Crit Care Shock (2025) 28:163-174

Predictive value of the Parsonnet score for in-hospital mortality following isolated coronary artery bypass graft surgery: A cross-sectional study at a single center in Indonesia

Muhammad Afdhal Ruslan[1], Hisbullah Hisbullah[1], Andi Adil[1], Syafri Kamsul Arif[1], Faisal Faisal[1], Muhammad Rum[1]

Abstract

***Objective*: Coronary artery bypass graft (CABG) surgery, while common for treating coronary artery stenosis, faces challenges in accurately predicting postoperative mortality, with the Parsonnet score being a frequently used tool that has yet to be adequately validated in high-mortality populations. This study aimed to evaluate the predictive capability of the Parsonnet score for in-hospital mortality among isolated CABG patients at an Indonesian cardiac centre.**

***Methods*: This cross-sectional study included patients who underwent CABG surgery and received care in the intensive care unit (ICU) at an integrated heart service facility from January 2019 to December 2023. Patients were categorized into survivors and non-survivors based on their in-hospital mortality status following surgery. The Parsonnet score was calculated according to established protocols.**

***Results*: Among 137 patients, the post-CABG mortality rate was 9.5%. Diabetes mellitus emerged as a significant independent risk factor for mortality (adjusted prevalence ratio [APR] 33.086, 95% confidence interval [CI] 3.85-297.16). The median Parsonnet score significantly differed between groups, with non-survivors scoring higher (8.00 [5.00-56.00] vs survivors 5.00 [0.00-61.00], p=0.002). The area under the curve (AUC) was determined to be 0.763 (95% CI 0.674-0.853, p=0.002), indicating good predictive performance. The optimal cut-off value was 5.50, achieving a sensitivity of 92.30% and a specificity of 37.10%. The Parsonnet score demonstrated moderate predictive value for mortality, particularly for scores exceeding 10 (p=0.006).**

***Conclusion*: In a population with a higher-than-average rate of post-CABG mortality, the Parsonnet score demonstrated solid predictive value and moderate calibration for mortality risk.**

Keywords: Coronary artery bypass, diabetes mellitus, intensive care units, mortality, risk assessment.

[1] Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia

Address for correspondence:
Muhammad Afdhal Ruslan
Department of Anasthesiology and Intensive Care, Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia
Perintis Kemerdekaan KM 10 St, Makassar 90245, Indonesia
Fax: (0411)587581
Email: afudaru@gmail.com

Introduction

Coronary artery bypass graft (CABG) stands as a landmark surgical intervention in the history of cardiac surgery, which has saved millions of people suffering from coronary artery disease. (1) As a standard procedure, CABG is used to address coronary artery stenosis. (2) Notably, it has become the most frequently performed cardiac surgical procedure worldwide. (3) Nonetheless, concerns persist regarding postoperative mortality rates associated with CABG procedures for heart disease. Global studies highlight significant variations in reported mortality rates following CABG procedures for cardiovascular disease. Research across five Eu-

ropean nations revealed a 30-day postoperative mortality rate of 3.0%, with lower-volume hospitals demonstrating higher mortality (5.2%) compared to high-volume centers (2.1%). (4) In contrast, Indonesian studies report elevated postoperative mortality rates. A 2014-2015 study at Dr. Kariadi Hospital Semarang documented a 14.3% post-CABG mortality rate, with cardiogenic shock accounting for half of these fatalities. (5) Similarly, a 2014-2016 analysis at Dr. Hasan Sadikin Hospital Bandung identified a 15.15% mortality rate among CABG patients. (6) A more recent investigation (2017-2023) at the Intensive Care Unit of Dr. Wahidin Sudirohusodo Hospital reported a 19.3% mortality rate among 429 adult cardiac surgery patients. (7)

Post-CABG mortality risk is multifactorial, arising from a combination of patient-specific variables including advanced age, male sex, cardiac functional status (e.g., reduced left ventricular ejection fraction), intraoperative parameters (e.g., prolonged aortic cross-clamp and cardiopulmonary bypass durations), and pre-existing comorbidities (e.g., diabetes, chronic kidney disease). (6) Post-CABG surgery risk scores are an important tool for assessing mortality risk. (8) Advances in preoperative screening, surgical techniques, and intensive care may reduce the risk of mortality following cardiac surgery. (9) Therefore, measuring tools to predict post-CABG surgery mortality are urgently needed.

