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ORIGINAL ARTICLE

Mortality Outcomes Associated with Blood Group O Versus Non-O in Patients Undergoing Coronary Artery Bypass Grafting

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Abstract

Background: Coronary artery bypass grafting (CABG) carries an operative mortality of 1–7%. Von Willebrand factor (vWF) levels are approximately 30% lower in individuals with blood group O compared to non–O groups, potentially influencing post–CABG mortality. This study aimed to compare mortality between blood group O and non–O in adult patients after on–pump CABG in the ICU.

Methods: A retrospective cohort study was conducted using secondary data from medical records of adult patients (>18 years) who underwent elective on–pump CABG in the ICU at Dr. Hasan Sadikin General Hospital, Bandung. A sample of 64 patients was required, with a 28–day follow–up post–CABG. Data were analyzed using unpaired t–tests, Mann–Whitney tests, Chi–square, and Fisher's exact tests, with significance set at p<0.05, using SPSS version 26.0.

Results: A total of 129 patients were included, comprising 64 patients with blood group O and 65 with non–O blood groups. Mortality in blood group O patients was 10.9% (7/64), compared with 29.2% (19/65) in non–O patients, a significant difference (p=0.010). Non–O blood group patients had nearly three times higher risk of mortality compared to those with blood group O.

Discussion: The observed mortality differences are related to variations in vWF and factor VIII levels among blood groups. Lower vWF levels in blood group O may provide a protective effect against macro–thrombosis in coronary grafts, whereas higher factor VIII levels in non–O groups increase the risk of microvascular thrombosis and secondary myocardial ischemia after on–pump CABG.

Conclusion: Adult patients undergoing on–pump CABG with non–O blood groups experience significantly higher mortality compared to those with blood group O. Blood group may be associated with postoperative mortality. However, its role as an independent prognostic factor requires further investigation.

Keywords: ABO blood group; CABG; ICU; Mortality

Introduction

Cardiovascular disease accounts for approximately 31% of deaths worldwide, with coronary artery bypass grafting (CABG) being the most commonly performed cardiac surgery.[1,2] According to the 2023 data from The Society of Thoracic Surgeons (STS), operative

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mortality for open–heart surgery ranges from 1% to 7%, influenced by preoperative, intraoperative, and postoperative risk factors.[2] Major perioperative complications include postoperative myocardial infarction (MI) with a mortality rate of 4.3%, stroke, which increases the risk of mortality fourfold, and bleeding requiring transfusion with a mortality rate of 7.5%.[3–6]

Blood group plays a critical role in hemostasis by influencing von Willebrand factor (vWF) levels. Individuals with blood group O have approximately 30% lower vWF levels than non–O groups, conferring a protective effect against thrombotic events such as MI, deep vein thrombosis (DVT), and cerebral ischemia.[7] Conversely, blood group O is also associated with a higher risk of significant bleeding in various clinical settings, including extracorporeal membrane oxygenation (ECMO) and post–polytrauma mortality.[7] Given that CABG carries substantial risk for both thrombotic and bleeding complications perioperatively, blood group may serve as a prognostic factor for postoperative mortality.

Although multiple factors influencing post–CABG mortality have been investigated, the impact of blood group O versus non–O on mortality after CABG, especially in Indonesia, remains unexplored. This study aims to compare 28–day mortality among adult patients undergoing on–pump CABG according to blood group (O vs. non–O) in the ICU at Dr. Hasan Sadikin General Hospital, Bandung. Understanding the influence of blood group on mortality may help clinicians optimize perioperative management strategies.

Subjects and Methods

This retrospective cohort study utilized secondary data from medical records of adult patients who underwent on–pump CABG and were admitted to the Intensive Care Unit (ICU) at Dr. Hasan Sadikin General Hospital, Bandung. The study was conducted with approval from the Ethics Committee of Dr. Hasan Sadikin General Hospital Bandung (No. DP.04.03/D.XIV.6.5/265/2025).

The study population included all adult patients (>18 years) who underwent elective on–pump CABG and were admitted to the ICU. Exclusion criteria included incomplete medical records, patients discharged from the ICU at their own request, and patients who underwent reoperation or ICU readmission.

