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Original Article

Relationship Between Preoperative Risk Factor Profiles and Clinical Outcomes In Patients Undergoing Isolated CABG Treated In the ICU: A Retrospective Observational Study

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Abstract

Background: Atherosclerotic Cardiovascular Disease (ASCVD) causes around 31% death all over the world. This disease can be managed with Coronary Artery Bypass Graft (CABG). Although its success ratio continues to increase, patients tend to have more complex conditions, which complicate the results.

Methods: This retrospective cohort study was conducted with samples consisting of ≥18 years old patients who underwent isolated CABG between January 2017 and June 2022 and were admitted to the Intensive Care Unit (ICU) afterward. Clinical outcomes measured were prolonged ICU and intrahospital mortality. A 77-hour post-procedural ICU treatment period is considered the standard of care.

Results: A total of 2611 patients were included. The mean age was 59 years. Geriatric, overweight, obesity, kidney failure, Heart Failure with reduced Ejection Fraction (HFrEF), Cardiogenic Shock, Left Main Disease (LMD), and Pre Incision Intra-Aortic Balloon Pump (IABP) are associated with prolonged ICU care; while female gender, Family history of ASCVD, Diabetes, Hypertension, Acute Coronary Syndrome (ACS), Stroke, and history of cardiac surgery are associated with higher mortality. The lengthening of ICU care is also associated with higher mortality (OR 4.02; p<0.00). According to multivariate analysis, the factors associated with prolonged ICU are geriatric, obesity, kidney failure, stroke, HFrEF, Cardiogenic shock, very poor Ejection Fraction (EF), urgent procedure and pre incision IABP, meanwhile factors associated with mortality are female, diabetes, stroke, history of ACS<24H, poor and very poor EF, History of Cardiac Surgery, and prolonged ICU itself.

Conclusions: In Indonesian isolated CABG patients, prolonged ICU stay and increased mortality are independently driven by specific demographic, comorbid, and clinical factors, necessitating targeted preoperative risk assessment to optimize outcomes.

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Keywords: Mortality, Prolonged ICU, Isolated-CABG, Risk Factor, Indonesia.

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Introduction

Atherosclerotic Cardiovascular Disease (ASCVD) is a major global health problem and accounts for approximately 31% of deaths worldwide. In Indonesia, ASCVD is one of the leading causes of mortality, alongside cancer and stroke.[1] Coronary Artery Bypass Grafting (CABG) is a well-established treatment option for this condition. The procedure is generally performed in patients with high-risk coronary occlusion or multivessel disease. Patients with failed Percutaneous Coronary Intervention (PCI) are also candidates for CABG, in accordance with the American College of Cardiology and American Heart Association (ACC/AHA) guidelines.[2]

Although the success rate of CABG continues to improve, patients undergoing this procedure tend to be older and have more complex clinical conditions. As a result, many of these patients require a prolonged stay in the intensive care unit.[3] Several predictive scoring systems are currently available to assess prognosis in patients undergoing major cardiac surgery, including CABG. However, the validation of these systems remains limited in Asian populations.[2] The length of stay in the intensive care unit also needs to be revisited, considering that prolonged Intensive Care Unit (ICU) stay has been associated with increased mortality during hospitalization as well as after hospital discharge.[4-5]

Studies examining the relationship between clinical profiles of patients undergoing isolated CABG and postoperative outcomes, especially length of stay in the intensive care unit, remain limited in Indonesia. A study conducted in Taiwan found that sex, smoking history, hypertension, procedural status, and renal function were independent risk factors for prolonged intensive care stay. Another study from Canada identified similar factors and further demonstrated that a prior history of CABG, diabetes, cerebrovascular disease, and ventricular function were associated with readmission mortality among CABG patients.[5-6] This study aims to describe the clinical profiles of patients undergoing isolated CABG who are treated in the intensive care unit and to evaluate their association with prolonged ICU stay and in-hospital mortality in Indonesia.

Methods

This retrospective cohort study was conducted in Harapan Kita National Heart Center. The study included patients aged 18 years or older who underwent an isolated CABG procedure between January 2017 and June 2022 and were admitted to the ICU after the procedure. Data were collected from the registry of the Adult Surgery Division, Research and Development Installation of Harapan Kita National Heart Center using a total sampling method.

