ORIGINAL ARTICLE

ADMISSION FRAILTY SCORE AS A GOOD CLINICAL SUBSTITUTE OF SOFA SCORE TO PROGNOSTICATE POST-PERCUTANEOUS CORONARY INTERVENTION PATIENTS ON ADVANCED LIFE-SUPPORT

Mirza Yousuf Baig, Muhammad Imran Ansari, Mujtaba Hassan, Muhammad Sohaib Arif, Aziz ur Rehman Memon, Madiha Umair, Jawed Abubaker

National Institute of Cardiovascular Diseases, Karachi-Pakistan

Background: This study aimed to assess and compare the prognostic value of frailty score (FS), Sequential Organ Failure Assessment (SOFA) score, and additive of FS and SOFA score, at the time of admission to the coronary care unit (CCU), for the prediction of short-term poor prognosis in post-myocardial infarction (MI) patients, requiring advanced life-support. **Methods**: A cohort of post-MI patients admitted to CCU. The FS and SOFA score were obtained at the time of CCU admission. The prognostic value of FS, SOFA score, and FS+SOFA score was assessed to predict in-hospital and short-term follow-up mortality. **Results**: The study sample consisted of 312 patients: females were 27.2% (85), and the mean age was 60.32±11.51 years. A concordance rate of 51.8% was observed between admission FS (≥3) and SOFA score (≥9). A total of 67.3% (210) patients were categorized as moderate to severely frail (≥3), while the SOFA score identified 26.0% (81) high-risk (≥9) patients. The receiver operating characteristics (ROC) analysis showed an area under the curve (AUC) of 0.707 [0.638–0.776], 0.764 [0.704–0.825], and 0.783 [0.724–0.842] for in-hospital mortality and 0.684 [0.621–0.746], 0.718 [0.659–0.778], and 0.744 [0.687–0.801] for 180-day cumulative mortality against FS, SOFA, and FS+SOFA score, respectively. A hazard ratio of 2.75 [1.61–4.71] and 2.51 [1.68–3.75] were observed for mortality during 180-day follow-up among patients with FS ≥3 and SOFA score ≥9, respectively. **Conclusion**: CCU admission Frailty Score is a good clinical substitute for SOFA score for an early prognostication of post-MI patients on advanced life-support.

Keywords: Myocardial infarction; Advanced life-support; SOFA score, Frailty score

Citation: Baig MY, Ansari MI, Hassan M, Arif MS, Memon AR, Umair M, *et al*. Admission frailty score as a good clinical substitute of sofa score to prognosticate post-percutaneous coronary intervention patients on advanced life-support. J Ayub Med Coll Abbottabad 2024;36(1):10–8.

DOI: 10.55519/JAMC-01-12352

INTRODUCTION

Despite the recent advancements in the treatment of cardiovascular diseases (CVD), it remains the leading global cause of premature mortalities.[1] Acute myocardial infarction (AMI) is the most common clinical manifestation of CVD, which requires the earliest mechanical revascularization. It is associated with an increased risk of complications, such as cardiogenic shock and life-threatening arrhythmias, requiring admission to coronary care units (CCU). It generally requires advanced life support such as mechanical ventilator support or counter-pulsation devices.[2–6]

ICU mortality rates are substantially high for post-AMI patients. Multiple clinical and laboratory risk stratification modalities have been proposed and validated for assessing mortality risk in these patients. The SOFA (sequential organ failure assessment score), SAPS (simplified acute physiology score), and APACHE (acute physiology and chronic health evaluation) are the commonly used scoring systems in current clinical practice.[7–9] These scoring systems are based on various clinical and laboratory assessments, followed by cumbersome calculations or the use of calculators, which generally leads to delays in the categorization of patients.

SOFA score comprises six variables of organ dysfunction based on lab parameters. It is calculated on admission and every 24–48 hours afterward, requiring one to two hours before investigations are available.[10] In recent years, the Frailty score, a score solely based on clinical assessments, has been introduced, and it has proven its potential role in predicting outcomes in critically ill patients, especially the elderly population. The Frailty score measures the state of reduced biological reserve and weakened resistance to stressors, which is more commonly observed in these patients. The stress of AMI itself and bed rest during hospitalization may cause increased frailty and decreased ability to perform activities of daily living (ADL).[11] It is based on clinical parameters and can be done at the bedside within minutes.

The frailty score can be an easy-to-use clinical criterion for the prompt assessment of patients and early prediction of outcomes at the time of ICU admission. It can also be a helpful tool for resource management in high-burden clinical setups such as ours. Therefore, this study aimed to assess and compare the prognostic value of frailty score, SOFA score, and additive of frailty and SOFA score at the time of admission to the ICU to predict short-term poor prognosis in post-percutaneous coronary intervention (PCI) patients requiring advanced life-support.

MATERIAL AND METHODS

The study sample consisted of a prospectively collected cohort of patients admitted to the coronary care unit (CCU) of the National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan. The study was conducted between August 2021 and January 2022. Patients in this study were included after approval from the ethical review committee, and consent for participation was obtained from the attendant or next of kin at the time of CCU admission.

Post-myocardial infarction adult patients (≥18 years) admitted to CCU after revascularization and needed advanced life-support (mechanical ventilator support or intra-aortic balloon pump (IABP) within 24 hours of CCU admission were included in this study. Patients with deferred revascularization (for medical or non-medical reasons), patients who refused to give consent for participation, patients with symptoms suggestive of severe hypoxic brain injury (GCS 3–8), or pediatric patients were not included in this study.

All the patients were managed by a team of consultants as per the usual CCU standard of practices and institutional protocols. Collected data for the study consisted of routine clinical assessments, demographic characteristics, management, and outcomes. Per the routine, the SOFA (Sequential Organ Failure Assessment) score was assessed at the time of admission to CCU and discharge from CCU. In addition to routine assessment, the Frailty score was assessed at baseline (retrospective before the event), at the time of admission to CCU, at the time of discharge from CCU, and every subsequent follow-up. Data regarding the patient's hospital course was also recorded, including mortality, major bleeding (required transfusion), mechanical ventilation duration, and the need for renal replacement therapy (RRT) session. All the surviving patients were followed (physically or telephonic) at the fixed post-discharge interval of 30 days, 90 days, and 180 days. In addition to survival status, frailty score, readmission, and six-minute walk test (only after 30 days), results were recorded during follow-up interactions.

