SCAI cardiogenic shock classification for predicting short-term mortality in acute myocardial infarction

Bui Vinh Ha[1], Van Duc Hanh[1]✉, Pham Manh Hung[2], Bui Thi Thanh Huyen[2], Nguyen Ngoc Quang[2]

[1] Vietnam National Heart Institute, Bach Mai Hospital

[2] Hanoi Medical University

Correspondence to

Dr. Van Duc Hanh

Vietnam National Heart Institute,

Bach Mai Hospital

Email: duchanhvan@gmail.com

Received 22 October 2024

Accepted 23 November 2024

Published online 30 November 2024

To cite: Bui VH, Van DH, Pham MH, et al. *J Vietnam Cardiol* 2024;**112E**:80-86

ABSTRACT

Background: Cardiogenic shock (CS) remains a critical complication of acute myocardial infarction (AMI) with severe outcomes. The Society for Cardiovascular Angiography and Interventions (SCAI) classification is a valuable tool for assessing the severity and progression of CS.

Objectives: Our study aimed to evaluate the association between initial SCAI classification and 30-day mortality in AMI patients and assess the prognostic value of SCAI changes within 24 hours post-admission.

Methods: All patients with AMI were classified according to the SCAI stages at admission and re-evaluated after 24 hours. 30-day mortality rates were compared across SCAI stages, and Cox regression analysis was used to assess the risk of death based on 24-hour transition SCAI classification.

Results: At admission, among 232 AMI patients, 50.8% were classified as SCAI A, 21.6% as SCAI B, 23.3% as SCAI C, and 4.3% as SCAI D/E. The 30-day mortality rates for each classification were 1.7% for SCAI A, 30.0% for SCAI B, 68.5% for SCAI C, and 90% for SCAI D/E. Within 24 hours of admission, 14.5% of patients experienced a worsening SCAI stage, 73.4% remained unchanged SCAI, and 12.1% showed improved SCAI. Patients with a worsening SCAI classification had a significantly higher risk of 30-day mortality, with an adjusted hazard ratio (HR) of 50.4 compared to those with stable SCAI status (p log-rank = 0.00001). Conversely, patients with stable or improved SCAI stages had notably lower mortality rates.

Conclusion: The initial SCAI stage at admission and its changes within 24 hours are crucial predictors of 30-day mortality in AMI patients with CS.

Keywords: Cardiogenic shock, SCAI classification, acute myocardial infarction, mortality rate, prognosis.

List of abbreviations

AMI: Acute Myocardial Infarction, EF = Ejection Fraction**,** SCAI: Society for Cardiovascular Angiography and Interventions, STEMI: ST-segment elevation myocardial infarction, Non-STEMI: non ST-segment elevation myocardial infarction.

INTRODUCTION

Cardiogenic shock due to myocardial infarction is a severe condition with high mortality rates; however, the treatment strategies remain challenging in clinical practice.[1] Various definitions, classifications, and diagnostic criteria for cardiogenic shock have been published based on clinical trials or treatment guidelines.[1–9] The inconsistency in the definition and classification of cardiogenic shock can pose difficulties for clinicians in practice as well as in the research application. Therefore, the Society for Cardiovascular Angiography and Interventions (SCAI) introduced a standardized classification of cardiogenic shock, known as the SCAI Cardiogenic Shock Classification.[10,11] This classification was subsequently validated and updated for improved clarity and precision.[12] In Vietnam, limitted studies have been conducted to classify cardiogenic shock patients; therefore, our study was designed to evaluate the ability of the SCAI classification at the time of admission and 24-hour transition SCAI classification to predict short-term mortality in patients with myocardial infarction.

STUDY SUBJECTS AND METHODS

Study site

Vietnam National Heart Institute, Bach Mai Hospital.

Study period

01/08/2022 – 02/04/2023.

Study subjects

232 patients with acute myocardial infarction (AMI) with ST-segment elevation (STEMI) and acute myocardial infarction without ST-segment elevation (NSTEMI).

