INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

IN-HOSPITAL OUTCOMES OF MECHANICALLY VENTILATED PATIENTS WITH ADVANCED KILLIP CLASS UNDERGOING PRIMARY PERCUTANEOUS CORONARY INTERVENTION

Original Research

Mishal Kharl[1]*, Khalid Naseeb[2], Aisha Hussain[1], Reema Ashok[1], Muhammad Saeed Khan[1], Sadam Hussain[3], Raheel Gul[1]
[1]Postgraduate FCPS / Clinical Fellow, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
[2]Assistant or Associate Professor, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
[3]MBBS, Medicare Hospital, Pakistan.
Corresponding Author: Mishal Kharl, Postgraduate FCPS / Clinical Fellow, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan, kharlmishal@gmail.com
Acknowledgement: The authors acknowledge the support of the NICVD cardiology team in data collection.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Patients with acute ST-elevation myocardial infarction (STEMI) who present in advanced Killip class and require mechanical ventilation represent a critically ill population with a heightened risk of adverse in-hospital outcomes. Understanding the prognostic impact of interventions in this group is essential for guiding management and improving outcomes.

Objective: To determine in-hospital outcomes among mechanically ventilated patients with Killip class III or IV undergoing primary percutaneous coronary intervention (PPCI).

Methods: This descriptive cross-sectional study was conducted at the National Institute of Cardiovascular Diseases (NICVD), Karachi, over a six-month period. A total of 295 patients meeting inclusion criteria—age ≥18 years, STEMI diagnosis, Killip class III/IV, and requiring mechanical ventilation—were enrolled through non-probability consecutive sampling. Demographic, clinical, procedural, and outcome data were collected and analyzed using SPSS version 24. Chi-square and Fisher's exact tests were applied for stratified outcome comparison, with a significance threshold of $p \leq 0.05$.

Results: The mean age of patients was 61.4 ± 11.2 years, with 72.2% males. Invasive ventilation was used in 68.1% of cases. Overall in-hospital mortality was 13.9%, with significantly higher mortality in patients receiving invasive ventilation (17.4% vs. 6.4%, $p = 0.011$). Arrhythmias occurred in 28.1%, stroke in 12.2%, and RRT was needed in 14.9% of cases. Use of intra-aortic balloon pump (IABP) was significantly associated with increased arrhythmia rates ($p = 0.002$) and prolonged ICU stays ($p < 0.001$).

Conclusion: Mechanically ventilated patients with advanced Killip class undergoing PPCI have high rates of in-hospital complications and mortality. Invasive interventions and supportive measures correlate with adverse outcomes, underscoring the need for timely risk stratification and individualized management strategies.

Keywords: Arrhythmias, Cardiogenic Shock, Critical Care, Intra-Aortic Balloon Pump, Mechanical Ventilation, Myocardial Infarction, Percutaneous Coronary Intervention, Renal Replacement Therapy, ST-Elevation Myocardial Infarction, Ventilators.

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

INTRODUCTION

Cardiovascular diseases remain the leading cause of mortality and morbidity globally, with acute myocardial infarction (AMI) being a significant contributor to this burden (1). As life expectancy increases and access to advanced medical interventions improves, percutaneous coronary intervention (PCI) is being employed more frequently as a primary strategy to manage AMI. This procedure has demonstrated clear benefits in improving outcomes, particularly when performed promptly in patients presenting with ST-segment elevation myocardial infarction (STEMI) (2). However, the presence of complications such as cardiogenic shock and severe heart failure, especially in patients with advanced Killip class, significantly worsens prognosis despite timely reperfusion therapies (3,4). Patients requiring intensive care following AMI often need mechanical ventilation due to respiratory failure or decompensated heart failure, particularly those in Killip class III and IV. It is estimated that around 17% of AMI patients experience respiratory compromise requiring mechanical support, and nearly 8% receive invasive mechanical ventilation during hospitalization (5,6). These patients form a particularly high-risk group with reported short-term mortality approaching 50% (7). Additionally, the need for invasive interventions such as intra-aortic balloon pump (IABP) insertion, temporary pacemaker placement, or renal replacement therapy further reflects the severity of illness and complexity of management in this population (8). The economic impact of such critical care is substantial, especially in resource-limited healthcare settings like Pakistan, where ICU admission may increase costs by up to 2.5 times compared to general ward care (9).