Calculating Frailty in critically ill patients has been fraught with discordances.[12,13] Differing frailty scores have been used at different reference points with significant inter-observer variabilities.[14,15] Moreover, patients in our part of the world have a poor understanding of their health and fitness, making it more challenging to assess frailty. Therefore, there is a need for a more objective assessment of frailty in the ICU setting. In our study, the frailty score was calculated using a modified version of the one used by Dodson *et al*. in the ACTION registry.[16] It was calculated by the intensivist, through the assessment of three patient-related domains, on a three-point scale of 0–2 (Table-1). It is related to patients' ability to walk and perform daily living activities (ADLs). The three patient-related domains included walking, cognition, and modified ADLs (mobility, grooming, dressing, and continence). Patients were categorized into the groups of "no frailty," "mild frailty," and "moderate to severe frailty" based on total frailty score values of 0, 1 to 2, and ≥3, respectively.[16] In case a patient was not able to follow commands due to some limitations (sedation, ventilation, IABP, or vascular sheath), he or she was assessed using a modified version of the score; for example, the power of legs was assessed in place of walking and bathing, swallowing assessment was assessed in place of eating, sedation interruption, and neurological examination in place of cognition.

The modified frailty point scoring system was as following; Walking/ Motor power: 0 points for “unassisted walking/ Lower limb motor power 4–5/5” ,1 point for “assisted walking/ lower limb motor power 2–3/ 5”, 2 points for “non-ambulatory/ lower limb motor power 0–1/ 5”. Cognition; 0 points for “normal cognition” ,1 point for “mildly impaired cognition”, 2 points for “moderately/ severely impaired cognition”. Activities of daily living (ADLs); 0 points for “independent in ADL” ,1 point for “requires partial assistance in ≥1 ADL”, 2 points for “requires full assistance in ≥1ADL”.

Patients were stratified into two groups of “none to mildly frail” and “moderate to severely frail” based on the admission (CCU) frailty score cutoff value of <3 and ≥3, respectively. Similarly, two groups of "low risk" and "high risk" were formed based on admission (CCU) SOFA score cutoff values of <9 and ≥9, respectively. The quantitative (continuous) characteristics were presented as either mean ± standard deviation (SD) or median [interquartile range (IQR)] appropriately, and qualitative (categorical) characteristics were presented as frequency and percentages. Two groups, either based on frailty or SOFA, were compared with the help of Chi-square/ Fisher's exact test or independent sample t-test/Mann-Whitney test, appropriately. The receiver operating characteristics (ROC) curve analysis was performed

for the frailty score, SOFA score, and additive of frailty and SOFA score for the assessment of in-hospital, 30-day, 90-day, and 180-day cumulative mortality. The area under the ROC curve (AUC) for each frailty score, SOFA score, and additive of frailty and SOFA score was obtained, and a 95% confidence interval (CI) was reported. The Kaplan–Meier hazard function for 180-day mortality by frailty and SOFA score at the time of CCU admission was obtained, the hazard ratio (along with 95% CI) was obtained, and Log Rank Test was applied. Univariate and multivariable binary logistic regression analyses for 180-day mortality were performed. The association of 180-day mortality with frailty and SOFA score, along with other clinical variables, was assessed in terms of unadjusted and adjusted odds ratio (OR) and its 95% CI. All statistical tests were conducted at the 0.05 level of significance.

RESULTS

The study sample consisted of 312 post-MI patients on advanced life-support; females were 27.2% (85) of the sample, and the mean age was 60.32±11.51 years. The frailty level of 67.3% (210) patients at admission to the ICU was categorized as moderate to severe, with an overall average score of 3.73±1.67. On average, it took 10–15 minutes to calculate Frailty Score. The clinical characteristics of patients with moderate to severe versus mild frailty are as follows: females were 31.4% vs. 18.6%; p=0.0017, mean age was 62.09±12.17 years vs. 56.68±9.01 years; p<0.001, history of IHD was observed in 19.5% vs. 8.8%; p=0.016, CKD was observed in 9% vs. 2.9%; p=0.048, 6.7% vs. 0%; p=0.008 had history of CVA, and 5.7% vs. 0%; p=0.014 had COPD/asthma, respectively. Inferior wall MI with RV infarct was observed in 20.5% vs. 14.7%; p=0.020, peri-procedure mean LVEDP was 27.25±9.19 mmHg vs. 24.49±8.51 mmHg; p=0.012, and optimal TIMI III flow was achieved in 81% vs. 91.2% of the patients with moderate to severe versus mild frailty, respectively. On echocardiography, 40.5% vs. 25.5%; p=0.009 were found to have a biventricular failure, and mean LVEF was measured to be 30.8±7.82% vs. 33.97±7.88%; p=<0.001, for the patients with moderate to severe versus mild frailty, respectively. The mean SOFA score at the time of admission to ICU was calculated to be 7.38±2.53 vs. 5.62±2.2; p<0.001 along with a median CRP of 9.26 [3–16] mg/L vs. 5 [1.5–10] mg/L; p=0.006 for the patients with moderate to severe versus mild frailty, respectively. During the ICU stay, TPM was needed by 21% vs. 7.8%; p=0.004 and steroids were needed by the 35.2% vs. 18.6%; p=0.003 of the patients with moderate to severe versus mild frailty, respectively (Table 1).

A concordance rate of 51.8% was observed between the admission frailty score (≥3) and sofa score (≥9). A total of 67.3% (210) patients were categorized as moderate to severely frail (≥3) based on frailty score at ICU admission, while SOFA score at ICU admission identified 26.0% (81) high risk (≥9) patients. A frailty score of ≥3 was found to be associated with poor prognosis and bad clinical course, which include prolonged ventilator duration (55.7% vs. 34.3%; p<0.001), longer ICU stay (3.2±2.02 vs. 2.67±2.2; p=0.036), higher readmission rate (19.2% vs. 7.4%; p=0.010), and higher cumulative 180-day mortality (39% vs. 15.7%; p<0.001), as compared to frailty score of <3, respectively (Table 3). Similarly, SOFA score of ≥9 was observed to be associated with prolonged ventilator duration (71.6% vs. 40.7%; p<0.001), longer ICU stay (4.06±2.86 vs. 2.66±1.6; p<0.001), and higher cumulative 180-day mortality (51.9% vs. 24.2%; p<0.001), as compared to SOFA score of <9, respectively (Table 2). A strong statistical association was observed between the frailty score at ICU admission and the Six Minute Walk (SMW) at discharge and follow-up. A significant number of patients with frailty score of <3 performed unassisted SMW at discharge (66.7% vs. 35.7%) as well as at follow-up (75.5% vs. 43.3%).

