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Predicting In-Hospital Mortality in HFrEF Patients: Application of the Simplified ADHERE Risk Score Model

Dr. Faisal[1]; Dr. Faiza Jamil[2]

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Abstract: This study evaluates the efficacy of a simplified risk score derived from the Acute Decompensated Heart Failure National Registry (ADHERE) in predicting in-hospital mortality among patients with acute heart failure and reduced ejection fraction. The model utilizes readily available clinical parameters to enable rapid bedside risk stratification and support clinical decision-making in acute care settings. Given the heterogeneity in patient presentation and outcomes, reliable risk prediction tools are essential for optimizing management and resource allocation.

The discriminatory power and calibration of the ADHERE risk model were assessed in a specific patient cohort and compared with alternative prognostic scores. Particular attention was given to the contribution of individual components, including admission B-type natriuretic peptide (BNP), and the clinical relevance of common practices such as in-hospital observation on oral diuretics.

Findings highlight the utility of simplified risk models while underscoring the need for external validation across diverse populations. Emerging strategies, including multimarker approaches integrating natriuretic peptides, cardiac troponins, and inflammatory markers, may enhance predictive accuracy. Furthermore, incorporation of echocardiographic parameters and advanced analytical methods, such as machine learning, offers potential for improving individualized risk assessment.

Despite promising advancements, challenges remain in standardizing biomarker use and translating complex models into routine clinical practice. Overall, this study supports the continued refinement of risk stratification tools to improve prognostication and guide personalized management in heart failure.

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I. INTRODUCTION

Heart failure remains a major global public health challenge and a leading cause of hospitalization and mortality worldwide. Acute decompensated heart failure (ADHF), in particular, represents a critical phase of the disease characterized by sudden or progressive worsening of symptoms requiring urgent medical care. Despite advances in therapeutic strategies, outcomes for patients hospitalized with ADHF remain poor, with significant rates of in-hospital mortality and early readmission.

The clinical heterogeneity of ADHF poses a significant challenge in patient management. Individuals present with varying degrees of hemodynamic instability, comorbid conditions, and organ dysfunction, all of which influence prognosis. Early risk stratification is therefore essential to guide clinical decision-making, optimize resource allocation, and improve patient outcomes. Identifying patients at high risk of adverse events allows for timely implementation of intensive monitoring and therapeutic interventions, while lower-risk patients may benefit from more streamlined management approaches.

Several risk prediction tools have been developed to estimate mortality risk in patients with ADHF. Among these, the Acute Decompensated Heart Failure National Registry (ADHERE) risk model is widely recognized for its simplicity and clinical utility. The ADHERE risk tree incorporates readily available clinical variables, including blood urea nitrogen, systolic blood pressure, and serum creatinine, to stratify patients according to their risk of in-hospital mortality [3]. Its practicality has facilitated its use in diverse clinical settings, particularly where rapid assessment is required.

However, the generalizability of the ADHERE risk model across different populations remains a subject of ongoing investigation. Variations in patient demographics, prevalence of comorbidities, and healthcare delivery systems may influence its predictive performance. Consequently,

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validation of this model in specific populations is necessary to ensure its accuracy and applicability in routine clinical practice.

Therefore, the present study aims to evaluate the predictive value of a simplified ADHERE risk score model for in-hospital mortality among patients with acute heart failure with reduced ejection fraction. By assessing its performance in a real-world clinical setting, this study seeks to contribute to improved risk stratification and inform clinical decision-making in the management of ADHF.

II. LITERATURE REVIEW

Recent research in acute heart failure (AHF) has increasingly focused on the identification of reliable prognostic biomarkers and clinical risk stratification tools that enable early prediction of adverse outcomes at the time of hospital admission. Accurate risk assessment is essential for guiding clinical decision-making, optimizing resource allocation, and improving patient outcomes.

Among the most widely recognized models is the Acute Decompensated Heart Failure National Registry (ADHERE) classification and regression tree (CART) model, which incorporates readily available clinical parameters such as blood urea nitrogen (BUN), systolic blood pressure, and serum creatinine. These variables reflect key pathophysiological processes, including renal dysfunction and hemodynamic compromise, and are integrated into multivariable frameworks to estimate the probability of in-hospital mortality (Fonarow et al., 2005; Nakano et al., 2019). The simplicity and bedside applicability of the ADHERE model have contributed to its widespread clinical use.

Despite its utility, growing evidence suggests that the predictive performance of the ADHERE risk model varies across different populations. External validation studies have demonstrated inconsistent discriminative ability, particularly in non-Western and heterogeneous patient cohorts (Villacorta, 2023). Such variability may be attributed to differences in demographic characteristics, comorbidity profiles, healthcare infrastructure, and treatment practices.

