Risk Factors Associated with Prolonged Intensive Care Length of Stay among Coronary Artery Bypass Surgery Patients

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Abstract

Cardiovascular diseases, particularly coronary artery disease (CAD), remain one of the leading causes of global mortality. Coronary Artery Bypass Graft (CABG) surgery is one of the most common treatments for CAD, aiming to reduce morbidity and improve patient quality of life. However, extended stays in the Intensive Care Unit (ICU) post-CABG can negatively affect patient outcomes and increase healthcare resource burdens. This study aims to identify the risk factors that significantly contribute to prolonged ICU stays in post-CABG patients at the National Cardiovascular Center Harapan Kita. A retrospective cohort study was conducted on 4564 patients who underwent CABG surgery between January 2017 and August 2024. Factors such as age, renal failure, stroke, cardiogenic shock, ejection fraction, and use of Intra-Aortic Balloon Pump (IABP) were analyzed. Bivariate analysis was performed using Stata 15.1 version through the Chi-square test, resulting in P-Value and Confidence Interval, and followed by multivariate logistic regression to determine significant predictors. Among the patients, 747 (16.3%) experienced prolonged ICU stays (≥72 hours). Significant risk factors for prolonged ICU stay included age ≥59 years (OR 1.43, 95% CI 1.16–1.71), history of renal failure (OR 2.39, 95% CI 1.74–3.28), preoperative stroke (OR 1.85, 95% CI 1.38–2.48), cardiogenic shock (OR 13.9, 95% CI 5.42–35.64), low ejection fraction (OR 2.66, 95% CI 1.33–3.73), and IABP use (OR 36.34, 95% CI 26.20–50.40). This study showed that there are several risk factors such as age, history of renal failure, preoperative stroke, cardiogenic shock, low ejection fraction, and IABP usage which needs attention to produce better outcome, especially for ICU stay in isolated CABG patients in Indonesia.

Keyword: CABG, Intensive Care, Prolonged Stay, Risk Factors

INTRODUCTION

Global mortality for years have been caused majorly by Cardiovascular diseases (Adam et al., 2021). Approximately one-third of deaths worldwide are attributed to ischemic heart disease (Bueno, 2018). Among these, coronary artery disease (CAD) is a significant contributor, particularly in low and middle-income countries. Global estimates suggest that cardiovascular diseases cause over 17.9 million deaths annually, with ischemic heart disease accounting for the largest proportion. In Indonesia, coronary artery disease (CAD) is the most common cardiovascular condition and ranked as the second leading cause of death in 2019 (GBD 2019 Diseases and Injuries Collaborators, 2020).

One of the most common treatments for CAD is Coronary Artery Bypass Graft (CABG) surgery. CABG is a revascularization procedure performed on high-risk patients or those no longer eligible for Percutaneous Coronary Intervention (PCI) (Zahara et al., 2023). As a tertiary

prevention method, CABG aims to reduce CAD-related morbidity and mortality in order to improve patients' quality of life (Rochayati et al., 2023). Developed countries have implemented advanced cardiac care systems that have significantly reduced mortality rates. However, in developing regions, limited healthcare resources and delayed treatment contribute to higher mortality and morbidity.

Cardiac surgery has an advanced development over recent decades, with an increasing number of patients undergoing open-heart procedures due to longer life expectancy and medical advancements (Tunc et al., 2018). Despite these improvements, challenges in cardiac surgery practice have also grown. Aging populations have led to more surgeries being performed on elderly patients with complex comorbid conditions (Kapadohos et al., 2017). Consequently, postoperative complications have increased, often resulting in prolonged ICU stays.