The ROC analysis for in-hospital mortality showed an AUC of 0.707 [0.638–0.776] and 0.764 [0.704–0.825] for the frailty and SOFA score, respectively. The incremental AUC of 0.783 [0.724–0.842] was observed with the addition of the frailty score to SOFA score. Similarly, for 180-day cumulative mortality, an AUC of 0.684 [0.621–0.746], 0.718 [0.659–0.778], and 0.744 [0.687–0.801] were observed for frailty, SOFA, and addition of frailty to SOFA score, respectively (Figure 1).

A significantly higher risk of mortality during 180-day follow-up was observed for the patients with a frailty score of ≥3 and patients with SOFA score of ≥9 with a hazard ratio of 2.75 [1.61–4.71] and 2.51 [1.68–3.75], respectively (Figure 2).

On multivariable logistic regression analysis, age (years), mechanical ventilator duration (hours), and ejection fraction (%) were found to be the independent predictors of 180-day cumulative mortality with adjusted odds ratios of 1.06 [1.02–1.09]; p<0.001, 1.03 [1.01v1.05]; p<0.001, and 0.91 [0.86–0.96]; p<0.001, respectively. Frailty score and SOFA score at the time of ICU admission showed a significant positive association with 180-day cumulative mortality with crude OR of 3.44 [1.89–6.28] and 1.40 [1.25–1.56], respectively; however, both of the scores failed to achieve statistical significance in multivariable analysis (Table-3).

Table-1: Distribution of clinical characteristics and management of patients by frailty status at admission

	Total	Admission Frailty		
		Mild frailty (1-2)	Moderate to Severe (≥3)	*p*-value
Total (N)	**312**	**102**	**210**	-
Sex				
Male	72.8% (227)	81.4% (83)	68.6% (144)	0.017
Female	27.2% (85)	18.6% (19)	31.4% (66)	
Age (years)	60.32 ± 11.51	56.68 ± 9.01	62.09 ± 12.17	<0.001
Type of myocardial infarction				
Anterior wall myocardial infarction (AWMI)	63.1% (197)	63.7% (65)	62.9% (132)	0.020
AWMI + left buddle branch block	1.3% (4)	0% (0)	1.9% (4)	
Inferior wall myocardial infarction (IWMI)	7.7% (24)	6.9% (7)	8.1% (17)	
IWMI + right ventricular infarct	18.6% (58)	14.7% (15)	20.5% (43)	
Posterior wall myocardial infarction	1.9% (6)	2.9% (3)	1.4% (3)	
Inferio-posterior wall myocardial infarction	2.9% (9)	2.9% (3)	2.9% (6)	
Lateral wall myocardial infarction	1.9% (6)	5.9% (6)	0% (0)	
NSTEMI	2.6% (8)	2.9% (3)	2.4% (5)	
Coronary catheterization				
Percutaneous coronary intervention	91% (284)	93.1% (95)	90% (189)	0.518
Plain old balloon angioplasty	6.7% (21)	5.9% (6)	7.1% (15)	
Left heart catheterization	2.2% (7)	1% (1)	2.9% (6)	
Time to reperfusion from symptom onset	12 [7 - 24]	10 [4 - 24]	12 [8 - 24]	0.052
Post-procedure thrombolysis in myocardial infarction (TIMI) flow				
0	0.6% (2)	0% (0)	1% (2)	0.049
I	2.2% (7)	2.9% (3)	1.9% (4)	
II	12.8% (40)	5.9% (6)	16.2% (34)	
III	84.3% (263)	91.2% (93)	81% (170)	
Cuprite vessel				
Left main	5.1% (16)	3.9% (4)	5.7% (12)	0.591
Left anterior descending artery	61.9% (193)	64.7% (66)	60.5% (127)	
Right coronary artery	23.7% (74)	19.6% (20)	25.7% (54)	
Left circumflex artery	7.4% (23)	8.8% (9)	6.7% (14)	
Obtuse marginal	1% (3)	1% (1)	1% (2)	
Diagonal	1% (3)	2% (2)	0.5% (1)	
Involved vessels				
Left main	14.1% (44)	13.7% (14)	14.3% (30)	0.894
Left anterior descending artery	88.8% (277)	87.3% (89)	89.5% (188)	0.551
Right coronary artery	68.6% (214)	65.7% (67)	70% (147)	0.441
Left circumflex artery	57.1% (178)	54.9% (56)	58.1% (122)	0.593
Obtuse marginal	3.8% (12)	2.9% (3)	4.3% (9)	0.562
Diagonal	2.2% (7)	2.9% (3)	1.9% (4)	0.562
Co-morbid conditions				
Hypertension	82.4% (257)	77.5% (79)	84.8% (178)	0.112
Diabetes mellitus	34.9% (109)	32.4% (33)	36.2% (76)	0.505
Smoker	28.2% (88)	31.4% (32)	26.7% (56)	0.386
Chronic kidney disease	7.1% (22)	2.9% (3)	9% (19)	0.048
History of cerebrovascular accident	4.5% (14)	0% (0)	6.7% (14)	0.008
COPD/asthma	3.8% (12)	0% (0)	5.7% (12)	0.014
Obese	4.2% (13)	3.9% (4)	4.3% (9)	0.880
History of congestive heart failure	2.6% (8)	1% (1)	3.3% (7)	0.217
History of ischemic heart diseases	16% (50)	8.8% (9)	19.5% (41)	0.016
Echocardiography findings				
Ejection fraction (%)	31.84 ± 7.96	33.97 ± 7.88	30.8 ± 7.82	<0.001
Ventricular septal rupture	0.6% (2)	0% (0)	1% (2)	0.323
Left ventricular dysfunction	96.2% (300)	92.2% (94)	98.1% (206)	0.001
Right ventricular dysfunction	36.2% (113)	26.5% (27)	41% (86)	0.013
Biventricular Failure	35.6% (111)	25.5% (26)	40.5% (85)	0.009
Moderate to severe mitral regurgitation	17.3% (54)	20.4% (21)	15.7% (33)	0.304
Moderate to severe tricuspid regurgitation	1.3% (4)	1% (1)	1.4% (3)	0.735
Moderate to severe aortic regurgitation	0.3% (1)	1% (1)	0% (0)	0.153
Moderate to severe aortic stenosis	0.3% (1)	0% (0)	0.5% (1)	0.483
Moderate to severe pericardial effusion	0.3% (1)	0% (0)	0.5% (1)	0.483
Left ventricular thrombus	1.9% (6)	3.9% (4)	1% (2)	0.073