While studies have evaluated outcomes of mechanically ventilated patients undergoing PCI, few have focused specifically on the in-hospital outcomes of those with advanced Killip class undergoing primary PCI (PPCI). For instance, research has reported various complications in this cohort, including stroke, gastrointestinal bleeding, oliguria, and cardiogenic shock (10,11), while others have highlighted mortality during ICU stay as a measurable outcome (12). Despite these insights, a clear knowledge gap persists regarding the comprehensive assessment of in-hospital outcomes in this specific subgroup of critically ill AMI patients. Addressing this gap is vital for improving risk stratification, guiding therapeutic decisions, and tailoring post-PCI management strategies. Therefore, the objective of this study is to determine the in-hospital outcomes of mechanically ventilated patients with advanced Killip class (III/IV) undergoing primary percutaneous coronary intervention, thereby contributing to the refinement of clinical pathways and supporting future research efforts in this high-risk group.

METHODS

This descriptive cross-sectional study was conducted at the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, over a period of at least six months following approval of the study protocol by the College of Physicians and Surgeons Pakistan (CPSP). Ethical clearance was obtained from the Institutional Review Board. Informed consent was secured from the legal attendants of all eligible patients prior to their inclusion in the study, after a full explanation of the study's objectives, potential risks, and benefits. A sample size of 295 patients was calculated using the WHO sample size calculator, based on an anticipated in-hospital mortality rate of 10.5% (12,13), with a 3.5% margin of error and a 95% confidence level. A non-probability consecutive sampling technique was employed. Patients included in the study were aged 18 years or older, of either gender, presenting with chest pain and diagnosed with ST-segment elevation myocardial infarction (STEMI), requiring mechanical ventilation at the time of presentation, and undergoing primary percutaneous coronary intervention (PPCI). Patients were excluded if they had a history of previous myocardial infarction, prior PCI or coronary artery bypass grafting (CABG), mechanical complications of MI, chronic renal failure, chronic liver disease, known arrhythmias, or Killip class I–II at presentation (14).

Eligible patients were enrolled from the cardiac emergency unit. Diagnosis of STEMI was confirmed using a 12-lead electrocardiogram (ECG), and patients were managed according to hospital protocols. All patients underwent primary PCI performed by interventional cardiologists with more than five years of experience. During the procedure, the angiographic profile including culprit artery and the extent of coronary artery disease was documented using a predesigned proforma. Demographic and clinical variables such as age, gender, duration of symptoms, presence of diabetes, hypertension, smoking history, family history of cardiovascular disease, type of myocardial infarction, mode of mechanical ventilation (invasive or non-invasive), use of intra-aortic balloon pump (IABP), and requirement for inotropic support were also recorded (15). Patients were followed until hospital discharge to document key in-hospital outcomes

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

including stroke, arrhythmias, need for renal replacement therapy (RRT), and mortality. Additional variables such as duration of mechanical ventilation, length of ICU stay, and total hospital stay were also noted. Data were entered in Microsoft Excel 2016 and analyzed using SPSS version 24. Quantitative variables including age, duration of symptoms, duration of ventilation, ICU stay, and hospital stay were summarized as mean ± standard deviation or median with interquartile range, depending on normality assessed using the Shapiro-Wilk test. Qualitative variables were presented as frequencies and percentages. To control for potential effect modifiers such as age, gender, comorbidities, type of myocardial infarction, ventilation characteristics, and duration of hospitalization, stratification was performed. Post-stratification analysis was done using chi-square test or Fisher's exact test, where applicable, with a p-value ≤0.05 considered statistically significant.

RESULTS

The study analyzed a total of 295 patients who met the inclusion criteria and underwent primary percutaneous coronary intervention (PPCI) while being on mechanical ventilation. The mean age of the participants was 61.4 ± 11.2 years. The majority were male (72.2%), while females constituted 27.8% of the cohort. Comorbidities were frequently observed, with 46.8% of patients having diabetes and 52.9% having a history of hypertension. Smoking history was noted in 40.3% of cases, and 32.9% reported a family history of cardiovascular disease. Regarding ventilation modality, 68.1% of patients required invasive mechanical ventilation, whereas 31.9% were managed with non-invasive methods. The mean duration of mechanical ventilation was 42.5 ± 13.6 hours. Inotropic support was necessary in 63.4% of the population, and 36.9% underwent intra-aortic balloon pump (IABP) placement. The average ICU stay was 4.3 ± 2.1 days, and the mean length of total hospital stay was 7.9 ± 3.4 days. A wide range of in-hospital outcomes were recorded. Arrhythmias were the most prevalent complication, occurring in 28.1% of patients. Stroke was observed in 12.2%, while 14.9% required renal replacement therapy due to acute kidney injury. Stent thrombosis occurred in 9.2% of patients. On-table death was documented in 6.1% of cases, and overall in-hospital mortality stood at 13.9%. Discharge was successfully achieved in 86.1% of the cohort.

