105 (16.7)	20 (15.5)	0.91 (0.54 - 1.54)	0.735
Indapamide	757	28 (3.7)	25 (4.0)	3 (2.3)	0.57 (0.17 - 1.93)	0.370
<i>Diuretics</i>	757	115 (15.2)	90 (14.3)	25 (19.4)	1.44 (0.88 - 2.35)	0.147
ACEI	757	98 (12.9)	77 (12.3)	21 (16.3)	1.39 (0.823 - 2.35)	0.217
ARAI	757	29 (3.8)	25 (4.0)	4 (3.1)	0.77 (0.26 - 2.26)	0.636
<i>Beta blockers</i>	757	90 (11.9)	74 (11.8)	16 (12.4)	1.06 (0.59 - 1.89)	0.843
<i>No routine CV medication</i>	757	496 (65.5)	412 (65.6)	84 (65.1)	0.98 (0.66 - 1.46)	0.915

ACEI = Angiotensin Converting Enzyme Inhibitors, ARAII = Angiotensin II receptor antagonists, COPD = Chronic Obstructive Pulmonary Disease, CV = Cardiovascular, CVA = Cerebrovascular accident, MRA = Mineralocorticoid Receptor Antagonist, SGLT2 = Sodium-glucose cotransporter 2, TB = Tuberculosis. ^bHistory of lung pathology (Asthma, Pulmonary Embolism, COPD, TB).

Table 3. Admission characteristics (Clinical, diagnostic and laboratory findings) of patients hospitalised for HF at LHD from 2021-2024.

Admission characteristics	N	Variable distribution	Alive n = 628 (%)	Death n = 129(%)	COR (95% CI) ^a	p-value
<i>Clinical characteristics</i>						
Median SBP (IQR; Q1 - Q3)	753	137 (114 - 162)	139 (118 - 168)	121 (103 - 143)	0.98 (0.98 - 0.99)	<0.001
<i>Hypotension (SBP <90 mmHg)</i>	753	35 (4.6)	24 (3.8)	11 (8.6)	2.07 (1.00 - 4.30)	0.049
Median Heart Rate (IQR; Q1 - Q3)	746	100 (85 - 114)	100 (86 - 114)	98 (82 - 113)	0.99 (0.99 - 1.01)	0.727
Tachycardia	746	363 (48.0)	307 (49.1)	56 (43.8)	0.8 (0.55 - 1.17)	0.258
<i>Median SaO₂ % (IQR; Q1 - Q3)</i>	679	94 (89 - 97)	95 (89 - 97)	93 (87 - 97)	0.99 (0.97 - 1.01)	0.178
<i>Hypoxia (SaO₂ % <90%)</i>	679	189 (27.8)	149 (26.6)	40 (33.6)	1.40 (0.91 - 2.13)	0.123
<i>Diagnostic investigations</i>						
ECG done	757	352 (46.5)	306 (48.7)	46 (35.7)	-	-
Sinus rhythm	352	202 (57.4)	179 (58.5)	23 (50.0)	0.71 (0.38 - 1.32)	0.279
Atrial fibrillation	352	94 (26.7)	78 (25.5)	16 (34.8)	1.56 (0.81 - 3.01)	0.187
Flutter	352	12 (3.4)	9 (2.9)	3 (6.5)	2.30 (0.60 - 8.83)	0.224
LVH	352	90 (25.6)	82 (26.8)	8 (17.4)	0.58 (0.26 - 1.28)	0.177
Ischaemia	352	41 (11.7)	36 (11.8)	5 (10.9)	0.91 (0.34 - 2.45)	0.848
Repolarisation abnormalities	352	67 (19.1)	60 (19.7)	7 (15.2)	0.54 (0.24 - 1.22)	0.138
Echocardiography done	757	412 (54.4)	363 (57.8)	49 (38.0)	-	-
HFpEF	412	152 (36.9)	132 (36.4)	20 (40.8)	1.07 (0.58 - 1.99)	0.826
HFmrEF	412	42 (10.2)	40 (11.0)	2 (4.1)	0.35 (0.81 - 1.55)	0.168
HfrEF	412	218 (52.9)	191 (52.6)	27 (55.1)	Ref	-
Median EF (IQR; Q1 - Q3)	412	39 (26 - 60)	39 (26 - 60)	39 (27 - 60)	1.01 (0.99 - 1.02)	0.574
<i>Laboratory findings</i>						
Leucocytosis	424	93 (22.0)	74 (20.4)	19 (30.6)	1.71 (0.94 - 3.11)	0.077
Median Haemoglobin level (IQR; Q1 - Q3)	455	11.3 (9.6 - 12.9)	11.4 (9.8 - 13)	10.8 (9.2 - 12.7)	0.93 (0.85 - 1.03)	0.155
Anaemia (Hb <12 mg/dL)	455	273 (60.0)	227 (58.5)	46 (68.7)	1.55 (0.89 - 2.70)	0.119

