DOI: 10.4274/forbes.galenos.2026.50133
Forbes J Med 2026;7:115-21

Original Article

Association of Serial Postoperative CASUS Scores With In-Hospital Mortality Among Patients With Prolonged Mechanical Ventilation After Open-Heart Surgery: A Retrospective Cohort Study

Anıl ONUR[1], Osman Sıla AYDIN[1], Ahmet Burak TATLI[2], Cihan Sedat AYTÜNÜR[1], Nuri Burkay SOYLU[1], Mesut ÖZTÜRK[1], Ahmet Kağan AS[2], Ümran KARACA[1], Tuğba ONUR[1]

[1]University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Bursa, Türkiye
[2]University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital, Clinic of Cardiovascular Surgery, Bursa, Türkiye

Cite as: Onur A, Aydın OS, Tatlı AB, et al. Association of serial postoperative CASUS scores with in-hospital mortality among patients with prolonged mechanical ventilation after open-heart surgery: a retrospective cohort study. Forbes J Med. 2026;7:115-21

ABSTRACT

Objective: To evaluate the association between serial cardiac surgery score (CASUS) measurements and in-hospital mortality, and to assess the day-specific discrimination of these measurements among patients requiring prolonged mechanical ventilation after open-heart surgery.

Methods: This single-center retrospective cohort screened 1,255 adults who underwent open-heart surgery with cardiopulmonary bypass (CPB). Of the 118 patients ventilated for more than 24 hours, 55 lacked the data required for the postoperative day 1 CASUS calculation, leaving 63 patients for analysis. CASUS was assessed on postoperative days 1-5 using linear mixed-effects models, receiver operating characteristic analysis, and logistic regression analysis.

Results: Twenty-one patients survived, and 42 died in hospital. CASUS availability decreased from 63 on day 1 to 59 on day 5 because four non-survivors died before subsequent measurements could be obtained. The group-by-day interaction was significant ($p<0.001$). Day 4 and day 5 scores were higher among non-survivors (Welch's t-test, $p=0.011$ and $p<0.001$, respectively). Day 5 CASUS showed moderate discrimination [area under the curve 0.729, 95% confidence interval (CI) 0.602-0.856; $p=0.004$]. At a cut-off >8.5, sensitivity was 55.3% and specificity was 90.5%. Among 59 complete cases, day-5 CASUS was associated with in-hospital mortality after adjustment for age, CPB duration, and EuroSCORE II (adjusted odds ratio 1.245, 95% CI 1.076-1.439; $p=0.003$).

Conclusion: Day 5 CASUS was associated with mortality and showed moderate discrimination in this selected cohort, but it represented a late severity marker rather than an early prognostic tool. External validation is required.

Keywords: Cardiac surgical procedures, respiration, artificial, mortality, risk assessment, intensive care units

Received: 02.07.2026
Accepted: 16.09.2026
Publication Date: 29.09.2026

Corresponding Author:
Anıl ONUR
University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Bursa, Türkiye
dr.anilonur@gmail.com
ORCID ID: 0000-0002-3957-922X

INTRODUCTION

Cardiopulmonary bypass (CPB) exposes patients undergoing open-heart surgery to several inflammatory stimuli. Contact between blood and the artificial circuit, together with operative trauma, endotoxemia, and ischemia-reperfusion, activates leukocytes and the vascular endothelium; proinflammatory cytokines, reactive oxygen metabolites, and nitric oxide are subsequently released. Systemic inflammation is frequent after cardiac surgery, although its clinical relevance and definition vary.[1] When this response becomes dysregulated, multiple organ dysfunction may follow and postoperative morbidity and mortality may increase.

Definitions of prolonged mechanical ventilation (PMV) differ across studies; in cardiac surgery, PMV is commonly defined as ventilation continuing beyond 24 hours. PMV is a major postoperative complication that is associated with greater in-hospital mortality, longer intensive care unit (ICU) stays, more infections, and higher treatment costs. A recent meta-analysis estimated an overall incidence of 20%, including approximately 12% after isolated coronary artery bypass grafting and confirmed an associated increase in mortality.[2] Reported independent predictors include female sex, preoperative leukocytosis, longer CPB exposure, elevated lactate levels, and reoperation for postoperative bleeding.[3] These consequences have prompted efforts both to validate existing tools and to develop new models

for identifying patients at risk; a recent study developed and validated one such model.[4]