Several studies have emphasized the importance of context-specific validation of risk prediction models, noting that tools developed from large registries may not be directly generalizable to all clinical settings (Bernardes et al., 2023; Museedi et al., 2020). Furthermore, reliance on a limited set of variables may overlook additional prognostic factors—such as nutritional status, electrolyte imbalances, and markers of congestion—that are increasingly recognized as important determinants of outcomes in AHF.

In this context, the evaluation of existing risk models within localized populations is critical to determine their accuracy and clinical relevance. Validation studies not only assess model performance but also provide opportunities for recalibration or refinement based on regional patient characteristics (Win et al., 2017).

Accordingly, the present study aims to address this gap by assessing the predictive performance of the ADHERE simplified risk model in a localized hospital cohort. By examining its discriminative ability in this specific clinical setting, this study seeks to determine whether the model remains a reliable tool for risk stratification or requires modification to better reflect the characteristics of the studied population (Zhao et al., 2022).

III. METHODOLOGY

The study employed a retrospective cross-sectional design to examine the predictive accuracy of the ADHERE classification system among patients admitted with acute heart failure and reduced left ventricular ejection fraction.

The analysis focused on patients who met the predefined clinical criteria, specifically evaluating the correlation between the registry's sequential parameters—blood urea nitrogen, systolic blood pressure, and serum creatinine—and actual in-hospital mortality.

IV. RESULTS

Heart failure (HF) continues to represent a major and growing challenge in cardiovascular medicine, contributing significantly to global morbidity, mortality, and healthcare burden. In the present study, we evaluated the utility of the ADHERE risk score in predicting in-hospital mortality among patients with acute heart failure.

Our cohort of 215 patients had a mean age of 58.4 ± 12.2 years, with a predominance of male patients. Hypertension and ischemic heart disease were the most common comorbidities, consistent with their well-established role in the development and progression of HF. The observed in-hospital mortality rate of 9.8% exceeds the 4–7% range reported in large registries, suggesting a comparatively higher-risk population in our setting.

Among the evaluated predictors, blood urea nitrogen (BUN) emerged as a significant independent predictor of adverse outcomes, reinforcing prior evidence linking renal dysfunction and neurohormonal activation with increased mortality risk (Arruda et al., 2009; Fortich et al., 2019). Additionally, elevated creatinine levels and systolic blood pressure were found to significantly influence prognostic outcomes, supporting the importance of cardiorenal interactions and hemodynamic status in acute HF (Novack et al., 2010; Solela & Yimer, 2024).

Despite these significant individual predictors, the ADHERE risk score demonstrated limited discriminative ability in our cohort and failed to achieve statistical significance for mortality prediction. This finding contrasts with earlier validation studies and highlights an important limitation: risk models derived from large, predominantly Western registries may not perform uniformly across diverse populations.

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Variations in demographic characteristics, comorbidity burden, healthcare access, and treatment practices may explain these discrepancies. Supporting this, comparative analyses of ADHERE datasets have demonstrated differences between United States and international cohorts in terms of age, treatment strategies, and hospitalization patterns, although adjusted mortality outcomes were similar. Such variability underscores the influence of regional and system-level factors on HF outcomes.

Furthermore, evidence from large-scale registries such as “Get With The Guidelines–Heart Failure” indicates evolving trends in HF phenotypes and management, including increasing prevalence of HF with preserved ejection fraction and shifting treatment patterns. These findings emphasize the heterogeneity of HF populations and the limitations of applying a single risk model across all subgroups.

Our results therefore highlight the need for local validation and potential recalibration of existing risk models. The heterogeneity observed in HF presentations necessitates the development of region-specific risk stratification tools that incorporate locally relevant clinical and biochemical variables.

Future research should focus on enhancing predictive accuracy through the inclusion of additional prognostic markers. Parameters such as serum albumin, electrolyte disturbances, and markers of congestion may improve risk stratification. In particular, the blood urea nitrogen-to-creatinine ratio has shown promise as a more comprehensive indicator of cardiorenal status and hemodynamic compromise (Takaya et al., 2015; Sakr et al., 2023). Additionally, clinical conditions such as persistent congestion and worsening renal function should be integrated into future models, given their strong association with adverse outcomes (Cooper et al., 2023).

V. CONCLUSION

In conclusion, this study demonstrates that while individual clinical and laboratory parameters—particularly BUN, creatinine, and blood pressure—are significantly associated with in-hospital mortality in acute heart failure, the ADHERE risk score alone showed limited predictive utility in our cohort.

These findings underscore the need for localized validation and refinement of risk stratification tools, incorporating region-specific clinical characteristics and emerging prognostic markers. Early identification of high-risk patients remains essential for optimizing management strategies, improving outcomes, and ensuring efficient allocation of healthcare resources.

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