The Parsonnet score is widely used as a systematic risk stratification scoring system in cardiac surgery and can be applied to different populations. (10) It has shown moderate predictive value for mortality after CABG surgery in various studies conducted at different centers. (11) While the Parsonnet score focuses exclusively on preoperative patient risk factors (e.g., age, comorbidities) and excludes intraoperative or procedural variables, it demonstrates superior predictive validity for cardiac surgery mortality compared to generalized severity scoring systems like Acute Physiology and Chronic Health Evaluation (APACHE), Simplified Acute Physiology Score (SAPS), and Mortality Probability Models (MPM). These latter systems incorporate postoperative physiological data and broader clinical parameters, which may dilute their specificity for surgical risk assessment. (12) Nevertheless, validation of the Parsonnet score in populations with relatively high CABG mortality rates, such as in this study, remains scarce. Discrepancies in the mortality scoring system validation across different centers may stem from variations in mortality incidence rates. (13,14) Moreover, previous multicenter studies have not extensively reported on the validation of the Parsonnet score for predicting mortality after CABG surgery. This study aimed to comprehensively evaluate the predictive capability of the Parsonnet score for mortality in patients undergoing CABG. The findings are expected to reinforce the validation of the Parsonnet score as a reliable predictor of postoperative mortality, rendering it a valuable tool in CABG management.

Methods

Research design

This study employed an analytical observational research design with a retrospective cross-sectional approach. This research protocol was reviewed and approved by the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University, Makassar (Protocol number: UH24070538) with number 934/UN4.6.4.5.31/PP36/2024, dated 29 October 2024.

Population and research setting

This retrospective cohort study analyzed adults aged ≥18 years who underwent elective or urgent CABG procedures and were admitted to the ICU of the Integrated Heart Center at Dr. Wahidin Sudirohusodo Hospital, Makassar, between January 2019 and December 2023. A total sampling strategy was employed, encompassing all eligible patients, regardless of their survival status, including those discharged to general wards (survivors) and those who did not survive. Eligibility requirements included confirmed completion of CABG surgery and availability of complete perioperative medical records accessible for retrospective analysis.

Data collection

Initially, anamnesis and clinical examination data were recorded from medical records to obtain patient data including age, gender, height, weight, body mass index (BMI), diabetes status, hypertension (systolic blood pressure >140 mmHg), dialysis dependence, other conditions such as severe asthma, paraplegia, acute structural defects and acute renal failure, ejection fraction (EF), cardiogenic shock, pacemaker dependence, and congenital heart disease in adults. The CABG procedure was then documented to obtain data on previous heart operations, emergency procedures, surgical procedures performed, and mortality rates. Patients were then divided into two groups, namely survivors and non-survivors, based on their mortality status during treatment at the same hospital after the surgery. The calculation was then carried out using Parsonnet score and classifying them into five categories, namely good (score 0-4,

predicted death 1%), moderate (score 5-9, predicted death 5%), poor (score 10-14, predicted death 9%), high (score 15-19, predicted death 17%), and very high (score 20+, predicted death 30%). In the final stage, an analysis was conducted to examine the relationship between the Parsonnet score and patient mortality.

Data analysis

Statistical analysis was conducted in two phases. First, descriptive methods (frequency distributions and mortality rate percentages) summarized postoperative outcomes. Second, inferential analyses evaluated associations between the Parsonnet score and mortality. Categorical comparisons employed the chi-square test (or Fisher's exact test), with statistical significance set at $p<0.05$. For continuous variables (e.g., Parsonnet score as a predictor), parametric tests (independent t-test for two groups; ANOVA for three or more groups) were applied to data that were normally distributed, as confirmed by the Kolmogorov-Smirnov test. Non-normally distributed data were analyzed using non-parametric alternatives (Mann-Whitney U or Kruskal-Wallis tests). To assess the predictive accuracy of the Parsonnet score, receiver operating characteristic (ROC) curve analysis was performed, calculating the optimal cut-off value, sensitivity, specificity, and area under the curve (AUC). All analyses were executed in SPSS 23.0 (IBM Corp., USA).