Various scoring systems have been developed to support clinical decision-making for cardiac surgery ICU patients. EuroSCORE II is widely used to assess preoperative mortality risk, but it was not designed for daily postoperative stratification, while commonly used postoperative scores such as Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evaluation (APACHE II) lack calibration specific to cardiac surgery patients. Although EuroSCORE II has shown good discrimination for mortality, it has been found unable to reliably predict risk in high-risk patients (score above 10), highlighting the need for new scoring systems.[5,6]

Cardiac surgery score (CASUS) was designed to allow repeated assessment of postoperative mortality in patients in the cardiac surgical ICU. Compared with other ICU scores, CASUS and SOFA both provided reliable estimates, but CASUS achieved better individual-level prediction and larger daily receiver operating characteristic (ROC) areas, leading investigators to recommend it for this setting.[7] The scored items are: glasgow coma scale, PaO_2/FiO_2, creatinine, bilirubin, renal replacement therapy, lactate, platelet count, pressure-adjusted heart rate, and support with an intra-aortic balloon pump or ventricular assist device. The calculation is straightforward and can be performed online at www.cardiac-icu.org. That study also reported high discrimination (AUC ≥0.90).[7]

In our country, data on the clinical validation of the CASUS score in cardiac surgery are limited. At our center, EuroSCORE II is used to predict postoperative mortality, yet the current literature suggests that CASUS provides more reliable results for daily risk assessment. Validation studies at various centers indicate that CASUS may require local modification and that its additive version offers practical advantages over the logistic version, particularly in settings with low mortality rates.[8] This suggests that the predictive value of CASUS in a high-risk, complicated patient group warrants further investigation and constitutes the primary hypothesis of our study.

PMV identifies a clinically severe postoperative subgroup in which evolving organ dysfunction may be reflected in serial CASUS measurements. However, the performance of CASUS in this restricted population has not been adequately characterized. Therefore, this study aimed to describe CASUS scores during the first five postoperative days and to evaluate their association with, and day-specific discriminatory performance for, in-hospital mortality among adults who required PMV (>24 hours) after open-heart surgery. Mortality was the study outcome and was not an inclusion criterion.

METHODS

Study Design and Patient Population

We assembled this retrospective cohort at a single center. Records of 1,255 adults who underwent open-heart surgery with CPB between June 1, 2024, and December 31, 2025 were screened. Among them, 118 patients required invasive mechanical ventilation for more than 24 hours postoperatively and therefore met the PMV definition. Off-pump and non-cardiac procedures were not part of the eligible source population. Fifty-five patients were excluded because the clinical or laboratory data required to calculate the postoperative day 1 CASUS score were incomplete. The remaining 63 patients met the PMV criterion and were categorized according to in-hospital survival: 21 survivors and 42 non-survivors.

The study was approved by the Medical Sciences Ethics Committee of the University of Health Sciences Bursa Yüksek İhtisas Training and Research Hospital on March 11, 2026 (decision no: 2024-TBEK 2026/03-02). Identifying approval details were submitted separately to the editorial office and were withheld from the blinded manuscript. The study was conducted in accordance with the Declaration of Helsinki. Owing to the retrospective design, the ethics committee waived the requirement for informed consent.

Inclusion and Exclusion Criteria

Patients aged 18 years or older who underwent open-heart surgery with CPB during the study period and developed PMV (>24 hours) were eligible. Off-pump and non-cardiac procedures were not eligible. Among patients meeting the PMV criterion, those with incomplete clinical or laboratory data required for the postoperative day 1 CASUS calculation were excluded. In-hospital mortality was not an inclusion criterion.

Data Collection and Variables

Information was abstracted retrospectively from four institutional sources: the encrypted hospital information system, the ICU monitoring records, the clinical charts, and the laboratory database. Collected demographic measures included age, sex, height, weight, and body mass index. Preoperative variables included diabetes mellitus, hypertension, coronary artery disease, chronic obstructive pulmonary disease, chronic kidney disease, ejection fraction, laboratory results, and EuroSCORE II. Procedure-related variables included operation type, CPB and aortic cross-clamp durations, and IABP or VAD use; postoperative variables were also recorded.

We applied the additive version of CASUS developed for cardiac surgical intensive care. Its 10 inputs include lactate, creatinine, bilirubin, pressure-adjusted heart rate, PaO_2/FiO_2, platelet count, Glasgow Coma Scale, IABP and VAD support, and renal replacement therapy. CASUS was calculated on postoperative days 1-5, when the required measurements were available. Postmortem measurements were structurally unavailable and not imputed.