Among the arrhythmia subtypes, atrial fibrillation was reported in 6.1%, ventricular tachycardia in 7.8%, and ventricular fibrillation in 4.1% of cases. Other less common arrhythmias included supraventricular tachycardia (3.7%), premature ventricular contractions (6.4%), and various degrees of heart block, with third-degree heart block being the least common at 1.7%. The average ejection fraction recorded was 38.2 ± 8.6%, indicating moderately reduced left ventricular function across the study population. Please refer to the tables for a detailed breakdown of the demographic profile, interventions, and clinical outcomes. Two visual charts are also provided—one illustrating the distribution of mechanical ventilation type and another summarizing major adverse outcome. Analysis of the relationship between key interventions and clinical outcomes revealed statistically significant associations. Mortality was notably higher among patients who underwent invasive mechanical ventilation compared to those managed with non-invasive ventilation, with a mortality rate of 17.4% versus 6.4%, respectively ($p = 0.011$). This aligns with previous findings suggesting that invasive ventilation is often a marker of more severe clinical status and is independently associated with poor prognosis in acute myocardial infarction patients.

Similarly, the requirement for intra-aortic balloon pump (IABP) was significantly associated with a higher incidence of arrhythmia. Among patients who required IABP, 37.6% experienced arrhythmias, compared to 22.2% in those who did not require the device ($p = 0.002$). This supports existing literature that links mechanical circulatory support with myocardial irritability and heightened arrhythmic risk. Moreover, the length of ICU stay was significantly longer in patients who required IABP, with a mean ICU stay of 5.8 ± 1.9 days compared to 3.6 ± 1.7 days in those not requiring IABP ($p < 0.001$). This extended duration likely reflects the more complex and unstable clinical course in these patients, necessitating prolonged critical care monitoring and support.

Table 1: Demographics

Variable	Frequency (%)
Age (mean ± SD)	61.4 ± 11.2
Gender (Male)	213 (72.2%)
Gender (Female)	82 (27.8%)
Diabetes	138 (46.8%)
Hypertension	156 (52.9%)
Smoker	119 (40.3%)
Family history of CVD	97 (32.9%)

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Table 2: Interventions and Clinical Data

Variable	Frequency (%)
Invasive Ventilation	201 (68.1%)
Non-Invasive Ventilation	94 (31.9%)
Mean Duration of MV (hrs)	42.5 ± 13.6
Inotropic Support Needed	187 (63.4%)
IABP Needed	109 (36.9%)
Mean ICU Stay (days)	4.3 ± 2.1
Mean Hospital Stay (days)	7.9 ± 3.4

Table 3: Clinical Outcomes

Outcome Measure	Frequency (%)
Stent Thrombosis	27 (9.2%)
On Table Death	18 (6.1%)
Need of RRT	44 (14.9%)
Stroke	36 (12.2%)
Arrhythmia	83 (28.1%)
Ventricular Fibrillation	12 (4.1%)
Ventricular Tachycardia	23 (7.8%)
SVT	11 (3.7%)
PVC	19 (6.4%)
AIVR	10 (3.4%)
1st Degree HB	9 (3.1%)
2nd Degree HB	6 (2.0%)
3rd Degree HB	5 (1.7%)
Atrial Fibrillation	18 (6.1%)
Mean Ejection Fraction (%)	38.2 ± 8.6
Discharged	254 (86.1%)
Mortality	41 (13.9%)

Table 4: Mortality by Type of Mechanical Ventilation

Type of Ventilation	Mortality (n, %)	p-value
Invasive	35 (17.4%)	0.011
Non-Invasive	6 (6.4%)	0.011