Continued

Thrombocytosis	410	10 (2.4)	10 (2.9)	-	-	-
Median BUN in mg/dL (IQR; Q1 - Q3)	401	49 (32.5 - 77.9)	48 (32.0 - 73.0)	73.5 (44.0 - 136.5)	1.01 (1.01 - 1.02)	<0.001
BUN >60 mg/dL	401	149 (37.2)	116 (34.0)	33 (55.0)	2.47 (1.36 - 4.13)	0.002
Median Creatinine in mg/dL (IQR; Q1 - Q3)	451	1.51 (1.1 - 2.7)	1.5 (1.2 - 2.8)	1.5 (1.1 - 2.7)	1.01 (0.94 - 1.09)	0.804
Creatinine >1.5 mg/dL	451	226 (50.1)	193 (50.1)	33 (50.0)	0.99 (0.59 - 1.68)	0.984
Hypernatraemia >145 mEq/L	307	11 (3.6)	10 (3.7)	1 (2.6)	Ref	
Hyponatraemia <135 mEq/L	307	130 (42.3)	110 (40.9)	20 (52.6)	1.82 (0.22 - 15.00)	0.579
Hyperkalaemia >5.5 mEq/L	306	34 (11.1)	29 (10.8)	5 (13.5)	1.06 (0.37 - 3.03)	0.907 ^b
Hypokalaemia <3.5 mEq/L	306	107 (35.0)	98 (26.4)	9 (24.3)	0.57 (0.25 - 1.28)	0.171 ^b

COR^a = Crude Odds Ratio; ^bRef = Normal potassium level.

Table 4. Precipitating factors and aetiologies of HF in patients hospitalised at LHD from 2021-2024.

Aetiologies and precipitating factors	N	Variable distribution	Alive n = 628 (%)	Death n = 129 (%)	COR (95% CI) ^a	p-value
<i>Precipitating factors</i>						
Rhythm disorder	757	94 (12.4)	81 (12.9)	13 (10.1)	0.76 (0.41 - 1.41)	0.378
Conduction disorder	757	5 (0.7)	5 (0.8)	-	-	-
Angina	757	9 (1.2)	9 (1.4)	-	-	-
Myocardial infarction	757	25 (3.3)	23 (3.7)	2 (1.6)	0.41 (0.09 - 1.78)	0.236
Pulmonary embolism/Cor pulmonale	757	16 (2.1)	10 (1.6)	6 (4.7)	3.02 (1.08 - 8.45)	0.036
Hypertensive crisis	757	85 (11.2)	78 (12.4)	7 (5.4)	0.40 (0.18 - 0.90)	0.026
Anemia	757	53 (7.0)	41 (6.5)	12 (9.3)	1.47 (0.75 - 2.88)	0.263
Medication non-adherence	757	84 (11.1)	72 (11.5)	12 (9.3)	0.79 (0.42 - 1.51)	0.477
Infection	757	120 (15.9)	94 (15.0)	26 (20.2)	1.43 (0.88 - 2.32)	0.143
Pneumonia	757	26 (3.4)	22 (3.5)	4 (3.1)	0.88 (0.30 - 2.59)	0.817
Lifestyle non-adherence	757	22 (2.9)	21 (3.3)	1 (0.8)	0.23 (0.03 - 1.69)	0.148
<i>Renal disease</i>						
Abnormal glycemia	757	42 (5.5)	33 (5.3)	9 (7.0)	1.35 (0.63 - 2.89)	0.438
No precipitating factor identified	757	15 (2.0)	13 (2.1)	2 (1.6)	0.75 (0.17 - 3.34)	0.701
<i>Aetiologies</i>						
Ischaemic cardiomyopathy	757	341 (45.0)	283 (45.1)	58 (45.0)	0.99 (0.68 - 1.46)	0.983
Arrhythmic cardiomyopathy	757	51 (6.7)	45 (7.2)	6 (4.7)	0.63 (0.26 - 1.51)	0.303
Dilated cardiomyopathy	757	74 (9.8)	60 (9.6)	14 (10.9)	1.15 (0.62 - 2.13)	0.651
Hypertensive heart disease	757	98 (12.9)	88 (14.0)	10 (7.8)	0.52 (0.26 - 1.02)	0.058
Cor pulmonale	757	216 (28.5)	189 (30.1)	27 (20.9)	0.62 (0.39 - 0.97)	0.037
Congenital heart disease	757	69 (9.1)	51 (8.1)	18 (14.0)	1.84 (1.03 - 3.26)	0.038
	757	2 (0.3)	2 (0.3)	-	-	-