Endpoints

The primary endpoint was in-hospital mortality. PMV (>24 hours) was the cohort-defining inclusion criterion and was not evaluated as an endpoint. The analyses assessed, within this selected PMV cohort only, the association and discriminatory performance of serial CASUS scores for mortality.

Statistical Analysis

Statistical analyses were performed with SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Normality was assessed with the Shapiro-Wilk test. Continuous variables are presented as mean ± standard deviation or median (interquartile range), as appropriate, and categorical variables as number and percentage. Between-group comparisons were performed using the independent-samples t test or Mann-Whitney U test for continuous variables, and the chi-square test or an exact test for categorical variables. Surgical procedure types were compared using the Fisher-Freeman-Halton exact test. The longitudinal CASUS course was examined using a linear mixed-effects model with a patient-specific random intercept, and with mortality group, postoperative day (as a categorical factor), and their interaction included as fixed effects. The model used all observed measurements and accommodated unbalanced follow-up, but it could not eliminate bias arising from informative dropout due to death. Day-specific observed CASUS scores were compared using Welch's t-test.

Day-specific ROC analyses included patients with an available CASUS measurement for the corresponding day; each AUC was tested against 0.5, and exploratory cut-offs were selected using the Youden index. No adjustment for multiple testing was applied; therefore, day-specific comparisons and ROC analyses were considered exploratory. The postoperative day-5 CASUS score was the predictor of interest in the logistic regression. Age, CPB duration, and EuroSCORE II were included on clinical grounds as adjustment covariates, rather than being selected by univariable p values. Univariable and adjusted odds ratios (ORs) with 95% confidence intervals were reported for the common complete-case day-5 population. Model fit was summarized using Nagelkerke R^2 and the Hosmer-Lemeshow test; the latter was not interpreted as evidence of good calibration. No formal a priori sample-size calculation was performed because all eligible patients in the predefined retrospective period were included. A two-sided p value <0.05 was considered statistically significant. This study was reported in accordance with STROBE guidelines.

RESULTS

Of 1,255 patients screened, 118 developed PMV lasting longer than 24 hours. Fifty-five patients were excluded because the clinical or laboratory data required to calculate the postoperative day 1 CASUS score were incomplete, leaving 63 patients in the final analysis. All 63 patients met the PMV criterion: 21 (33.3%) survived and 42 (66.7%) died during hospitalization.

The mean age was 66.1±5.9 years among survivors and 66.1±9.7 years among non-survivors (p=0.980). No significant differences were found in sex distribution (p=0.270), body mass index (p=0.590), diabetes mellitus (p=0.580), hypertension (p=0.780), chronic obstructive pulmonary disease (p=0.470), chronic kidney disease (p=0.510), ejection fraction (p=0.640), or EuroSCORE II (p=0.220). The cohort included 27 CABG operations, 17 combined operations, 11 valve operations, and 8 aortic operations. The type of surgical procedure did not differ by mortality status (Fisher-Freeman-Halton exact p=0.403; Table 1).

Intraoperative characteristics were similar between survivors and non-survivors (Table 2). CASUS measurements were available for 63, 62, 62, 60, and 59 patients on postoperative days 1-5, respectively. All 21 survivors had measurements through day 5. Among non-survivors, one patient died on postoperative day 1, two on day 3, and one on day 4; therefore, subsequent CASUS measurements were unavailable. The linear mixed-effects model showed a group-by-day interaction [$F(4, 235)=5.28$; $p<0.001$], indicating different average score patterns for survivors and non-survivors. In the exploratory unadjusted Welch's t-tests, scores were 5.6±3.6 versus 8.7±5.5 on day 4 (p=0.011) and 4.6±3.2 versus 9.4±6.5 on day 5 (p<0.001), respectively (Table 3, Figure 1).

The effective sample sizes for ROC analyses on postoperative days 1-5 were 63, 62, 62, 60, and 59, respectively. AUCs were 0.584 on day 1 (p=0.281), 0.575 on day 2 (p=0.337), 0.620 on day 3 (p=0.126), 0.664 on day 4 (p=0.037), and 0.729 on day 5 (p=0.004). The exploratory Youden cut-off for day 4 was >8.5 (sensitivity 53.8%, specificity 76.2%), and the day 5 cut-off was >8.5 (sensitivity 55.3%, specificity 90.5%). Day 5 CASUS, therefore, showed moderate discrimination but limited sensitivity in this selected cohort. EuroSCORE II did not show evidence of discrimination (AUC =0.413; p=0.265). All day-specific analyses and cut-offs were internally derived and should be considered exploratory (Table 4, Figure 2).