	Total	Admission Frailty		
		Mild frailty (1-2)	Moderate to Severe (≥3)	*p*-value
Peri-procedure LVEDP (mmHg)	26.34 ± 9.05	24.49 ± 8.51	27.25 ± 9.19	0.012
Arrhythmias	30.1% (94)	23.5% (24)	33.3% (70)	0.077
Need of vasopressors/inotropes	63.8% (199)	59.8% (61)	65.7% (138)	0.308
Vasopressors/inotropes duration (hours)	24 [24 - 48]	24 [24 - 48]	24 [24 - 48]	0.026
Temporary pacemaker	16.7% (52)	7.8% (8)	21% (44)	0.004
Intra-aortic balloon pump	17.6% (55)	15.7% (16)	18.6% (39)	0.530
Elective intubation	80.4% (251)	81.4% (83)	80% (168)	0.774
Post CPR	20.8% (65)	20.6% (21)	21% (44)	0.941
Post CPR intubation	18.3% (57)	16.7% (17)	19% (40)	0.610
Time to achieve ROSC	5.15 ± 4.64	2.86 ± 2.29	6.25 ± 5.09	<0.001
Use of steroids	29.8% (93)	18.6% (19)	35.2% (74)	0.003
Use of bicarbonate	63.5% (198)	60.8% (62)	64.8% (136)	0.494
Need of re-intubation	7.4% (23)	5.9% (6)	8.1% (17)	0.483
Bedsores	6.4% (20)	5.9% (6)	6.7% (14)	0.791
Antibiotics	14.4% (45)	11.8% (12)	15.7% (33)	0.352
Procalcitonin (ng/ml)	5.11 ± 6.94	3.95 ± 4.67	5.52 ± 7.57	0.323
C-reactive protein (mg/L)	7 [2 - 13]	5 [1.5 - 10]	9.26 [3 - 16]	0.006
Albumin (mg/dL)	3.55 ± 0.47	3.6 ± 0.44	3.53 ± 0.49	0.213
Cumulative balance				
Negative	39.5% (116)	47% (47)	35.6% (69)	0.111
Equal	2.4% (7)	1% (1)	3.1% (6)	
Positive	58.2% (171)	52% (52)	61.3% (119)	
SOFA score at ICU Admission	6.8 ± 2.56	5.62 ± 2.2	7.38 ± 2.53	<0.001
<9	86.2% (269)	97.1% (99)	81% (170)	<0.001
9 to 11	10.6% (33)	2.9% (3)	14.3% (30)	
>11	3.2% (10)	0% (0)	4.8% (10)	
Frailty score at baseline (before event)	0.49 ± 1.03	0.09 ± 0.29	0.69 ± 1.2	<0.001
No frailty (0)	74.7% (233)	91.2% (93)	66.7% (140)	<0.001
Mild frailty (1-2)	17.6% (55)	8.8% (9)	21.9% (46)	
Moderate to severe (≥3)	7.7% (24)	0% (0)	11.4% (24)	
Mean Frailty Score at ICU Admission	3.73 ± 1.67	1.69 ± 0.47	4.72 ± 1.01	<0.001

NSTEMI: non-ST elevation myocardial infarction, COPD: chronic obstructive pulmonary disease, LVEDP: left ventricular end-diastolic pressure, CPR: cardiopulmonary resuscitation, ROSC: Return of spontaneous circulation, ICU: intensive care unit, SOFA: sequential organ failure assessment

Table-2: Distribution of clinical course and outcomes of patients by frailty and SOFA score

	Total	Frailty Score at ICU Admission			SOFA Score at ICU Admission		
		1 to 2	≥3	*p*-value	<9	≥9	*p*-value
Total (N)	**312**	**102**	**210**	-	**231**	**81**	-
MV duration (hours)	24 [24 - 48]	24 [24 - 48]	48 [24 - 48]	0.001	24 [24 - 48]	48 [24 - 48]	<0.001
MV duration >24 hours	48.7% (152)	34.3% (35)	55.7% (117)	<0.001	40.7% (94)	71.6% (58)	<0.001
Days in ICU	3.02 ± 2.09	2.67 ± 2.2	3.2 ± 2.02	0.036	2.66 ± 1.6	4.06 ± 2.86	<0.001
Need of RRT	6.7% (21)	3.9% (4)	8.1% (17)	0.168	6.5% (15)	7.4% (6)	0.778
RRT sessions	2.32 ± 0.72	2.4 ± 0.89	2.29 ± 0.69	0.779	2.4 ± 0.74	2.14 ± 0.69	0.446
LVEDP at Discharge	15.13 ± 5.4	14.33 ± 5.23	15.52 ± 5.45	0.068	14.51 ± 5.32	16.94 ± 5.27	0.001
SOFA Score at discharge	3.82 ± 4.86	2.33 ± 3.08	4.55 ± 5.39	<0.001	2.75 ± 3.71	6.97 ± 6.31	<0.001
<9	84.3% (263)	94.1% (96)	79.5% (167)	0.010	90.5% (209)	66.7% (54)	<0.001
9 to 11	3.5% (11)	2% (2)	4.3% (9)		2.6% (6)	6.2% (5)	
>11	11.2% (35)	3.9% (4)	14.8% (31)		6.9% (16)	23.5% (19)	
Not available	1% (3)	0% (0)	1.4% (3)		0% (0)	3.7% (3)	
Six Minute Walk: at discharge							
Not performed	33.3% (104)	25.5% (26)	37.1% (78)	<0.001	32.9% (76)	34.6% (28)	<0.001
Performed with assistance	1.3% (4)	1% (1)	1.4% (3)		1.3% (3)	1.2% (1)	
Performed without assistance	45.8% (143)	66.7% (68)	35.7% (75)		53.2% (123)	24.7% (20)	
Not available	19.6% (61)	6.9% (7)	25.7% (54)		12.6% (29)	39.5% (32)	
Six Minute Walk: at follow-up							
Not performed	19.9% (62)	12.7% (13)	23.3% (49)	<0.001	19% (44)	22.2% (18)	<0.001
Performed with assistance	1% (3)	0% (0)	1.4% (3)		0.4% (1)	2.5% (2)	
Performed without assistance	53.8% (168)	75.5% (77)	43.3% (91)		63.6% (147)	25.9% (21)	
Not available	25.3% (79)	11.8% (12)	31.9% (67)		16.9% (39)	49.4% (40)	
Bleeding	3.8% (12)	5.9% (6)	2.9% (6)	0.192	3.5% (8)	4.9% (4)	0.553
Readmission	14.7% (37)	7.4% (7)	19.2% (30)	0.010	13.4% (27)	20.4% (10)	0.212
Mortality							
In-hospital	19.6% (61)	6.9% (7)	25.7% (54)	<0.001	12.6% (29)	39.5% (32)	<0.001
Up to 30 days	25.3% (79)	11.8% (12)	31.9% (67)	<0.001	16.9% (39)	49.4% (40)	<0.001
Up to 90 days	28.8% (90)	13.7% (14)	36.2% (76)	<0.001	20.8% (48)	51.9% (42)	<0.001
Up to 180 days	31.4% (98)	15.7% (16)	39% (82)	<0.001	24.2% (56)	51.9% (42)	<0.001