Inclusion criteria

Diagnosis of STEMI based on the 2018 Fourth Universal Definition of Myocardial Infarction.[13] Diagnosis of NSTEMI based on the 2020 European Society of Cardiology Guidelines.[14]

Exclusion criteria

Patients or their families who refused to participate in the study. Patients with severe comorbidities, such as end-stage liver, kidney, or respiratory diseases, which could affect short-term mortality outcomes.

Study design

Cohort study.

Sampling method

We included all patients diagnosed with acute myocardial infarction admitted and treated at the Vietnam National Heart Institute, Bach Mai Hospital, from 01/08/2022 to 02/04/2023.

SCAI Classification of Cardiogenic Shock applied in the study (evaluated at admission and 24 hours post-admission):

SCAI Stage A: All patients diagnosed with acute myocardial infarction at the Vietnam National Heart Institute identified as being at risk of developing cardiogenic shock. SCAI Stage A includes patients presenting with clinical signs such as cool extremities, palpable peripheral pulses, normal consciousness, no pulmonary rales, systolic blood pressure (SBP) ≥ 100 mmHg, and normal renal function.

- **SCAI Stage B**: Patients with cool extremities, palpable peripheral pulses, normal consciousness, possible pulmonary rales, SBP < 90 mmHg or a drop in SBP > 30 mmHg from baseline, heart rate ≥ 100 beats/min, and normal lactate levels.
- **SCAI Stage C**: Clinically congested, cool and moist skin, pulmonary rales, oliguria, lactate ≥ 2 mmol/L, creatinine increase 1.5 times above normal values, elevated NT-proBNP.
- **SCAI Stage D**: Severe, refractory congestion, extensive pulmonary rales, prolonged lactate ≥ 2 mmol/L, requiring high-dose vasopressors or mechanical circulatory support.
- **SCAI Stage E**: Unconsciousness, circulatory collapse, lactate ≥ 8 mmol/L, pH < 7.2, severe hypotension despite maximal hemodynamic support.

24-hour transition SCAI classification: SCAI classification was assessed upon patient admission and reassessed 24 hours later. Based on these classifications, we categorized the patients as follows: "***unchanged SCAI***" if the classification remained the same after 24 hours, "***worsening SCAI***" if the classification worsened compared to admission, and "***improved SCAI***" if the classification improved after 24 hours.

Study outcome

All-cause mortality within 30 days of admission. Data on this outcome was collected through phone calls to the patient's family.

Data collection method

A standardized research medical record form was used to collect data for all patients enrolled in the study. Information included demographics, medical history, clinical symptoms, echocardiographic parameters, blood test results, and all-cause mortality status within 30 days.

Data Analysis

Data was entered using SPSS 20.0 software and checked internally for inconsistencies or errors. Data analysis was performed using Stata 14.0 software. For qualitative variables, we calculated frequency and percentage to describe the characteristics of the study population. For quantitative data, we calculated mean ± standard deviation. We computed adjusted HR using Cox regression to explore the association between early cardiovascular events and cardiogenic shock classification. Kaplan-Meier curves and log-rank tests were conducted to compare the differences in the timing of mortality events among patients with different cardiogenic shock classifications. For statistical significance, $p < 0.05$ was considered significant. For HR or adjusted HR, statistical significance was determined when the 95% CI did not include 1.

Ethics of the Study

The study was conducted in compliance with ethical principles in medical research.

RESULTS

Table 1. *Clinical and Paraclinical Characteristics of Study Subjects According to SCAI Classification*

