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Original Research

Correlation between Cardiopulmonary Bypass Time (CPB Time) during Coronary Artery Bypass Graft on ICU Length of Stay

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ABSTRACT

Background: Coronary heart disease (CHD) is one of the deadliest diseases in Indonesia. Coronary artery bypass graft using cardiopulmonary bypass (CPB) is an integral measure in its treatment. The objective of this study is to identify the correlation of CPB Time and Length of Stay (LOS) in the Intensive Care Unit (ICU) in Dr. Soetomo General Academic Hospital, Surabaya. **Material and Methods:** This study was conducted using observational and analytic methods.. The population are coronary heart disease patients who underwent coronary artery bypass graft. A total sampling method was used from the medical records of Dr. Soetomo General Academic Hospital, Surabaya from October 2021 until September 2022. The research variables are: CPB time and ICU LOS. The relationship between CPB and ICU LOS was analyzed using the Spearman correlation test and logistic regression as well Mann-Whitney test using Microsoft Excel and SPSS version 25. **Results:** From the results of the correlation test, there is no correlation between CPB Time and ICU LOS with a correlation coefficient of r=0212, there is no significant difference between CPB ≤180 minutes and CPB >180 minutes on ICU LOS p=0.123. From the overall sample, the average age was 62.24+7.765 years, with the majority of the sample were male 87.3%. **Conclusion:** There is no correlation between the CPB Time and ICU LOS in patients after coronary artery bypass graft at RSUD Dr. Soetomo.

Highlights:

1. CHD remains one of the most threatening CVD in Indonesia. Studies discussing CHD will contribute in future studies for cardiologists to assert better options for treatment.

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Introduction

Coronary heart disease is one of the world's major causes of death. The World Health Organization (WHO) in its report noted that more than seven million people died from coronary heart disease worldwide [1]. Until now, patients with coronary heart disease are the most treated in the world [2]. Coronary Artery Bypass Surgery is a major surgical operation in which a blocked coronary artery is bypassed through a harvested vein or artery. By performing Coronary Artery Bypass Surgery, it is hoped that the bypass can restore blood flow to the ischemic myocardium, restore function, survival, and reduce the patient's angina [3]. However, side effects, postoperative complications, and surgical stress associated with the use of cardiopulmonary bypass still occur. A systemic inflammatory response may be induced by cardiopulmonary bypass machine use, leading to the secretion of numerous pro-inflammatory cytokines and endotoxins.. Consequently, this can lead to the entrapment of neutrophils in the pulmonary capillaries.[4]

Following heart surgery, it is customary to provide patients with intensive care in the Intensive Care Unit (ICU). The Intensive Care Unit (ICU) is a division inside a hospital that comprises medical personnel and specialised equipment designed to provide treatment and surveillance for patients experiencing severe illnesses, accidents, diseases, or complications that pose a significant risk to their lives [5].One of the indications for admitting patients to the ICU is postoperative patients including patient who underwent coronary artery bypass graft [6]. The rise in the volume of patients undergoing cardiac surgery leads to an potential increase of post-operative patients admitted to the Intensive Care Unit (ICU), thus leading to differences in the duration of recovery for each heart operation.

Material and Methods

This was an observational analytic study. The population are coronary heart disease patients who undergo coronary artery bypass graft. A total sampling method was used with medical records that was stored in Dr. Soetomo General Academic Hospital, Surabaya which dated from October 2021 until September 2022 who met the inclusion criteria. Incomplete data and a patient with COVID-19 were the inclusion criteria. The independent variable in this study was CPB Time, meanwhile the dependent variable was ICU LOS of the patients. Variables were collected from Soetomo General Academic Hospital, Surabaya medical records with no follow up, processed, and analyzed using Microsoft Excel and SPSS ver 25. This study had received ethical clearance from Dr. Soetomo General Academic Hospital, Surabaya (no.2147/110/4/V/2023) on 9 June 2023.

Result

Table 1. Clinical Profile of Coronary Heart Disease Patients with Cardio PulmonaryBypass in ICU of RSUD Dr. Soetomo October 2021 - September 2022

Characteristics	Mean±SD	N	(%)
Total		71	100%
Gender			
Male		62	87.3%
Female		9	12.7%
Age (years)			
46-55 years	62.24±7.765	14	19,71%
56-65 years		27	38,02%
>65 years old		30	42,2%
Cardiopulmonary Bypass Time			
<180 minutes	123.7±41.8	68	95,7%
>180 minutes		3	4,3%
ICU duration			
1 day	2.92±2.209	7	9.9%
2 days		31	43.7%
3 days		20	28.2%
4 days		5	7%
5 days		2	2.8%
6 days		5	7%
16 days		1	1.4%

Source: Research Data, Processed

Table 5.1 provides a brief review of patients' clinical features with coronary heart disease who received cardiopulmonary bypass graft with cardiopulmonary bypass machine at RSUD Dr Soetomo between October 2021 and September 2022. The majority of coronary heart disease patients who underwent cardiopulmonary bypass machine procedures at RSUD DR Soetomo were male (87.3%). Most of these patients were over the age of 65 (42.2%), with an average age of 62.24 ± 7.765 years. According to the profile data, 68 patients had a Cardiopulmonary Pulse Time less than 180 minutes, whereas 3 patients had a Cardiopulmonary Pulse Time greater than 180 minutes. The Kolmogorov-Smirnov normality test It was discovered that the ICU LOS score was not in line with the normal distribution, with a p-value of less than 0.001. Consequently, modifications will be implemented starting from conversion of parametric tests to non-parametric tests.