MV: mechanical ventilator, ICU: intensive care unit, RRT: renal replacement therapy, LVEDP: left ventricular end-diastolic pressure, SOFA: sequential organ failure assessment

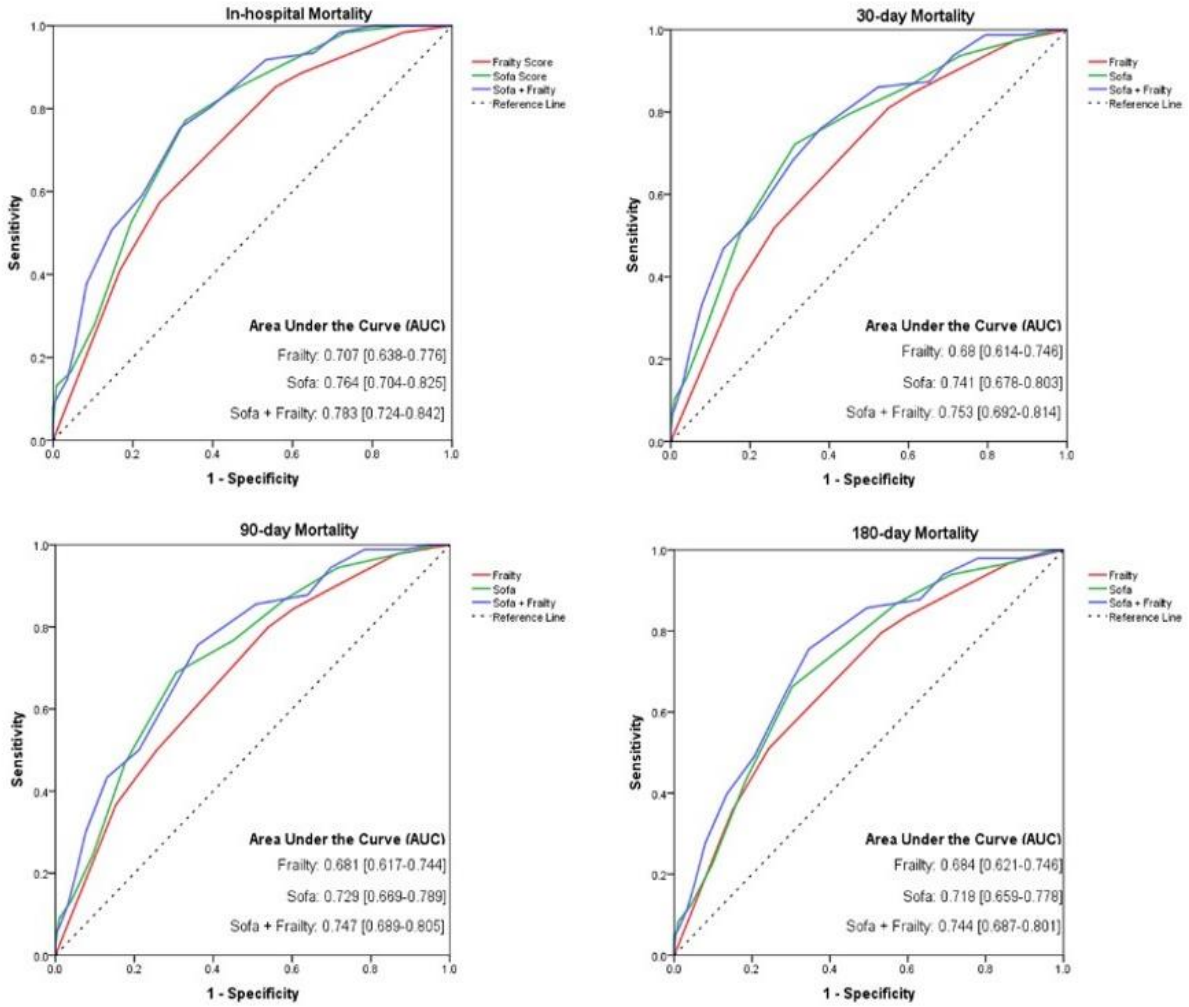

Figure-1: The receiver operating characteristic (ROC) analysis of frailty and SOFA score for in-hospital and post-discharge mortality