The day-5 complete-case analyses included 59 patients (21 survivors and 38 non-survivors). In univariable analysis, day 5 CASUS was associated with mortality (OR 1.204, 95% CI 1.055-1.375; p=0.006), whereas age (OR 1.004, 95% CI 0.941-1.070; p=0.913), CPB duration (OR 1.003, 95% CI 0.994-1.013; p=0.490), and EuroSCORE II (OR 0.836, 95% CI 0.621-1.126; p=0.239) were not associated with mortality. After adjustment, day 5 CASUS remained associated with higher odds of in-hospital mortality (adjusted OR 1.245, 95% CI 1.076-1.439; p=0.003); each one-point increase corresponded to a 24.5% increase in the adjusted odds, not the probability, of mortality. The Hosmer-Lemeshow test did not indicate a gross lack of fit (chi-square =8.382, df=8; p=0.397), but calibration cannot be established from this test in a small sample. Nagelkerke R^2 was 0.309, and the model was neither internally nor externally validated (Table 5, Figure 3).

Table 1. Demographic, preoperative, and procedural characteristics [mean ± SD, n (%)]			
Variable	**Survivors (n=21)**	**Non-survivors (n=42)**	**p**
Age (years)	66.1±5.9	66.1±9.7	0.980
Sex (M/F)	10/11 (47.6/52.4)	27/15 (64.3/35.7)	0.270
BMI (kg/m^2)	28.1±5.4	27.4±4.4	0.590
Diabetes mellitus	12 (57.1)	28 (66.7)	0.580
Hypertension	15 (71.4)	28 (66.7)	0.780
CAD	19 (90.5)	34 (81.0)	0.470
COPD	4 (19.0)	5 (11.9)	0.470
CKD	5 (23.8)	7 (16.7)	0.510
EF (%)	46.0±10.4	47.3±10.7	0.640
EuroSCORE II	6.1±2.5	5.5±1.3	0.220
Surgical procedure type, n (%)			**0.403**
CABG	10 (47.6)	17 (40.5)	
Combined surgery	3 (14.3)	14 (33.3)	
Valve surgery	5 (23.8)	6 (14.3)	
Aortic surgery	3 (14.3)	5 (11.9)	

Student's t-test/Mann-Whitney U test, chi-square test, or exact test, as appropriate. The overall surgical procedure distribution was compared using the Fisher-Freeman-Halton exact test. BMI: Body mass index, CABG: Coronary artery bypass grafting, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease, CKD: Chronic kidney disease, EF: Ejection fraction, SD: Standard deviation, M/F: Male/Female

Table 2. Intraoperative characteristics (mean ± SD)			
Variable	**Survivors (n=21)**	**Non-survivors (n=42)**	**p**
Cross-clamp time (min)	82.0±46.5	87.5±47.6	0.660
CPB time (min)	130.2±43.7	139.8±64.6	0.540
Total surgical time (min)	205.7±41.4	216.0±40.7	0.353

Student's t-test. CC: Cross-clamp, CPB: Cardiopulmonary bypass, Min: Minutes, SD: Standard deviation

Table 3. Daily postoperative CASUS scores according to in-hospital mortality status (mean ± SD)			
Postoperative day	**Survivors**	**Non-survivors**	**p†**
Day 1 (n=21/42)	9.3±3.2	10.3±3.6	0.243
Day 2 (n=21/41)	7.0±3.7	8.5±5.0	0.209
Day 3 (n=21/41)	6.2±4.4	8.8±6.1	0.061
Day 4 (n=21/39)	5.6±3.6	8.7±5.5	0.011*
Day 5 (n=21/38)	4.6±3.2	9.4±6.5	<0.001**
Group × day interaction, p‡			<0.001**

†Welch's t-test. Day-specific p values are unadjusted and exploratory. ‡Group-by-day interaction from the linear mixed-effects model: $F(4, 235)=5.28$; $p<0.001$. Later observations unavailable because of death were not imputed. Sample sizes are presented as survivors/non-survivors. *$p<0.05$; **$p<0.001$. SD: Standard deviation

DISCUSSION

Among the 63 patients in this single-center PMV cohort, higher CASUS values later in the postoperative course were associated with mortality before discharge. Exploratory between-group differences emerged on postoperative days 4 and 5; in the adjusted day-5 model, the association with CASUS persisted after accounting for age, CPB duration, and EuroSCORE II. However, the day-5 AUC of 0.729 represents moderate, rather than high, discrimination, and the sensitivity at the exploratory >8.5 cut-off was 55.3%. The finding supports an association with evolving postoperative severity in this restricted cohort, and does not establish an early prediction tool or a definitive clinical threshold.

