

PerfSCORE as a Predictor of Early Mortality in Open-Heart Surgery: Comparative Evaluation with NIRS and S100B

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ABSTRACT

Background: This study aims to investigate the correlation between NIRS and S100B, and the effects of NIRS, S100B, and PerfSCORE parameters on morbidity and mortality in patients undergoing open-heart surgery who had their cardiopulmonary bypass (CPB) flow volume adjusted using NIRS. **Methods:** In this prospective study, 60 adult patients undergoing open-heart surgery between January and June 2024 were enrolled. Intraoperative NIRS values were recorded at baseline, at the initiation of cardiopulmonary bypass (CPB), at CPB termination, and at the end of surgery for both cerebral hemispheres. Serum S100B levels were measured preoperatively (T1), and postoperatively at 6 hours (T2) and 24 hours (T3). Correlation analyses were performed between NIRS values and S100B levels. In addition, the effects of S100B, NIRS, and PerfSCORE on mortality and morbidity were compared. **Results:** A total of 73 procedures were performed in 60 patients. A weak negative correlation was found between early NIRS values and postoperative S100B levels ($r = -0.163$ to -0.282). No significant correlation was observed between NIRS2 values and S100B, while a weak positive correlation emerged between NIRS3 and S100B1. No significant association was found between S100B levels and the incidence of early mortality or neurological complications. In contrast, PerfSCORE parameters were significantly associated with early mortality (Nagelkerke's $R^2 = 0.765$), showing a prediction accuracy of 83.3% for deceased patients and 98.1% for survivors. **Conclusion:** Although weak correlations exist between cerebral oxygenation and S100B levels, S100B protein alone does not appear to be a reliable marker for early mortality. PerfSCORE parameters demonstrated greater predictive value and clinical utility.

KEYWORDS: Heart surgery, mortality, NIRS, PerfSCORE, S100B

INTRODUCTION

Despite advances in surgical techniques and pre- and postoperative care, cerebrovascular complications remain a cause of morbidity and mortality in patients undergoing open-heart surgery.^[1] These complications are often associated with factors such as extracorporeal circulation and intraoperative hypotension. The incidence of cerebrovascular events during cardiac surgery is estimated to be around 5%, ranging from transient ischemic attacks and temporary visual disturbances to permanent strokes.^[2] In particular, the occurrence of a permanent stroke significantly increases postoperative mortality.^[3]

Near-infrared spectroscopy (NIRS) is a noninvasive technique used to monitor regional cerebral oxygen saturation (rSO₂) during surgery using sensors implanted in the forehead. NIRS provides a real-time assessment of cerebral perfusion. A reduction of 25% or more in baseline rSO₂ is considered clinically significant and typically leads to interventions to improve cerebral oxygenation by increasing perfusion.^[4,5]

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S100B, a calcium-binding protein primarily found in astroglial cells, has been studied as a potential biomarker of cerebral injury in the context of cardiac surgery. During cardiopulmonary bypass (CPB) procedures, structural disruption of neuronal cells can cause S100B to leak into the cerebrospinal fluid and subsequently cross the blood–brain barrier (BBB), leading to measurable elevations in serum.^[6] Previous studies have reported 50- to 100-fold increases in S100B following cardiac surgery with CPB and have linked these elevations to microembolization and postoperative neurological dysfunction.^[7,8] However, the clinical utility of S100B remains controversial due to variability in timing, surgical factors, and inconsistent correlations with neurological outcomes.^[9]

PerfSCORE is a perfusion scoring system that includes intraoperative variables such as fluid balance, transfusion volume, hematocrit (Hct), active clotting time (ACT), arterial blood gases (PaO₂, PaCO₂, pH, base excess (BE)), potassium levels, and CPB time. Previous studies have identified several of these parameters—particularly CPB time, transfusion volume and PaO₂—as independent predictors of mortality.^[10,11]

The aim of this study was to evaluate the neuroprotective utility of intraoperative NIRS monitoring by analyzing its correlation with postoperative S100B protein levels. In addition, we compared the S100B, NIRS, and PerfSCORE parameters as predictors of mortality and morbidity.