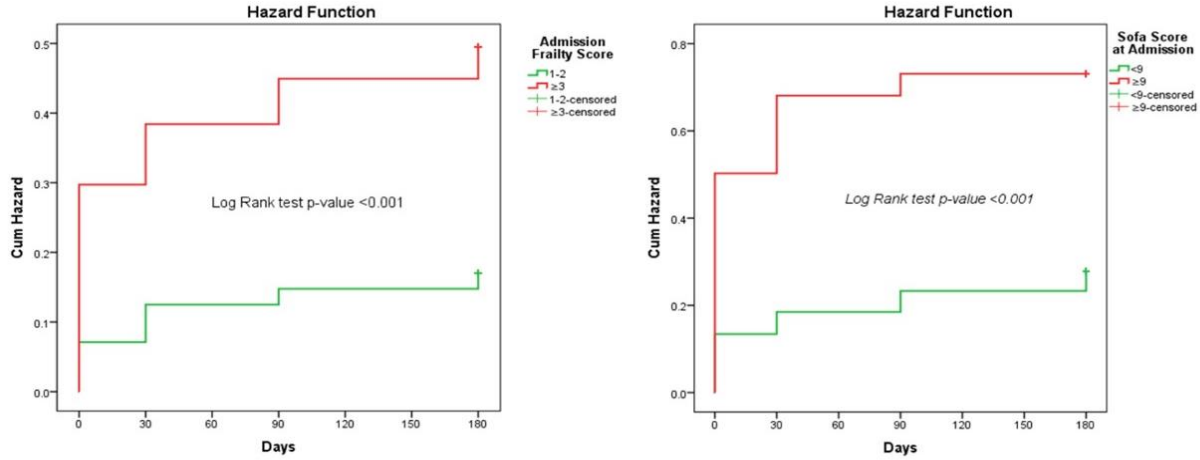

Figure-2: The Kaplan–Meier hazard function for 180-day mortality by Frailty and SOFA score at the time of ICU admission

Table-3: Univariate and multivariable binary logistic regression analysis for 180-day cumulative mortality

	Univariate		Multivariable	
	OR [95% CI]	***p*-value**	**OR [95% CI]**	***p*-value**
Female	1.47 [0.87 - 2.49]	0.148	2.00 [0.91 - 4.41]	0.084
Age (years)	1.04 [1.02 - 1.07]	<0.001	1.06 [1.02 - 1.09]	<0.001
IWMI with right ventricular infarct	1.57 [0.87 - 2.83]	0.136	1.94 [0.73 - 5.16]	0.184
Time to reperfusion from symptom onset	1.00 [1.00 - 1.01]	0.477	-	-
TIMI flow < III	2.45 [1.32 - 4.56]	0.005	1.33 [0.55 - 3.25]	0.529
Mechanical ventilator duration (hours)	1.03 [1.02 - 1.04]	<0.001	1.03 [1.01 - 1.05]	<0.001
Hypertension	0.93 [0.50 - 1.73]	0.817	-	-
Diabetes mellitus	1.54 [0.94 - 2.53]	0.085	1.04 [0.51 - 2.12]	0.906
Smoker	1.03 [0.60 - 1.74]	0.922	-	-
Chronic kidney diseases	1.91 [0.80 - 4.59]	0.147	1.09 [0.31 - 3.86]	0.891
History of cerebrovascular accident	2.27 [0.78 - 6.67]	0.134	2.11 [0.46 - 9.65]	0.335
COPD/Asthma	1.59 [0.49 - 5.14]	0.439	-	-
Obese	2.67 [0.87 - 8.16]	0.085	2.71 [0.68 - 10.82]	0.159
Moderate to severe mitral regurgitation	1.70 [1.05 - 2.77]	0.032	1.42 [0.71 - 2.84]	0.321
Ejection fraction (%)	0.91 [0.87 - 0.94]	<0.001	0.91 [0.86 - 0.96]	<0.001
Right ventricular dysfunction	2.34 [1.43 - 3.83]	<0.001	-	-
Biventricular failure	2.45 [1.50 - 4.02]	<0.001	1.28 [0.62 - 2.63]	0.499
Peri-procedure LVEDP (mmHg)	1.03 [1.01 - 1.06]	0.016	1.00 [0.96 - 1.04]	0.968
Left ventricular thrombus	1.09 [0.20 - 6.07]	0.918	-	-
Arrhythmias	1.11 [0.66 - 1.86]	0.695	-	-
Need of vasopressors/inotropes	3.00 [1.71 - 5.25]	<0.001	0.60 [0.20 - 1.81]	0.367
Need of temporary pacemaker	1.78 [0.96 - 3.27]	0.066	0.72 [0.28 - 1.82]	0.483
Need of intra-aortic balloon pump	3.04 [1.67 - 5.52]	<0.001	1.69 [0.67 - 4.27]	0.263
Elective intubation	0.70 [0.39 - 1.26]	0.239	-	-
Post CPR intubation	1.35 [0.74 - 2.46]	0.329	-	-
SOFA score at ICU admission	1.40 [1.25 - 1.56]	<0.001	1.15 [0.92 - 1.44]	0.216
Use of steroids	2.94 [1.76 - 4.89]	<0.001	1.99 [0.88 - 4.50]	0.098
Use of bicarbonate	1.57 [0.94 - 2.62]	0.086	0.63 [0.27 - 1.48]	0.287
C-reactive protein (mg/L)	1.04 [1.01 - 1.07]	0.014	1.00 [0.97 - 1.03]	0.998
Albumin (mg/dL)	0.47 [0.28 - 0.81]	0.006	0.73 [0.35 - 1.51]	0.398
Positive balance	0.9 [0.56 - 1.46]	0.675	-	-
Frailty score at ICU admission	3.44 [1.89 - 6.28]	<0.001	1.08 [0.47 - 2.5]	0.850

OR: odds ratio, CI: confidence interval, IWMI: inferior wall myocardial infarction, TIMI: thrombolysis in myocardial infarction, COPD: chronic obstructive pulmonary disease, LVEDP: left ventricular end-diastolic pressure, CPR: cardiopulmonary resuscitation, ICU: intensive care unit, SOFA: sequential organ failure assessment

DISCUSSION

The Frailty Syndrome (or simply put Frailty) is a state of decreased physiologic reserves due to aging and poor health, making a person more prone to adverse outcomes when faced with stressors. It is more concerned with the patient's biological age (rather than chronological age) and physiologic reserves. This state is characterized by a complex multisystem inflammatory involvement in the form of altered musculoskeletal, cardiac, endocrine, neurological, and haematological functions.[10] It is an increasingly-recognized problem, especially in older adults, with an estimated global prevalence of around 12%.[17] The frailty score is a cost-effective solution for predicting adverse outcomes and has been validated in various studies.[18]