Earlier work has generally assessed CASUS in larger cardiac surgical cohorts and reported greater discrimination than we observed. In studies of acute aortic dissection and mixed postoperative patient populations, CASUS supported the

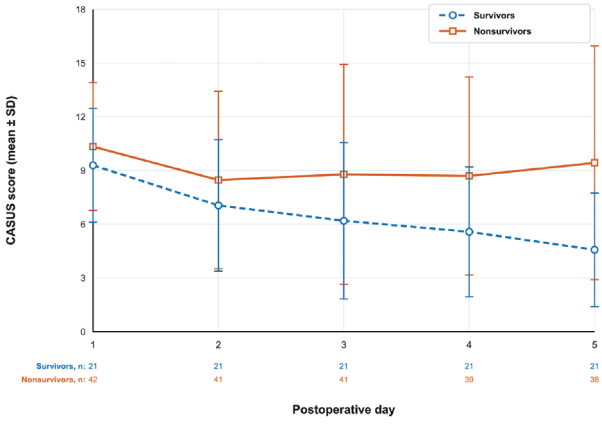

Figure 1. Daily postoperative CASUS scores according to in-hospital mortality status. Points represent observed group means and error bars represent standard deviations. Day-specific sample sizes (survivors/non-survivors) for postoperative days 1-5 were 21/42, 21/41, 21/41, 21/39, and 21/38, respectively. The reduction in available observations among non-survivors reflects deaths that occurred before later measurements. Lines connect group-level means for visualization only, and do not represent patient-specific trajectories. Daily between-group comparisons, using Welch's t-test, were exploratory and not adjusted for multiple testing.

CASUS: Cardiac surgery score, SD: Standard deviation

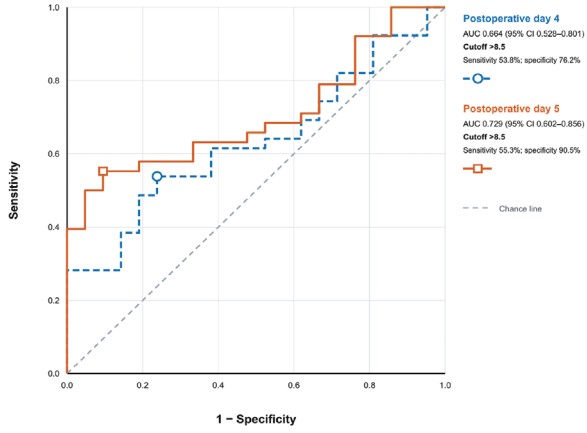

Figure 2. Receiver operating characteristic curves for postoperative day 4 and day 5 CASUS scores for discriminating in-hospital mortality. The day-4 analysis included 60 patients (21 survivors and 39 non-survivors): AUC =0.664 (95% CI 0.528-0.801), p=0.037; the Youden cut-off was >8.5, with 53.8% sensitivity and 76.2% specificity. The day-5 analysis included 59 patients (21 survivors and 38 non-survivors). AUC =0.729 (95% CI 0.602-0.856), p=0.004; the Youden cut-off was >8.5, with 55.3% sensitivity and 90.5% specificity. The dashed diagonal denotes chance discrimination. These internally derived cut-offs are exploratory and center-specific, rather than validated clinical thresholds.

AUC: Area under the curve, CASUS: Cardiac surgery score, CI: Confidence interval

assessment of mortality and sometimes outperformed general ICU scores.[9,10] A study confined to CABG patients in Türkiye found higher CASUS values among patients who were reintubated or who died within 30 days; for 7-day mortality and prolonged ICU stay, its AUCs exceeded those of APACHE II.[11] On postoperative day 2, logistic CASUS provided moderate discrimination for predicting prolonged ICU stay.[12] A separate postoperative cohort also reported that CASUS discriminated mortality risk after cardiac surgery.[13] Our estimates were less favorable (day 5 AUC: 0.729; sensitivity: 55.3%). The proximity of our exploratory cut-off to values reported in other cohorts is descriptive only and neither validates the cut-off nor supports stand-alone clinical use.