Continued

Non-identified causes	757	112 (14.8)	86 (13.7)	26 (20.2)	1.59 (0.98 - 2.59)	0.061
<i>Pericardial disease</i>	757	22 (2.9)	16 (2.5)	6 (4.7)	1.87 (0.72 - 4.86)	0.202
Peripartum cardiomyopathy	757	12 (1.6)	11 (1.8)	1 (0.8)	0.44 (0.06 - 3.42)	0.432
Valvular heart disease	757	56 (7.4)	48 (7.6)	8 (6.2)	0.80 (0.37 - 1.73)	0.570
Rheumatic heart disease	757	2 (0.3)	2 (0.3)	-	-	-
Toxic	757	3 (0.4)	2 (0.3)	1 (0.8)	2.45 (0.22 - 27.17)	0.467
High output heart failure (anaemia, sepsis)	757	41 (5.4)	29 (4.6)	12 (9.3)	2.12 (1.05 - 4.27)	0.036

COR^a = Crude Odds Ratio.**Table 5.** Management and outcomes of patients hospitalised for HF at LHD from 2021-2024.

Management and outcomes	N	Variable distribution	Alive n = 628 (%)	Death n = 129(%)	COR (95% CI) ^a	p-value
Medications during hospitalisation						
Calcium channel blockers	757	218 (28.8)	198 (31.5)	20 (15.5)	0.40 (0.24 - 0.66)	<0.001
Dobutamine	757	39 (5.2)	24 (3.8)	15 (11.6)	3.31 (1.68 - 6.51)	<0.001
Loop diuretics	757	673 (88.9)	563 (89.6)	110 (85.3)	0.67 (0.38 - 1.16)	0.151
Beta blockers	757	299 (39.5)	260 (41.4)	39 (30.2)	0.61 (0.41 - 0.92)	0.019
Mineralocorticoid receptor antagonists	757	174 (23.0)	150 (23.9)	24 (18.6)	0.73 (0.45 - 1.18)	0.196
RAAS inhibitors	757	231 (30.5)	207 (33.0)	24 (18.6)	0.46 (0.29 - 0.75)	0.002
SGLT2 inhibitors	757	72 (9.5)	62 (9.9)	10 (7.8)	0.77 (0.38 - 1.54)	0.456
Medications at discharge						
Calcium channel blockers	757	163 (21.5)	159 (25.3)	4 (3.1)	0.09 (0.03 - 0.26)	<0.001
Loop diuretics	757	490 (64.7)	449 (71.5)	41 (31.8)	0.19 (0.12 - 0.28)	<0.001
Beta blockers	757	337 (44.5)	321 (51.1)	16 (12.4)	0.14 (0.08 - 0.23)	<0.001
Mineralocorticoid receptor antagonists	757	170 (22.5)	159 (25.3)	11 (8.5)	0.27 (0.14 - 0.52)	<0.001
RAAS inhibitors	757	227 (30.0)	220 (35.0)	7 (5.4)	0.11 (0.05 - 0.23)	<0.001
SGLT2 inhibitors	757	83 (11.0)	75 (11.9)	8 (6.2)	0.49 (0.23 - 1.04)	0.062
Median duration of hospitalisation in days (IQR; Q1 - Q3)	757	8 (5 - 12)	8 (6 - 12)	5 (3 - 10)	0.97 (0.94 - 1.00)	0.062