Postoperative care after CABG is a crucial concern worldwide due to prolonged ICU stays. In the United States, the average ICU stay after CABG is approximately 2-3 days, though complications can extend this duration (Kao et al., 2022). European countries report similar averages, emphasizing early mobilization and enhanced recovery protocols (Tunc et al., 2018). In contrast, South Asian countries face extended ICU stays due to higher preoperative comorbidities and resource constraints (Arviolla et al., 2023).Prolonged ICU stays can adversely impact patient outcomes and bring additional strain on hospital resources and costs (Kao et al., 2022). Prolonged ICU stays will affect bed availability, potentially causing surgery cancellations and longer patient queues (Mansjoer & Sutrisna, 2020). Therefore, identifying risk factors associated with prolonged ICU stays following CABG can yield substantial benefits.

Several studies have identify the risk factors for postoperative cardiac complications and prolonged ICU stays. Proven factors include age (Arviolla et al., 2023; Bauer et al., 2021), gender, use of cardiopulmonary bypass machines (Kao et al., 2022), smoking history (Oliveira et al., 2013), diabetes mellitus, hypertension (K. S. Ibrahim et al., 2024), renal failure (Almashrafi et al., 2016; Rochayati et al., 2023), low ejection fraction (Tunc et al., 2018), and the procedural status (Zhang et al., 2021).

Given Indonesia's increasing burden of cardiovascular diseases, understanding these risk factors is crucial for optimizing patient outcomes and resource allocation. The National Cardiovascular Center Harapan Kita, the country's leading referral hospital for cardiovascular care, reported a 33% increase in CABG surgeries between 2022 and 2023. This location was chosen due to its representative patient population from diverse regions across Indonesia and

its pivotal role in shaping national cardiovascular treatment protocols. With patients from diverse regions, this hospital provides a unique setting for a comprehensive study on risk factors for prolonged ICU stays. Addressing these factors could help improve patient management strategies and reduce hospital costs.

METHODS

This study used a retrospective design. The study population included 5348 patients who underwent CABG at the National Cardiovascular Center Harapan Kita between January 2017 and August 2024,Patients who were over 18 years, underwent CABG, received postoperative intensive care, and survived beyond 72 hours of ICU care were included in this study.Subjects were chosen as a participant in this study by total population sampling. 597 patients who received complex cardiac procedures, 20 patients who didn't undergo post-operative intensive care, 153 patients who died within 72 hours, and 14 patients with incomplete data were excluded from the source population. A total of 4564 patients as eligible subjects meeting the inclusion and exclusion criteria were selected as the study subjects.

The outcome studied was the duration of ICU stay, classified as normal (<72 hours) or prolonged (≥72 hours) based on previous studies (K. S. Ibrahim et al., 2024; Kao et al., 2022; Zhang et al., 2021). In Harapan Kita, from the preliminary research, the normal intensive care length of stay range between 24 – 48 hours (Median 24 hours; IQR 20 – 41 hours). Age was categorized based on the median value due to skewed distribution, resulting in two groups: <59 years and ≥59 years. EF was classified into normal (EF ≥50%), mild dysfunction (EF 40-49.99%), moderate dysfunction (EF 30-39.99%), and severe dysfunction (<30%) following the American College of Cardiology guidelines (Kosaraju et al., 2024). Other variables such as Gender (Male/Female); Smoking History (No, if patients didn't smoke at all/Yes, if patients have a history of smoking or still smoking); Diabetes; Dyslipidemia, Renal Failure; Hypertension; Stroke; Myocardial Infarction; Angina Pectoris; Cardiogenic Shock; Arrhytmia; Procedural Status; CPB Usage; and IABP Usage are obtained from patient's medical record with the yes or no category and did not require further categorization.

This study did not conduct an independent validity test because all variables were collected from the hospital's electronic medical records (EMR) which follows standardized clinical protocols, ensuring that all diagnoses and measurements are based on established medical guidelines. These records are documented by certified healthcare professionals using validated diagnostic criteria routinely applied in clinical practice. Therefore, the data used in

this study were considered inherently valid due to the hospital's adherence to professional standards and accredited medical procedures.