MATERIALS AND METHODS

Study design

This study is a single-center, prospective, observational study conducted at Antalya Training and Research Hospital between January and June 2024. The study was approved by the institution's ethics committee (reference number: 2024-036, date: April 4, 2024), and written informed consent was obtained from all participants.

Sample size calculation

Sample size estimation was performed using GPower software based on logistic regression analysis. Assuming an odds ratio (OR) of 2.5, a two-sided alpha level of 0.05, and a statistical power of 80%, the minimum sample size required to detect a statistically significant association was calculated as 60 participants. Accordingly, the study was conducted with 60 participants.

Patients with chronic kidney disease, congestive heart failure (HF), recent cerebrovascular accident, or recent myocardial infarction were excluded from the study. A total of 60 adult patients undergoing open-heart surgery with complete data on S100B protein levels, NIRS values, and PerfSCORE parameters were included.

All data were prospectively collected and analyzed using Statistical Package for the Social Sciences version 23.0 (IBM Corp., Armonk, NY).

Sample collection and biomarker measurement

Venous blood samples were collected via a central venous catheter during routine perioperative monitoring at three time points: T1: preoperatively, on arrival in the operating room, T2: within the first 6 hours after surgery, T3: 24 hours postoperatively. All serum samples were stored at –80°C until analysis. S100B protein concentrations were measured using a commercially available ELISA kit (BTLAB, China) according to the manufacturer's protocol. NIRS values were continuously monitored intraoperatively using frontal scalp sensors placed bilaterally on the forehead. NIRS is a validated method for monitoring regional cerebral oxygen saturation in cardiac surgery.^[12] The following time points were used for data collection [Figure 1].

NIRS 1: At the start of surgery

NIRS 2: At the start of CPB

NIRS 3: At the end of CPB

NIRS 4: At the end of surgery

PerfSCORE parameters—including fluid balance, transfusion volume, Hct, ACT, arterial blood gases (pH, PaCO₂, PaO₂, BE), potassium, and total CPB time—were recorded intraoperatively.^[13] The PerfSCORE scoring is 7–10 points → adequate perfusion, 11–14 points → moderate perfusion risk, 15–21 points → high perfusion risk.

In addition, extra variables, such as CPB time, aortic clamping time, intubation time, intensive care unit and hospital stay duration, and pre- and postoperative hemodynamic data, were recorded and analyzed.

Anesthesia technique

Peripheral IV access was established using an 18G catheter. Standard intraoperative monitoring included ECG, pulse oximetry, and invasive blood pressure measurement via a 20G radial artery catheter. General anesthesia was induced with intravenous propofol (2 mg/kg), fentanyl (0.1 µg/kg), and vecuronium (0.15 mg/kg) and maintained with 4–5 MAC desflurane in 50% oxygen and air, together with continuous infusion of propofol, fentanyl, and vecuronium.^[7,8] A 7F central venous catheter was placed in the right internal jugular vein for CVP monitoring. Mechanical ventilation settings included a tidal volume of 8–10 mL/kg, PEEP of 5 cmH₂O, and end-tidal CO₂ between 32 and 35 mmHg.

Surgical technique

Coronary artery bypass grafting (CABG) was performed using a classic median sternotomy. Aortic and right atrial cannulation was performed using a two-stage venous cannula. Isothermal blood cardioplegia was administered after aortic cross-clamping to achieve diastolic cardiac arrest. For mitral valve procedures, bicaval cannulation was used and the left atrium was accessed via a transeptal incision. For ascending aortic replacement or Bentall procedures, femoral or subclavian arterial cannulation was used together with two-stage venous cannulation.^[13,14]

Statistical analysis

Data were expressed as mean $\pm$ standard deviation (SD). Group comparisons were made using unpaired *t*-tests. Pearson's correlation coefficient was used to assess relationships between continuous variables. Statistical significance was defined as $P < 0.05$. Logistic regression analysis was used to assess predictors of early mortality, and model performance was assessed using Nagelkerke's R^2 coefficient.

RESULTS

Demographic parameters

Demographic analyses are shown in Table 1 and surgical diversity in Table 2.

