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Emergency Heart Failure Mortality Risk Grade-7 Score Performance in Patients with Acute Heart Failure admitted at a Tertiary Care Center

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ABSTRACT

Introduction

Heart failure is a major cause of morbidity and mortality worldwide with annual mortality of 8-9%. Acute heart failure patients require frequent Emergency Department visits and hospitalization. Emergency Heart Failure Mortality Risk Grade (EHMRG) score helps to risk stratify such patients. We aimed to study its performance at a tertiary care centre in Nepal.

Methods

This is an analytical, study involving 175 acute heart failure patients admitted at Emergency department over 1 year. The score was calculated for each patient and they were followed up for 30 days post discharge for readmission. The primary outcome studied was 7 day mortality.

Results

The median age was 66 years with 94 (53.7%) of the patients being male. Ischemic (38.3%) and dilated (25.1%) cardiomyopathies were the most common etiologies. Twenty seven (15.3%) of the patients required re-hospitalization within 1 month.There was statistically significant association ($p<0.001$) between 7-day mortality and high EHMRG scores (Class 5 and 4). No 7-day mortality was observed in the very low, low, and intermediate-risk groups. In the high-risk group (Class 4), 1 patient died while 15 survived. In the very high-risk group (Class 5), 29 patients died compared to 45 who survived.

Conclusion

Mortality within 7 days and readmission rates were higher in patients with high EHMRG scores. No mortalitites were encountered in patients with low scores. EHMRG can be a valuable tool to stratify acute heart failure patients as it can identify patients with high risk of 7 day mortality. It can help physician in deciding whether to discharge or admit the patients from Emergency rooms.

Keywords
Emergency; EHMRG-7; heart failure; risk stratification

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INTRODUCTION

Worldwide prevalence of heart failure (HF) is estimated to be 64.34 million cases[1] and 6.2 million in USA alone[2]. Acute HF patients require frequent emergency department visits and re-hospitalization putting enormous burden on hospital resources[3].

Despite the presence of other algorithms to identify those at increased risk who benefit from hospitalization[4], universally accepted scoring system is still lacking. Emergency Heart Failure Mortality Risk Grade(EHMRG)-7 score was designed to predict 7 day mortality in acute HF patients[5] and has been validated in several countries[6,7,8]. Its performance in Nepal has not yet been studied.

The primary objective of our study was to determine whether the EHMRG-7 score predicts mortality in patients with acute HF within 7 days of admission. The secondary objective of the study was to correlate the severity of HF with high EHMRG-7 scores on the basis of hospital stay, CCU admission, AKI, CPR, intubation, arrhythmias, hospital acquired pneumonia, cardiogenic shock with inotrope use, readmission within 30 days of discharge and pulmonary edema.

METHODS

This study was a cross-sectional study including patients admitted to the ED of MCVTC with the diagnosis of acute heart failure from May 2023 to February 2024. Ethical clearance was obtained from IRC of IOM. Participants who fulfilled both the inclusion criteria were consecutively enrolled for the study and evaluated. Sample size of 175 was calculated after adding 10 percent non response rate, with 95% confidence interval and 5% margin of error.

The diagnosis of heart failure was done clinically using Framingham heart failure criteria[9], and aided by NT-pro BNP levels as decided by the treating physician. Clinical, demographic and laboratory data were collected at the emergency department(ED) itself from charts, history and clinical examinations. For readmissions, only the data from first admission during the study period was included. Management decisions including CCU admission were made on the clinical discretion of the treating doctors (cardiology residents or faculties at MCVTC). If the patient was discharged from ER itself, the patient was followed up with telephone call till 7 days for clinical details and information regarding mortality. During the admission, parameters like length of hospital stay, CCU admission, AKI, CPR, intubation, arrhythmias, hospital acquired pneumonia, cardiogenic shock with inotrope use and pulmonary edema were obtained. It was also included for those surviving beyond 7 days of admission. The patients were followed up for 1 month for any readmissions.