RAAS = Renin-Angiotensin Aldosterone System; SGLT2 = Sodium-glucose cotransporter 2; COR^a = Crude Odds Ratio.

4. Discussion

This retrospective cohort study of 757 heart failure (HF) patients at Laquintinie Hospital, Douala (2021-2024), found a 17.0% in-hospital mortality rate. Multivariable logistic regression identified elevated blood urea nitrogen (BUN) (aOR = 1.01, 95% CI: 1.01 - 1.02, $p < 0.001$), dobutamine use (aOR = 2.85, 95% CI: 1.30 - 6.25, $p = 0.009$), and admission in 2023-2024 (aOR = 1.79, 95% CI: 1.15 - 2.80, $p = 0.010$) as independent predictors of increased mortality. Hypertensive heart dis-

ease (aOR = 0.40, 95% CI: 0.21 - 0.77, $p = 0.006$) was associated with lower mortality. Calcium channel blockers (aOR = 0.61, 95% CI: 0.33 - 1.10, $p = 0.102$), RAAS inhibitors (aOR = 0.65, 95% CI: 0.39 - 1.09, $p = 0.100$), beta-blockers (aOR = 0.70, 95% CI: 0.43 - 1.11, $p = 0.129$), age (aOR = 1.01, 95% CI: 1.00 - 1.02, $p = 0.069$), and ischemic/dilated cardiomyopathy (aOR = 0.82, 95% CI: 0.47 - 1.42, $p = 0.475$) were not significant in the adjusted model.

Just 9.5% of patients received newer treatments like SGLT2 inhibitors, a trend consistent with other low- and middle-income countries (LMICs) where usage varies from 10.3% to 36.7%, due to high costs, limited access, and lack of physician familiarity [14]-[16]. These therapies have been proven to reduce mortality and hospitalisations in HF with reduced ejection fraction (HFrEF) [17] but their impact on mortality in African settings is still to be explored.

The 17.0% mortality rate aligns with SSA studies reporting 3.7% - 19% in-hospital HF mortality (2022-2024) [5], but contrasts with lower rates in earlier SSA reports (4.2%, 2007-2010) [18] and European cohorts (2.1% - 3.4%) [19]. A 2024 study from Guadeloupe reported a 14.9% in-hospital mortality rate, noting similar challenges with diagnostic access and medication availability, reinforcing regional trends in poor HF outcomes [20]. The higher mortality in 2023-2024 (36.4% in 2024 vs. 12.4% in 2021), potentially reflect case-mix changes, such as a higher proportion of patients with advanced HF or comorbidities like renal dysfunction, likely contributed to worse outcomes, as seen in elevated BUN levels. Health-system factors, including diagnostic shortages (e.g., limited echocardiography) and delays in care due to post-COVID-19 resource constraints, further exacerbated mortality mirroring trends in SSA where resource constraints exacerbate outcomes [2] [9]. Unlike a Burkina Faso study (2015-2017) where deceased patients were older (65.4 vs. 55.7) [21], age was not significant in our adjusted model, possibly due to the younger cohort (median 63 years) and non-ischemic aetiologies like hypertensive heart disease (28.5%). According to a recent scoping review [5], multiple factors, including electrolyte imbalances, anemia, low blood pressure, renal failure, old age, infections, and medication issues, are associated with heart failure outcomes in sub-Saharan Africa (SSA), but patient heterogeneity complicates comparisons. Our model agrees with The “Get With the Guidelines-Heart Failure” risk score, which is recommended for inpatients [22]. It proposes age, systolic blood pressure, heart rate, serum sodium, blood urea nitrogen, COPD and race as predictive factors. Further research is needed to validate prognostic scores for personalized, risk-based care in SSA heart failure patients in SSA.