Cerebral monitoring and neural biomarkers

A moderate but statistically significant correlation was found between cerebral oxygen saturation (NIRS) and serum levels of S100B, a marker of neural injury [Table 3]. Preoperative NIRS–S100B correlation yielded a coefficient of 0.42 ($P = 0.001$), which further increased postoperatively to 0.47 ($P < 0.001$). This suggests that cerebral perfusion is moderately associated with biochemical indicators of neural stress, reinforcing the importance of continuous cerebral monitoring in high-risk cardiac procedures.

Perfusion profiles and patient demographics

A total of ten core perfusion parameters were assessed using the PerfSCORE system, revealing a wide range of perfusion statuses among the study population [Table 4]. Each parameter exhibited a distinct distribution pattern across normal, abnormal, and severely abnormal categories.

The PerfSCORE evaluation is shown in Table 5. For instance, BE values were within normal limits in 52 patients, while 7 exhibited abnormal and 1 had severely abnormal values. Comparable variability was observed for parameters such as ACT, Hct, and total cardiopulmonary bypass time (Tcpgb), reflecting the heterogeneity in intraoperative physiological responses.

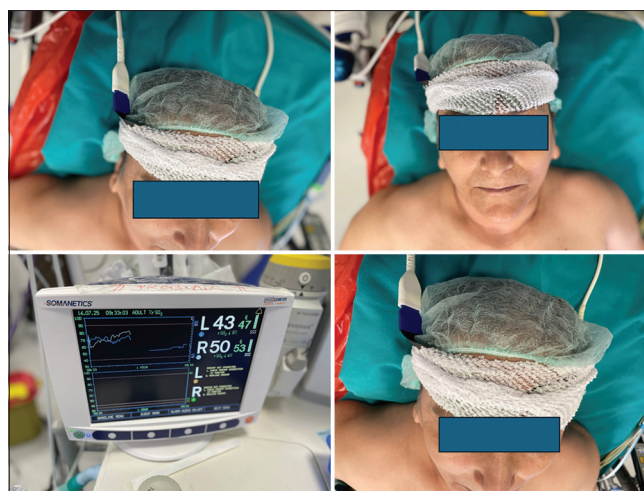


Figure 1: Monitoring using near-infrared spectroscopy (NIRS) during open-heart surgery

Table 1: Demographic parameters

Parameter	Value (mean $\pm$ SD/n. %)
Age	62.05 $\pm$ 9.60 (23-79)
Sex (M/F)	39:21:00
Mortality	6:60 (3 of them were discharged from the hospital)
PerfScore	6.71 $\pm$ 2.30 (2–12)
UF	5:60 (all ex)
Height	165.71 $\pm$ 9.64 (144–190)
Weight	79.78 $\pm$ 14.35 (48–122)
BSA	1.86 $\pm$ 0.20 (1.45–2.38)
EF	54.70 $\pm$ 8.14 (30–65)
BE	1.08 $\pm$ 2.75 (–4.10–8.20)
PCO2	42.06 $\pm$ 8.68 (25.10–64)

ACT: Activated clotting time; BE: Base deficit; BSA: Body surface area; EF: Ejection fraction; Hct: Hematocrit; UF: Ultrafiltration

Table 2: Surgeries

Operation	Frequency	Percent (%)
Cabg	31	51,7
MVR	5	8,3
AVR	8	13,3
Aort	1	1,7
Combine	15	25
Total	60	100

Aort: Ascending aortic replacement; AVR: Aort valve replacement; Cabg: Coronary artery bypass grafting; MVR: Mitral valve replacement; Combine Surgery: Aort valve replacement and ascending aortic replacement; AVR + MVR; Bentall; Cabg + AVR; Cabg + MVR; Cabg + Mitral Ring; MVR + De Vega annuloplasty

Predictive performance of perfusion-related metrics

In the study cohort, early mortality occurred in six patients, and early cerebrovascular accidents (CVA) were observed in three patients. PerfSCORE was used to predict early mortality, and receiver operating characteristic (ROC) curve analysis was performed

to evaluate the effect of individual perfusion-related parameters on mortality. ROC analysis [Table 6] [Figure 2] demonstrated moderate discriminatory ability across five perfusion-related scores. Among these, the