Characteristics	Overall (n = 232)	SCAI Classification at Admission				
		SCAI A (n = 118)	SCAI B (n = 50)	SCAI C (n = 54)	SCAI D/E (n = 10)	p
Age (years)	70.1 ± 12.7	67.5 ± 13.5	70.9 ± 12.5	73.4 ± 10.1	70.1 ± 12.7	0.001
Female	73 (31.5%)	33 (28.0%)	16 (32.0%)	21 (38.9%)	3 (30.0%)	0.56
Hypertension	147 (63.4%)	81 (68.6%)	26 (52.0%)	34 (63.0%)	6 (60.0%)	0.23
Diabetes	60 (25.9%)	22 (18.6%)	16 (32.0%)	16 (29.6%)	6 (60.0%)	0.01
Dyslipidemia	6 (2.6%)	5 (4.2%)	1 (2.0%)	0 (0%)	0 (0%)	0.39
Systolic Blood Pressure (mmHg)	121.3 ± 23.5	132.9 ± 11.0	122.1 ± 21.5	100.6 ± 15.9	95.0 ± 22.2	0.001
Diastolic Blood Pressure (mmHg)	74.6 ± 13.2	79.9 ± 11.0	75.6 ± 12.9	64.2 ± 9.9	60. 0 ± 13.1	0.001
Heart Rate (beats/min)	87.1 ± 22.5	80.8 ± 13.7	90.4 ± 25.7	97.4 ± 26.6	88.3 ± 42.2	0.001
ST-Elevation Myocardial Infarction	166 (71.6%)	83 (70.3%)	30 (60.0%)	46 (85.2%)	7 (70.0%)	0.04
Creatinin (µmol/L)	109.8 ± 86.8	90.1 ± 44.7	117.0 ± 106.1	123.4 ± 58.4	226.3 ± 251.3	0.0001
Troponin T (ng/L)	2,140.7 ± 2,957.9	1,714.9 ± 3,157.3	1,664.3 ± 1,868.2	3,604.9 ± 3,152.3	1,744.1 ± 1,144.8	0.001
NT-proBNP (pg/mL)	9,446.5 ± 11,472.4	3,868.7 ± 7,546.9	9,197.2 ± 11,178.1	14,976.3 ± 12,173.9	11,728.5 ± 1,144.8	0.0001
(Ejection Fraction) EF (%)	45.2 ± 11.5	50.4 ± 9.4	41.9 ± 10.6	38.0 ± 9.2	34.6 ± 17.6	0.0001
pH at Admission	7.38 ± 0.10	7.42 ± 0.03	7.42 ± 0.06	7.37 ± 0.11	7.23 ± 0.10	0.0001
Lactate at Admission (mmol/L)	3.8 ± 4.0	1.3 ± 0.6	1.7 ± 0.9	4.1 ± 2.6	12.7 ± 6.2	0.0001
30-Day Mortality	63 (27.2%)	2 (1.7%)	15 (30.0%)	37 (68.5%)	9 (90.0%)	0.001

Bui VH, Van DH, Pham MH, et al. *J Vietnam Cardiol* 2024;**112E**:80-86. doi:10.58354/jvc.112E.2024.880

Comment: The more severe the SCAI classification of cardiogenic shock, the more deteriorated the clinical parameters (systolic blood pressure, diastolic blood pressure, and heart rate) and laboratory test results (blood pH, admission blood lactate, creatinine, troponin T, NT-proBNP, and EF).

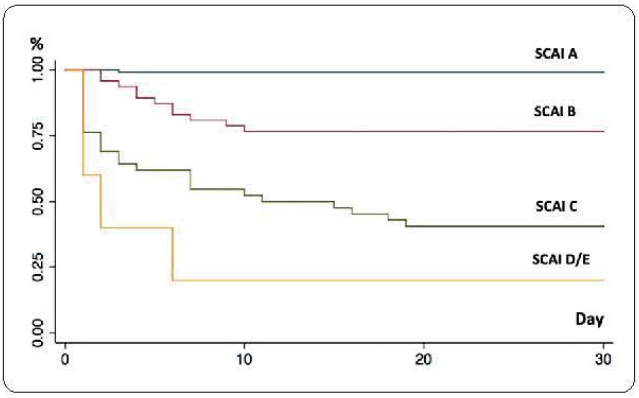

Figure 1. 30-day Mortality Rate by Changes in SCAI Classification

Comment: The severe cardiogenic shock group (SCAI C/D/E) has a significantly lower survival rate compared to the mild shock group (SCAI A/B), with a log-rank p-value of 0.0001.