Data analysis was performed using STATA 15.1. software. Bivariate analysis was conducted using Chi-square tests, with variables having a p-value less than 0.25 will be included in the multivariate analysis. Multivariate analysis was conducted using backward logistic regression, followed by a goodness-of-fit test to identify the best final model and adjusted Odds Ratios (aOR). A p-value less than 0.05 was considered statistically significant, and a goodness-of-fit test p-value more than 0.05 indicated the model tested was fit.

RESULTS

A total of 4564 patients met the inclusion and exclusion criteria. Among these, 747 patients (16.3%) experienced prolonged ICU stays (≥72 hours). Patient ages ranged from 28 to 98 years, with a median age of 59 years. Those aged ≥59 years (57.97%), male patients, smokers, had a history of diabetes, dyslipidemia, renal failure, hypertension, stroke, myocardial infarction, angina pectoris, cardiogenic shock, arrhythmia, reduced ejection fraction, urgent/emergency procedural status, CPB usage, and IABP usage were more prevalent in the prolonged ICU stay group compared to those with normal ICU stays (<72 hours) (Table 1).

Table 1 Bivariate Analysis of Risk Factors Associated with Prolong ICU Stay Post-CABG

Variable	ICU Stay <72 hours		ICU Stay ≥ 72 hours		P Value	Crude OR	95% CI
	n	%	n	%			
Age							
<59	1792	46.95	314	42.03			
≥ 59	2025	53.05	433	57.97	0.013*	1.22	1.04 – 1.43
Gender							
Male	3222	84.41	633	84.74			
Female	595	15.59	114	15.26	0.821	0.975	0.784 – 1.212
Smoking							
No	1711	44.83	316	42.30			
Yes	2106	55.17	431	57.70	0.204	1.10	0.94 – 1.29
Diabetes Mellitus							
No	2125	55.67	411	55.02			
Yes	1692	44.33	336	44.98	0.743	1.02	0.87 – 1.20
Dyslipidemia							
No	2075	54.36	391	52.34			
Yes	1742	45.64	356	47.66	0.311	1.08	0.92 – 1.26
Renal failure							

No	3629	95.07	662	88.62			
Yes	188	4.93	85	11.38	0.000*	2.47	1.89 – 3.24
Hypertension							
No	1408	36.89	248	33.20			
Yes	2409	63.11	499	66.80	0.055*	1.17	0.99 – 1.38
Stroke							
No	3541	92.77	653	87.42			
Yes	276	7.23	94	12.58	0.000*	1.84	1.44 – 2.36
Myocardial Infarction							
No	2430	63.66	433	57.97			
Yes	1387	36.34	314	42.03	0.003*	1.27	1.08 – 1.49
Angina Pectoris							
No	1344	35.21	238	31.86			
Yes	2473	64.79	509	68.14	0.079*	1.16	0.98 – 1.37
Cardiogenic Shock							
No	3811	99.84	731	97.86			
Yes	6	0.16	16	2.14	0.000*	13.9	5.42 – 35.64
Arrhytmia							
No	3761	98.53	723	96.79			
Yes	56	1.47	24	3.21	0.001*	2.22	1.37 – 3.62
Ejection Fraction							
Normal (≥50%)	2565	67.20	322	43.11			
Mild Dysfunction (40-49%)	745	19.52	158	21.15	0.000*	1.68	1.37 – 20.07
Moderate Dysfunction (30-39%)	408	10.69	145	19.41	0.000*	2.83	2.26 – 3.53
Severe Dysfunction (<30%)	99	2.59	122	16.33	0.000*	9.81	7.35 – 13.11
Procedural Status							
Elective	3673	96.23	658	88.09			
Urgent/Emergency	144	3.77	89	11.91	0.000*	3.45	2.61 – 4.55
CPB Usage							
No	1181	30.94	202	27.04			
Yes	2636	69.06	545	69.70	0.034*	1.20	1.01 – 1.44
IABP Usage							
No	3764	98.61	448	59.97			
Yes	53	1.39	299	40.03	0.000*	47.39	34.83 – 64.50