Table 2. Correlation between CPB Time and ICU LOS at RSUD Dr. Soetomo October 2021-September 2022

Total (%)	CPB Time (Mean±SD)	ICU LOS (Mean±SD)	Logistic Regression	Korelasi Spearman	
			Sig.	Correleation Coefficient	Sig.
71(100%)	123.7±41.8	2.92±2.09	0.720	0.212	0.076

Source: Research Data, Processed

To see the degree of association between CPB Time and ICU LOS, Logistic Regression and Spearman correlation analysis techniques were performed. The regression test found a significance value of 0.720. Logistic Regression test showed that the duration of cardiopulmonary bypass machine had no effect on ICU LOS.

In the relationship analysis using the Spearman correlation technique, it was found that the coefficient correlation value was 0.212 and the significance was 0.076. From these results, it is known that the Spearman significance value indicates that there is no significant relationship between cardiopulmonary bypass time and ICU LOS. The Coefficient Correlation value shows a weak correlation value which is in the range of 0.00 - 0.25. The Coefficient Correlation value also shows a positive value, which indicates that the relationship between the two variables is unidirectional, Thus, the longer the duration of the cardiopulmonary bypass machine, the longer the duration of the patient's ICU LOS, and vice versa.

Table 3**.** Test of Differences in ICU LOS on the Cardiopulmonary Bypass Time with Values ≤180 minutes and >181 minutes at Dr. Soetomo Hospital October 2021-September 2022

CPB Time	n (%)	CPB Time Median (min-max)	ICU LOS Median (min-max)	Mann Whitney
				Asymp. Sig.
≤180 minutes	68(95,7%)	117.7±30	2.84±2.190	0.123
>180 minutes	3(4,3%)	260±44.2	4.67±1.315	

Patients were grouped by their CPB Time (≤180 minutes and >180 minutes) to see the difference between their ICU LOS. It was found that of the total participants, 68 (95.7%) patients had Cardiopulmonary Bypass Time ≤180 minutes, with an average Cardiopulmonary Bypass Time of 117.7±30 minutes and an average ICU LOS of 2.84±2.190 days. Meanwhile, 3 (4.3%) patients had a Cardiopulmonary Bypass Time >181 minutes, with an average Cardiopulmonary Bypass Time of 260±44.2 minutes and an average ICU LOS of 4.67±1.315 days.The Mann-Whitney test was conducted to evaluate if there was a difference.

The Mann-Whitney test results show an Asymp. Sig. value of 0.123. With a significance value far above the 0.05 confidence level, It can be inferred that there is no significant difference in ICU LOS between patients. with Cardiopulmonary Shortening Time ≤180 minutes and >181 minutes. This result indicates that the median ICU LOS values in the two groups are not significantly different.

Discussion

Correlation between CPB Time and ICU LOS

The absence of a meaningful correlation between extended use of the cardiopulmonary bypass machine and the ICU LOS may be attributed to other factors that occur simultaneously, such as age, mean pulmonary artery pressure, and the ratio of PaO2/FIO2 which its significance has been identified as one of the risk factors for ICU LOS among patients who have received coronary artery bypass surgery [7]. Madhavan contended that while the duration of cardiopulmonary bypass/graft time by itself did not show statistical significance, patients who had a longer usage of the cardiopulmonary machine had a 1.67 times higher risk of mortality [8]. Elderly individuals generally experience reduced levels of treatment intensity and earlier decisions to restrict life-sustaining measures compared to younger individuals. This can take the form of either withholding or stopping care [9]. The prevalence of sepsis seems to rise with advancing age. Furthermore, the presence of unusual clinical symptoms and age-related factors such as the use of indwelling catheters, multiple medications, institutionalization, reduced kidney function, and inadequate nutritional status, all contribute to difficulties in managing sepsis and result in unfavorable outcomes. These factors can also lead to prolonged ICU LOS following sepsis.[10]