Several variable groups were analyzed in this study, including classical ASCVD risk factors, comorbid factors, and cardiology-specific risk factors. Smoking status was defined as patients who were former smokers or current active smokers. Diagnosis of diabetes (E.11), dyslipidemia (E.78), and hypertension (I.10) in the sample were established by the physician during hospitalization. Information on family history of ASCVD and comorbid conditions, other than renal failure, was obtained from the patient's medical history as recorded by the resident physician at the time of initial admission to the emergency department. A patient's history of Acute Coronary Syndrome (ACS) was defined as prior hospitalization due to cardiac arrest or the presence of clinical evidence based on electrocardiography or echocardiography.

The diagnosis of atrial fibrillation used in this study was made based on electrocardiographic findings obtained either at the time of admission to the emergency department or during hospitalization before the procedure. Ejection Fraction (EF), Left Main Disease (LMD) and the number of arteries involved were determined by echocardiography. Urgent procedures were defined as those performed in patients with hemodynamic instability or persistent chest pain. Emergency procedures were defined as those performed in patients with unsuccessful PCI. The use of pre-incision Intra-Aortic Balloon Pump (IABP) was defined as the insertion of the IABP performed in the operating room prior to the skin incision. Pre-incision IABP was generally performed in patients with an EF below 30%, accompanied by impaired cardiac performance based on echocardiography by eye-balling method, or with hemodynamic instability requiring inotropic support.

A duration of 77 hours or ±3 days of post-procedure care in the intensive care unit was set as a benchmark for the length of normal care according to several previous studies and the 90th percentile of the current dataset.[4-6] The period of re-entry to the intensive care unit after transfer from a regular ward was not accounted for in this study. The clinical outcomes measured in this study were prolonged ICU stay and in-hospital mortality.

Table 1. Patient risk factor profile and their relationship with length of care and mortality.

Variable	Total		Prolonged		P-value	OR	95% CI	Mortality		P-value	OR	95% CI
	n	%	n	%				n	%			
Age Group Category												
Young Adult	134	5.09	9	6.77	0.26	0.66	0.32-1.28	4	3.01	0.65	0.68	0.25-1.88
Elderly	1913	73.27	183	9.57	0.23	0.84	0.64-1.11	81	4.23	0.94	0.98	0.64-1.51
Geriatric	564	21.60	69	12.23	0.05	1.35	1.01-1.80	26	4.61	0.63	1.12	0.71-1.75
Nutritional Status												
Underweight	55	2.11	6	10.91	0.82	1.11	0.47-2.61	2	3.64	0.82	0.85	0.20-3.52
Normal	467	17.89	40	8.57	0.26	0.82	0.57-1.16	22	4.71	0.59	1.14	0.71-1.84
Overweight	521	19.95	35	6.72	0.01	0.59	0.41-0.86	21	4.03	0.78	0.93	0.58-1.52
Obese	1548	59.29	179	11.56	0.01	1.56	1.19-2.06	65	4.20	0.87	0.97	0.66-1.43
Sex												
Male	2219	84.99	222	10.00	0.90	0.98	0.69-1.40	84	3.79	0.01	0.53	0.34-0.83
Female	392	15.01	40	10.20	0.90	1.02	0.72-1.47	27	6.89	0.01	1.88	1.20-2.94
Classic ASCVD Risk Factor												
Smoker	1384	53.01	131	9.47	0.30	0.87	0.68-1.13	53	3.83	0.26	0.80	0.54-1.17
Family History of ASCVD	398	15.24	40	10.05	0.99	1.00	0.70-1.43	25	6.28	0.03	1.66	1.05-2.62
Diabetes	1089	41.71	106	9.73	0.67	0.94	0.73-1.23	64	5.88	0.00	1.89	1.29-2.77
Dyslipidemia	940	36.00	93	9.89	0.89	0.98	0.77-1.28	40	4.26	1.00	1.00	0.67-1.49
Hypertension	1727	66.14	184	10.65	0.14	1.23	0.93-1.63	85	4.92	0.02	1.71	1.09-2.67
Comorbid Factor												
Kidney Failure	186	7.12	42	22.58	0.00	2.92	2.02-4.24	10	5.38	0.43	1.31	0.67-2.55
Cr Clearance 50-85	1208	46.27	125	10.35	0.72	1.05	0.81-1.35	50	4.14	0.76	0.94	0.64-1.38
Cr Clearance <50	419	16.05	68	16.23	0.00	1.86	1.38-2.51	22	5.25	0.28	1.30	0.81-2.11
Dialysis	34	1.30	10	29.41	0.00	3.84	1.82-8.13	1	2.94	0.74	0.71	0.10-5.34
Stroke	201	7.70	26	12.94	0.15	1.37	0.89-2.11	17	8.46	0.00	2.28	1.33-3.90
COPD	35	1.34	5	14.29	0.40	1.50	0.58-3.91	1	2.86	0.68	0.66	0.9-4.86
Immunosuppressant Therapy	14	0.54	0	0.00	-	-	-	1	7.14	0.59	1.74	0.23-13.41
Cerebrovascular Disease	109	4.17	11	10.09	0.98	1.01	0.53-1.90	6	5.50	0.51	1.33	0.57-3.10
Vascular Disorder	17	0.65	3	17.65	0.30	1.93	0.55-6.80	1	5.88	0.74	1.41	0.19-10.74