Results

Characteristics of research samples

This research was conducted on 137 patients who underwent CABG surgery and were treated in the ICU of the Integrated Heart Center of Dr. Wahidin Sudirohusodo Hospital, Makassar, from January 2019 to December 2023. The mean age of the participants was 56.74 years with a standard deviation of 7.74 years. The majority of participants were male (86.10%), non-obese (94.90%), non-diabetic (65.70%), hypertensive (57.70%), had fair-grade intraoperative ejection fraction (54.70%), did not undergo preoperative intra-aortic balloon pump (IABP) procedures (87.60%), were not dialysis-dependent (91.20%), and had no catastrophic conditions (96.40%). The baseline characteristics of the study participants are shown in **Table 1**. All participants underwent primary CABG surgery, had no left ventricular aneurysm, did not undergo emergency CABG or experience catheterization complications, had no other comorbidities, and did not undergo additional surgical procedures. In this study, the majority of Parsonnet scores were categorized as low-risk (40.10%), followed by moderate-risk (36.50%), and very high-risk (15.30%).

Prevalence of post-CABG mortality

This study revealed that the majority of participants (90.50%) survived after undergoing CABG surgery, while only a small proportion (9.50%) did not survive. **Table 2** illustrates the differences in baseline characteristics between the survivor and non-survivor groups. The non-survivor group had a higher mean age compared to the survivor group. Both groups were homogeneous in terms of sex and obesity status, but heterogeneous in diabetes mellitus and hypertension status.

Analysis of predictor factors for post-CABG mortality

Table 3 presents the preliminary analysis of factors associated with post-CABG mortality. Risk factors included in the multivariate analysis were age, diabetes mellitus status, intraoperative ejection fraction grade, and catastrophic conditions, as these had a prevalence ratio >1.00 and p-value <0.250. Conversely, preoperative IABP procedures and dialysis dependence were identified as protective factors against post-CABG mortality in this study, though they were not statistically significant.

Table 4 shows further analysis of factors associated with mortality after CABG surgery. In this study, diabetes mellitus status was a significant risk factor for mortality after CABG surgery ($p=0.002$). The value of the adjusted prevalence ratio (APR) for diabetes mellitus status was 33.086 (95% CI 3.85-297.16). Other factors, such as age, degree of intraoperative ejection fraction, and catastrophic conditions, were not significant risk factors for mortality after CABG surgery ($p>0.05$).

Relationship between Parsonnet score and post-CABG mortality

The results of the analysis on the relationship between the Parsonnet score and mortality in patients undergoing CABG are presented in **Table 5**. The data are presented as median (min-max) based on the Kolmogorov-Smirnov test, which showed that the two outcome groups did not follow a normal distribution ($p<0.001$). The non-survivor group had a significantly higher median Parsonnet score compared to the survivor group (8.00 [5.00-56.00] vs 5.00 [0.00-61.00], $p=0.002$). This difference is further illustrated in **Figure 1**.

Discrimination, sensitivity, and specificity of the Parsonnet score against post-CABG mortality

The AUC analysis results for the Parsonnet score

and mortality in patients after CABG surgery are presented in **Figure 2**. The blue curve line is above the green diagonal curve line and tends to approach the upper left corner of the graph. This indicates that the predictive value of the Parsonnet score for patient mortality after CABG surgery is considered good.

Table 6 presents the AUC value, sensitivity, specificity, and cut-off point of the Parsonnet score for predicting mortality in patients after CABG surgery. The AUC value was 0.763 (95% confidence interval [CI] 0.674-0.853, p=0.002). An AUC value of ≥0.70 indicated that the Parsonnet score had a good discriminative ability in predicting mortality after the surgery. The optimal cut-off point was 5.50, with a sensitivity of 92.30% and specificity of 37.10%. These findings suggested that a Parsonnet score <5.50 indicated a low mortality risk, whereas a score >5.50 indicated a high mortality risk, making it useful for predicting mortality in patients after the surgery.

Calibration of the Parsonnet score in predicting mortality in post-CABG surgery

In this study, the calibration test results of the Parsonnet score in predicting mortality in post-CABG surgery are presented in **Table 7**. Based on the cross-tabulation between observed and expected values, the Parsonnet score of 0-4 underestimated mortality compared to the observed results. In contrast, scores of 5-9 overestimated mortality compared to the observed results. The Parsonnet score accurately predicted mortality in the >10 score range. The calibration test using the Hosmer-Lemeshow test yielded a p-value of 0.006, indicating a significant difference between the predicted and observed mortality rates based on the Parsonnet score risk categories. Thus, the analysis suggested that the Parsonnet score had moderate calibration in predicting mortality in patients with post-CAGB surgery.

