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Association of GWTG-HF Risk Score with Major Adverse Cardiovascular Events in Acute Heart Failure Patients: A Retrospective Study in a Tertiary Hospital in Indonesia

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ABSTRACT

Introduction: Heart failure (HF) affects approximately 64 million people globally, contributing to high mortality, morbidity, reduced quality of life, and substantial healthcare burden. Acute heart failure (AHF) requires urgent intervention and carries elevated risks of mortality and major adverse cardiovascular events (MACE). The Get With The Guidelines-Heart Failure (GWTG-HF) risk score, originally developed for predicting in-hospital mortality in HF patients, has shown potential in forecasting MACE in certain populations. However, its association with MACE in Indonesian AHF patients remains underexplored.

Method: This retrospective observational cohort study included 319 AHF patients admitted to Adam Malik General Hospital, Medan, Indonesia, from January 2024 to March 2025. Patient characteristics, GWTG-HF scores, and in-hospital MACE were recorded. Statistical analyses involved receiver operating characteristic (ROC) curves and multivariate regression.

Results: Patients had a mean age of 55 years, with 54.5% males. Median hospital stay was 5 days (range 1–47). Predominant features included acute decompensated HF (65.8%), infection as etiology (46.7%), HFrEF (52.0%), coronary heart disease (62.4%), and smoking (50.8%). In-hospital MACE occurred in 20.4% of patients, primarily mortality (18.8%), increasing with GWTG-HF risk categories (low: 8.1%; moderate: 17.4%; high: 36.7%). Age, systolic blood pressure, heart rate, sodium, and blood urea nitrogen significantly influenced MACE ($p<0.05$). The GWTG-HF score demonstrated good predictive performance for MACE (AUC 0.759, $p<0.001$; sensitivity 63.2%; specificity 78.1%).

Conclusion: The GWTG-HF score is significantly associated with in-hospital MACE in Indonesian AHF patients, supporting its utility as a risk stratification tool to guide clinical decisions and optimize management.

Keywords

Acute Heart Failure, GWTG Score, Major Cardiovascular Events

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INTRODUCTION

Heart failure (HF) is a clinical syndrome characterized by typical symptoms such as dyspnea, ankle swelling, and fatigue, often accompanied by signs such as elevated jugular venous pressure, pulmonary crackles, and peripheral edema. This results from structural or functional cardiac abnormalities, leading to increased intracardiac pressure and/or inadequate cardiac output at rest or during exercise. Most cases arise from myocardial dysfunction in the systolic, diastolic, or both phases, with contributions from valvular abnormalities, pericardial/endocardial disorders, and rhythm/conduction disturbances [1].

In developed countries, age-adjusted HF incidence has declined due to improved cardiovascular disease management; however, the overall prevalence has increased with population aging. HF affects more than 64 million individuals worldwide. In Europe, the incidence is approximately 3–5 per 1000 person-years, with a prevalence of 1–2% in adults, increasing from <1% in those aged <55 years to >10% in those aged >70 years. Approximately 50% of the patients had heart failure with reduced ejection fraction (HFrEF), while the remainder had heart failure with preserved ejection fraction (HFpEF) or mildly reduced ejection fraction (HFmrEF). The long-term ESC of the Cardiology registry data indicate proportions of 60% HFrEF, 24% HFmrEF, and 16% HfpEF [1].

HF remains a complex syndrome with persistently high morbidity and mortality rates, which are projected to increase with global aging and impose substantial healthcare burdens. Effective risk stratification is essential for optimizing management, including outpatient follow-up, pharmacotherapy titration, and device therapies. Individual clinical parameters, such as age, blood pressure, heart rate, renal function, B-type natriuretic peptide levels, inflammatory biomarkers, echocardiographic findings, respiratory capacity, anemia, and sleep-disordered breathing, serve as prognostic indicators to distinguish high- from low-risk patients [2]. In the REPORT-HF registry, crude 1-year mortality varied across Asia, being highest in Indonesia (34.1%) and lowest in Korea (10.9%), with Indonesian patients (n=337 discharged alive) having a median age of 56 years and 38.6% being female [3]. In Indonesia, age-adjusted cardiovascular mortality increased from 2000 to 2019, contributing significantly to the overall burden [4]. Local data from a Medan hospital (2019) reported 417 HF admissions, predominantly in males (72.7%), with hypertension as the leading risk factor (64%) and major cardiovascular events in 184 patients [5].