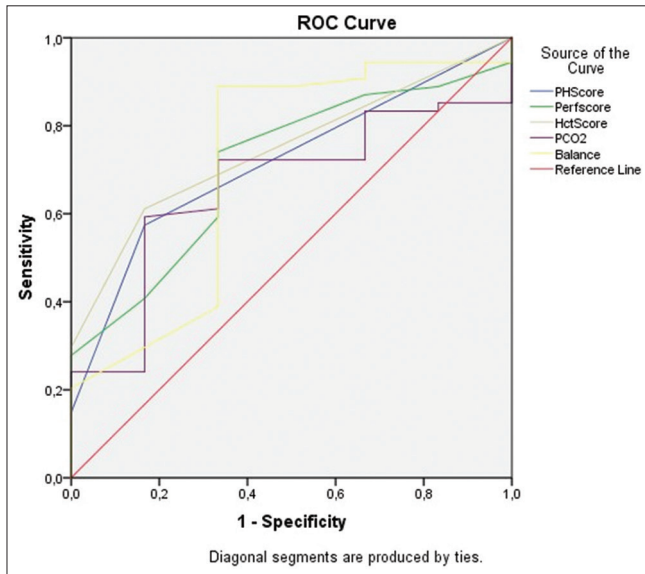


Figure 2: Receiver operating characteristic (ROC) curve analysis

Table 3: Correlations between NIRS and S100B values

NIRS	Correlations	S100B1	S100B2	S100B3
NIRS 1	<i>r</i>	-0.163	-0.224	-0.282
	<i>P</i>	0.212	0.086	0.029
NIRS 2	<i>r</i>	0.059	0.010	-0.078
	<i>P</i>	0.654	0.940	0.552
NIRS 3	<i>r</i>	0.112	0.026	-0.003
	<i>P</i>	0.396	0.843	0.984
NIRS 4	<i>r</i>	-0.154	-0.156	-0.231
	<i>P</i>	0.24	0.233	0.076

NIRS: Near-infrared spectroscopy

Hct score achieved the highest area under the curve (AUC = 0.747, $P = 0.049$), indicating relatively strong predictive capability. This was followed by PCO2 (AUC = 0.724), pH (AUC = 0.716), fluid balance (AUC = 0.711), and PerfSCORE (AUC = 0.708), with P values ranging from 0.074 to 0.096. While none exhibited exceptional discrimination alone, these parameters collectively showed promise as prognostic tools.

Multivariate regression analysis and model efficacy

Binary logistic regression identified PerfSCORE as the most influential independent predictor of early adverse events (OR = 1.42, 95% CI: 1.18–1.71, $P < 0.001$), implying a 42% increase in risk per unit rise in PerfSCORE [Table 7]. Additional significant predictors included the Hct score (OR = 1.15, $P = 0.021$), fluid balance (OR = 1.11, $P = 0.007$), and pH score (OR = 1.21, $P = 0.011$). In contrast, the PCO2 score did not achieve statistical significance ($P = 0.143$). The model's performance was robust, with a Nagelkerke R^2 of 0.765, suggesting that approximately 77% of the variability in clinical outcomes could be explained by the included parameters. The model accurately classified 98.1% of patients who experienced adverse events ("ex") and 83.3% of those who did not ("non-ex").

Integrated predictive insights and clinical implications

The collective findings from ROC and regression analyses underscore the clinical utility of integrated perfusion assessment, particularly the PerfSCORE system, in forecasting early adverse events. The combination of high classification accuracy and a strong explanatory model supports the use of PerfSCORE as a central component in perioperative risk stratification. Notably, PerfSCORE outperformed individual metrics, affirming the benefit of a composite, multidimensional