Discussion

This study reported a postoperative mortality rate of 9.50% among CABG patients, which is comparatively lower than findings from domestic counterparts, but higher than rates observed in international settings. For example, a 2014 Indonesian cohort study at Dr. Kariadi Hospital, Semarang, documented a 14.3% mortality rate among post-CABG cases. (5) On the other hand, when compared with more developed countries, the mortality prevalence rate in this study was relatively higher. In a Canadian study, it was reported that a total of 3271 patients (67%) underwent isolated CABG surgery, while others underwent valve surgery or combined procedures with an overall mortality rate of 6.37% (n=311). (15) Notably, European data revealed even lower 30-day mortality rates post-CABG, with an aggregate of 3.0% across institutions, where mortality further varied by surgical volume: high-volume centers reported 2.1%, contrasting with 5.2% in low-volume hospitals. (4)

This study conducted an initial analysis of factors related to post-CABG surgery mortality, showing risk factors included age, diabetes mellitus status, degree of intraoperative ejection fraction, and catastrophic conditions. Further analysis showed that only diabetes mellitus status was a significant risk factor for mortality after CABG surgery. Post-CABG mortality rates vary significantly based on procedural and patient-related factors. While elective surgeries typically report mortality rates of 1-2%, this risk escalates with emergent cases, prior acute myocardial infarction, or comorbidities such as diabetes mellitus, chronic kidney disease, and severe coronary artery disease (CAD) affecting vessel quality. (16,17) Additional determinants include advanced age, male sex, reduced left ventricular ejection fraction (LVEF), prolonged aortic cross-clamp and cardiopulmonary bypass durations, and pre-existing multimorbidity. (6) For instance, a meta-analysis of 11 randomized trials (n=11,518) comparing percutaneous coronary intervention (PCI) and CABG outcomes revealed that 5-year mortality in both groups was predominantly associated with diabetic patients presenting with multivessel CAD, underscoring the interplay between metabolic disease and coronary anatomy complexity. (18)

Diabetes mellitus significantly exacerbates atherosclerosis progression and elevates morbidity and mortality risks in individuals with coronary heart disease, particularly after an acute coronary syndrome. This heightened risk is primarily driven by chronic hyperglycemia, which promotes the formation of advanced glycation end products (AGEs). These compounds compromise vascular wall elasticity and destabilize atherosclerotic plaques, thereby increasing the likelihood of plaque rupture —a critical mechanism underlying acute cardiovascular events in diabetic populations. (19)

The current analysis identified a statistically significant correlation between elevated Parsonnet scores and postoperative mortality in patients undergoing CABG, with the scoring system demonstrating clinically meaningful predictive performance. These observations align with earlier findings, where the Parsonnet model demonstrated strong prognostic utility for valvular procedures. (11) A study in Saudi Arabia also confirmed that the application of the

Parsonnet score yielded excellent results, consistent with internationally reported findings. (20) Additionally, the Parsonnet score demonstrated good predictive value in studies conducted at various centers, including Wythenshawe Hospital in Manchester and the Sarajevo Heart Center. (12)

The Parsonnet score, a widely used risk stratification tool in cardiac surgery, (21) categorizes preoperative risk into five distinct severity tiers, providing clinicians with a straightforward framework for predicting mortality and morbidity. Its adoption by surgical teams has been bolstered by studies validating its efficacy in forecasting in-hospital outcomes, particularly postoperative complications and mortality. While advanced computational models have emerged to refine risk assessment, their complexity often limits practicality in clinical workflows. Consequently, the Parsonnet score remains a preferred choice among cardiologists and surgeons for its balance of simplicity and reliability in preoperative planning. (10,11)

The diagnostic test results yielded an AUC value of 0.763, indicating that the Parsonnet score has good discriminative ability, meaning it can effectively distinguish between patients who survive and those who do not after CABG. The optimal cut-off value of the Parsonnet score for predicting mortality was 5.50, with a sensitivity of 92.30% and a specificity of 37.10%. The calibration test, using the Hosmer-Lemeshow test, resulted in a p-value of 0.006, indicating a significant difference between the predicted and observed mortality rates based on the Parsonnet score risk categories. Thus, the analysis suggests that the Parsonnet score has moderate calibration in predicting mortality in post-CABG surgery.