Major adverse cardiovascular events (MACE) typically comprise a composite of all-cause death, myocardial infarction, coronary revascularization, stroke, and heart failure hospitalization, contributing to substantial morbidity, mortality, reduced quality of life, and increased healthcare costs [6-8]. MACE has profound socioeconomic implications, with cardiovascular diseases causing over 17 million deaths annually [9,10]. In Indonesia, coronary heart disease is the leading cause of death, with an increasing prevalence of risk factors such as obesity and diabetes [11]. Several risk prediction models have been developed, including the Seattle Heart Failure Model, GWTG-HF, ADHERE, MAGGIC-HF, and GISSI-HF models [12]. Comprehensive scores that incorporate multiple parameters better predict outcomes. For instance, the AHEAD score targets the long-term risk of acute HF [2].

In 2010, Peterson et al. developed and validated the GWTG-HF risk score to predict in-hospital mortality in acute HF using seven admission variables: age, systolic blood pressure, blood urea nitrogen, heart rate, serum sodium level, history of chronic obstructive pulmonary disease, and non-black race. Derived from 39,783 patients across 198 U.S. hospitals, it reported 2.86% in-hospital mortality and a similarly poor prognosis in HFrEF and HFpEF [13]. Subsequent studies have confirmed its discriminatory ability for in-hospital and 1-year mortality [14]. In Japanese cohorts, higher GWTG-HF scores were correlated with elevated natriuretic peptide levels and increased all-cause mortality (23.9%) and cardiovascular events (28%) [15]. Validation in Japan showed good discrimination, which was enhanced by the addition of BNP [16]. In Asian-American patients, comparable outcomes supported generalizability [17]. Indian studies have demonstrated competitive performance versus APACHE II with a significant NT-proBNP correlation [18]. External validations consistently affirmed reliability, although local adaptation may be needed owing to demographic variations [19].

The GWTG-HF score offers practical advantages by utilizing routinely collected admission variables for easy calculation and high-risk identification to inform decision making [20]. Its applicability for mortality and MACE prediction in acute HF warrants further evaluation, particularly in underrepresented populations. At Adam Malik General Hospital, Medan, no routine risk scoring assesses mortality or MACE in patients with HF, prompting an investigation into the association between the GWTG-HF score and in-hospital MACE in acute HF. Despite the availability of these scores, their routine clinical use remains limited because of their complexity and individual-level accuracy. HF prognosis involves multifaceted factors, with acute exacerbations signaling worse outcomes and high readmission rates (10–30% within 90 days to 1 year) [12].

METHOD

This retrospective observational cohort study investigated the association between the Get With The Guidelines-Heart Failure (GWTG-HF) risk score and in-hospital major adverse cardiovascular events (MACE) in patients with acute heart failure (AHF).