The demographics of our study correlate well with previous literature. Most of our patients were males (72.8%) with anterior wall ST-elevation myocardial infarction as the predominant type of myocardial infarction. Left heart catheterization was done in all patients in whom percutaneous coronary intervention was attempted in 91% of patients, and TIMI-III flow was achieved in 84.3% of patients. Although studies have shown that frail patients tend to receive less invasive treatments,[19] this was not seen in our research. This difference could partly be explained by the fact that frailty is an emerging and misinterpreted concept in our part of the world. In most cases, the left anterior descending artery was the culprit vessel (61.9%). Non-ST-elevation myocardial infarction was noted in only 2.6% of patients, which is incongruent with other studies.[19]

A majority (67.3%) of our patients were classified as having moderate to severe frailty. Other studies on patients with myocardial infarction have reported a frequency of around 12–34%.[19–21] The frequency is highly variable due to a wide variety of tools to assess Frailty and the lack of a uniform definition. It has been well established from the above studies that frail patients tend to be more critically ill during hospitalization. The higher percentage of our patients having moderate to severe frailty reflects the fact that they were on advanced life support.

Frail patients require a longer duration of mechanical ventilation and have higher chances of extubation failure.[22] In our study, patients with Frailty score ≥3 or SOFA score ≥9 also required a longer duration of mechanical ventilation, although they did not seem to differ about the need for IABP.

A higher Frailty Score at the time of myocardial infarction is associated with increased all-cause mortality. In-hospital mortality rates of 7–24% have been reported for patients with myocardial infarction having higher frailty scores.[19, 23] The adverse outcomes of frail patients are also consistently seen in cardiac as well as non-cardiac critically ill patients.[24] Not only is frailty associated with cardiovascular diseases, but it also increases cardiovascular deaths by three-fold.[25] The higher mortality (25.7%) in our study reflects the fact that our study population was more critically ill, having multiple co-existing poor prognostic factors. Whether or not there is a difference in the judgment capacity of different tools for frailty assessment is uncertain. Overall poor prognosis remains even after excluding other risk factors.

The SOFA score comprises six variables of organ function assessment. Although originally described in patients with sepsis, it has good prediction outcomes in all critically ill patients including cardiac patients.[26, 27] A raised SOFA score is associated with increased mortality and adverse outcomes. In our study, we compared SOFA score with Frailty in predicting outcomes. ROC analysis for the Frailty Score and SOFA Score showed good and comparable discrimination capacity for both scores. This indicates that the Frailty Score can be a good cost-effective substitute for the SOFA score. Instead of relying on investigations and complex calculations, the Frailty score can be a simple clinical assessment. Frailty score has also been compared with other scales of cardiac prognostication, notably the GRACE score, with better results.[28] More studies with larger populations are needed on this matter.

Both Frailty and SOFA scores were associated with poor quality of life at follow-up as assessed by the 6-minute walk test at discharge and follow-up. Studies have shown that frail patients who survive are mostly dependent and have a low quality of life.[29, 30] Thus it becomes a matter of debate whether frail patients should be subjected to extensive interventions if their quality of life cannot be improved. Alternatively, it can also be argued that there is a need to recognize additional management requirements of this population for optimal functions. Thus Frailty assessment is helpful in clinical decision-making for treatment options, the risk versus benefit, and additional management considerations.

To the best of our knowledge, this is the first study from our region to examine the association between myocardial infarction and frailty score as a predictor of outcome. The follow-up of the patients ensured short- as well as long-term implications of the results. Moreover, we compared frailty outcomes with a validated SOFA score. There are a few limitations in our study. This is a single-center observational study. This data is insufficient to predict outcomes using frailty; therefore, more extensive studies are needed to validate our results.

We recommend that more studies be conducted to improve the current dearth of frailty assessments in critically ill patients. Frail patients with myocardial infarction may require additional treatment considerations other than percutaneous coronary interventions. Frail patients discharged should have a nutritional and rehabilitation plan along with geriatric follow-up as needed.

CONCLUSION

In conclusion, both higher Frailty and SOFA scores in patients with myocardial infarction at the time of admission in ICU are associated with increased in-hospital, 30-day, 90-day, and 180-day mortality. In addition, the Frailty Score performs well as a simple clinical substitute for the complex SOFA score.

AUTHORS' CONTRIBUTION

MYB, MIA: Conceived the idea. MIA, MH, MSA: Design the study. AUR, MU: Data collection. MYB, MIA, JA: Contributed to write-up. MYB, MIA: Reviewed the manuscript. MIA: Supervision.

REFERENCES

1. Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, *et al*. Heart disease and stroke statistics—2018 update: a report from the American Heart Association. Circulation 2018;137(12):e67–492.
2. Ariza Sole A, Salazar-Mendiguchia J, Lorente-Tordera V, Sanchez-Salado JC, Gonzalez-Costello J, Moliner-Borja P, *et al*. Invasive mechanical ventilation in acute coronary syndromes in the era of percutaneous coronary intervention. Eur Heart J Acute Cardiovasc Care 2013;2:109–17.
3. Lopez Messa JB, Andrés De Llano JM, Berrocal De La Fuente CA, Pascual Palacin R, Analisis Retraso Infarto Agudo M. Characteristics of acute myocardial infarction patients treated with mechanical ventilation. Data from the ARIAM registry. Rev Esp Cardiol 2001;54:851–9.
4. Kouraki K, Schneider S, Uebis R, Tebbe U, Klein HH, Janssens U, *et al*. Characteristics and clinical outcome of 458 patients with acute myocardial infarction requiring mechanical ventilation. Results of the BEAT registry of the ALKK-study group. Clin Res Cardiol 2011;100:235.
5. Zahger D, Maimon N, Novack V, Wolak A, Friger M, Gilutz H, *et al*. Clinical characteristics and prognostic factors in patients with complicated acute coronary syndromes requiring prolonged mechanical ventilation. Am J Cardiol 2005;96:1644.
6. Lesage A, Ramakers M, Daubin C, Verrier V, Beynier D, Charbonneau P, *et al*. Complicated acute myocardial