Previous studies have reported varying discrimination and calibration values for the Parsonnet score in predicting mortality after CABG surgery. A study in India reported that the AUC was found to be 0.73 (0.64-0.81) for CABG surgery, concluding that the Parsonnet score had moderate discrimination ability for CABG surgery. In the same study, the results of the model calibration test showed $p<0.01$, indicating that the Parsonnet score had poor calibration capabilities for CABG surgery. (11) In a population in Algeria, a study assessing the Parsonnet score in CABG patients reported good calibration, with Hosmer-Lemeshow test results ($\chi^2=8.40$, $p=0.395$) confirming adequate model fit. The observed-to-expected mortality ratios varied across risk strata (2.55, 4.36, 1.01). However, discriminatory power was moderate, with an AUC of 0.737 (95% CI 0.520-0.953), suggesting the score effectively stratified risk but had limitations in preprecisely predicting individual outcomes. (22) A study in Saudi Arabia confirmed that the Parsonnet score had a good calibration in line with internationally reported results. Therefore, it can be stated that the Parsonnet score could be applied as a predictor of mortality in the Saudi population. However, in this study, this scoring had lower discrimination than data from other centers. (20)

This study had several limitations that should be considered when generalizing the study's results. This study was conducted exclusively on patients undergoing CABG surgery at a single center with a relatively small sample size. In addition, this study did not measure specific biomarkers to predict mortality, which would have provided a more accurate comparison of predictor factors.

Conclusion

In this study with a relatively high prevalence of mortality after isolated CABG, the Parsonnet score was significantly associated with in-hospital mortality in this population, demonstrating good predictive value. Additionally, the Parsonnet score showed good discrimination and moderate calibration in predicting in-hospital mortality after isolated CABG. Further research could investigate the relationship between the Parsonnet score and other mortality predictors, such as inflammatory cytokines, to develop a combined predictive tool for mortality in patients undergoing CABG surgery. These findings supported the recommendation to use the Parsonnet score as a tool for predicting mortality in patients undergoing CABG in ICU settings during daily clinical practice.

Acknowledgments

The authors would like to thank Farhamna Academic for their assistance in preparing this manuscript. Thanks to the staff of the Anesthesiology and Intensive Care Department at Hasanuddin University Medical Faculty, who assisted in providing treatment and monitoring variables. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Table 1. Characteristics of research samples

Parameter (n=137)	n (%)
Age (years), mean±SD	56.74±7.74
Gender	
- Male	118 (86.10)
- Female	19 (13.90)
Obesity	
- Yes	7 (5.10)
- No	130 (94.90)
Diabetes mellitus status	
- Yes	47 (34.30)
- No	90 (65.70)
Hypertension status	
- Yes	79 (57.70)
- No	58 (42.30)
Intraop ejection fraction	
- Good	55 (40.10)
- Moderate	75 (54.70)
- Poor	7 (5.10)
Surgical history	
- First	137 (100)
- Second	0 (0.00)
Preoperative intra-aortic balloon pump	
- Yes	17 (12.40)
- No	120 (87.60)
Left ventricular aneurysm	
- Yes	0 (0.00)
- No	137 (100)
Emergency CABG surgery or catheterization complication	
- Yes	0 (0.00)
- No	137 (100)
Dialysis dependence	
- Yes	12 (8.80)
- No	125 (91.20)
Catastrophic condition	
- Yes	5 (3.60)
- No.	132 (96.40)
Other conditions	
- Yes	0 (0.00)
- No.	137 (100)
Undergoing other surgical procedures	
- Yes	0 (0.00)
- No.	137 (100)
Parsonnet score	
- Good	55 (40.10)
- Moderate	50 (36.50)
- Poor	4 (2.90)
- High	7 (5.10)
- Very high	21(15.30)

Legend: SD=standard deviation; CABG=coronary artery bypass graft.

Table 2. Differences in baseline characteristics of research samples based on mortality outcomes

Parameter	Survivors (n=124) n (%)	Non-survivors (n=13) n (%)	p-value
Age (years), mean±SD	56.29±7.71	61.00±6.94	0.036[a]
Gender - Male - Female	 107 (86.29) 17 (13.71)	 11 (84.62) 2 (15.38)	 1.000[b]
Obesity - Yes - No	 7 (5.64) 117 (94.36)	 0 (0) 13 (100)	 1.000[b]
Diabetes mellitus status - Yes - No	 35 (28.23) 89 (71.77)	 12 (92.31) 1 (7.69)	 <0.001[b]
Hypertension status - Yes - No	 66 (53.23) 58 (46.77)	 13 (100) 0 (0)	 0.001[c]

Legend: SD=standard deviation.
[a]Independent t-test; [b]Fisher's exact test; [c]Chi square test.