EHMRG-7 uses various parameters - age, arrival by ambulance, systolic blood pressure, heart rate, SpO2 , potassium cocnentration, creatinine concentration, troponin level , active cancer and metolazone use. The score was calculated using the free online calculator. https://coachcalculator.ices.on.ca/#/ [10] Then, according to the original article by Lee et al [5], the patients were classified into 5 groups as described in the Table 1.

Continuous variables are described as mean ± standard deviation if normally distributed, or as median and interquartile range (IQR) if non-normally distributed. Categorical variables are presented as counts and percentages. Differences in mortality among EHMRG risk groups were assessed using the chi-square test at a significance level of 5%. This test evaluated whether the distribution of mortality (7-day mortality) differed significantly across the EHMRG risk categories. To examine the relationship between EHMRG score and length of hospital stay, a Spearman correlation test was performed. All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 25 (Armonk, NY, USA).

Table 1. *EHMRG-7 classification*

EHMRG Quintile	Score Range	Category	% mortality
1	≤-49.1	Very low	0
2	-49 to -15.9	Low	0
3	-15.8 to 17.9	Intermediate	0.7
4	18 to 56.5	High	1.9
5a	56.6 to 89.3	Very high	3.9
5b	≥89.4		8.2

RESULTS

Table 2 outlines the characteristics of a cohort of 175 individuals, with a balanced gender distribution (53.7% male, 46.3% female) and a majority Hindu ethnicity (85.1%). High prevalence of smoking (67.4%) and alcohol consumption (35.4%) were noted. Common symptoms included shortness of breath (100%), orthopnea (80%), and cough (62.3%). Significant cardiac conditions included severe valvular lesions (93.1%), coronary artery disease (39.4%), and dilated cardiomyopathy (26.9%). Non-cardiac risk factors such as hypertension (44%) and

Table 2. Characteristics of cohort

Characteristics		Number (%)
Gender	Male	94 (53.7%)
	Female	81(46.3%)
Ethnicity	Hindu	149 (85.1%)
	Buddhist	24(13.7%)
	Muslim	2(1.1%)
Alcohol consumer		62 (35.4%)
Smoker		118 (67.4%)
Symptoms	Shortness of Breath (SOB)	175 (100%)
	Body Swelling	94 (53.7%)
	Paroxysmal Nocturnal Dyspnea (PND)	63(36.0%)
	Chest Pain	14(8.0%)
	Orthopnea	140(80.0%)
	Syncope	1(0.6%)
	Fever	14(8.0%)
	Cough	109(62.3%)
Comorbid Conditions	Cardiac	
	Coronary Artery Disease	69(39.4%)
	Rheumatic Heart Disease	34(19.4%)
	Dilated Cardiomyopathy	47(26.9%)
	Congenital Heart Disease	3(1.7%)
	Hypertension	77(44.0%)
	Mitral Valve Prolapse	1(0.6%)
	Non cardiac	
	Ischemic Cardiovascular Accident	18(10.3%)
	Diabetic Mellitus	58(33.1%)
	Chronic obstructive lungs disease	37(21.1%)
	Chronic kidney disease	7(4.0%)
Valvular lesions	Mitral Regurgitation	163 (93.1%)
	Tricuspid Regurgitation	
	Aortic Regurgitation	
	Mitral Stenosis	
	Aortic Stenosis	
Right Ventricular dysfunction		7(4.0%)
Atrial Fibrillation		53(30.3%)
In Hospital Complications	Ventricular Tachycardia/Ventricular Fibrillation	10(5.7%)
	Arrhythmia (VT, VF,PEA,Asystole)	12(6.9%)
	Paroxysmal Supraventricular Tachycardia	3(1.7%)
	Pulmonary Edema	66(37.7%)
Miscellaneous	Inotrope use	68(38.9%)
	Readmission in 1 month	25(14.3%)
	CCU	74(42.3%)
	Intubation	34(19.4%)
	CPR	34(19.4%)
	GTN use	79(45.1%)