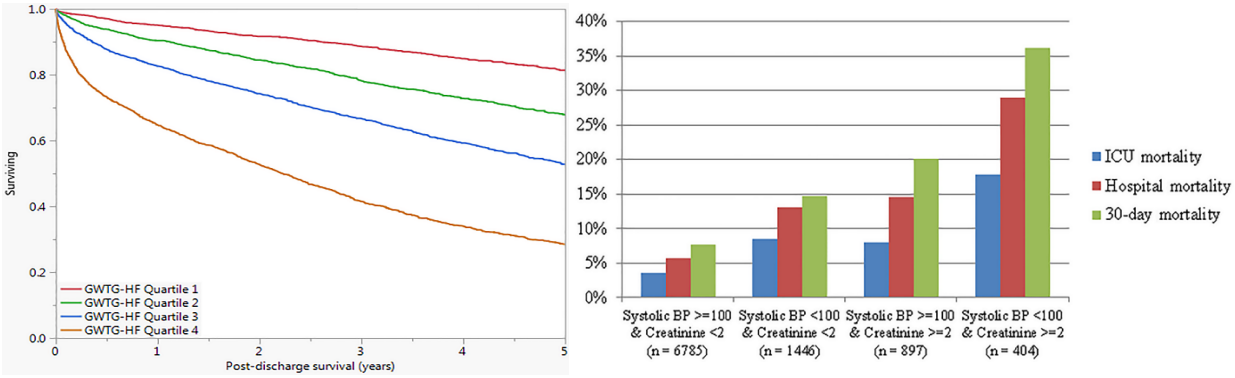

Figure 1. Nomogram of the Get With the Guidelines-Heart Failure (GWTG-HF) risk score (adapted from Peterson et al. 2010).

This study was conducted at the Adam Malik General Hospital, a tertiary referral center in Medan, Indonesia. Data will be retrieved from medical records of consecutive patients admitted for AHF between January 2024 and March 2025. The target population comprised adult patients diagnosed with AHF. Eligible participants were aged ⩾18 years, admitted through the emergency department or directly to the wards, and had a diagnosis supported by history, physical examination, and ancillary investigations. Patients were required to have complete medical records sufficient for GWTG-HF score calculation. The exclusion criteria were end-stage renal disease requiring hemodialysis, implanted pacemaker, pregnancy, palliative care status, and congenital heart disease. The minimum sample size was calculated to detect a clinically meaningful difference in MACE incidence between the high- and low-risk GWTG-HF categories, yielding approximately 77 patients per group for a total of 231 patients. However, all consecutive eligible patients during the study period were included to enhance precision. Data collection involved a review of electronic and paper medical records. Baseline characteristics, admission vital signs, laboratory results, comorbidities, and in-hospital outcomes were also recorded. The GWTG-HF risk score was computed using seven established variables and categorized into low-, moderate-, and high-risk groups. The primary outcome was in-hospital MACE, a composite endpoint that included all-cause mortality, acute myocardial infarction, stroke, cardiogenic shock, and malignant ventricular arrhythmia.

The operational definitions for key variables, including the components of the GWTG-HF score (age, systolic blood pressure, heart rate, blood urea nitrogen, serum sodium, COPD history, and race) and MACE, followed the established guidelines and prior validations. Categorical data are expressed as frequencies and percentages, while continuous data are presented as mean ± standard deviation or median (range) based on normality assessed using the Kolmogorov-Smirnov test. Associations were examined using the chi-square or Fisher's exact tests for categorical variables and independent t-tests or Mann-Whitney U tests for continuous variables. Significant bivariate predictors were included in the multivariate logistic regression models. Statistical analyses were performed using SPSS version 22, with $p < 0.05$, denoting significance. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara, and research permission was obtained from the Research and Development Unit of the Adam Malik General Hospital.

RESULTS

This retrospective cohort study included 319 patients with acute heart failure (AHF) admitted to the Adam Malik General Hospital, Medan, Indonesia, between January 2024 and March 2025. Initially, 382 potential

cases were identified from the hospital records; 63 were excluded due to incomplete data or meeting the exclusion criteria, yielding the final analytical sample.

Table 1. Baseline Categorical Characteristics by GWTG-HF Risk Category

Parameter	Low (n=124)	Moderate (n=86)	High (n=109)
Male sex	85 (68.5%)	50 (58.1%)	78 (71.6%)
Acute decompensated HF	82 (66.1%)	61 (70.9%)	69 (63.3%)
Acute pulmonary edema	39 (31.5%)	22 (25.6%)	30 (27.5%)
Cardiogenic shock	0 (0.0%)	0 (0.0%)	6 (5.5%)
Infection etiology	50 (40.3%)	36 (41.9%)	45 (41.3%)
Coronary heart disease	76 (61.3%)	51 (59.3%)	72 (66.1%)
Smoking	64 (51.6%)	39 (45.3%)	59 (54.1%)
Hypertension	72 (58.1%)	44 (51.2%)	49 (45.0%)
HFrEF	53 (42.7%)	46 (53.5%)	67 (61.5%)
Furosemide use	115 (92.7%)	84 (97.7%)	108 (99.1%)