Elevated BUN and dobutamine use likely reflect advanced HF and end-organ dysfunction, consistent with global literature [23]. The protective effect of hypertensive heart disease may relate to effective local management or lower severity compared to other aetiologies. The increased mortality in 2023-2024 may stem from higher patient volumes (233 vs. 136 in 2021), delayed presentations, or resource shortages during post-COVID-19 recovery [23]. Leukocytosis indicative of severe infections (20.4% alive, 30.6% deceased, $p = 0.077$) and anemia (58.5% alive, 68.7% deceased, $p = 0.119$)

associated with hypoxic stress, are usually markers of severity but were not significant in this study, possibly due to limited diagnostic testing or lower severity.

Strengths include the large cohort size and comprehensive multivariable analysis adjusting for key predictors. However, the retrospective design limits validity of causal inferences because of the high risk of misclassification with only few patients doing an echocardiography (54.4%). Although missing laboratory investigations like BUN were handled with robust statistical methods (multiple imputation), missing NYHA class and ejection fraction data limited severity adjustment, potentially underestimating the impact of HF stage on mortality. Survival bias may have influenced retrospective data, and unmeasured confounders (e.g., income, healthcare access) were not fully addressed, consistent with findings from a recent review highlighting socioeconomic barriers to HF care [5].

Implications and Actions Needed

The 17.0% mortality rate and low use of SGLT2 inhibitors highlight the need for health system reforms, including subsidized diagnostics, clinician training on 2022 AHA/ACC/HFSA guidelines, and task-shifting to improve guideline uptake in Cameroon. More studies should be conducted to evaluate the impact of guideline adherence on mortality.

5. Conclusion

In-hospital HF mortality was high, driven by elevated BUN, dobutamine use, and later admission years, potentially reflecting increased patient acuity or resource constraints. Hypertensive heart disease and higher systolic blood pressure were protective. Interventions to enhance diagnostic access (e.g., echocardiography, ECG), and address systemic healthcare barriers are critical. Prospective studies are needed to investigate rising mortality trends and optimize HF management in Cameroon.

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Reporting Checklist

The authors have completed the STROBE reporting checklist.

Data Availability Statement

The data supporting the conclusions of this study are available from the corresponding author (SD) upon reasonable request.

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Ethical Approval

Ethical approval was obtained from the Regional Human Health Research Ethics Committee for the Littoral (Reference: 2024/CE/CRERESH-LITTORAL). Informed consent was waived due to the retrospective nature of the study. All procedures adhered to relevant ethical guidelines and regulations for the use of anonymized secondary data.