Cardiology Specific Factor												
History of ACS	1047	40.10	106	10.12	0.90	1.02	0.78-1.32	53	5.06	0.09	1.38	0.95-2.03
<24 Hours	48	1.84	8	16.67	0.12	1.82	0.84-3.93	6	12.50	0.00	3.34	1.39-8.04
1-7 Days	68	2.60	11	16.18	0.09	1.76	0.91-3.40	7	10.29	0.01	2.69	1.20-6.03
8-21 Days	68	2.60	11	16.18	0.09	1.76	0.91-3.40	3	4.41	0.95	1.04	0.32-3.36
>21 Days	724	27.73	63	8.70	0.16	0.81	0.60-1.09	31	4.28	0.96	1.01	0.66-1.54
Missing	139	5.32										
HFrEF (EF<41%)	544	20.83	113	20.77	0.00	3.40	2.60-4.44	31	5.70	0.06	1.50	0.98-2.30
Cardiogenic Shock	13	0.50	10	76.92	0.00	31.03	8.55-113.49	2	15.38	0.05	4.15	0.90-18.96
Atrial Fibrillation	26	1.00	3	11.54	0.79	1.18	0.35-3.95	2	7.69	0.38	1.89	0.44-8.11
Left Main Disease	895	34.28	108	12.07	0.01	1.39	1.07-1.80	43	4.80	0.32	1.22	0.83-1.81
Blood Vessel Abnormalities												
One	48	1.84	5	10.42	0.81	1.12	0.44-2.87	2	4.17	0.95	1.05	0.25-4.38
Two	243	9.31	25	10.29	0.89	1.03	0.67-1.59	8	3.29	0.44	0.75	0.36-1.56
Three	2320	88.85	232	10.00	0.87	0.97	0.65-1.44	101	4.35	0.47	1.28	0.66-2.48
Ejection Fraction	54.00 (±13.910)											
Good (>50%)	1616	61.89	105	6.50	0.00	0.46	0.34-0.59	53	3.28	0.00	0.51	0.35-0.74
Moderate (31-50%)	789	30.22	104	13.18	0.00	1.60	1.23-2.08	37	4.69	0.47	1.16	0.78-1.74
Poor (21-30%)	139	5.32	26	18.71	0.00	2.18	1.39-3.41	16	11.51	0.00	3.26	1.86-5.69
Very Poor (<=20%)	22	0.84	10	45.45	0.00	7.73	3.31-18.07	5	22.73	0.00	6.89	2.50-19.03
Procedural Status												
Elective	2431	93.11	219	9.01	0.00	0.32	0.22-0.46	95	3.91	0.00	0.42	0.24-0.73
Urgent	175	6.70	41	23.43	0.00	3.07	2.11-4.47	15	8.57	0.00	2.29	1.30-4.03
Emergency	5	0.19	2	40.00	0.03	6.02	1.00-36.17	1	20.00	0.08	5.67	0.63-51.18
Pre-Incision IABP	60	2.30	32	53.33	0.00	11.59	6.86-19.59	3	5.00	0.77	1.19	0.37-3.86
History of Cardiac Surgery	32	1.23	3	9.38	0.90	0.93	0.28-3.06	4	12.50	0.02	3.30	1.13-9.57

ASCVD: Atherosclerotic Cardiovascular Disease; COPD: Chronic Obstructive Pulmonary Disease; ACS: Acute Coronary Syndrome; HFrEF: Heart Failure with Reduced Ejection Fraction; IABP: Intra-Aortic Balloon Pump.

Data analysis was conducted using SPSS 17, which was manufactured in the USA in 2009. Continuous variables were presented as mean and standard deviation, while categorical variables were presented as frequency and proportion. All of the categorical variables were then compared with the clinical outcomes using bivariate logistic regression analysis with the chi-square test. Variables with a P-value of < 0.25 in bivariate analysis were then reanalyzed using the multivariate logistic regression analysis, and variables with a P-value of <0.05 were considered as independent risk factors.