Sample size calculation was based on a comparative test for unpaired categorical data with significance level α=0.025 ($Z\alpha$=2.58) and power β=0.95 ($Z\beta$=1.64). The sample size was calculated based on an expected difference in mortality between groups derived from previous CABG outcome studies, which reported postoperative mortality rates ranging from approximately 2% to 5% within 30 days.[8] In addition, emerging evidence suggests potential differences in outcomes according to ABO blood groups, although the magnitude of effect remains variable across studies. Based on these considerations, an estimated difference between groups was used to determine the minimum required sample size.[9,10] Anticipating a 10% dropout rate, the required total sample was 64 subjects.

The independent variable was blood group, categorized as O and non–O (A, B, and AB), while the dependent variable was 28–day post–CABG mortality. Potential confounders included EuroSCORE II, cardiopulmonary bypass (CPB) duration, vasoactive agent use, and perioperative complications. Blood group data were obtained from laboratory ABO typing tests recorded in the medical records. Mortality was defined as death within 28 days after CABG.

Data collection involved reviewing medical records to record patients' demographic and clinical characteristics at ICU admission, clinical course during ICU stays, length of stay (LOS) in ICU and hospital, and patient outcomes up to 28 days post–CABG. Collected data underwent editing, coding, entry, and cleaning before analysis using Microsoft Excel 2024 and SPSS version 26.0.

Descriptive analysis was performed to characterize the sample. Numerical data such as age, CPB duration, and EuroSCORE II were presented as mean±standard deviation,

median, and range. In contrast, categorical data, such as sex and blood group, were presented as frequencies and percentages. Normality of numerical data was assessed using the Shapiro–Wilk test for sample sizes <50 and the Kolmogorov–Smirnov test for sample sizes ≥50. Comparisons between O and non–O groups were conducted using unpaired t–tests for normally distributed numerical data or Mann–Whitney tests for non–normally distributed data. Categorical variables were compared using Chi–square tests if assumptions were met (no expected value <5 in ≥20% of cells), or Fisher's Exact test for 2×2 tables. Statistical significance was set at p≤0.05.

Results

A total of 129 adult patients undergoing on–pump CABG in the ICU at Dr. Hasan Sadikin General Hospital were included, comprising 64 patients with blood group O and 65 with non–O blood groups. The baseline demographic and clinical characteristics of the study population are summarized in Table 1.

Overall, most patients were aged 18–65 years and predominantly male. Comparison between groups showed a significant difference in age distribution (p=0.021), with a higher proportion of patients aged 18–65 years in the non–O group. No significant differences were observed in sex or anthropometric parameters between the groups (all p>0.05).

In terms of clinical characteristics, hypertension and NYHA III classification were more frequently observed in the non–O group (p=0.023 for both). ICU length of stay was also significantly different, with a slightly longer duration in the blood group O group (p=0.020). Other variables, including renal function, comorbidities, ejection fraction, CPB

Table 1 Baseline Demographic and Clinical Characteristics of Patients by Blood Group

Variables	Blood Group O (n=64)	Blood Group Non-O (n=65)	Total (n=129)	p–value
Age (years)				0.021*
18–65	43(67.2%)	55(84.6%)	98(76.0%)	
66–79	21(32.8%)	10(15.4%)	31(24.0%)	
Gender				0.587
Male	54(84.4%)	57(87.7%)	111(86.0%)	
Female	10(15.6%)	8(12.3%)	18(14.0%)	
Body weight				0.979
Mean±std	65.61±11.022	65.66±11.436	65.64±11.189	
Median	66.00	65.00	65.00	
Range (min–max)	47.00–97.00	43.00–99.00	43.00–99.00	
Body height				0.094
Mean±std	161.19±7.470	163.66±6.969	162.43±7.300	
Median	162.00	165.00	163.00	
Range (min–max)	141.00–176.00	142.00–185.00	141.00–185.00	
BMI				0.529
Mean±std	24.71±4.153	24.30±3.285	24.51±3.732	
Median	24.10	24.20	24.10	
Range (min–max)	19.08–36.61	14.70–33.76	14.70–36.61	

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Table 1 (Continued)