Several factors may explain the lower discrimination compared with prior validation studies: restriction to patients with PMV; a narrowed, more severe risk spectrum; small sample size; high outcome prevalence; use of day-specific, rather than maximum or summary, scores; different mortality definitions; and loss of later measurements due to death. The absence of uncomplicated patients is especially important, because the performance in a restricted PMV cohort cannot be extrapolated to the full postoperative cardiac surgery population.

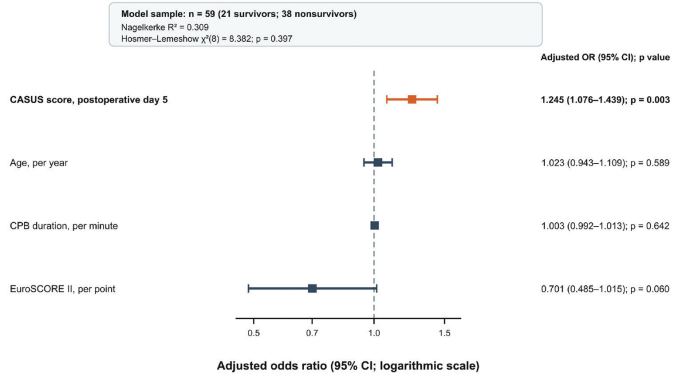

Figure 3. Adjusted associations with in-hospital mortality among patients with an available postoperative day 5 CASUS score. Odds ratios and 95% confidence intervals were estimated from a multivariable binary logistic regression model that included postoperative day 5 CASUS, age, cardiopulmonary bypass duration, and EuroSCORE II. The model included 59 patients (21 survivors and 38 non-survivors). Four non-survivors who died before postoperative day 5 had no day 5 score and were not included. Points represent adjusted odds ratios, horizontal lines represent 95% confidence intervals, and the dashed vertical line denotes OR =1. The CASUS estimate is highlighted in orange. The Hosmer-Lemeshow test did not indicate gross lack of fit; however, calibration remains uncertain because of the small sample size and the absence of validation.

CASUS: Cardiac surgery score, CI: Confidence interval, CPB: Cardiopulmonary bypass, OR: odds ratio

Table 4. Exploratory ROC analyses of CASUS and EuroSCORE II for in-hospital mortality					
Variable (n)	**AUC (95% CI)**	**Cut-off**	**Sensitivity**	**Specificity**	**p†**
CASUS, day 1 (63)	0.584 (0.432-0.735)	-	-	-	0.281
CASUS, day 2 (62)	0.575 (0.429-0.720)	-	-	-	0.337
CASUS, day 3 (62)	0.620 (0.478-0.761)	-	-	-	0.126
CASUS, day 4 (60)	0.664 (0.528-0.801)	>8.5	53.8%	76.2%	0.037*
CASUS, day 5 (59)	0.729 (0.602-0.856)	>8.5	55.3%	90.5%	0.004*
EuroSCORE II (63)	0.413 (0.248-0.578)	-	-	-	0.265

†Versus H0: AUC =0.5. Day-specific analyses used available cases. No adjustment for multiple testing was applied. Youden cut-offs were derived and evaluated in the same dataset and are exploratory, center-specific estimates. *p<0.05. AUC: Area under the curve, CI: Confidence interval, ROC: Receiver operating characteristic, CASUS: Cardiac surgery score

Table 5. Univariable and multivariable logistic regression analyses for in-hospital mortality (complete-case n=59; 21 survivors and 38 non-survivors)					
Variable	**n**	**Unadjusted OR (95% CI)**	**p**	**Adjusted OR (95% CI)**	**p**
CASUS, day 5	59	1.204 (1.055-1.375)	0.006	1.245 (1.076-1.439)	0.003
Age	59	1.004 (0.941-1.070)	0.913	1.023 (0.943-1.109)	0.589
CPB duration	59	1.003 (0.994-1.013)	0.490	1.003 (0.992-1.013)	0.642
EuroSCORE II	59	0.836 (0.621-1.126)	0.239	0.701 (0.485-1.015)	0.060

The day-5 CASUS was the predictor of interest. Age, CPB duration, and EuroSCORE II were included on clinical grounds as adjustment covariates, rather than being selected on the basis of univariable significance. Nagelkerke R^2=0.309; Hosmer-Lemeshow χ^2=8.382, df=8, p=0.397. A non-significant Hosmer-Lemeshow test does not establish good calibration in this small sample. OR: Odds ratio, CI: Confidence interval, CPB: Cardiopulmonary bypass, CASUS: Cardiac surgery score

External validation studies indicate that CASUS performance and calibration can vary across health-care systems and may require local updating.[8,14] This supports independent validation rather than the adoption of a center-specific value derived from and tested in the same cohort. Our day 4 and day 5 cut-offs may be optimistic and should be regarded only as exploratory estimates.