The baseline characteristics are summarized in Tables 1 and 2. The cohort had a median age of 55 years (range, 18–85 years), with a male predominance (213 patients; 66.8%). The most common clinical presentation was acute decompensated heart failure (212 patients, 66.5%), followed by acute pulmonary edema. Infection was the leading etiology (131 patients, 41.1%), and coronary heart disease was the most frequent comorbidity (199 patients, 62.4%). HFrEF was present in 166 patients (52.0%). Loop diuretics (furosemide) were prescribed to almost all patients (307 patients, 96.2%).

Table 2. Baseline Continuous Characteristics by GWTG-HF Risk Category (Median (range) unless stated otherwise)

Parameter	Low (n=124)	Moderate (n=86)	High (n=109)
Age (years)	51.5 (18–75)	58 (23–82)	61 (21–85)
Length of stay (days)	5 (2–23)	5 (1–47)	6 (1–30)
Systolic BP (mmHg)	140 (100–235)	121 (90–195)	105 (70–153)
Heart rate (bpm)	87.5 (30–146)	99.5 (44–185)	109 (34–212)
Sodium (mEq/L)	143 (122–151)	141 (128–150)	142 (114–152)
BUN (mg/dL)	14.5 (3.7–57.5)	19.2 (6.5–60.7)	28 (7.5–100)

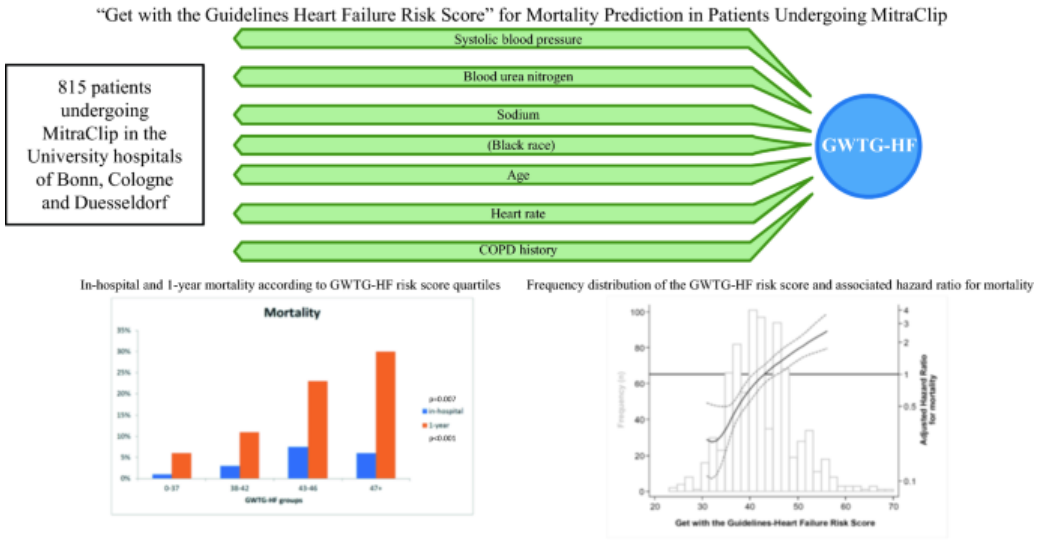

Figure 2. Incidence of in-hospital major adverse cardiovascular events (MACE) stratified by GWTG-HF risk categories.

The patients were stratified into low-(n = 124, 38.9 %), moderate-(n = 86, 27.0 %), and high-risk (n = 109, 34.2 %) categories according to the GWTG-HF risk score (Table 3). Higher risk categories were associated with older age, lower systolic blood pressure, higher heart rate, elevated blood urea nitrogen levels,

and higher prevalence of chronic obstructive pulmonary disease. In-hospital major adverse cardiovascular events (MACE) occurred in 95 patients (29.8%), predominantly all-cause mortality (60 patients, 18.8%), followed by cardiogenic shock and malignant arrhythmias.