Table 4: PerfSCORE parameters scoring system

Parameters	Score ranges		
	0	1	2
Ph (IU)	7.35–7.45	7.30–7.34 and 7.46–7.50	<7.30 and >7.50
BE (IU)	>-2	-2 to -4	<-4
PaCO2 (mmHg)	30–40	25–29 and 41–45	<25 and >45
PaO2 (mmHg)	150–250	100–149 and 251–300	<100 and >300
ACT (s)	>480	400–480	<400
Fluid Balance (ml)	<4000	4000–5000	>5000
Donor blood transfused (units)	0	1–2	>2
Hct (%)	22–28	19–21 and 29–31	<19 and >31
K (mmol)	4.0–5.0	3.5–3.9 and 5.1–5.5	<3.5 and >5.5
Tcpb (min)	<100	100–150	>150

ACT: Activated clotting time; BE: Base excess; HCT: Hematocrit; Tcpb: Total cardiopulmonary bypass time

approach over isolated parameter evaluation. These results advocate for the incorporation of PerfSCORE into routine clinical workflows, enabling more personalized, data-driven intraoperative management strategies aimed at enhancing patient safety and outcomes in cardiac surgery.

DISCUSSION

The aim of this study was to demonstrate the correlation between NIRS and S100B. It was expected that the probability of cerebrovascular events, mortality, morbidity, length of hospital stay, length of intensive care stay, and renal failure would increase with S100B protein elevation in patients with low NIRS, but this could not be statistically proven.

The main results of this study are as follows:

- (i) PerfSCORE parameters are more valuable than S100B as a marker of early mortality,
- (ii) NIRS and S100B show a weak negative correlation,
- (iii) NIRS and S100B are not predictors of early mortality.

Jönsson *et al.*^[15] conducted a study in 2001 on 684 adult patients undergoing cardiac surgery. In the study, S100B protein elevation was associated with infarct area in 20 patients with CVA. In this study, unlike our study, patients did not undergo more than one surgical procedure and St Thomas' solution was used as the cardioplegia solution. In our study, infarct area was not

calculated in patients with CVA. No correlation was found between S100B elevation and CVA and mortality.

A study by Johnsson *et al.*^[16] in 2003 on 1075 patients concluded that even a small increase in blood S100B levels 2 days after cardiac surgery was associated with a poor prognosis, especially if it was associated with central nervous system complications. This study included patients who underwent combined surgery, similar to our study.

As a follow-up to this study, Jönsson *et al.*^[17] in 2004 showed that S100B levels 1 hour after surgery were the most informative in a study of 56 CABG cases. Increased S100B levels due to surgical site contamination did not affect outcome. It was concluded that S100B has limited clinical value as a predictive measure of postoperative cognitive dysfunction after cardiac surgery. In our study, patients underwent valve surgery, aortic surgery, and combined surgery other than CABG.

In the study by Ramos *et al.*^[18] it was stated that there is a relationship between the late persistent increase in serum S100B levels after heart surgery and neurological dysfunction. In the study by Ramos *et al.*,^[18] it was shown that there is a correlation between S100B and cardiac troponin I levels, and it was also stated that the early increase in S100B levels may be due to heart tissue.

In the 2011 study by Varrica *et al.*^[19] on 26 patients with congenital heart disease, S100B and adiponectin levels were measured after surgery, and although there was a change in S100B levels after surgery, it was observed that the adiponectin rate remained constant. It was concluded that S100B is not affected by adipose tissue.

A 2014 review by Yuan *et al.*^[20] evaluated data from studies conducted between 1990 and 2014 with S100B follow-up in open-heart surgery. Brain injury in cardiac surgery may be associated with younger age, lower body temperature, and longer duration of CPB during surgery. They concluded that effective interventions with modified CPB circuit filters or oxygenators and supplemental anesthetics or priming solution components may reduce brain injury.