*Variables with p-values less than 0.25 will be included in multivariate analysis

Age, history of renal failure, hypertension, stroke, myocardial infarction, angina pectoris, cardiogenic shock, arrhythmia, ejection fraction, procedural status, use of cardiopulmonary bypass (CPB), and intra-aortic balloon pump (IABP) had a p-value less than 0.25 in the

bivariate analysis and were therefore included in the multivariate analysis. Further analysis was conducted to identify the best-fit model, as presented in Tables 2 and 3.

Table 2. Multivariat Model with Logistic Regression and Goodness of Fit Test to Produce The Best Fit Final Model

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7**
CPB Usage	0.753	.	.	.	.	.	.
Angina Pectoris	0.762	0.759	.	.	.	.	.
Myocardial Infarction	0.396	0.396	0.350	.	.	.	.
Procedural Status	0.373	0.376	0.366	0.321	.	.	.
Hypertension	0.242	0.244	0.241	0.230	0.215	.	.
Aritmia	0.087	0.087	0.087	0.082	0.069	0.060	.
EF							
EF ≥50	Ref	Ref	Ref	Ref	Ref	Ref	Ref
EF 40-49%	0.021	0.021	0.021	0.020	0.018	0.020	0.018
EF 30-39%	0.000	0.000	0.000	0.000	0.000	0.000	0.000
EF<30%	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cardiogenic Shock	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Age	0.001	0.001	0.001	0.001	0.001	0.001	0.000
IABP	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Renal Failure	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stroke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Goodness of fit	0.0624	0.2955	0.4538	0.5845	0.4184	0.3604	0.5997

**7^{th} model is a final model with Goodness of Fit p-value 0.5997 (>0.05)

Table 3. Variables Predicting Prolonged ICU Stay after adjusting for Multivariate Analysis

Variables	Coefficient (B)	SE (B)	aOR	95% CI	P-Value
Age					
<59					
≥ 59	0.3485773	0.0988171	1.41	1.16 - 1.71	0.000
EF					
EF ≥50					
EF 40-49%	0.2884583	0.1216814	1.33	1.05 - 1.69	0.018
EF 30-39%	0.549278	0.1386338	1.73	1.31 - 2.27	0.000
EF<30%	0.9802279	0.2085711	2.66	1.77 - 4.01	0.000
Cardiogenic Shock					
No					
Yes	2.055032	0.6024145	7.80	2.39 - 25.42	0.001
IABP Usage					
No					
Yes	3.582633	0.1661946	35.96	25.96 - 49.81	0.000
Renal Failure					
No					
Yes	0.8720358	0.1619116	2.39	1.74 - 3.28	0.000
Stroke					
No					
Yes	0.6183501	0.1493156	1.85	1.38 - 2.48	0.000

Pseudo R2 = 0.2534

Multivariate analysis showed that variables significantly associated with prolonged ICU stay included age, EF, cardiogenic shock, IABP usage, renal failure, and preoperative stroke (P <0.05). All of these variables also have confidence interval range from greater than one, didn't getting through from zero to one, indicating that there is a significant positive prediction. The goodness-of-fit test confirmed that the final regression model had an acceptable fit with a p-value of 0.5997 (>0.05). This indicates that the model accurately represents the data in predicting prolonged ICU stays. The equation derived from the best-fit model is as follows.

$$LOS \geq 72hours = -2.636799 + 0.3485773\ (\text{Age}) + 0.2884583(EF\ \text{EF}\ 40-49\%) + 0.549278(EF\ 30-39\%) + 0.9802279(EF < 30\%) + 2.055032\ (\text{Cardiogenic Shock}) + 3.582633\ (\text{IABP Usage}) + 0.8720358\ (\text{Renal Failure}) + 0.6183501\ (\text{Stroke})$$