Table 3. Characteristics of Valvular lesions

Characteristics	Number (%)
Valvular lesions	163 (93.1%)
Mitral Regurgitation	
None	22(12.6%)
Mild	71(40.6%)
Moderate	63(36.0%)
Severe	19(10.9%)
Tricuspid Regurgitation	
None	76(43.4%)
Mild	37(21.1%)
Moderate	50(28.6%)
Severe	12(6.9%)
Aortic Regurgitation	
None	150(85.7%)
Mild	8(4.6%)
Moderate	6(3.4%)
Severe	11(6.3%)
Mitral Stenosis	
None	159(90.9%)
Mild	1(0.6%)
Moderate	3(1.7%)
Severe	12(6.9%)
Aortic Stenosis	
None	173(98.9%)
Mild	0(0.0%)
Moderate	0(0.0%)
Severe	2(1.1%)

diabetes mellitus (33.1%) were also prominent. High rates of critical interventions and complications were observed, including cardiogenic shock (38.9%), intubation (19.4%), and CPR (19.4%).

Ischemic cardiomyopathy (38.3%) and dilated cardiomyopathy (25.1%) were the most common cause of HF. Valvular heart disease accounted for 24.6%, followed by myocarditis (4.6%) and heart failure with preserved ejection fraction (4%). Rare causes included VSD Eisenmenger (0.6%), ASD Eisenmenger (1.1%), pulmonary embolism (0.6%), Ebstein's anomaly (0.6%), and hypertrophic obstructive cardiomyopathy (0.6%).

The EHMRG variables for the cohort indicate a median age of 66 years (IQR: 54-76). 36% of patients arrived by ambulance. The median triage systolic blood pressure was 120 mmHg (IQR: 100-130), with a median heart rate of 90 bpm (IQR: 84-120) and a median O2 saturation of 90% (IQR: 80-94). Serum creatinine had a median value of 1 mg/dL (IQR: 0.8-1.8). Potassium levels varied, with 35.4% of patients having levels below 4.0 mEq/L, 36.6% between 4.0 and 4.5 mEq/L, and 28% above 4.5 mEq/L. Elevated troponin levels were found in 44% of patients. Active cancer was found in (0.6%) and 3.4% were using metolazone.

The severity of heart failure was defined by NYHA classification. 49.7% of patients were classified as NYHA Class III and 41.1% as Class IV. Only 9.1% of the patients were in NYHA Class II,with none in class I.

Normal LVEF was observed in 26.3% of patients, while mild, moderate and severe LVSD noted in 12.6%, 25.1% and 36% respectively.

Table 3 shows the frequency of patients in each risk group. 20% were classified into very low risk group while 16% and 74% belonged to high and very high risk groups.

7-day mortality rate for the cohort was 17.1%. The table 4 demonstrates the association between 7-day mortality and EHMRG risk groups using a Fisher exact test at the 5% level of significance. The results show a statistically significant association ($p < .001$).Specifically, no 7-day mortality was observed in the very low, low, and intermediate-risk groups. In the high-risk group, 1 patient died while 15 survived. In the very high-risk group, 29 patients died compared to 45 who survived. This indicates a significant increase in 7-day mortality with higher EHMRG risk categories.

There is a significant positive correlation between EHMRG score and hospital stay duration in days among the 145 patients who survived as shown in Table 5 and Graphs 1.. The Spearman correlation

Table 3. Comparison of 7-day mortality by EHMRG-7 classification

Category	Number (%)	7-day mortality		Fisher exact test value	p-value
		Yes	No		
Very low	35 (20.0)	0	35	43.921	<0.001
Low	27 (15.4)	0	27		
Intermediate	23 (13.1)	0	23		
High	16 (9.1)	1	15		
Very high	74 (42.3)	29	45		

coefficient rho is 0.638, and the p-value is less than .001, suggesting a strong and statistically significant relationship.