ICU LOS can also be influenced by changes in pulmonary artery pressure, particularly when there is a reduction in the compliance of the left atrium. This reduction can result in an elevation of left atrial pressure, which is linked to a higher degree of severity in mitral stenosis. A sudden rise in intracranial pressure might result in an elevation of mean arterial pressure, subsequently impacting cardiac output and other circulatory variables [11]. The utilization of inotropic drugs might promptly

enhance the compromised left atrial function in individuals suffering from heart failure and atrial fibrillation [12]. The PaO2/FIO2 ratio measures the level of oxygenation and is used to diagnose adult acute respiratory distress syndrome (ARDS) in critically unwell individuals [13]. Pathological diseases, particularly respiratory disorders such as atelectasis, ARDS, acute pulmonary oedema, and pneumonia, as well as changes in hemodynamic status such as cardiogenic shock and septic shock, can result in low PaO2/FIO2 ratio values. Atelectasis, a condition where the lungs collapse partially or completely, can result in anomalies in gas exchange during surgery. This can be further exacerbated by inflammation caused by the surgery, resulting to pulmonary dysfunction after the operation, even in patients without pre-existing lung damage. Despite the fact that the patient had mechanical ventilation and recruitment maneuvers to maintain their lungs during and after surgery, a lower PaO2/FiO2 ratio may indicate persistent lung dysfunction, which may impact ICU LOS.[14]

Comorbidities such as diabetes mellitus, hypertension, pulmonary TB, asthma, autoimmune hemolytic anaemia (AIHA), stroke, coronary artery disease (CAD), and renal insufficiency might also contribute to prolonged ICU LOS [15]. Arrhythmias are a major contributor to the prolonged ICU LOS [16]. Cardiovascular conditions often manifest as arrhythmias. A quantifiable decrease in the probability of arrhythmia may lead to a decrease in ICU LOS. Arrhythmias are commonly observed in elderly patients with heart disease who exhibit greater severity of acute illness. These patients also require higher levels of ventilation, vasopressors, and renal replacement therapy. Additionally, they often have a history of tachyarrhythmias [17]. COVID-19 may also act as a mediator that can cause irregular cardiac rhythms, potentially increasing the likelihood of arrhythmia during severe conditions other than heart failure, myocarditis, and acute coronary syndrome [18].

A separate study found that regulating oxygenation levels within 6 hours of surgery had a significant impact on ICU LOS. This effect could be attributable to the use of non-invasive assisted ventilation following cardiothoracic surgery, which improves oxygenation.[19]

The administration of inotropic agents is frequently linked to unfavorable outcomes, including impaired kidney function, prolonged ICU LOS, and heightened mortality rates within the hospital setting[20]. Inotropic medications are frequently administered to patients undergoing coronary artery bypass surgery (CABG) in order to enhance heart function [21]. Administering inotropic drugs is a significant risk factor that independently contributes to prolonged ICU LOS [20]. This was also refuted by McKinlay[22] previously, stating that inotropic support medications are typically administered to older

patients undergoing cardiopulmonary bypass procedures with extended aortic pump usage. Nevertheless, a study conducted in China found a noteworthy correlation between the duration of cardiopulmonary bypass and an extended ICU LOS ($p<0.05$). Reduced vascular resistance may result from the systemic inflammatory response, production of endothelial nitric oxide, serotonin, and adenosine, and the use of a cardiopulmonary bypass machine.[20]

Test of Differences in ICU LOS on the Cardiopulmonary Bypass Time with Values ≤180 minutes and >180 minutes

Cardiopulmonary bypass is commonly used during coronary artery bypass surgery. Madhavan[8] categorizes the duration of cardiopulmonary bypass time into two groups: those that are equal to or less than 180 minutes (≤180 minutes) and those that are greater than 180 minutes (>180 minutes) where cardiopulmonary bypass time over 180 minutes is included as the prolonged cardiopulmonary bypass time. The absence of statistical significance in the difference of ICU LOS between patients with cardiopulmonary bypass times above ≤180 minutes and those with times exceeding 180 minutes may be attributed to other patient characteristics, such as age, mean pulmonary artery pressure, and PF ratio [7]. Additional factors that can influence ICU LOS include the presence of other medical disorders upon admission, the utilization of intra-aortic balloon pumps, the need for emergency surgery, preexisting renal dysfunction before surgery, and the requirement for further medical interventions. These factors have the potential to prolong the duration of a patient's stay in the ICU [23]. Research has demonstrated that employing an intra-aortic balloon pump (IABP) in patients undergoing coronary artery bypass graft (CABG) surgery is beneficial in enhancing hemodynamics and ejection fraction, as well as reducing the ICU LOS. Placing an intra-aortic balloon pump (IABP) early, especially before surgery, has been linked to improved outcomes, such as decreased ICU LOS and lower fatality rates [24]. Several factors can impact the likelihood of undergoing a second surgery following coronary artery bypass grafting (CABG), such as the utilization of an intra-aortic balloon pump, the need for emergency surgery, and the administration of clopidogrel prior to the operation [25]. Prolonged ICU LOS following coronary artery bypass grafting (CABG), can also be caused by the need for additional surgery, which is linked to higher rates of death during the hospital stay and a worse long-term outlook.[26]

Conclusion

In conclusion, CPB time is not related to ICU LOS in patients undergoing cardiopulmonary bypass at RSUD Dr. Soetomo. ICU LOS in patients with CPB time ≤180 minutes did not differ compared to

patients with CPB time >180 minutes at RSUD Dr. Soetomo.

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