Results

A total of 2611 patients met the inclusion and exclusion criteria. The median age of the patients was 59 years, with the majority being elderly and having obesity. Geriatric status, Body Mass Index (BMI)>23, renal failure with creatinine clearance <50 or requiring dialysis, and history of stroke were significant factors associated with prolonged ICU stay. Female sex, history of ASCVD, diabetes, hypertension, and stroke were significantly associated with mortality. Although a history of ACS was not associated with clinical outcomes, an onset of ACS <7 days prior to the procedure was significantly associated with mortality. LMD, Heart Failure with reduced Ejection Fraction (HFrEF), and cardiogenic shock were also significantly associated with prolonged ICU stay (Table 1).

Approximately 10% (n=262) of the patients required prolonged intensive care, of whom 15 required readmission to the ICU after transfer to a regular ward. Prolonged ICU stay was significantly associated with mortality, with an odds ratio of 4.017 for patient death. This warrants a separate focus to improve future patient clinical outcomes (Table 2).

Table 2. Relationship between length of stay and patient mortality.

Variable	Mortality		P-value	OR	95%
	n	%			
Normal Intensive Care Period	79	3.4	0.000	4.017	2.61-6.19
Prolonged Intensive Care Period	32	12.3			

After reanalysis using the logistic regression method, it was found that geriatric status, obesity, severe decline in renal function and dialysis, cardiogenic shock, HFrEF, especially with EF <20%, urgent procedure, and pre-incision IABP were independently associated with prolonged ICU stay. Female sex, history of ASCVD, diabetes, stroke, ACS <24 hours, EF <30%, prior cardiac surgery, and prolonged ICU stay were identified as independent risk factors for mortality (Table 3).

Discussion

This study was conducted at a national referral center for cardiovascular disease. Therefore, the study population can be considered representative of patients undergoing isolated CABG in Indonesia. The majority of patients in this study were elderly patients and had obesity as their nutritional status. The geriatrics age group (p=0.02; OR 2.54; 95% CI 1.15-5.60) and obesity (p=0.00; OR 1.82; 95% CI 1.35-2.45) were independently associated with prolonged ICU stay. According to Kao et al. (2022), age was significantly associated with the length of the treatment duration, particularly at older ages (70.9 ± 12.2; p = 0.002). An interesting finding in this study was that patients requiring prolonged ICU care had a lower BMI compared to those with shorter ICU stays (23.6±3.9 vs 25.4±3.2). As the referenced study was conducted in Taiwan, the BMI parameter used was consistent with the Asian population standards, which are also applicable to Indonesia.[6] Mortality among patients undergoing isolated CABG in this study was relatively low and comparable with previous studies. Suwatri et.al. (2022) reported mortality rates of 5.7% in patients undergoing off-pump coronary artery bypass and 16.2% in those undergoing coronary artery bypass grafting. The difference between these two bypass methods was not significantly associated with mortality.[7]

Gender was not associated with length of ICU stay in this study; however, it was associated with a higher risk of mortality, with an odds ratio of 1.88 (p=0.009; 95% CI 1.17-3.00). In contrast, a research by Hassan, et al. (2012) found slightly different results where female sex among patients undergoing major cardiac surgery was significantly associated with prolonged ICU stay (p<0.0001). Although the study included various types of cardiac surgery, CABG was the most frequently performed procedure in their cohort.[8]

Table 3. Multinomial logistic regression for the clinical outcome.

A. Prolong ICU

Variable	P-value	OR	95% CI
Age Group			
Elderly	0.10	1.89	0.89-4.01
Geriatric	0.02	2.54	1.15-5.60
Nutritional Status			
Obesity	0.00	1.82	1.35-2.45
Risk Factor			
Hypertension	0.42	1.13	0.83-1.50
Comorbid Factors			
Kidney Failure			
Cr Clearance <50	0.02	1.51	1.08-2.12
Dialysis	0.00	4.75	2.13-10.58
Stroke	0.04	1.59	1.02-2.47
Cardiology Specific Factor			
History of ACS			
<24 Hours	0.84	1.10	0.43-2.79
1-7 Days	0.53	0.77	0.35-1.71
8-21 Days	0.69	0.85	0.37-1.92
>3 Weeks	0.66	0.93	0.68-1.28
HFrEF	0.00	0.07	0.16-3.13
Cardiogenic Shock	0.00	20.46	4.20-99.65
Left Main Disease	0.83	1.03	0.77-1.38
Ejection Fraction			
Moderate	0.08	1.32	0.97-1.80
Poor	0.17	1.46	0.85-2.51
Very Poor	0.00	5.05	1.88-13.59
Procedural Status			
Urgent	0.00	2.78	1.76-4.41
Emergency	0.42	2.78	0.23-33.64
Pre Incision IABP	0.00	5.47	2.96-10.09