A study conducted by Hansen *et al.*^[21] in 2019 found a correlation between S100B and NIRS in infants, but

Table 5: PerfSCORE values

Parameters	Patient Groups		
	0	1	2
Ph	28	25	7
BE	52	7	1
PaCO ₂	24	16	20
PaO ₂	12	9	39
ACT	31	25	4
Fluid balance	60	0	0
Donor blood transfused	19	29	12
Hct	26	18	16
K	38	16	6
Tcpb	24	26	10

ACT: Activated clotting time; BE: Base excess; HCT: Hematocrit; Tcpb: Total cardiopulmonary bypass time

Table 6: ROC curve analysis

Risk factor	Area	Std. Error	Sig. (p)	Lower bound (CI: 95)	Upper bound (CI: 95)
Ph score	0.716	0.093	0.085	0.534	0.898
Perf score	0.708	0.098	0.096	0.517	0.9
Hct score	0.747	0.082	0.049	0.585	0.908
PCO ₂ score	0.724	0.114	0.074	0.5	0.948
Balance	0.711	0.126	0.091	0.465	0.958

CI=Confidence interval

Table 7: Regression analysis

Parameter	OR	95% CI	P
PerfSCORE	1.42	1.18–1.71	<0.001
Hct score	1.15	1.02–1.29	0.021
Fluid balance	1.11	1.03–1.20	0.007
PCO2 score	1.09	0.97–1.23	0.143
pH score	1.21	1.05–1.40	0.011
Model summary			Value
-2 Log Likelihood			11.679
Cox and Snell R square			0.366
Nagelkerke R square			0.765
Observed	Predicted	Percentage correct	
	No Ex	Ex	
No Ex	53	1	
Ex	1	5	
Overall percentage	%98.1	%83.3	

Binary logistic regression model included PerfSCORE, Hct score, fluid balance, PCO2 score, and pH score. Nagelkerke's $R^2=0.765$. The model predicted ex status with 83.3% accuracy and non-ex with 98.1% accuracy. CI=Confidence interval; OR=Odds ratio

no relationship was found between S100B and NIRS in neonates. It was concluded that S100B release in neonates is associated with the development of the BBB and that S100B levels should be interpreted according to age-related reference values. Our study was an adult study, and similar to Hansen's findings in infants, no strong correlation was found between NIRS and S100B. The variability of S100B levels in adults due to age or additional diseases is unknown.^[21]

Baktiar *et al.*^[22] included 55 patients who underwent open-heart surgery in their study in 2019, and the S100B rate was higher in patients with postoperative cognitive dysfunction. It was concluded that S100B could be used as a marker for cognitive dysfunction after open-heart surgery.^[22]

Lapergola *et al.*^[23] in their 2022 review concluded that S100B measurement may give different results depending on the type of surgery and the patient. Differences between adult and pediatric cardiac surgery—such as use of alpha-stat strategy, CPB duration, deep hypothermic arrest, and preoperative congenital conditions—may affect S100B release. They reported that S100B release from adipose tissue, sternotomy, pump on/off phase, autotransfusion and spilled mediastinal blood, cardiomyotomy suction, thoracic, and pericardial drainage may affect S100B levels in blood samples taken from the pump. In addition, inflammation due to hypoxia-hyperoxia during cooling/warming, BBB changes due to temperature, anesthetic management, and CPB phases may contribute to exaggerated S100B levels.^[23] This also supports our study.

In the study by Jegger *et al.*,^[24] CPB duration, blood transfusion, and PaO2 were independent risk factors

for mortality. Fluid balance, blood transfusion, PaO2, PerfSCORE, and CPB duration were independent parameters for predicting morbidity. PerfSCORE is a perfusion quality score that objectively measures perfusion performance. In our study, PerfSCORE was more significant than S100B as an independent predictor of mortality.

In the study by Traub *et al.*,^[25] it was stated that elevated S100B levels in patients with chronic HF were associated with both cardiac and cognitive dysfunction. The significant correlation between S100B and NT-proBNP levels suggests an interaction between cardiac stress and brain health in patients with HF. However, the fact that S100B did not affect mortality likely reflects acute damage rather than long-term outcomes. This supports the idea that S100B cannot be used as a mortality marker, as in our study. As a result of our study, we believe that S100B can reach very high levels in different patients due to CPB, hypothermia, and ischemia-reperfusion in open-heart surgery and therefore cannot be used as a marker of mortality or morbidity. The PerfSCORE parameters are more valuable than S100B as a marker of early mortality.

If the study is conducted in an isolated group of patients undergoing a single type of open-heart surgery, significant results may be obtained.