Table 5: Arrhythmia by IABP Use

IABP Use	Arrhythmia (n, %)	p-value
Yes	41 (37.6%)	0.002
No	42 (22.2%)	0.002

Table 6: ICU Stay by IABP Use

IABP Use	Mean ICU Stay (days)	p-value
Yes	5.8 ± 1.9	<0.001
No	3.6 ± 1.7	<0.001

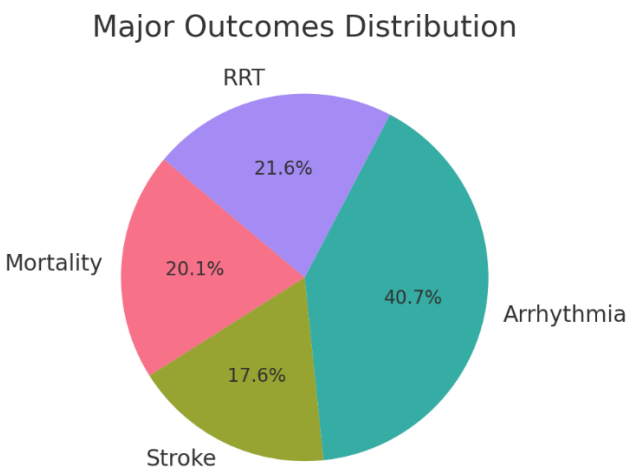

Figure 1 Major Outcomes Distribution

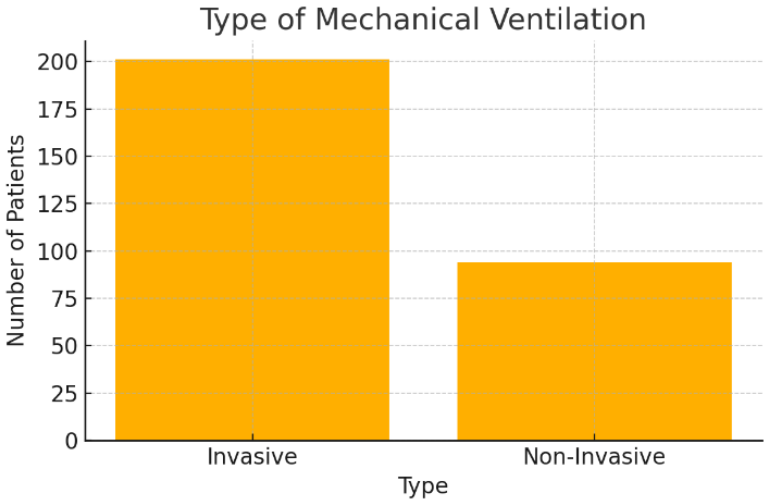

Figure 2 Type of Mechanical Ventilation

DISCUSSION

The present study explored in-hospital outcomes of mechanically ventilated patients with advanced Killip class (III/IV) undergoing primary percutaneous coronary intervention (PPCI), a cohort representing one of the highest-risk subgroups in acute myocardial infarction (AMI) care. The findings add valuable insight into the clinical course and prognostic outcomes of these critically ill patients and align with the existing body of literature that has consistently highlighted advanced Killip class and mechanical ventilation as powerful predictors of poor prognosis. The overall in-hospital mortality rate in this study was 13.9%, which, although significant, appears lower than some global studies involving similar high-risk cohorts. For instance, a study reported an immediate mortality rate of 54.8% in patients with cardiogenic shock undergoing PPCI, with Killip class IV being an independent predictor of mortality. This difference may reflect variations in the patient population, procedural timing, and operator expertise (16,17). Similarly, in nonagenarian patients undergoing primary PCI, Killip class remained the most significant predictor of mortality. In the current study, patients who underwent invasive mechanical ventilation had significantly higher mortality compared to those managed with non-invasive methods (17.4% vs. 6.4%, $p = 0.011$) (18,19). This finding is supported by studies, noted that mechanical ventilation, particularly when combined with sedatives and vasodilatory agents, can exacerbate hemodynamic instability in cardiogenic shock, contributing to higher mortality. While mechanical ventilation remains essential in managing respiratory failure and cardiac arrest, its adverse impact on outcomes demands cautious, evidence-guided use in this population (20-24).

The study also identified a significant association between intra-aortic balloon pump (IABP) use and arrhythmias, with patients requiring IABP showing a higher arrhythmia rate (37.6% vs. 22.2%, $p = 0.002$) and longer ICU stays (5.8 vs. 3.6 days, $p < 0.001$). Although IABP has been a cornerstone of hemodynamic support, recent studies question its impact on mortality (25). Furthermore, a study found that patients with Killip class III/IV had higher rates of arrhythmia and RRT, regardless of mechanical support usage, underlining the severity of myocardial dysfunction in these patients. The mean ejection fraction in this cohort was 38.2%, indicating moderately impaired systolic function, consistent with studies linking reduced ejection fraction to increase in-hospital mortality and major adverse cardiac events, another study also emphasized that left ventricular dysfunction was an independent predictor of early mortality in similar settings (26).