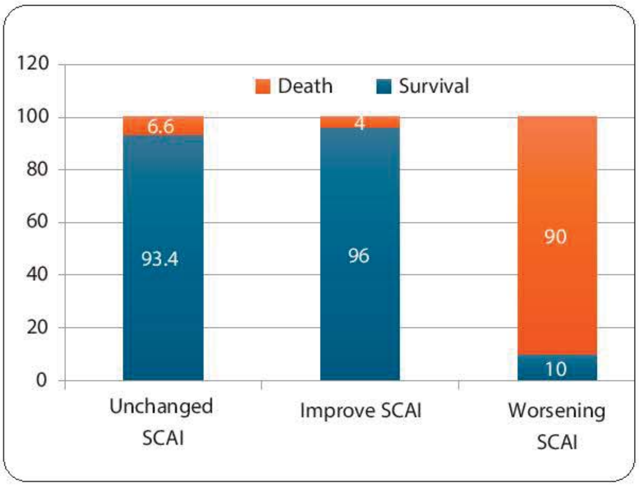

Figure 2. 30-day Mortality Rate by Changes in SCAI Classification

Comment: The 30-day mortality rate is significantly higher in the group with worsening SCAI classification, while it is lower in the group with improved or unchanged SCAI classification.

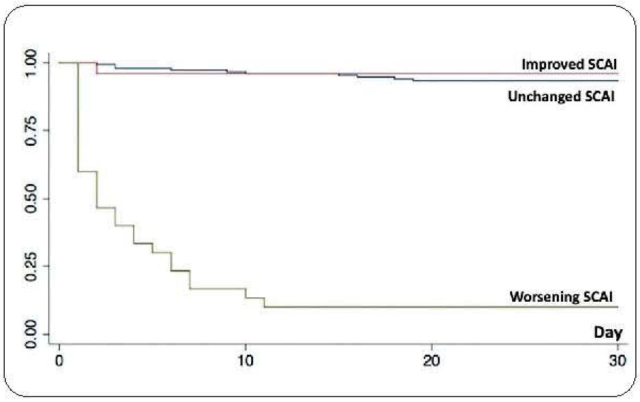

Figure 3. 30-day mortality by 24-hour SCAI transition

Comment: The group with worsening SCAI classification within 24 hours has a significantly lower survival rate compared to the group with unchanged or improved SCAI classification within 24 hours, with a log-rank p-value of 0.0000.

Table 2. 30-day Mortality Risk by SCAI Improvement

Variable	Crude HR (95% CI)	Adjusted HR (95% CI)
Improved SCAI	0.6 (0.1 – 4.8)	1.1 (0.1 – 8.9)
Worsening SCAI	127.8 (32.9 – 495.0)	50.4 (17.9 – 141.6)
Male	0.4 (0.2 – 0.8)	0.6 (0.3 – 1.4)
Age ≥ 70	5.7 (2.4 – 13.8)	3.5 (1.3 – 9.8)
Coronary artery stenting	0.1 (0.05 – 0.4)	0.4 (0.2 – 0.9)
Reference group: unchanged SCAI		

Comment: Compared to patients with unchanged SCAI classification, those with worsening SCAI classification after 24 hours have a 50.4-fold higher risk of 30-day mortality (adjusted for gender, age, and coronary stenting status).