Variables	Blood Group O (n=64)	Blood Group Non-O (n=65)	Total (n=129)	p–value
Creatinine preop				
Mean±std	1.52±0.952	1.80±1.466	1.66±1.241	0.357
Median	1.11	1.23	1.13	
Range (min–max)	0.09–4.28	0.40–8.90	0.09–8.90	
CC				
Mean±std	58.72±28.534	57.93±32.766	58.32±30.622	0.883
Median	59.00	57.00	58.00	
Range (min–max)	11.00–130.00	5.00–191.67	5.00–191.67	
Risk factors				
COPD	8(12.5%)	13(20.0%)	21(16.3%)	0.249
DM	45(70.3%)	43(66.2%)	88(68.2%)	0.612
Hypertension	35(54.7%)	48(73.8%)	83(64.3%)	0.023*
NYHA				
NYHA I	14(21.9%)	11(16.9%)	25(19.4%)	0.477
NYHA II	12(18.8%)	18(27.7%)	30(23.3%)	0.229
NYHA III	6(9.4%)	15(23.1%)	21(16.3%)	0.023*
NYHA IV	2(3.1%)	6(9.2%)	8(6.2%)	0.273
NYHA not recorded	35(54.7%)	26(40.0%)	61(47.3%)	0.095
EF %				
Mean±std	47.07±10.721	43.52±11.561	45.29±11.251	0.073
Median	48.50	41.00	45.00	
Range (min–max)	25.00–68.00	19.00–66.00	19.00–68.00	
CPB duration				
Mean±std	92.92±36.366	83.95±46.622	88.40±41.928	0.764
Median	100.00	100.00	100.00	
Range (min–max)	0.00–200.00	0.00–158.00	0.00–200.00	
CABG type				
Elective	55(85.9%)	52(80.0%)	107(82.9%)	0.370
Urgent	9(14.1%)	13(20.0%)	22(17.1%)	
Vasoactive usage				
Yes	41(64.1%)	50(76.9%)	91(70.5%)	0.109
No	23(35.9%)	15(23.1%)	38(29.5%)	
ICU length of stay				
Mean±std	3.34±1.729	2.88±2.631	3.11±2.233	0.020*
Median	3.00	2.00	3.00	
Range (min–max)	1.00–10.00	1.00–21.00	1.00–21.00	

Tabel 1 (Continued)

Variables	Blood Group O (n=64)	Blood Group Non-O (n=65)	Total (n=129)	p–value
Hospital length of stay				
Mean±std	9.13±6.411	8.55±5.037	8.84±5.744	0.577
Median	8.00	8.00	8.00	
Range (min–max)	2.00–52.00	2.00–33.00	2.00–52.00	
Euro score II (%)				
Mean±std	2.10±1.845	2.06±1.709	2.08±1.771	0.919
Median	1.53	1.33	1.47	
Range (min–max)	0.50–7.95	0.09–7.20	0.09–7.95	

Note: For numerical data, p-values were calculated using the unpaired t-test if the data were normally distributed, or using the Mann–Whitney test if the data were not normally distributed. For categorical data, p-values were calculated using the Chi-square test, with the Kolmogorov–Smirnov test and Fisher's Exact test as alternatives when the assumptions for Chi-square were not met. Statistical significance was defined as p<0.05

duration, type of surgery, vasoactive drug use, hospital length of stay, and EuroSCORE II, were comparable between groups (all p>0.05).

Mortality analysis revealed statistically significant findings. Of the total 129 patients, 26 deaths (20.2%) occurred during ICU stay after CABG. Mortality distribution differed significantly between the two groups (p=0.010), with non–O blood group patients exhibiting a higher mortality rate (29.2%) than O blood group patients (10.9%). This indicates that patients with non–O blood groups have a higher risk of death following on–pump CABG.

Analysis of mortality causes revealed that cardiac–related complications were the leading cause of death after CABG, accounting for 18 of the 26 deaths. Perioperative myocardial infarction (PMI) was the most frequent cause, with 13 cases, 9 occurring in the non–O blood group and 4 in the O blood group. Myocardial infarction (MI) accounted for 5 deaths, including 4 cases in the non–O group and 1 case in the O group. Infections were responsible for 5 deaths, including sepsis (2 cases in the non–O group), pneumonia (2 cases, 1 in each group), and hospital–acquired pneumonia (HAP) (1 case in the non–O group). Additionally, 3 deaths resulted from combinations of conditions: sepsis with HAP in 1 patient with blood group O, PMI with HAP in 1 patient with blood group non–O, and pulmonary oedema with HAP in 1 patient with blood group non–O.