The group-by-day interaction indicates that average postoperative CASUS patterns differed between survivors and non-survivors. It does not establish the trajectory itself as an independent predictor because the regression model included day-5 CASUS rather than an individual change score or slope. EuroSCORE II also had a confidence interval for the AUC that included 0.5 in this selected cohort. The inverse EuroSCORE II estimate was imprecise and should be regarded as a potentially unstable finding in this small, selected cohort rather than as evidence of a protective association. Accordingly, this cohort-specific estimate cannot be used to judge EuroSCORE II performance in broader populations. Combined preoperative and postoperative approaches remain of interest.[15]

Prior research that directly analyzed delta CASUS found that changes over time can be prognostically informative.[16] Our analysis did not model delta CASUS or a patient-specific slope. Such direct trajectory measures should be examined prospectively in a larger cohort before the postoperative CASUS course can be considered an independently validated predictor.

All patients in this study were selected because they developed PMV; the PaO_2/FiO_2 ratio is a component of CASUS. Respiratory dysfunction, therefore, contributed to both cohort selection and the measured score. This conceptual overlap may affect the score distribution and apparent performance, and may further limit extrapolation to patients without PMV. Findings in other critically ill subgroups, including patients receiving extracorporeal life support, provide clinical context but do not remove this limitation.[17]

Dynamic risk assessment may help characterize changes in postoperative severity.[18] Nevertheless, a CASUS value obtained on day 5 is relatively late and may reflect persistent organ dysfunction, complications, and treatment response among patients who survived long enough to be assessed. It should not be interpreted as an early prognostic marker, and clinical use requires prospective validation.

Study Limitations

Several limitations should be considered. Because the data were derived from a retrospective, single-center PMV cohort, generalizability to uncomplicated postoperative patients is limited. Fifty-five of 118 PMV patients (46.6%) were excluded because the data required for the postoperative day 1 CASUS score were incomplete, potentially introducing additional selection bias. All eligible patients from the prespecified interval were analyzed; therefore, no pre-specified sample-size target was set. The day-5 regression included only 59 patients (21 survivors and 38 non-survivors) and used four predictors; estimates may be unstable, and no internal or external validation was performed. Four non-survivors had no later scores because they died before day 5.

Informative dropout and conditioning on availability at day 5 may have affected longitudinal and regression estimates; a mixed-effects model does not eliminate this bias. Because the study did not model an individual delta CASUS or slope, the trajectory was not established as an independent predictor. No multiplicity adjustment was applied; day-specific comparisons and ROC analyses were exploratory, and internally derived cut-offs may be optimistic and center-specific. Selection on PMV also overlaps conceptually with the PaO_2/FiO_2 component of CASUS. Finally, the comparison was limited to EuroSCORE II and did not include postoperative comparators such as SOFA or APACHE II.

CONCLUSION

In this selected single-center cohort of open-heart surgery patients with PMV lasting longer than 24 hours, a higher postoperative day 5 CASUS score was associated with increased odds of in-hospital mortality and demonstrated moderate discriminatory ability. The day-5 score should be interpreted as a marker of evolving postoperative severity in patients for whom the measurement was available, rather than as an early prognostic marker. Differences in average daily score patterns did not indicate that the trajectory was an independent predictor. The exploratory, center-specific cut-offs require validation in larger multicenter cohorts before clinical use.

Ethics

Ethics Committee Approval: The study was approved by the Medical Sciences Ethics Committee of the University of Health Sciences Bursa Yüksek İhtisas Training and Research Hospital on March 11, 2026 (decision no: 2024-TBEK 2026/03-02).