B. Mortality

Variable	P-value	OR	95% CI
Female	0.04	1.76	1.04-2.97
Risk Factor			
Smoker	0.70	0.91	0.58-1.43
Family History of ASCVD	0.02	1.80	1.10-2.92
Diabetes	0.01	1.75	1.17-2.61
Hypertension	0.14	1.42	0.89-2.25
Stroke	0.04	1.83	1.02-3.26
Cardiology Specific Factor			
History of ACS			
<24 Hours	0.01	3.37	1.27-8.91
1-7 Days	0.08	2.26	0.90-5.69

HFrEF	0.68	0.90	0.54-1.49
Cardiogenic Shock	0.60	1.58	0.28-8.93
Ejection Fraction			
Poor	0.00	3.30	1.76-6.19
Very Poor	0.00	8.72	2.86-26.61
Procedural Status			
Urgent	0.24	1.48	0.77-2.85
Emergency	0.50	2.40	0.18-31.23
Pre Incision IABP	0.08	0.30	0.08-1.13
History of Cardiac Surgery	0.04	3.53	1.07-11.67
Prolong ICU Period	0.00	3.53	2.18-5.70

ACS: Acute Coronary Syndrome; HFrEF: Heart Failure with reduced Ejection Fraction; IABP: Intra-Aortic Balloon Pump; ASCVD: Atherosclerotic Cardiovascular Disease; ICU: Intensive Care Unit.

Smoking, which is a well-established risk factor for cardiovascular diseases, was not associated with clinical outcomes in this study. Similarly, Saxena et al. (2022) found that smoking was not significantly associated with mortality within 30 days after surgery. However, smoking was associated with late mortality after 37 months in both active smokers (OR 1.41, 95% CI 1.26-1.59; p<0.001) or former smokers (OR 1.73, 95% CI 1.47-2.05; p<0.001).[9] Only severe renal failure, dialysis, and stroke were found as independent risk factors for prolonged ICU stay in this study. Previous studies obtained different results, where other comorbidities such as diabetes, hypertension, history of ASCVD, dyslipidemia, cerebrovascular disease, vascular disease, and COPD all had a significant association with prolonged ICU stay among patients undergoing isolated CABG.[5] History of ASCVD, diabetes, hypertension, and stroke was all associated with mortality in this study. However, after multivariate analysis, hypertension was no longer a significant predictor. According to the EuroSCORE II model for predicting mortality in major cardiac surgery, a history of ASCVD and insulin-treated diabetes are included as predictive parameters, whereas hypertension and stroke are not.[10] In the present study, most patients with a history of stroke had limited mobility, which may have contributed to an increased risk of mortality. In contrast, another study conducted by Herlitz et al. (1996) found that patients with hypertension tended to have increased mortality during the first 30 days after CABG and that late mortality (between days 30 and 2 years) was significantly higher than in non-hypertensive patients.[11]

LMD, HFrEF, cardiogenic shock, and EF<50% were identified as cardiology-specific factors associated with prolonged ICU stay in the bivariate analysis. However, after multivariate analysis, only HFrEF, cardiogenic shock, and EF <20% remained independently associated with prolonged ICU stay. Previous studies conducted by Heimrath et al. (2007) obtained slightly different results, where ventricular function <50% was found to be 1.3 times (95%CI 1.1-1.5), causing intensive care readmission or death.[5] In contrast, Gonasdotir et al. (2020) reported that only a history of ASCVD was independently associated with prolonged ICU stay.[12] Oliveira et al. (2013) also found that EF<50% was not associated with prolonged ICU stay, although it was an independent factor for longer length of stay in the general ward.[13] Although in this study the involvement of the left main artery was not an independent risk factor for prolonged ICU period, the previous study conducted by Heimrath et al. (2007) reported opposite findings. That study also reported that the number of blood vessels beyond the main vessels was significantly associated; these associations were not observed in the present study.[5] Regarding mortality, Rinaldi et al. (2022) reported that left ventricular function <30% increased by 3.23 times (p=0.017; 95%CI = 1.23-8.45) the risk of death within 30 days after the procedure. That study also found that Myocardial Infarction (MI) occurring within 3 months before the procedure had no significant relationship with 30-day mortality. In contrast, the present study found that the incidence of MI occurring <24 hours prior to the procedure was associated with a 3.14-fold increase in in-hospital mortality.[2]