DISCUSSION

Clinical and paraclinical characteristics by SCAI Classification at admission

The mean age of patients with acute myocardial infarction (AMI) in our study was 70.1 years, with 31.5% female. Previous studies reported a mean age of 69.3 years with 37% female among patients in cardiovascular intensive care units, and 67 years with

28% female in cardiogenic shock patients.[15,16] In our study, apart from diabetes, no significant differences in the prevalence of cardiovascular conditions and risk factors were observed among the SCAI shock subgroups. However, other studies have noted significant differences in cardiovascular history and risk factors across these subgroups.[16] Therefore, demographic characteristics, cardiovascular history, and risk factors may vary across studies depending on the population. Despite these variations, most studies consistently indicate that the mean age of patients in the more severe shock categories (SCAI C/D/E) is generally higher than those in the milder shock categories (SCAI A/B)).[15,17] Clinical parameters such as heart rate, systolic blood pressure, and diastolic blood pressure showed significant variation across SCAI shock subgroups. Additionally, laboratory parameters at admission, including white blood cell count, urea, creatinine, glucose, NT-proBNP, troponin T, pH, blood lactate levels, and left ventricular ejection fraction (EF), differed significantly among SCAI subgroups (Table 1). These findings align with previous reports.[15–18]

The distribution of AMI patients across SCAI classifications at admission in our study was 50.8% for SCAI A, 21.6% for SCAI B, 23.3% for SCAI C, 3.4% for SCAI D, and 0.9% for SCAI E. Variations in SCAI classification rates at admission are influenced by the study population and clinical setting. Studies conducted in shock centers reported that around 80% of patients were classified as having severe shock (SCAI C/D/E) upon admission.[16,17] In contrast, over 70% of patients in cardiovascular intensive care units (CICU) presented with mild shock (SCAI A/B) at admission.[15]

Relation between SCAI Classification at admission and 30-day mortality

The more severe the SCAI classification, the higher the 30-day mortality rate. In our study, all patients classified as SCAI E at admission died, while 75% of those classified as SCAI D did not survive. In contrast, the 30-day mortality rates for patients in the SCAI A and SCAI B groups were 1.7% and 30.0%, respectively. Patients classified as SCAI C and SCAI D/E had a significantly higher mortality rate compared to those in the SCAI A and SCAI B groups, with a log-rank p-value of 0.0001 (Figure 1). Previous research has shown similar results. A study involving over 1,000 patients demonstrated a clear distinction in short-term survival probabilities among SCAI subgroups, with the highest 30-day survival observed in SCAI A, followed by progressively lower survival in SCAI B, SCAI C, SCAI D, and the lowest in SCAI E.[16] Another analysis of mortality risk based on SCAI classification found that, using SCAI C as the reference, the mortality risk for patients classified as SCAI D and SCAI E was 4.1 times and 10.3 times higher, respectively, in those diagnosed with either AMI or acute heart failure.[17]

30-day mortality based on 24-hour SCAI transiton

SCAI classification at admission offers a good prognostic insight, but it becomes even more predictive when reassessed 24 hours post-admission.[19,20] In our study, among the 207 AMI patients who survived 24 hours from admission, 73.4% had unchanged SCAI after 24 hours, while 12.1% improved and 14.5% worsened. We observed that patients with improved or unchanged SCAI had a better 30-day survival prognosis than those whose SCAI classification worsened (Figure 2 and 3). We performed a Cox regression analysis to assess 30-day mortality risk based on SCAI improvement. Variables included in the model were gender, age, and coronary stenting status, with the unchanged SCAI group as the reference. The results indicated that patients with worsening SCAI after 24 hours had a 50.4-fold higher mortality risk compared to the unchanged SCAI group, while the improved SCAI group did not show a significant reduction in mortality. Additionally, age over 70 years was an independent predictor of increased mortality risk, with a 3.5-fold increase compared to those under 70 (Table 2).

A study involving 237 patients with cardiogenic shock, of whom 43% had AMI and 37% had acute heart failure, ranging from SCAI B to SCAI D, across 11 cardiac centers in Italy, indicated that SCAI classification is dynamic and suggested that reassessment at 24 hours post-admission provides better prognostic accuracy for mortality than admission-based classification alone.