CONCLUSION

This study demonstrates that PerfSCORE and related perfusion parameters provide robust and independent prediction of early adverse outcomes following cardiac surgery. Multivariate regression analysis revealed PerfSCORE as the most powerful independent predictor (OR = 1.42, 95% CI: 1.18–1.71, $P < 0.001$), with Hct score (OR = 1.15, $P = 0.021$), fluid balance (OR = 1.11, $P = 0.007$), and pH score (OR = 1.21, $P = 0.011$) also showing significant predictive value. The overall model displayed excellent explanatory power (Nagelkerke $R^2 = 0.765$) and high classification accuracy, correctly identifying 98.1% of adverse events and 83.3% of nonevents. These findings strongly support the integration of comprehensive perfusion assessment—particularly PerfSCORE—into perioperative risk stratification and management protocols to improve patient outcomes in cardiac surgery.

Limitations

The limitations of this study are as follows. First, it is a single-center study, which may limit the generalizability of the findings to larger patient populations and different clinical settings. Second, the sample size, while adequate

for initial modeling, remains relatively modest and may not capture the full spectrum of variability in perfusion parameters and outcomes. Third, although the PerfSCORE system integrates multiple perfusion-related variables, potential confounding factors—such as intraoperative management differences, unmeasured comorbidities, and variations in surgical technique—could have influenced the results. Additionally, the study focused on early postoperative outcomes, and longer-term prognostic implications of PerfSCORE were not evaluated. Finally, although the regression model used demonstrated strong predictive performance, larger, prospective, and multicenter studies are needed to establish the accuracy and clinical utility of these findings.

Declarations

Compliance with ethical standards.

Ethical approval

Ethical approval for this study was obtained from Antalya Training and Research Hospital. The decision number is 2024/036, dated 04.04.2024. Written and verbal informed consent was obtained from individuals who agreed to participate in the study. Participants were given a voluntary informed consent form, stating that they could withdraw from the study at any time and that their data would be stored.