The use of pre-incision IABP was independently associated with prolonged ICU stay in this study. Previous studies have reported similar results where the use of preoperative IABP had a significant relationship with longer ICU stay; those associations did not remain significant after multivariate analysis.[5-6] On the other hand, the use of preoperative IABP has been reported as a potential protective factor for mortality. A meta-analysis by Zangrillo et al. (2015) demonstrated that preoperative IABP use was associated with a reduced risk of in-hospital mortality as well as mortality within 30 days after the procedure.[14] Prolonged ICU stay itself was significantly associated with mortality, increasing the risk of death by 4.01 times (p = 0.000; 95% CI 2.61-6.19). Although this finding is consistent with the results of previous studies, the OR found in this study was relatively higher when compared to the study of Heimrath et.al. (2007), which obtained a HR of 2.47 (p = 0.001; 95%CI 1.89-3.22).[5]

Limitation of Study

Several limitations must be considered when interpreting the findings of this research. First, the retrospective observational design is inherently subject to bias, including information bias, and does not allow for the establishment of a causal relationship between risk factors and outcomes. Second, as this study was conducted at a single tertiary referral center (Harapan Kita National Heart Center), the patient population may include patients with more complex clinical conditions than those treated at general hospitals. This may limit the external validity and generalizability of the results to other healthcare settings in Indonesia.

Furthermore, data on family history and certain comorbidities were obtained through patient interviews at the time of admission, which may have introduced recall bias. Finally, the analysis did not account for the total duration of intensive care for patients who required ICU readmission after transfer to a general ward, which may have led to an underestimation of the overall intensive care burden in those cases.

Conclusion

Among patients undergoing isolated CABG in Indonesia, independent risk factors for prolonged ICU stay include geriatric age, obesity, severe renal impairment, cardiogenic shock, EF <20%, urgent procedure status, and pre-incision IABP use. In-hospital mortality was independently associated with female sex, history of ASCVD, diabetes, stroke, ACS within 24 hours prior to the procedure, EF <30%, and previous cardiac surgery. Furthermore, prolonged ICU stay was significantly associated with increased mortality, with an odds ratio of 4.017. These findings underscore the importance of comprehensive preoperative risk assessment to optimize clinical outcomes and improve intensive care utilization in patients undergoing isolated CABG.

List of Abbreviations

ACC	American College of Cardiology
ACS	Acute Coronary Syndrome
AHA	American Heart Association
ASCVD	Atherosclerotic Cardiovascular Disease
BMI	Body Mass Index
CABG	Coronary Artery Bypass Grafting
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
EF	Ejection Fraction
HFrEF	Heart Failure with reduced Ejection Fraction
IABP	Intra-Aortic Balloon Pump
ICU	Intensive Care Unit
LMD	Left Main Disease
MI	Myocardial Infarction
OR	Odds Ratio
PCI	Percutaneous Coronary Intervention

Ethical Clearance

This study was conducted in accordance with the ethical standards of the institutional and/or national research committee and with the Declaration of Helsinki. Ethical approval was obtained from the National Cardiovascular Center Harapan Kita ethics committee.

Publication Approval

All authors are consent to the publication of this manuscript.

Authors Contributions

RZ: Contributed to conceptualizing the research topic and title, establishing the research outline, and coordinating the entire study process—encompassing sampling, data processing, and manuscript preparation; DFS: Responsible for direct field sampling and the analysis of medical records as the primary study data. They also performed data analysis, drafted the results, and completed the comprehensive preparation of the manuscript; BW: Contributed to providing critical insights for defining the research concept and its expansion, establishing the framework for data analysis, and providing strategic guidance on the direction of the discussion; S: Contributed to providing critical insights for defining the research concept and its expansion and providing strategic guidance on the direction of the discussion; BH: Contributed to providing critical insights for defining the research concept and its expansion and providing strategic guidance on the direction of the discussion.

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Conflict of Interest

The authors declare no conflict of interest.

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Generative AI and AI-Assisted Technologies in the Writing Process

The author(s) did not use generative AI or AI-assisted technologies in the writing of this manuscript. All content, data analysis, and interpretations are the original work of the authors.

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