Statistical analysis using the Chi–square test demonstrated a significant difference in mortality proportions between blood group O

Tabel 2 Comparison of Mortality Between Blood Group O and Non-O Patients

Variables	Blood Group O n=64 (%)	Blood Non-O n=65(%)	Total n=129(%)	p–value
Mortality events				
Yes	7 (10.9)	19 (29.2)	26 (20.2)	0.010*
No	57 (89.1)	46 (70.8)	103 (79.8)	

Note: For categorical data, p-values were calculated using the Chi-square test, with the Kolmogorov–Smirnov test and Fisher's Exact test as alternatives when the assumptions for the Chi-square test were not met. Statistical significance was defined as p <0.05

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Table 3 Distribution of Causes of Mortality in Post-CABG Patients by Blood Group

Causes of Death	Blood Group O n=7(%)	Blood Group Non-O n=19(%)	Total n=26(%)	p-value
Cardiac causes				
Perioperative myocardial infarction (PMI)	4 (57.1)	9 (47.4)	13 (50.0)	0.69
Myocardial infarction (MI)	1 (14.3)	4 (21.1)	5 (19.2)	0.69
Infection				
Sepsis	0 (0)	2 (10.5)	2 (7.7)	0.50*
Pneumonia	1 (14.3)	1 (5.3)	2 (7.7)	1.00*
Hospital-acquired pneumonia (HAP)	0 (0)	1 (5.3)	1 (3.8)	1.00*
Combination of causes				
Sepsis+HAP	1 (14.3)	0 (0)	1 (3.8)	0.27*
PMI+HAP	0 (0)	1 (5.3)	1 (3.8)	1.00*
Lung oedema+HAP	0 (0)	1 (5.3)	1 (3.8)	1.00*
Total patients	7 (26.9)	19 (73.1)	26 (100)	

Note: Data are presented as numbers (percentage). Statistical analysis was performed using the Chi-square test or Fisher's Exact test where appropriate. A p-value < 0.05 was considered statistically significant.

and non–O patients (p=0.010). These findings support the study hypothesis that adult patients undergoing on–pump CABG with non–O blood groups have higher postoperative mortality compared to those with blood group O. Although some differences in baseline characteristics were observed between the groups, particularly in age distribution, hypertension, and NYHA III classification, the higher mortality in the non–O blood group persisted. However, as this analysis did not include multivariable adjustment, these findings should be interpreted with caution. Further studies that appropriately adjust for potential confounders are needed to clarify whether blood group plays an independent role in predicting post–CABG mortality.

Discussion

This study demonstrated a significant difference in post–CABG mortality between blood group O (10.9%) and non–O (29.2%) patients, with non–O patients experiencing nearly threefold higher mortality risk (p=0.010).[2,4] This finding is novel in the CABG literature and suggests that the ABO blood group may have a potential association with postoperative outcomes, although this relationship should be interpreted with caution

The baseline characteristics were well–balanced between groups, with significant differences noted only in age distribution (p=0.021) and hypertension prevalence (p=0.023).[11,12] Patients in the blood group O cohort tended to be older, with a significantly higher proportion aged >65 years, while hypertension was less common in this group. These baseline differences indicate that the two groups were not fully comparable and may have contributed to the observed mortality differences. As such, the apparent survival advantage in blood group O should be interpreted with caution.[7] The lower prevalence of hypertension in blood group O patients aligns with meta–analytic evidence demonstrating that blood group O is associated with a reduced risk of cardiovascular disease compared to non–O blood groups (OR 0.89; 95% CI 0.85–0.93; p<0.00001), possibly related to differential angiotensin–converting enzyme (ACE) activity in the renin–angiotensin system.[13]