The equation above predicts the likelihood of prolonged ICU Stay based on various clinical factors. The baseline log odds for patients without any additional risk factors is -2.636799. Age is associated with an increased risk, as each year of age raises the log odds by 0.3485773. Reduced ejection fraction also significantly impacts the risk, with EF 40-49%, 30-39%, and <30% increasing the log odds by 0.2884583; 0.549278; and 0.9802279, respectively, compared to normal EF. Cardiogenic shock and the use of IABP are the strongest predictors of prolonged ICU stay, each increasing the log odds by 2.055032 and 3.582633, indicatingthat patients with these conditions are at a much higher risk. Additionally, a history of kidney failure (0.8720358) and stroke (0.6183501) further increase the likelihood of prolonged ICU stay..

DISCUSSION

This study was conducted at the National Cardiovascular Center Harapan Kita. As a national referral hospital, the number of cardiovascular services provided by Harapan Kita, including cardiac surgery, has steadily increased over the years. The hospital's surgical unit reported a total of 1448 surgeries in 2022, which rose to 1880 in 2023. CABG was the most frequently performed procedure, with 751 cases in 2022 and a 33% increase to 1115 cases in 2023 (Instalasi Bedah PJNHK, 2024). Patients receiving services at Harapan Kita came from various regions across Indonesia. Thus, the findings of this study are expected to be generalizable to the population of CABG patients in Indonesia.

Prolonged ICU stays (≥72 hours) were observed in 16% of patients. These extended ICU stays may lead to adverse clinical outcomes, including in-hospital mortality and complications (Osinaike et al., 2015). Over time, prolonged ICU stays may also result in reduced physical abilities, prolonged rehabilitation periods, reduced quality of life, and limited ability to return to normal daily activities (Kao et al., 2022).

Patients with prolonged ICU stays represent a significant hospital subpopulation as they disproportionately consume ICU resources (Almashrafi et al., 2016). In addition, limited ICU

bed capacity increases the risk of surgery cancellations, leading to longer queues for surgical patients (K. S. Ibrahim et al., 2024). At Harapan Kita, 117 surgeries (10.4%) were canceled in 2023, with 95 cancellations (81.1%) due to full bed capacity (Instalasi Bedah PJNHK, 2024).

This study identified several statistically significant risk factors for prolonged ICU stays. The strongest predictors of prolonged ICU stay were cardiogenic shock and the use of IABP. The Intra-Aortic Balloon Pump (IABP) is a mechanical assist device that inflates a balloon after the aortic valve closes, increasing diastolic pressure. It then deflates before the aortic valve opens, reducing cardiac workload and enhancing systolic pressure. IABP usage was found to increase the risk of prolonged ICU stays by 36.34 times (95% CI 26.20–50.40) in patients undergoing CABG. The result on this study might be influenced by chance variation, explaining the wide confidence interval range. This could be happened as a result of patient diversity. A more precise CI may require additional data or refined models.

The use of IABP as a prophylactic to assist patients with critical condition needs on a failing heart has been established for a long time. However, patients receiving IABP are considered more likely to experience bleeding, prolonged ventilation, limb ischemia, and prolonged ICU stay due to possible contraindications (Singh, 2024). Study conducted by (Daoulah et al., 2024) with multicenter restrospective cohort stated that patient with IABP statistically had longer ventilation times [8.5 hours (6-23) vs 15.5 hours (IQR 5 – 60.5), P = 0.03) and longer ICU length of stay [3 (IQR 2-5) vs 4 (2-7.5) days, P = 0.01). This can be attributed to the critical condition of patients requiring IABP compared to those who do not. IABP insertion had to consider several conditions, such as duration, advanced age, IABP support intervention timing without any complications, cardiac function, and hemodynamic conditions(Shah et al., 2020).