Table 3. Univariate analysis of factors associated with post-CABG mortality

Variables Assessed	Prevalence ratio (95% CI)	p-value
Age (years)	1.087 (1.00-1.17)	0.041[a]
Gender	1.144 (0.23-5.62)	0.799[b]
Obesity	0.00 (NA)	0.999[a]
Diabetes mellitus status	30.514 (3.82-243.55)	<0.001[b]
Hypertension status	$3.182x10^8$ (NA)	0.997[a]
Intraop ejection fraction	1.919 (0.71-5.20)	0.200[a]
Surgical history	NA	NA
Preoperative intra-aortic balloon pump	0.563 (0.07-4.62)	0.592[a]
Left ventricular aneurysm	NA	NA
Emergency CABG surgery or catheterization complication	NA	NA
Dialysis dependence	0.856 (0.10-7.22)	0.710[b]
Catastrophic condition	7.333 (1.10-48.67)	0.039[a]
Other conditions	NA	NA
Undergoing other surgical procedures	NA	NA

Legend: CABG=coronary artery bypass graft; CI=confidence interval; NA=not available.
[a]Simple logistic regression; [b]Chi square test

Table 4. Multivariate analysis of factors associated with post-CABG mortality

Variables assessed	Adjusted prevalence ratio (95% CI)	p-value
Age	1.090 (0.99-1.20)	0.079
Diabetes mellitus status	33.806 (3.85-297.16)	0.002
Intraop ejection fraction	2.310 (0.52-10.22)	0.270
Catastrophic condition	10.658 (0.58-197.30)	0.112

Legend: CABG=coronary artery bypass graft; CI=confidence interval.
Data was analyzed using the multiple logistic regression test.

Table 5. Relationship between Parsonnet score and post-CABG mortality

Mortality	Median	Min	Max	p-value
Non-survivors	8.00	5.00	56.00	0.002
Survivors	5.00	0.00	61.00	

Legend: CABG=coronary artery bypass graft.
Data was analyzed using the Mann-Whitney test.

Table 6. Results of ROC curve analysis on Parsonnet score and post-CABG surgery mortality

Analysis parameter	Value
AUC	0.763
Sensitivity	92.30%
Specificity	37.10%
Cut-off	5.50

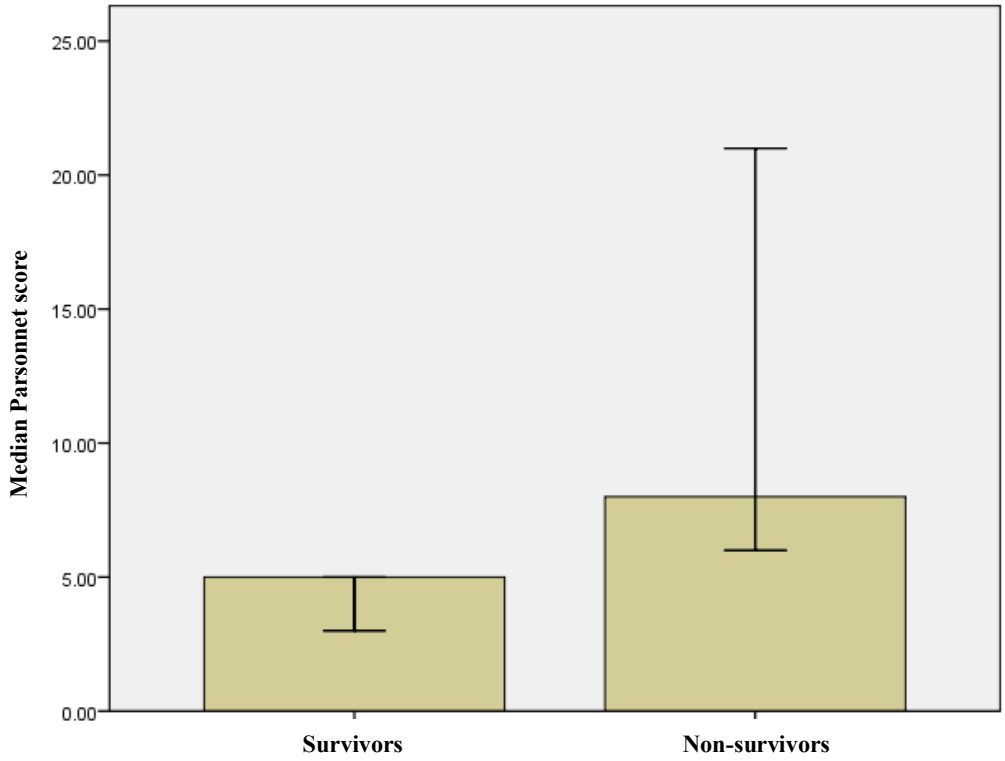
Legend: ROC=receiver operating characteristic; CABG=coronary artery bypass graft; AUC=area under the curve.