Anthropometric parameters, including

body weight, height, and body mass index (BMI), did not differ significantly between blood group O and non–O patients: mean body weight was 65.61±11.02 kg vs. 65.66±11.44 kg (p=0.979), height was 161.19 cm vs. 163.66 cm (p=0.094), and BMI was 24.71 vs. 24.30 (p=0.529). The similarity of anthropometric parameters across blood groups suggests that body weight, height, and BMI are unlikely to act as confounders in the relationship between blood group and post–CABG mortality, indicating that observed differences in clinical outcomes are more likely driven by molecular and vascular factors, such as variations in von Willebrand factor levels and platelet adhesion.[7]

The present findings appear to contrast with the initial theoretical framework outlined in the Introduction, which suggested that individuals with blood group O, due to lower von Willebrand factor (vWF) levels, might be more susceptible to bleeding–related complications and potentially worse outcomes. However, in this cohort, patients with blood group O had lower mortality than those in non–O groups. This discrepancy highlights the complex and context–dependent role of hemostatic factors in cardiac surgery, where both thrombotic and bleeding risks coexist and may influence outcomes differently.[7]

From a mechanistic perspective, individuals with blood group O are known to have lower plasma vWF and factor VIII levels, which have been associated with a reduced thrombotic tendency. While this phenotype may increase bleeding risk in some settings, it may also confer relative protection against thrombotic complications, particularly in the prothrombotic environment following cardiopulmonary bypass.[7, 14]

In the current study, the predominance of perioperative myocardial infarction as a cause of death, especially among non–O patients, may support this hypothesis. Increased thrombotic tendency in non–O groups has been linked to higher levels of coagulation factors, which may contribute to adverse cardiovascular events in both acute and perioperative settings.[3, 15]

Nevertheless, existing evidence remains inconsistent. While some large studies suggest that blood group O is associated with lower cardiovascular risk, others have reported no significant relationship between ABO blood group and outcomes in critically ill or surgical populations.[7,13] In addition, perioperative factors are likely to play a more substantial role in determining outcomes after CABG.[1]

The significantly longer ICU length of stay in blood group O patients (3.34 days vs. 2.88 days; p=0.020), despite lower mortality, is intriguing and warrants discussion.[13] This paradoxical finding may reflect several mechanisms: (1) a more conservative post–operative management approach in blood group O patients, prioritizing close monitoring despite clinical stability; (2) early detection and intervention for subclinical complications before progression to death; or (3) differential bleeding management protocols that necessitate prolonged ICU observation.[13] Notably, hospital length of stay was comparable between groups (p=0.577), suggesting that the ICU stay difference does not translate to prolonged overall hospitalization, and long–term mortality implications remain to be determined in prospective studies.[14, 16]

ABO blood group status may improve preoperative risk stratification and inform perioperative management strategies in CABG patients. [1,12] Non–O patients undergoing on–pump CABG may benefit from enhanced anticoagulation protocols, more aggressive thromboembolism prophylaxis, closer perioperative hemodynamic monitoring, and consideration of modified cannulation techniques to mitigate graft thrombosis.[12] Conversely, blood group O patients require careful monitoring for postoperative bleeding given their anti–thrombotic phenotype.[16] Integration of ABO blood group into validated risk scores (e.g., EuroSCORE II) warrants investigation as a potential tool for individualized perioperative decision–making. [1]

This single–center retrospective cohort study cannot establish causality and may be subject to unmeasured confounders, selection bias, and center–specific practices. Prospective multicenter studies with standardized

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protocols and direct measurement of vWF and factor VIII levels are essential to confirm these findings and evaluate blood–group–informed risk stratification in CABG populations.

Conclusion

Adult patients undergoing on–pump CABG in the ICU at RSUP Dr. Hasan Sadikin Bandung with non–O blood groups were observed to have higher postoperative mortality compared to those with blood group O, with perioperative myocardial infarction identified as the most frequent cause of death. However, this association should be interpreted with caution, as the ABO blood group alone may not be the primary determinant of postoperative outcomes. Perioperative factors, including baseline comorbidities, intraoperative conditions, and postoperative management, are likely to play a more significant role in influencing mortality in this population. Therefore, the findings of this study may reflect a complex interplay of clinical and biological factors rather than a direct causal relationship, and further studies with appropriate adjustment for confounding variables are warranted.

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