Cardiogenic shock is caused by severe myocardial dysfunction, leading to reduced cardiac output, which in turn leads inadequate blood and oxygen supply to vital organs (Jung et al., 2021). Clinically, cardiogenic shock is characterized by hypotension that cannot be cured with fluid resuscitation and signs of organ hypoperfusion (Vahdatpour et al., 2019). In this study, patients with a history of cardiogenic shock had a 13.9-fold increased risk (95% CI 5.42–35.64) of experiencing prolonged ICU stays. This finding also might be influenced by chance variation due to patient's diversity, resulting in a wide range of confidence interval.

Several studies have emphasized that prolonged ICU stays in cardiogenic shock patients are linked to complications such as acute kidney injury, respiratory failure, and secondary infections. These conditions derived from prolonged ventilator use, hemodynamic instability, and increased inflammatory responses (M. Ibrahim et al., 2021). Overall, the finding of this

study highlight the need for a proactive approach in managing CABG patients at risk of cardiogenic shock. Early detection of high-risk patients and prompt initiation of mechanical support can improve survival rates for patient with pre-operative cardiogenic shock while minimizing ICU stays.

Patients aged ≥59 years were 1.43 times more likely to experience prolonged ICU stays compared to those <59 years (95% CI 1.16–1.71). This finding aligns with previous research, which reported that older patients have a 3.34 increased risk ($p < 0.05$) of extended ICU stays (Arviolla et al., 2023). Older patients tend to present with more severe conditions due to physiological and anatomical changes, such as DM, stroke, delirium, and lung complications comorbidities (Hussain & Harky, 2019)The decline in muscle mass and tone as we get older can prolong myocardial recovery (Sadeghi et al., 2019). This situation often leads to prolonged ventilator usage, increasing the risk of ventilator-associated infections and extending ICU stays (Arviolla et al., 2023).

Renal failure is a significant risk factor associated with prolonged ICU stays. Patients with preoperative renal failure were 2.39 times more likely to experience prolonged ICU stays compared to those without (95% CI 1.74–3.28). This finding is consistent with previous research indicating that patients with renal failure have a 4.01 times increased risk ($p < 0.01$) of prolonged postoperative ICU stays (Almashrafi et al., 2016). Renal failure actually was also the risk factor of developing coronary artery disease. Mechanisms such as inflammatory responses, coronary artery calcification, immune suppression, and other factors worsen patient prognoses (Li et al., 2020).

Poor renal function may lead to a condition where patients require hemodialysis, which can significantly increase postoperative care needs and extend ICU stays (Kao et al., 2022). Besides that, pre-operative renal failure itself is one of the key patient characteristics that contraindicates early extubation. Additionally, preoperative renal failure can increase the risk of reduced cardiac output (Low Cardiac Output Syndrome), resulting on a condition where the supply of oxygen and nutrients to body tissues is diminished (Bojar, 2021). This finding underscores the critical need for management of patient with pre-operative renal failure to prevet severe postoperative complications, including prolonged ICU stays.

Patients with preoperative stroke are 1.85 more likely to stay longer in ICU (95% CI 1.38–2.48) of compared to those without stroke. Similar findings were reported by Bottle et al., who observed that preoperative stroke increased the risk of prolonged ICU stays by 1.31 times (95% CI 1.11–1.56). Stroke is associated with a higher risk of complications. This condition can worsen surgical outcomes due to impaired cerebral blood flow regulation.

Neurological deficits often require specialized care and more intensive rehabilitation, potentially extending the patient's length of stay in the hospital before discharge (Bottle et al., 2014).

Patients with low preoperative ejection fractions have higher morbidity and mortality risks, as this condition can lead to Low Cardiac Output Syndrome (LCOS) (Arviolla et al., 2023). Statistically, this study found that patients with preoperative EF levels of 40–49%, 30–39%, and <30% had 1.33; 1.73; and 2.66-fold increased risks, respectively, of prolonged ICU stays compared to patients with EF ≥50%. These findings are consistent with previous studies that reported higher EF levels significantly increase the likelihood of patients experiencing normal ICU stays (HR 9.5) (Mansjoer & Sutrisna, 2020). Bauer et al. similarly found that higher EF levels significantly prevent prolonged ICU stays, with an OR of 0.53 (95% CI 0.44–0.63) (Bauer et al., 2021).