Availability of data and material

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Authors contributions

AK: Conceptualization, data curation, project administration, writing—original draft. AAO: Data curation, investigation, writing—original draft. SK: Data curation, investigation, methodology, writing—original draft. GÖ: Data curation, investigation, writing—original draft. HY: Investigation, formal analysis, project administration, writing—original draft. MSA: Writing—original draft.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Bucerius J, Gummert JF, Borger MA, Walther T, Doll N, Onnasch JF, *et al.* Stroke after cardiac surgery: A risk factor analysis of 16,184 consecutive adult patients. *Ann Thorac Surg* 2003;75:472-8.
- Mao Z, Zhong X, Yin J, Zhao Z, Hu X, Hackett ML. Predictors associated with stroke after coronary artery bypass grafting: A systematic review. *J Neurol Sci* 2015;357:1-7.
- Selnes OA, Grega MA, Bailey MM, Pham L, Zeger S, Baumgartner WA, *et al.* Neurocognitive outcomes 3 years after coronary artery bypass graft surgery: A controlled study. *Ann Thorac Surg* 2007;84:1885-96.
- Murkin JM, Adams SJ, Novick RJ, Quantz M, Bainbridge D, Iglesias I, *et al.* Monitoring brain oxygen saturation during coronary bypass surgery: A randomized, prospective study. *Anesth Analg* 2007;104:51-8.
- Fischer GW. Recent advances in application of cerebral oximetry in adult cardiovascular surgery. *Semin Cardiothorac Vasc Anesth* 2008;12:60-9.
- Jönsson H, Johnsson P, Alling C, Bäckström M, Bergh C, Blomquist S. S-100beta after coronary artery surgery: Release pattern, source of contamination, and relation to neuropsychological outcome. *Ann Thorac Surg* 1999;68:2202-8.
- Korfias S, Stranjalis G, Boviatsis E, Psachoulia C, Jullien G, Gregson B, *et al.* Serum S-100B protein monitoring in patients with severe traumatic brain injury. *Intensive Care Med* 2007;33:255-60.
- Tomaszewski D. Biomarkers of brain damage and postoperative cognitive disorders in orthopedic patients: An update. *Biomed Res Int* 2015;2015:402959.
- Anderson RE, Hansson LO, Nilsson O, Djlai-Merzoug R, Settergren G. High serum S100B levels for trauma patients without head injuries. *Neurosurgery* 2001;48:1255-8.
- Arcieri L, Federici D, Giordano R. Current trends in perfusion strategies for neonates undergoing aortic arch repair: The rough path to the perfect idea. *J Thorac Dis* 2020;12:3436-8.
- Bove T, Calabrò MG, Landoni G, Aletti G, Marino G, Crescenzi G, *et al.* The incidence and risk of acute renal failure after cardiac surgery. *J Cardiothorac Vasc Anesth* 2004;18:442-5.
- Hogue CW, Levine A, Hudson A, Lewis C. Clinical applications of near-infrared spectroscopy monitoring in cardiovascular surgery. *Anesthesiology* 2021;134:784-91.
- Kouchoukos NT, Blackstone EH, Hanley FL, Kirklin JK. *Kirklin/Barratt-Boyes Cardiac Surgery: Morphology, Diagnostic Criteria, Natural History, Techniques, Results, and Indications*. 4th ed. Elsevier Health Sciences; 2013. p. 354.
- Xiling Z, Puehler T, Sondergaard L, Frank D, Seoudy H, Mohammad B, *et al.* Transcatheter mitral valve repair or replacement: Competitive or complementary? *J Clin Med* 2022;11:3377.
- Jönsson H, Johnsson P, Birch-Iensen M, Alling C, Westaby S, Blomquist S. S100B as a predictor of size and outcome of stroke after cardiac surgery. *Ann Thorac Surg* 2001;71:1433-7.
- Johnsson P, Lundqvist C, Alling C, Ravn H, Blomquist S. S100B as a predictor of unsuccessful outcome in treated acute ischemic stroke. *Stroke* 2003;34:1864-8.
- Jönsson H, Johnsson P, Birch-Iensen M, Alling C, Westaby S, Blomquist S. Postoperative serum S100B levels for prediction of persistent cognitive dysfunction after coronary bypass surgery. *Thorac Cardiovasc Surg* 2004;52:346-9.
- Ramos JG, Gold MI, Avellaneda NA, Fabiano J, Esslinger A, Maraj M. Relationship between S100B protein and neurological dysfunction after cardiac surgery. *Rev Bras Anesthesiol* 2004;54:448-60.
- Varrica A, Alaimo G, Martino F, Martorana A, Scuderi R, Del Gaudio M, *et al.* Evaluation of serum S100B and adiponectin in congenital heart disease surgery. *Interact Cardiovasc Thorac*

- Surg 2011;13:304–8.
20. Yuan SM, Lin H. S100B protein in cardiac surgery. *Interact Cardiovasc Thorac Surg* 2014;18:603–10.
 21. Hansen JH, KissnerL, Logoteta J, Juy O, Dütschke P, AttmannT, *et al.* S100B and its relation to cerebral oxygenation in neonates and infants undergoing surgery for congenital heart disease. *Congenit Heart Dis* 2019;14:427-37.
 22. Baktiar Y, Soenarto RF, Alates A, Auerkari AN, S100B as a serologic marker for cognitive dysfunction following open-heart surgery. *Int J Appl Pharm* 2020,12,50-3.
 23. Lapergola G, Graziosi A, D'Adamo E, Brindisino P, Ferrari M, Romanelli A, *et al.* S100B in cardiac surgery brain monitoring: friend or foe? *Clin Chem Lab Med* 2022;60:317-31 [doi: 10.1515/ccm-2021-1012].
 24. Jegger D, Revelly JP, Horisberger J, von Segesser LK, Ruchat P. Establishing an association between a peri-operative perfusion score system (PerfSCORE) and post-operative patient morbidity/mortality during CPB cardiac surgery. *Perfusion* 2007;22:311-6.
 25. Traub J, Schuhmann MK, Sell R, Frantz S, Störk S, Stoll G, Frey A. S100B serum levels in chronic heart failure patients: A multifaceted biomarker linking cardiac and cognitive dysfunction. *Int J Mol Sci* 2024;25:9094.