Table 6 demonstrates the association between EHMRG risk categories and various comorbidities during the hospital admission, with statistical significance assessed using chi-square tests at a 5% level. The events were followed up beyond 7 days for surviving patients within index hospital stay. A significant association was found between LVEF severity and EHMRG risk categories ($p = 0.003$), with severe LVEF patients more frequently categorized as Very High risk. Inotrope usage ($p < 0.001$), cardiogenic shock ($p < 0.001$), acute kidney injury (AKI) ($p < 0.001$), pneumonia ($p < 0.001$), CPR requirement ($p < 0.001$), readmission within 1 month ($p < 0.001$), pulmonary edema ($p < 0.001$), and GTN usage ($p < 0.001$) were all significantly associated with higher EHMRG risk categories, particularly Very High risk. Arrhythmia also showed a significant association ($p = 0.01$). A substantial number of patients were classified as High and Very High risk, highlighting the strong correlation between higher EHMRG risk scores and the presence of severe comorbidities. Linear-by-linear association was assessed where noted, confirming these associations at a 5% significance level.

The association between EHMRG risk categories and various comorbidities was analyzed using Fisher's exact test, with statistical significance defined as a ppp-value less than 0.05.

DISCUSSION

This study explored the applicability of EHMRG-7 score to identify the acute HF patients who are at increased risk of death and complications related to HF at a tertiary care centre in Nepal .

The mean age of the cohort was 62.1 years while in the original study[5] it was 75.4 years. 46.3% of the patients were female while 53.7 were male. In previous study done in Nepal, higher prevalence of HF in female subgroup was reported[11].

The most common cause of heart failure was ischemic heart disease (38.3%) followed by DCM (25.1%). This finding is different from findings in other studies. In a study done in Nepal, DCM followed by Rheumatic heart disease were the most common cause of HF in a tertiary care centre[12]. This difference can be explained by referral bias of ischemic heart disease patients to the PCI capable centre.

In our study, 7 day in hospital mortality was observed in 17.1% of the patients. This is higher than the mortality rate noted in the original study[5] (2.4%). This is also higher than that noted in a national study[13]. While comparing mortality rates among different EHMRG classes, none of the patients in the classes 1, 2 or 3 died within the first 7 days of admission. This is similar to the result of other studies In comparison, 64.4% of the EHMRG Class 5 and 6.6% of those in class 4 died. This is also significantly higher than that observed in the study by Lee et al. They had found mortalities of class 4 to be 1.9% and class 5 to be 3.9% at the end of 7 days. This could be because the following few reasons. First, there is a difference in HF severity among enrolled patients. Our cohort had higher presenting NYHA class. Second, the patients tend to present late in their disease course. Third, multiple co-morbidities are prevalent in the patients coming to our center. Fourth, there is a lower proportion of patients being admitted through our emergency transport facilities which aren't very robust in our country.