Informed Consent: Owing to the retrospective design, the requirement for informed consent was waived by the ethics committee.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.O., O.S.A., N.B.S., Concept: A.O., M.Ö., Design: O.S.A., M.Ö., Data Collection or Processing: A.B.T., C.S.A., Analysis or Interpretation: N.B.S., T.O., Literature Search: A.O., Ü.K., T.O., Writing: A.O., C.S.A., A.K.A., Ü.K., T.O.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Squiccimarro E, Stasi A, Lorusso R, Paparella D. Narrative review of the systemic inflammatory reaction to cardiac surgery and cardiopulmonary bypass. Artif Organs. 2022;46:568-77.
2. Wang Q, Tao Y, Zhang X, et al. The incidence, risk factors, and hospital mortality of prolonged mechanical ventilation among cardiac surgery patients: a systematic review and meta-analysis. Rev Cardiovasc Med. 2024;25:409.
3. Aksoy R, Karakoc AZ, Cevirme D, et al. Predictive factors of prolonged ventilation following cardiac surgery with cardiopulmonary bypass. Braz J Cardiovasc Surg. 2021;36:780-7.
4. Liu Q, Chen P, Wang W, et al. A novel scoring model for predicting prolonged mechanical ventilation in cardiac surgery patients: development and validation. Front Cardiovasc Med. 2025;12:1573874.
5. Mastroiacovo G, Bonomi A, Ludergnani M, et al. Is EuroSCORE II still a reliable predictor for cardiac surgery mortality in 2022? A retrospective study study. Eur J Cardiothorac Surg. 2022;64:ezad294.
6. Howell NJ, Head SJ, Freemantle N, et al. The new EuroSCORE II does not improve prediction of mortality in high-risk patients undergoing cardiac surgery: a collaborative analysis of two European centres. Eur J Cardiothorac Surg. 2013;44:1006-11; discussion 1011.
7. Doerr F, Badreldin AM, Heldwein MB, et al. A comparative study of four intensive care outcome prediction models in cardiac surgery patients. J Cardiothorac Surg. 2011;6:21.
8. Wilson B, Tran DTT, Dupuis JY, McDonald B. External validation and updating of the cardiac surgery score for prediction of mortality in a cardiac surgery intensive care unit. J Cardiothorac Vasc Anesth. 2019;33:3028-34.
9. Gürcü ME, Külahcioglu S, Karaca Baysal P, et al. Comparison of sequential organ failure assessment score and cardiac surgery score systems for mortality prediction after emergency acute aortic dissection surgery. Ulus Travma Acil Cerrahi Derg. 2022;28:1298-304.
10. Badreldin AM, Doerr F, Ismail MM, et al. Comparison between sequential organ failure assessment score (SOFA) and cardiac surgery score (CASUS) for mortality prediction after cardiac surgery. Thorac Cardiovasc Surg. 2012;60:35-42.
11. Uğur S, Acarel M, Yapıcı N. CASUS and APACHE II score in predicting mortality after coronary artery bypass grafting. Turk Gogus Kalp Damar Cerrahisi Derg. 2023;31:343-51.
12. Pimentel MF, Soares MJF, Murad JA Junior, et al. Predictive factors of long-term stay in the ICU after cardiac surgery: logistic CASUS score, serum bilirubin dosage and extracorporeal circulation time. Braz J Cardiovasc Surg. 2017;32:367-71.
13. Raut S, Hussain A, Ariyaratnam P, et al. Validation of cardiac surgery score (CASUS) in postoperative cardiac patients. Semin Cardiothorac Vasc Anesth. 2020;24:304-12.
14. Singh A, Liang C, Mick SL, Udeh C. External validation of the cardiac surgery score in a quaternary hospital in the United States of America. J Intensive Care Med. 2022;37:1318-27.
15. Doerr F, Heldwein MB, Bayer O, et al. Combination of European System for Cardiac Operative Risk Evaluation (EuroSCORE) and cardiac surgery score (CASUS) to improve outcome prediction in cardiac surgery. Med Sci Monit Basic Res. 2015;21:172-8.
16. Badreldin AM, Kroener A, Heldwein MB, et al. Prognostic value of daily cardiac surgery score (CASUS) and its derivatives in cardiac surgery patients. Thorac Cardiovasc Surg. 2010;58:392-7.
17. Hofmann B, Gmelin MJ, Metz D, et al. Cardiac surgery score (CASUS) improves outcome prediction in patients treated with extracorporal life support (ECLS). Perfusion. 2018;33:36-43.
18. Diaz-Soto JC, Couture EJ, Nabzdyk CGS. Quo vadis cardiac surgery risk score? From predicting to impacting outcomes in cardiac surgery. J Cardiothorac Vasc Anesth. 2022;36:995-7.