MACE incidence increased markedly across risk strata: 8.1% in low-risk, 29.1% in moderate-risk, and 55.0% in high-risk groups (p<0.001)

Table 3. In-Hospital MACE by GWTG-HF Risk Category

Event	Low (n=124)	Moderate (n=86)	High (n=109)	p-value
Any MACE	10 (8.1%)	25 (29.1%)	60 (55.0%)	<0.001
All-cause mortality	5 (4.0%)	15 (17.4%)	40 (36.7%)	
Cardiogenic shock	2 (1.6%)	13 (15.1%)	36 (33.0%)	

Multivariate logistic regression identified age (OR 1.052; 95% CI 1.027–1.078; p=0.001), systolic blood pressure (OR 0.974; 95% CI 0.964–0.985; p=0.001), heart rate (OR 1.015; 95% CI 1.004–1.026; p=0.006), BUN (OR 1.033; 95% CI 1.013–1.054; p=0.001), and sodium (OR 0.990; 95% CI 0.946–1.036; p=0.011) as independent predictors of MACE

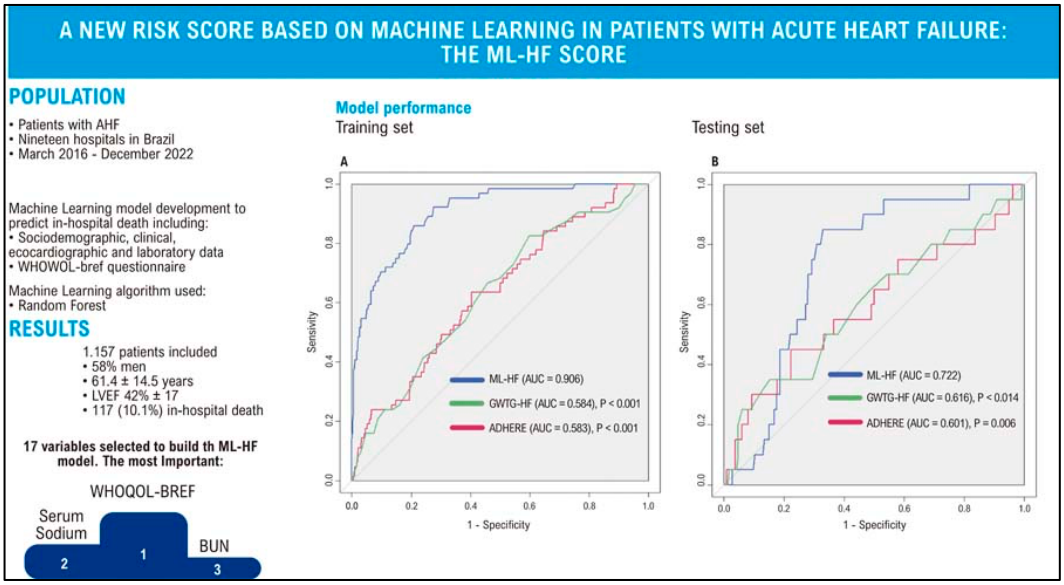

Figure 3. Receiver operating characteristic (ROC) curve of the GWTG-HF risk score for predicting in-hospital MACE (AUC = 0.759)

Receiver operating characteristic analysis demonstrated good discriminatory performance of the GWTG-HF score for in-hospital MACE (AUC 0.759; 95% CI not reported; p<0.001), with a sensitivity of 63.2% and specificity of 78.1%.

DISCUSSION

This retrospective cohort study of 319 patients with acute heart failure (AHF) at a tertiary hospital in Indonesia confirmed a strong association between the Get With The Guidelines-Heart Failure (GWTG-HF) risk score and in-hospital major adverse cardiovascular events (MACE). The observed MACE rate of 29.8%, which increased to 55.0% in high-risk patients, underscores the utility of the score in identifying individuals requiring intensified management.