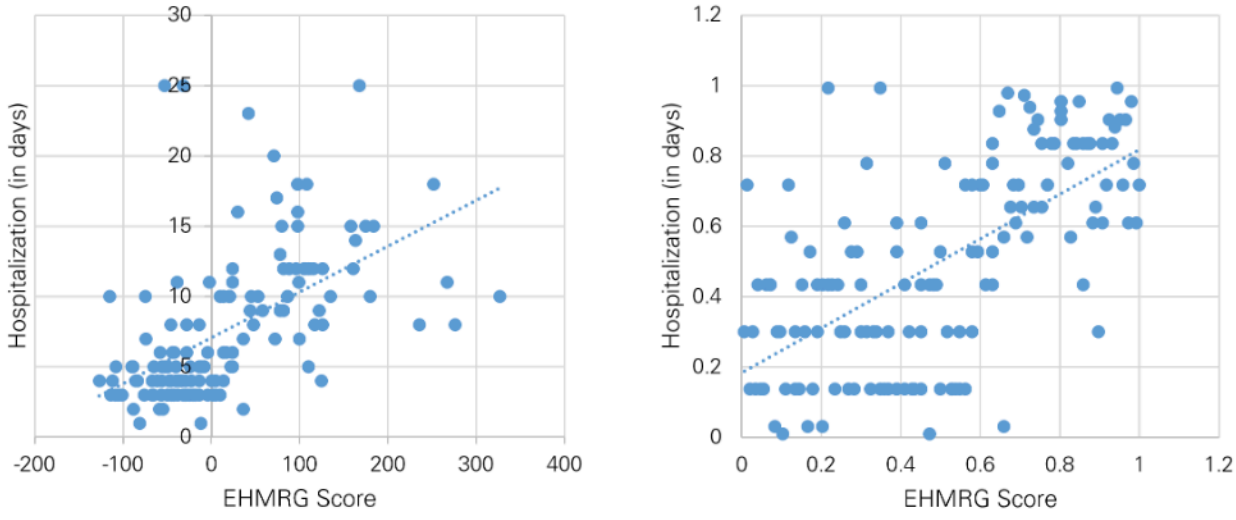

Figure 1. Correlation between EHMRG score and hospital stay duration. 1a. Raw Scatterplot between Hospitalization in days and EHMRG Score. 1b. Ranked Scatterplot between Hospitalization in days and EHMRG Score

Table 6. Association between EHMRG categories with complications

Characteristics		EHMRG Risk Category Frequency					Test value	p-value
		Very Low	low	Intermediate	High	Very High		
LVEF severity	Normal	13	9	10	2	12	17.79	0.10
	Mild	5	4	2	2	9		
	Moderate	6	7	5	8	18		
	Severe	11	7	6	4	35		
INOTROPE	Yes	0	2	0	6	60	117.56	<0.001
	No	35	25	23	10	14		
Cardiogenic Shock	yes	0	2	0	6	60	117.56	<0.001
	no	35	25	23	10	14		
AKI	Yes	2	4	2	6	63	101.36	<0.001
	No	33	23	21	10	11		
Pneumonia	Yes	0	1	0	2	52	97.64	<0.001
	No	35	26	23	14	22		
CPR	Yes	0	0	0	1	33	52.83	<0.001^
	No	35	27	23	15	41		
Readmission in 1 month	Yes	0	2	0	2	21	22.76	<0.001
	No	35	25	23	14	53		
Pulmonary Edema	Yes	0	2	0	4	60	118.67	<0.001
	No	35	25	23	12	14		
Arrhythmia	Yes	1	0	1	0	10	6.98	0.082
	No	34	27	22	16	64		
GTN	YES	0	3	1	8	67	137.89	<0.001
	NO	35	24	22	8	7		

There is a significant positive correlation between higher EHMRG score and hospital stay duration in days among alive patients (Spearman correlation coefficient rho 0.638, and the $p < 0.001$). This finding is similar to a previous study done in Dutch population[14].

Readmission within 30 days of discharge was significantly associated with higher EHMRG scores ($p<0.001$). The EHMRG-7 score was designed to predict short term outcomes, although, in a previous study[7] higher score showed increased 7- and 30-day rehospitalization rates- however the discriminatory power was poor (0.61-0.67).

Significant association was noted between higher scores and secondary outcomes-cardiogenic shock, arrhythmias, in-hospital pneumonia, CCU admission, inotrope use, and pulmonary edema. A significant association was found between LVEF severity and EHMRG risk categories ($p = 0.003$), with severe LVEF patients more frequently categorized as Very High risk.

Overall, the study showed that EHMRG-7 is a valuable tool for risk stratification of acute HF patients in Nepal, demonstrating predictive capability for 7 day mortality and associated complications. Its use can effectively minimize hospital admission for those at low risk and maximize allocation of hospital resources for those with higher scores. Prediction of outcome has significant effect on patient management[15]. The study also highlights need for use of a longer term mortality outcome score[6].

There are several limitations to this study. First, the study was conducted in a single center and it remains to be seen if it can also be validated in other center in Nepal. Second, HF due to acute coronary syndromes were not included in the investigation in accordance with the original study by Lee et al. Third, Nepal has poor emergency medical transport system, because of which few of the patients presented at the ED on their own- taxi, or personal vehicles- which possibly influenced the scores.

CONCLUSION

Seven-day mortality and readmission rates were higher in patients with high EHMRG scores. Mortalities were not encountered in patients with low scores. The EHMRG -7 tool can be helpful in identifying acute HF patients who are at heightened risk of death and associated complications. The score can aid physician in deciding for hospitalization or discharge of these patients from the ED.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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