Gender has been reported in several studies as a risk factor for prolonged ICU stays after CABG (Bauer et al., 2021; Kao et al., 2022). Female gender is in risk to experience pre-operative comorbidities such as atrial fibrillation and acute kidney injury, which in turn develop to postoperative complications (Bojar, 2021). A study found that female patients have higher risk to experience dialysis (OR 1.31 95% CI 1.12 – 1.52); sternum infection (OR 1.43 95% CI 1.11 – 1.83); and longer hospitalization stay (OR 1.2 95% CI 1.0 – 1.4) (Dixon et al., 2022). The likelihood of females being a risk factor for poor outcomes after CABG can be explained in relation to the more complex anatomy of the female body. Woemen tend to have smaller coronary arteries for grafting, narrower conduits, and a more diffuse pattern of coronary artery disease (Haider et al., 2020). However, this study did not find similar results (p-value > 0.05). This discrepancy may be due to differences in population-specific risk factors.

Smoking was proven as a risk factor predicting an increased length of stay in the ICU by 4.87 times more than those who didn’t smoke (95% CI 1.39 – 17.05) (Kao et al., 2022). However, this study didn’t find a significant prediction of smoking on prolonged ICU stay (p-value >0.05). Smoking has been associated with increased delirium, lung complications, wound infection, and multisystem failure. Smoking may be a moderating factor of prolonged ICU length of stay and therefore shouldn’t be taken for granted by promoting smoking cessation as a secondary intervention or perioperatively tertiary intervention (Kao et al., 2022).

(Kao et al., 2022) also found a significant results of CPB usage on prolonged ICU stay. Patient undergoing bypass procedure had 3.51 (95% CI 1.29 – 9.54) higher risk to stay in ICU longer than those who undergo the off-pump procedure. This can be explained by several negative effects of CPB machine usage, such as systematic inflammatory response syndrome,

atrial cerebral effects, and lower survival rate. Current study result failed to produce similar significant results, with P-value > 0.05. Thus, the significant findings of other study suggested to pay more attention to monitoring organ function after CPB in ICU care.

Similar variations were observed for other factors such as hypertension, diabetes mellitus, dyslipidemia, myocardial infarction, angina pectoris, arrhythmia, and procedural status, which were not proved statistically significant as predictors of prolonged ICU stays in this study. In contrast, previous research has shown that these factors significantly extend ICU stays for CABG patients (Bauer et al., 2021; Kao et al., 2022; Tunc et al., 2018; Zhang et al., 2021).

This study has some limitations, especially regarding the information bias. The data used in this study derived from hospital electronical medical records, where there was a probability of invalid data because input error, and the error can't be found and validated from another source. Another limitation in this study is in relation with generalizability. This study only investigates patients undergoing CABG, while in fact, there are other types of cardiac surgery, namely valve, congenital, or vascular surgery, with different clinical and surgical mechanisms, Thus, the findings from this study, on factors influencing prolonged ICU stay, couldn't be generalized to other procedures.

CONCLUSIONS

Based on the findings of this study, *there are several risk factors such as age, history of renal failure, preoperative stroke, cardiogenic shock, low ejection fraction, and IABP usage which needs attention to produce better outcome, especially for ICU stay in isolated CABG patients in Indonesia.* These risk factors can be considered to build an independent scoring system that can be used to predict patient's length of stay. These factors alsorequire special attention in the postoperative management of patients, as they can influence recovery and overall long-term prognosis. Additionally, surgical queue management based on these risk factors is essential to prevent delays caused by limited ICU bed capacity

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