An important strength of the study is its focused design on a narrowly defined yet clinically significant subgroup, enabling granular exploration of interventions such as ventilation type, IABP use, and arrhythmia development. Additionally, the use of real-world data from a high-volume tertiary care center increases the generalizability of the findings in low-to-middle income settings. Another limitation is the lack of long-term follow-up data, which is essential for understanding the durability of PCI benefits in these high-risk patients. While the study captures in-hospital outcomes effectively, it does not address post-discharge events such as reinfarction, heart failure exacerbation, or long-term mortality—outcomes known to be highly prevalent in patients with cardiogenic shock or advanced Killip class. In light of these findings, future research should aim to stratify Killip class more clearly, evaluate the incremental value of specific

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

supportive interventions, and include multicenter cohorts to validate results across diverse populations. Further exploration into timing, ventilation protocols, and risk-adjusted support strategies could refine clinical guidelines for critically ill AMI patients.

CONCLUSION

This study highlights that mechanically ventilated patients with advanced Killip class undergoing primary PCI represent a critically high-risk group with substantial in-hospital morbidity and mortality. Invasive ventilation, need for IABP, and arrhythmias were significantly associated with adverse outcomes. These findings emphasize the need for early risk stratification and targeted peri-procedural strategies to improve clinical outcomes in this vulnerable population.

AUTHOR CONTRIBUTION

Author	Contribution
Mishal Kharl*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Khalid Naseeb	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Aisha Hussain	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Reema Ashok	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Saeed Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sadam Hussain	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Raheel Gul	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFERENCES

1. Isogai T, Saad AM, Kaur M, Shekhar S, Gad MM, Miyasaka RL, et al. Transcatheter Mitral Valve Repair and Mitral Valve Surgery Following Acute Myocardial Infarction (Insights From a Nationwide Cohort Study). Am J Cardiol. 2021;152:174-7.
2. Stähli BE, Varbella F, Linke A, Schwarz B, Felix SB, Seiffert M, et al. Timing of Complete Revascularization with Multivessel PCI for Myocardial Infarction. N Engl J Med. 2023;389(15):1368-79.
3. Yang YL, Wu CH, Hsu PF, Chen SC, Huang SS, Chan WL, et al. Systemic immune-inflammation index (SII) predicted clinical outcome in patients with coronary artery disease. Eur J Clin Invest. 2020;50(5):e13230.
4. Ang SP, Chia JE, Jaiswal V, Bandyopadhyay D, Iglesias J, Mohan GVK, et al. Subclinical Hypothyroidism and Clinical Outcomes After Percutaneous Coronary Intervention: A Meta-Analysis. Curr Probl Cardiol. 2023;48(8):101719.
5. Zhou S, Zhang Y, Dong X, Zhang X, Ma J, Li N, et al. Sex Disparities in Management and Outcomes Among Patients With Acute Coronary Syndrome. JAMA Netw Open. 2023;6(10):e2338707.
6. Jolly SS, d'Entremont MA, Pitt B, Lee SF, Mian R, Tyrwhitt J, et al. Routine Spironolactone in Acute Myocardial Infarction. N Engl J Med. 2025;392(7):643-52.
7. Vallabhajosyula S. Response by Vallabhajosyula to Letter Regarding Article, "Sex Disparities in the Management and Outcomes of Cardiogenic Shock Complicating Acute Myocardial Infarction in the Young". Circ Heart Fail. 2021;14(2):e008139.
8. Vallabhajosyula S, Katz JN, Menon V. Quantification of Vasoactive Medications and the "Pharmaco-Mechanical Continuum" in Cardiogenic Shock. Circ Heart Fail. 2022;15(4):e008736.
9. Takeuchi S, Honda S, Nishihira K, Kojima S, Takegami M, Asaumi Y, et al. Prognostic impact of heart failure admission in survivors of acute myocardial infarction. ESC Heart Fail. 2024;11(4):2344-53.