The demographic profile—predominantly male (66.8%) with a median age of 55 years—is consistent with global HF epidemiology, where male preponderance reflects higher exposure to ischemic triggers and differing hormonal influences on cardiac remodeling [21-37]. Acute decompensated heart failure dominated presentations, but high-risk strata showed enrichment for cardiogenic shock and right ventricular failure,

aligning with evidence that advanced hemodynamic compromise portends poor short-term outcomes [38,39]. Acute coronary syndrome, the leading etiology in high-risk patients (48.6%), reinforces its role in precipitating rapid deterioration, extensive myocardial necrosis, and arrhythmogenic substrates [38]. The comorbidity burden escalated with the risk category, with coronary heart disease, chronic kidney disease, and chronic obstructive pulmonary disease being more prevalent in high-risk groups. [38] These findings corroborate those of multinational registries demonstrating the multiplicative prognostic impact of cardiorenal and cardiopulmonary interactions [39]. HFrEF predominance in high-risk patients (61.5%) versus HFpEF in low-risk strata reflects greater structural myocardial damage and neurohormonal activation in reduced ejection fraction phenotypes [37].

Guideline-directed therapy revealed near-universal loop diuretic use, modest ARNI uptake in severe cases, and strikingly low SGLT2 inhibitor prescription, highlighting persistent implementation gaps in resource-constrained settings despite robust evidence for mortality reduction across ejection fraction spectra [40,41]. Laboratory derangements, such as elevated BUN, lower systolic blood pressure, tachycardia, and relative hyponatremia in high-risk patients, mirror established markers of cardiorenal syndrome, inadequate perfusion, and neurohormonal dysregulation [42-51]. Multivariate analysis identified age, systolic blood pressure, heart rate, BUN, and sodium as independent MACE predictors, recapitulating the core GWTG-HF components and validating their pathophysiological relevance [52-61]. The score's discriminatory performance (AUC 0.759) compares favorably with external validations in diverse populations, confirming moderate to good accuracy using readily available admission variables [62]. This supports the routine GWTG-HF calculation for early risk stratification, potentially guiding resource allocation, monitoring intensity, and timely escalation of advanced therapies.

The strengths of this study include the comprehensive characterization of a Southeast Asian cohort and addressing the underrepresented regions in the HF prognostication literature. The limitations of this study include its single-center retrospective design, potential selection bias from the exclusion criteria, and the inability to assess race effects due to ethnic homogeneity. Prospective multicenter validation, ideally incorporating contemporary biomarkers or machine learning enhancements, would strengthen the generalizability of our findings. In conclusion, the GWTG-HF risk score reliably predicts in-hospital MACE in Indonesian patients with AHF, offering a simple, pragmatic tool to optimize clinical decision-making and improve outcomes in real-world practice.

CONCLUSION

In this retrospective study of 319 patients with acute heart failure at a tertiary hospital in Indonesia, the Get With The Guidelines-Heart Failure (GWTG-HF) risk score demonstrated good discriminatory performance (AUC 0.759; $p < 0.001$) in predicting in-hospital major adverse cardiovascular events (MACE; 29.8%), which increased significantly from 8.1% in the low-risk to 55.0% in the high-risk categories ($p < 0.001$). Age, systolic blood pressure, heart rate, blood urea nitrogen level, and sodium level were independent predictors. These findings validate the clinical utility of the GWTG-HF score for effective risk stratification in Asian populations, enabling the early identification of high-risk patients to guide their management and improve their outcomes.

DECLARATIONS

Ethics approval and consent to participate were obtained. Permission for this study was obtained from the Ethics Committee of the Universitas Sumatera Utara and Haji Adam Malik General Hospital.

CONSENT FOR PUBLICATION

The Authors agree to the publication in the Journal of Society Medicine.

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COMPETING INTERESTS
The authors declare that there is no conflict of interest in this report.

AUTHORS' CONTRIBUTIONS
All authors significantly contribute to the work reported execution, acquisition of data, analysis, and interpretation, or in all these areas. Contribute to drafting, revising, or critically reviewing the article. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

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