Table 7. Cross-tabulation analysis based on Parsonnet score categories

Parsonnet score	Non-survivors (n)		Survivors (n)		Total
	Expected	Observed	Expected	Observed	
0-4	3.409	0	51.591	55	55
5-9	4.154	9	45.846	41	50
10-14	1.461	1	9.539	10	11
15-19	3.976	3	17.024	18	21

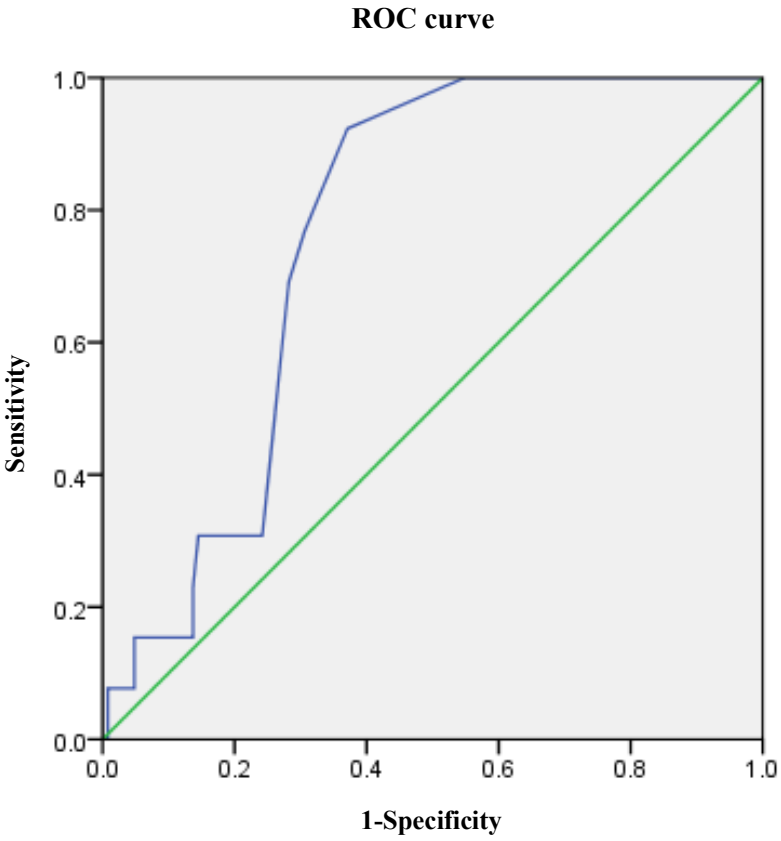
Data was analyzed using logistic regression analysis and the Hosmer-Lemeshow test.

Figure 1. Median difference in Parsonnet score between the survivors and non-survivors groups post-CABG mortality



Legend: CABG=coronary artery bypass graft.
Data is presented as median±95% confidence interval.

Figure 2. ROC curve of Parsonnet score on mortality in patients with post-CABG surgery



Legend: ROC=receiver operating characteristic; CABG=coronary artery bypass graft.