10. Pinton F, Prado G, Bezerra C, Júnior J, Campos C, Almeida B, et al. Primary percutaneous coronary intervention in the oldest-old age: clinical outcomes and predictors of in-hospital mortality in nonagenarians patients with ST-segment elevation myocardial infarction. European Heart Journal. 2020;41.
11. Kapur NK, Kim RJ, Moses JW, Stone GW, Udelson JE, Ben-Yehuda O, et al. Primary left ventricular unloading with delayed reperfusion in patients with anterior ST-elevation myocardial infarction: Rationale and design of the STEMI-DTU randomized pivotal trial. Am Heart J. 2022;254:122-32.
12. Martin J. Persistent mortality and heart failure burden of anterior ST-segment elevation myocardial infarction following primary percutaneous coronary intervention: real-world evidence from the US Medicare Data Set. BMJ Open. 2023;13(6):e070210.
13. Kumar R, Khan K, Rahooja K, Chachar K, Khan MQ, Ali A, et al. Outcomes of ST-Segment Elevation Myocardial Infarction in a Cohort of Cardiogenic Shock Patients Undergoing Primary Percutaneous Coronary Intervention. Pakistan Heart Journal. 2023.
14. Khadanga S, Savage PD, Pecha A, Rengo J, Ades PA. Optimizing Training Response for Women in Cardiac Rehabilitation: A Randomized Clinical Trial. JAMA Cardiol. 2022;7(2):215-8.
15. Wu LN, Hu R, Yu JM. Morphine and myocardial ischaemia-reperfusion. Eur J Pharmacol. 2021;891:173683.
16. DeFilippis EM, Givertz MM, Blankstein R. Letter by DeFilippis et al Regarding Article, "Sex Disparities in the Management and Outcomes of Cardiogenic Shock Complicating Acute Myocardial Infarction in the Young". Circ Heart Fail. 2021;14(2):e008033.
17. Lenselink C, Ricken K, Groot HE, de Bruijne TJ, Hendriks T, van der Harst P, et al. Incidence and predictors of heart failure with reduced and preserved ejection fraction after ST-elevation myocardial infarction in the contemporary era of early percutaneous coronary intervention. Eur J Heart Fail. 2024;26(5):1142-9.
18. Angelini F, Franchin L, Bocchino P, Morici N, Wańha W, Savonitto S, et al. In-hospital outcomes in nonagenarian patients undergoing primary percutaneous coronary intervention. Minerva cardiology and angiology. 2022.
19. Liu H, Su Y, Shen J, Jiao Y, Li Y, Liu B, et al. Improved heart function and cardiac remodelling following sacubitril/valsartan in acute coronary syndrome with HF. ESC Heart Fail. 2024;11(2):937-49.
20. Solangi B, Shah J, Kumar R, Batra M, Ali G, Butt M, et al. Immediate in-hospital outcomes after percutaneous revascularization of acute myocardial infarction complicated by cardiogenic shock. World Journal of Cardiology. 2023;15:439-47.
21. Costa R, Trêpa M, Oliveira M, Frias A, Campinas A, Luz A, et al. Heart Failure Incidence Following ST-Elevation Myocardial Infarction. Am J Cardiol. 2022;164:14-20.
22. Komatsu J, Nishimura Y, Sugane H, Hosoda H, Imai R-I, Nakaoka Y, et al. Early Invasive Strategy for Octogenarians and Nonagenarians With Acute Myocardial Infarction. Circulation Reports. 2024;6:263-71.
23. Jabir A, Geevar Z, Mohanan PP, Gupta MD, Ramakrishnan S, Meena CB, et al. COVID-19 infected ST-Elevation myocardial infarction in India (COSTA INDIA). Indian Heart J. 2023;75(4):243-50.
24. Elkaryoni A, Elgendy IY, Genev I, Khalil M, Darki A. Change in Hospitalization Rates After Percutaneous Coronary Intervention for Chronic Total Occlusion (from a Nationwide Cohort Sample). Am J Cardiol. 2021;142:141-3.
25. Berezin AE, Berezin AA. Adverse Cardiac Remodelling after Acute Myocardial Infarction: Old and New Biomarkers. Dis Markers. 2020;2020:1215802.
26. Kumar R, Khan KA, Rahooja K, Chachar K, Khan MQ, Ali A, et al. Outcomes of ST-Segment Elevation Myocardial Infarction in a Cohort of Cardiogenic Shock Patients Undergoing Primary Percutaneous Coronary Intervention. Pak Heart J. 2023;56(2):157-62.