Author Contributions

Concept and study design: SD and EMM. Data collection: EMM. Data analysis and interpretation: EMM. Manuscript drafting: All authors. Final manuscript approval: All authors. Supervision: KF. SD and EMM had full access to all study data and take full responsibility for the integrity and accuracy of the data analysis. All authors have agreed to the submission of the manuscript in its current form.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Gouda, H.N., Charlson, F., Sorsdahl, K., Ahmadzada, S., Ferrari, A.J., Erskine, H., *et al.* (2019) Burden of Non-Communicable Diseases in Sub-Saharan Africa, 1990-2017: Results from the Global Burden of Disease Study 2017. *The Lancet Global Health*, **7**, e1375-e1387. [https://doi.org/10.1016/s2214-109x\(19\)30374-2](https://doi.org/10.1016/s2214-109x(19)30374-2)
- [2] Gtif, I., Bouzid, F., Charfeddine, S., Abid, L. and Kharrat, N. (2021) Heart Failure Disease: An African Perspective. *Archives of Cardiovascular Diseases*, **114**, 680-690. <https://doi.org/10.1016/j.acvd.2021.07.001>
- [3] Shahim, B., Kapelios, C.J., Savarese, G. and Lund, L.H. (2023) Global Public Health Burden of Heart Failure: An Updated Review. *Cardiac Failure Review*, **9**, e11. <https://doi.org/10.15420/cfr.2023.05>
- [4] Ciapponi, A., Alcaraz, A., Calderón, M., Matta, M.G., Chaparro, M., Soto, N., *et al.* (2016) Burden of Heart Failure in Latin America: A Systematic Review and Meta-Analysis. *Revista Española de Cardiología (English Edition)*, **69**, 1051-1060. <https://doi.org/10.1016/j.rec.2016.04.054>
- [5] Siddikatou, D., Mandeng Ma Linwa, E., Ndobu, V., Nkoke, C., Mouliom, S., Ndom, M.S., *et al.* (2025) Heart Failure Outcomes in Sub-Saharan Africa: A Scoping Review of Recent Studies Conducted after the 2022 AHA/ACC/HFSA Guideline Release. *BMC Cardiovascular Disorders*, **25**, Article No. 302. <https://doi.org/10.1186/s12872-025-04756-y>
- [6] Dzudie, A., Barche, B., Nkoke, C., Ngatchuesi, V.G., Ndom, M.S., Mouliom, S., *et al.* (2022) Survival Rate and Predictors of 36-Month Mortality in Patients with Heart Failure in Sub Saharan Africa: Insights from the Douala Heart Failure Registry (Do-HF). *Cardiovascular Diagnosis and Therapy*, **12**, 577-588. <https://doi.org/10.21037/cdt-22-166>
- [7] Ogah, S.O., Adebisi, A. and Sliwa, K. (2019) Heart Failure in Sub-Saharan Africa. In: Rescigno, G.S. and Firstenberg, M., Eds., *Topics in Heart Failure Management*, IntechOpen, 61-99. <https://doi.org/10.5772/intechopen.82416>
- [8] Dokainish, H., Teo, K., Zhu, J., Roy, A., AlHabib, K.F., ElSayed, A., *et al.* (2017)

Global Mortality Variations in Patients with Heart Failure: Results from the International Congestive Heart Failure (INTER-CHF) Prospective Cohort Study. *The Lancet Global Health*, **5**, e665-e672.