infarction requiring mechanical ventilation in the intensive care unit: prognostic factors of clinical outcome in a series of 157 patients. Crit Care Med 2004;32(1):100–5.
7. Aoyama D, Morishita T, Uzui H, Miyazaki S, Ishida K, Kaseno K, *et al*. Sequential organ failure assessment score on admission predicts long-term mortality in acute heart failure patients. ESC Heart Fail 2020;7(1):245–53.
8. Bennett CE, Wright RS, Jentzer J, Gajic O, Murphree DH, Murphy JG, *et al*. Severity of illness assessment with application of the APACHE IV predicted mortality and outcome trends analysis in an academic cardiac intensive care unit. J Crit Care 2019;50:242–6.
9. Nishihira K, Watanabe N, Kuriyama N, Shibata Y. Clinical outcomes of nonagenarians with acute myocardial infarction who undergo percutaneous coronary intervention. Eur Heart J Acute Cardiovasc Care 2020;9(5):488–95.
10. Dodson JA, Hochman JS, Roe MT, Chen AY, Chaudhry SI, Katz S, *et al*. The association of frailty with in-hospital bleeding among older adults with acute myocardial infarction: Insights from the ACTION Registry. JACC Cardiovasc Interv 2018;11:2287–96.
11. Lambden S, Laterre PF, Levy MM, Francois B. The SOFA score—development, utility and challenges of accurate assessment in clinical trials. Crit Care 2019;23(1):1–9.
12. Singh M, Stewart R, White H. Importance of frailty in patients with cardiovascular disease. Eur Heart J 2014;35(26):1726–31.
13. Falvey JR, Ferrante LE. Frailty assessment in the ICU: translation to 'real-world' clinical practice. Anaesthesia 2019;74(6):700–3.
14. Pugh RJ, Battle CE, Thorpe C, Lynch C, Williams JP, Campbell A, *et al*. Reliability of frailty assessment in the critically ill: a multicentre prospective observational study. Anaesthesia 2019;74(6):758–64.
15. Pugh RJ, Ellison A, Pye K, Subbe CP, Thorpe CM, Lone NI, *et al*. Feasibility and reliability of frailty assessment in the critically ill: a systematic review. Crit Care 2018;22(1):49.
16. Bertschi D, Waskowski J, Schilling M, Donatsch C, Schefold JC, Pfortmueller CA. Methods of Assessing Frailty in the Critically Ill: A Systematic Review of the Current Literature. Gerontology 2022;68(12):1321–49.
17. Chen X, Mao G, Leng S. Frailty syndrome: an overview. Clin Interv Aging 2014;9:433–41.
18. O'Caoimh R, Sezgin D, O'Donovan MR, Molloy DW, Clegg A, Rockwood K, *et al*. Prevalence of frailty in 62 countries across the world: a systematic review and meta-analysis of population-level studies. Age Ageing 2021;50:96–104.
19. Anand A, Cudmore S, Robertson S, Stephen J, Haga K, Weir CJ, *et al*. Frailty assessment and risk prediction by GRACE score in older patients with acute myocardial infarction. BMC Geriatr 2020;20(1):102.
20. Patel A, Goodman SG, Yan AT, Alexander KP, Wong CL, Cheema AN, *et al*. Frailty and Outcomes After Myocardial Infarction: Insights from the CONCORDANCE Registry. J Am Heart Assoc 2018;7(18):e009859.
21. Ekerstad N, Javadzadeh D, Alexander KP, Bergström O, Eurenius L, Fredrikson M, *et al*. Clinical Frailty Scale classes are independently associated with 6-month mortality for patients after acute myocardial infarction. Eur Heart J Acute Cardiovasc Care 2022;11(2):89–98.
22. Singh M, Rihal CS, Lennon RJ, Spertus JA, Nair KS, Roger VL. Influence of frailty and health status on outcomes in patients with coronary disease undergoing percutaneous revascularization. Circ Cardiovasc Qual Outcomes 2011;4:496–502.
23. Fernando SM, McIsaac DI, Rochwerg B, Bagshaw SM, Muscedere J, Munshi L, *et al*. Frailty and invasive mechanical ventilation: association with outcomes, extubation failure, and tracheostomy. Intensive Care Med 2019;45(12):1742–52.
24. Kundi H, Wadhera RK, Strom JB, Valsdottir LR, Shen C, Kazi DS, *et al*. Association of Frailty With 30-Day Outcomes for Acute Myocardial Infarction, Heart Failure, and Pneumonia Among Elderly Adults. JAMA Cardiol 2019;4(11):1084–91.
25. Afilalo J, Alexander KP, Mack MJ, Maurer MS, Green P, Allen LA, *et al*. "Frailty assessment in the cardiovascular care of older adults". J Am Coll Cardiol 2014;63:747–62.
26. Muscedere J, Bagshaw SM, Boyd G, Sibley S, Norman P, Day A, *et al*. The frailty, outcomes, recovery and care steps of critically ill patients (FORECAST) study: pilot study results. Inten Care Med Exp 2022;10(1):23.
27. Veronese N, Cereda E, Stubbs B, Solmi M, Luchini C, Manzato E, *et al*. Risk of cardiovascular disease morbidity and mortality in frail and pre-frail older adults: Results from a meta-analysis and exploratory meta-regression analysis. Ageing Res Rev 2017;35:63–73.
28. Jentzer JC, Bennett C, Wiley BM, Murphree DH, Keegan MT, Gajic O, *et al*. Predictive Value of the Sequential Organ Failure Assessment Score for Mortality in a Contemporary Cardiac Intensive Care Unit Population. J Am Heart Assoc 2018;7(6):e008169.
29. Elias A, Agbarieh R, Saliba W, Khoury J, Bahouth F, Nashashibi J, *et al*. SOFA score and short-term mortality in acute decompensated heart failure. Sci Rep 2020;10(1):20802.
30. Kojima G, Iliffe S, Jivraj S, Walters K. Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. J Epidemiol Community Health 2016;70:716–21.

Submitted: August 8, 2023	*Revised: December 26, 2023*	*Accepted: December 26, 2023*

Address for Correspondence:

Dr. Mirza Yousuf Baig, Post Fellow, Critical Care Medicine, National Institute of Cardiovascular Diseases, Karachi- Pakistan
Cell: +92 333 311 4789
Email: dr.myousufbaig@gmail.com