Adjusting for factors such as age, gender, lactate levels, glomerular filtration rate, central venous pressure, vasopressor use, and mechanical support devices, the study concluded that SCAI classification at 24 hours was an independent predictor of in-hospital mortality. This underscores the importance of early and aggressive intervention in cardiogenic shock to stabilize hemodynamics, particularly in patients with severe presentations.[19] In another study, 300 AMI patients classified as SCAI C, D, and E were monitored using left ventricular assist devices (LVADs) and assessed for cardiogenic shock severity at admission and 24 hours post-admission, using both invasive and non-invasive hemodynamic measurements. The results indicated that for patients with similar initial shock severity, a deterioration in shock severity after 24 hours led to decreased survival at discharge, emphasizing the critical nature of the "golden hours" in managing shock.[21] Baran et al. evaluated 166 cardiogenic shock patients classified by SCAI stage at admission and at 24 hours, following them for 30-day mortality. They found that reassessment of the SCAI stage at 24 hours served as a strong predictor of 30-day survival, with patients whose shock severity improved demonstrating better outcomes than those with stable or worsening conditions. Notably, patients with unchanged shock severity after 24 hours had outcomes similar to those whose condition worsened.[20]

Limitations of the Study

Our study has several limitations. First, the sample size is relatively small, predominantly comprising patients classified as SCAI A, with a limited number of cases in the SCAI D and SCAI E groups. As a result, we could not thoroughly analyze the clinical characteristics, paraclinical findings, and cardiovascular events of the SCAI D and SCAI E subgroups. Second, the in-hospital mortality rate could not be directly assessed, as families often requested discharge when the patient's condition deteriorated. Consequently, instead of reporting in-hospital mortality, we evaluated the proportion of patients who either died or were discharged in critical condition. It should be noted that many of these patients did not die immediately after discharge but may have passed away days later. Third, the assessment of 30-day mortality was based on follow-up phone calls to the patients' relatives, as there is no centralized mortality management database in Vietnam. This method may introduce recall bias concerning the exact date of death. To minimize this limitation and improve the accuracy of our data, we often cross-checked the date of death using both lunar and solar calendars during follow-up calls.

CONCLUSION

The SCAI classification effectively predicts 30-day mortality in acute myocardial infarction patients with cardiogenic shock. A higher SCAI stage at admission and 24 hours post-admission is associated with increased 30-day mortality rates. Monitoring changes in SCAI classification over time can guide treatment decisions and enhance patient outcomes.

REFERENCE

1. Vahdatpour C, Collins D, Goldberg S. Cardiogenic Shock. *J Am Heart Assoc*. 2019;8(8):e011991. doi:10.1161/JAHA.119.011991
2. Sciaccaluga C, Mandoli GE, Ghionzoli N, et al. Risk stratification in cardiogenic shock: a focus on the available evidence. *Heart Fail Rev*. 2022;27(4):1105-1117. doi:10.1007/s10741-021-10140-7
3. Hochman JS, Sleeper LA, Webb JG, et al. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. SHOCK Investigators. Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock. *N Engl J Med*. 1999;341(9):625-634. doi:10.1056/NEJM199908263410901
4. Thiele H, Zeymer U, Neumann FJ, et al. Intraaortic balloon support for myocardial infarction with cardiogenic shock. *N Engl J Med*. 2012;367(14):1287-1296. doi:10.1056/NEJMoa1208410
5. Bauer T, Zeymer U, Hochadel M, et al. Use and outcomes of multivessel percutaneous coronary intervention in patients with acute myocardial infarction complicated by cardiogenic shock (from the EHS-PCI Registry). *Am J Cardiol*. 2012;109(7):941-946. doi:10.1016/j.amjcard.2011.11.020

6. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J*. 2016;37(27):2129-2200. doi:10.1093/eurheartj/ehw128
7. Ouweneel DM, Eriksen E, Sjauw KD, et al. Percutaneous Mechanical Circulatory Support Versus Intra-Aortic Balloon Pump in Cardiogenic Shock After Acute Myocardial Infarction. *J Am Coll Cardiol*. 2017;69(3):278-287. doi:10.1016/j.jacc.2016.10.022
8. Thiele H, Akin I, Sandri M, et al. PCI Strategies in Patients with Acute Myocardial Infarction and Cardiogenic Shock. *N Engl J Med*. 2017;377(25):2419-2432. doi:10.1056/NEJMoa1710261
9. Lee JM, Rhee TM, Hahn JY, et al. Multivessel Percutaneous Coronary Intervention in Patients With ST-Segment Elevation Myocardial Infarction With Cardiogenic Shock. *J Am Coll Cardiol*. 2018;71(8):844-856. doi:10.1016/j.jacc.2017.12.028
10. Baran DA, Grines CL, Bailey S, et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock: This document was endorsed by the American College of Cardiology (ACC), the American Heart Association (AHA), the Society of Critical Care Medicine (SCCM), and the Society of Thoracic Surgeons (STS) in April 2019. *Catheter Cardiovasc Interv*. 2019;94(1):29-37. doi:10.1002/ccd.28329
11. Burkhoff D, Garan AR, Kapur NK. The SCAI Cardiogenic Shock Staging System Gets Taken for a Test Drive. *J Am Coll Cardiol*. 2019;74(17):2129-2131. doi:10.1016/j.jacc.2019.08.1020
12. Naidu SS, Baran DA, Jentzer JC, et al. SCAI SHOCK Stage Classification Expert Consensus Update: A Review and Incorporation of Validation Studies: This statement was endorsed by the American College of Cardiology (ACC), American College of Emergency Physicians (ACEP), American Heart Association (AHA), European Society of Cardiology (ESC) Association for Acute Cardiovascular Care (ACVC), International Society for Heart and Lung Transplantation (ISHLT), Society of Critical Care Medicine (SCCM), and Society of Thoracic Surgeons (STS) in December 2021. *J Am Coll Cardiol*. 2022;79(9):933-946. doi:10.1016/j.jacc.2022.01.018
13. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth universal definition of myocardial infarction (2018). *Eur Heart J*. 2019;40(3):237-269. doi:10.1093/eurheartj/ehy462
14. Collet JP, Thiele H, Barbato E, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42(14):1289-1367. doi:10.1093/eurheartj/ehaa575
15. Jentzer JC, Wiley BM, Anavekar NS, et al. Noninvasive Hemodynamic Assessment of Shock Severity and Mortality Risk Prediction in the Cardiac Intensive Care Unit. *JACC Cardiovasc Imaging*. 2021;14(2):321-332. doi:10.1016/j.jcmg.2020.05.038
16. Schrage B, Dabboura S, Yan I, et al. Application of the SCAI classification in a cohort of patients with cardiogenic shock. *Catheter Cardiovasc Interv*. 2020;96(3):E213-E219. doi:10.1002/ccd.28707
17. Thayer KL, Zweck E, Ayouty M, et al. Invasive Hemodynamic Assessment and Classification of In-Hospital Mortality Risk Among Patients With Cardiogenic Shock. *Circ Heart Fail*. 2020;13(9):e007099. doi:10.1161/CIRCHEARTFAILURE.120.007099
18. Jentzer JC, van Diepen S, Barsness GW, et al. Cardiogenic Shock Classification to Predict Mortality in the Cardiac Intensive Care Unit. *J Am Coll Cardiol*. 2019;74(17):2117-2128. doi:10.1016/j.jacc.2019.07.077
19. Morici N, Frea S, Bertaina M, et al. SCAI stage reclassification at 24 h predicts outcome of cardiogenic shock: Insights from the Altshock-2 registry. *Catheter Cardiovasc Interv*. 2023;101(1):22-32. doi:10.1002/ccd.30484
20. Baran DA, Long A, Badiye AP, et al. Prospective validation of the SCAI shock classification: Single center analysis. *Catheter Cardiovasc Interv*. 2020;96(7):1339-1347. doi:10.1002/ccd.29319
21. Hanson ID, Tagami T, Mando R, et al. SCAI shock classification in acute myocardial infarction: Insights from the National Cardiogenic Shock Initiative. *Catheter Cardiovasc Interv*. 2020;96(6):1137-1142. doi:10.1002/ccd.29139