References

1. Shekar PS. Cardiology patient page. On-pump and off-pump coronary artery bypass grafting. Circulation 2006;113:e51-2.
2. Priyantoro K, Soerianata S. Non surgical management of unprotected isolated ostial left main coroner artery disease. J Kardiol Indones 2012;33:166-73.
3. Melly L, Torregrossa G, Lee T, Jansens J-L, Puskas JD. Fifty years of coronary artery bypass grafting. J Thorac Dis 2018;10:1960-7.
4. Gutacker N, Bloor K, Cookson R, Gale CP, Maynard A, Pagano D, et al. Hospital surgical volumes and mortality after coronary artery bypass grafting: using international comparisons to determine a safe threshold. Health Serv Res 2017;52:863-78.
5. Harahap GA, Nurcahyo WI, Ismail A. Mortalitas operasi jantung coronary artery bypass graft di RSUP Dr Kariadi Semarang periode Januari 2014 - Desember 2014. Jurnal Kedokteran Diponegoro 2016;5:160-6.
6. Ariaty GM, Sudjud RW, Sitanggang RH. Angka mortalitas pada pasien yang menjalani bedah pintas koroner berdasar Usia, jenis kelamin, left ventricular ejection fraction, cross clamp time, cardio pulmonary bypass time, dan penyakit penyerta. Jurnal Anestesi Perioperatif 2017;5:155-62.
7. Nur YS, Hisbullah, Adil A, Arif SK, Muchtar F, Wirawan NS. Relationship between the degree of pulmonary hypertension and postoperative mortality in adult cardiac surgery. Crit Care Shock 2024;27:17-24.
8. Rianda RA, Semedi BP, Subagjo A, Avidar YP. EuroSCORE II as predictor of mortality and morbidity in post-CABG Patient in Dr. Soetomo General Academic Hospital. Indonesian Journal of Anesthesiology and Reanimation 2022;4:14-21.
9. Janikowski K, Morawiec R, Jegier B, Jaszewski R, Lelonek M. EuroSCORE II does not show better accuracy nor predictive power in comparison to original EuroSCORE: A single-centre study. Kardiol Pol 2016;74:469-75.
10. Krishna N, Varma PK. Risk stratification in cardiac surgery. Indian J Thorac Cardiovasc Surg 2015;3:224-33.
11. Srilata M, Padhy N, Padmaja D, Gopinath R. Does Parsonnet scoring model predict mortality following adult cardiac surgery in India? Ann Card Anaesth 2015;18:161-9.
12. Kacila M, Tiwari KK, Granov N, Omerbasić E, Straus S. Assessment of the initial and modified Parsonnet score in mortality prediction of the patients operated in the Sarajevo heart center. Bosn J Basic Med Sci 2010;10:165-8.
13. Zahara R, Soeharto DF, Widyantoro B, Sugisman, Herlambang B. Validation of EuroSCORE II Scoring System on Isolated CABG Patient in Indonesia. Egypt Heart J 2023;75:86.
14. In KR, Oh YE, Moon HS, Jung S, Kang SH, Sung JK, et al. Comparison and validation of several scoring systems for non-variceal upper gastrointestinal bleeding: a retrospective study. Sci Rep 2024;14:27940.
15. de Varennes B, Lachapelle K, Cecere R, Ergina P, Shum-Tim D, Tchervenkov C, et al. Application of the Parsonnet scoring system for a Canadian cardiac surgery program. Can J Cardiol 2007;23:1061-5.
16. Bachar BJ, Manna B. Coronary artery bypass graft. Treasure Island (FL): StatPearls Publishing; 2021.
17. Harky A, Hussain SMA. Complications of coronary artery bypass grafting. Int J Med Rev 2019;6:1-5.
18. Head SJ, Milojevic M, Daemen J, Ahn J-M, Boersma E, Christiansen EH, et al. Mortality after coronary artery bypass grafting versus percutaneous coronary intervention with stenting for coronary artery disease: a pooled analysis of individual patient data. Lancet 2018;391:939-48.
19. Fishman SL, Sonmez H, Basman C, Singh V, Poretsky L. The role of advanced glycation end-products in the development of coronary artery disease in patients with and without diabetes mellitus: a review. Mol Med 2018;24:59.
20. Syed AU, Fawzy H, Farag A, Nemlander A. Predictive value of EuroSCORE and Parsonnet scoring in Saudi population. Heart Lung Circ 2004;13:384-8.
21. Ladha KS, Wijeysundera DN. Prognostic Risks and Preoperative Assessment. In: Cheng DCH, Martin J, David T, editors. Evidence-Based Practice in Perioperative Cardiac Anesthesia and Surgery. Switzerland: Springer Cham; 2021.
22. Boukhmis A, Nouar ME-A, Guerchani MK. Applicability of the Commonly Used Risk Scores for Coronary Bypass Surgery in Algeria. J Saudi Heart Assoc 2022;34:24-31.

This page is intentionally left blank