- [9] Ajayi, A.A., Sofowora, G.G. and Ladipo, G.O. (2020) Explaining Heart Failure Hyper-Mortality in Sub Saharan Africa: Global Genomic and Environmental Contribution Review. *Journal of the National Medical Association*, **112**, 141-157. <https://doi.org/10.1016/j.jnma.2020.02.003>
- [10] Talha, K.M., Anker, S.D. and Butler, J. (2023) SGLT-2 Inhibitors in Heart Failure: A Review of Current Evidence. *International Journal of Heart Failure*, **5**, 82-90. <https://doi.org/10.36628/ijhf.2022.0030>
- [11] Cowie, M.R., Mourilhe-Rocha, R., Chang, H., Volterrani, M., Ban, H.N., Campos de Albuquerque, D., et al. (2022) The Impact of the COVID-19 Pandemic on Heart Failure Management: Global Experience of the Optimize Heart Failure Care Network. *International Journal of Cardiology*, **363**, 240-246. <https://doi.org/10.1016/j.ijcard.2022.06.022>
- [12] Peduzzi, P., Concato, J., Kemper, E., Holford, T.R. and Feinstein, A.R. (1996) A Simulation Study of the Number of Events per Variable in Logistic Regression Analysis. *Journal of Clinical Epidemiology*, **49**, 1373-1379. [https://doi.org/10.1016/s0895-4356\(96\)00236-3](https://doi.org/10.1016/s0895-4356(96)00236-3)
- [13] McDonagh, T.A., Metra, M., Adamo, M., Gardner, R.S., Baumbach, A., Böhm, M., et al. (2021) 2021 ESC Guidelines for the Diagnosis and Treatment of Acute and Chronic Heart Failure. *European Heart Journal*, **42**, 3599-3726. <https://doi.org/10.1093/eurheartj/ehab368>
- [14] Ashinze, P., Abdul-Rahman, T. and Wireko, A.A. (2023) The Usage of SGLT-2 Inhibitors in the Management of Heart Failure in Rural Africa: Mitigating the Barriers to the Optimal Adoption of a Novel, Adjuvant Therapeutic Agent in the Management of Heart Failure. *Therapeutic Advances in Cardiovascular Disease*, **17**, 1-2. <https://doi.org/10.1177/17539447231202933>
- [15] Pierce, J.B., Vaduganathan, M., Fonarow, G.C., Ikeaba, U., Chiswell, K., Butler, J., et al. (2023) Contemporary Use of Sodium-Glucose Cotransporter-2 Inhibitor Therapy among Patients Hospitalized for Heart Failure with Reduced Ejection Fraction in the Us: The Get with the Guidelines-Heart Failure Registry. *JAMA Cardiology*, **8**, Article No. 652. <https://doi.org/10.1001/jamacardio.2023.1266>
- [16] Varshney, A.S., Calma, J., Kalwani, N.M., Hsiao, S., Sallam, K., Cao, F., et al. (2024) Uptake of Sodium-Glucose Cotransporter-2 Inhibitors in Hospitalized Patients with Heart Failure: Insights from the Veterans Affairs Healthcare System. *Journal of Cardiac Failure*, **30**, 1086-1095. <https://doi.org/10.1016/j.cardfail.2023.12.018>
- [17] Docherty, K.F., Bayes-Genis, A., Butler, J., Coats, A.J.S., Drazner, M.H., Joyce, E., et al. (2022) The Four Pillars of Hfref Therapy: Is It Time to Treat Heart Failure Regardless of Ejection Fraction? *European Heart Journal Supplements*, **24**, L10-L19. <https://doi.org/10.1093/eurheartjsupp/suac113>
- [18] Damasceno, A., Mayosi, B.M., Sani, M., Ogah, O.S., Mondo, C., Ojji, D., et al. (2012) The Causes, Treatment, and Outcome of Acute Heart Failure in 1006 Africans from 9 Countries. *Archives of Internal Medicine*, **172**, 1386-1394. <https://doi.org/10.1001/archinternmed.2012.3310>
- [19] Metra, M., Tomasoni, D., Adamo, M., Bayes-Genis, A., Filippatos, G., Abdelhamid, M., et al. (2023) Worsening of Chronic Heart Failure: Definition, Epidemiology, Management and Prevention. a Clinical Consensus Statement by the Heart Failure Association of the European Society of Cardiology. *European Journal of Heart Fail-*

- ure*, **25**, 776-791. <https://doi.org/10.1002/ejhf.2874>
- [20] Mumbulu, E.T., Nkodila, A.N., Saint-Joy, V., Moussinga, N., Makulo, J.R. and Buila, N.B. (2024) Survival and Predictors of Mortality in Patients with Heart Failure in the Cardiology Department of the Center Hospitalier Basse Terre in Guadeloupe: Historical Cohort Study. *BMC Cardiovascular Disorders*, **24**, Article No. 599. <https://doi.org/10.1186/s12872-024-04268-1>
- [21] Mandi, D.G., Bamouni, J., Yaméogo, R.A., Naïbé, D.T., Kaboré, E., Kambiré, Y., *et al.* (2020) Spectrum of Heart Failure in Sub-Saharan Africa: Data from a Tertiary Hospital-Based Registry in the Eastern Center of Burkina Faso. *Pan African Medical Journal*, **36**, Article No. 30. <https://doi.org/10.11604/pamj.2020.36.30.19321>
- [22] Zhao, H. and Cui, W. (2022) Prognostic Risk Scores for Patients with Heart Failure. *British Journal of Hospital Medicine*, **83**, 1-16. <https://doi.org/10.12968/hmed.2021.0594>
- [23] Shoaib, A., Van Spall, H.G.C., Wu, J., Cleland, J.G.F., McDonagh, T.A., Rashid, M., *et al.* (2021) Substantial Decline in Hospital Admissions for Heart Failure Accompanied by Increased Community Mortality during COVID-19 Pandemic. *European Heart Journal—Quality of Care and Clinical Outcomes*, **7**, 378-387. <https://doi.org/10.1093/ehjqcco/qcab040>