

# Comparison of SOFA and PIRO Scores as Predictors of Mortality in Patients with Cardiogenic Shock and Concomitant Sepsis

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**Received:** 14<sup>th</sup> June, 2026; **Revised:** 20<sup>th</sup> July 2026; **Accepted:** 20<sup>th</sup> August, 2026; **Available Online:** 05<sup>th</sup> September 2026

## ABSTRACT

**Background:** Cardiogenic shock with sepsis is associated with high mortality from cardiac dysfunction, systemic hypoperfusion, inflammation, and multiorgan dysfunction. Accurate risk stratification is essential for prognosis and decision-making. This study compares the performance of the SOFA and PIRO scores for predicting in-hospital mortality among patients at the CVCU, Heart Center, Dr. Wahidin Sudirohusodo General Hospital, Makassar.

**Methods:** This retrospective cohort study included 156 CVCU patients with cardiogenic shock and sepsis. SOFA and PIRO scores were calculated from medical records. The primary outcome was in-hospital mortality. Performance was assessed by receiver operating characteristic analysis; AUCs were compared using the DeLong test. Risk stratification, Brier score, decision curve analysis, and Firth penalized logistic regression were performed.

**Results:** Among 156 patients, 114 (73.1%) died in hospital and 42 (26.9%) survived. SOFA had AUC 0.793 (95% CI, 0.703–0.884) and PIRO 0.707 (95% CI, 0.601–0.814); the difference was not statistically significant (DeLong P = 0.159). Cutoffs: 9.5 for SOFA and 10.5 for PIRO. SOFA sensitivity/specificity were 61.4%/90.3% versus 76.2%/61.3% for PIRO. Mortality increased across SOFA tertiles from 50% to 84% to 96% and PIRO tertiles from 57% to 84% to 89% (P for trend < 0.001). SOFA had lower Brier score (0.144 vs. 0.161). After age-adjusted Firth regression, higher PIRO score remained associated with in-hospital mortality (OR, 1.24 per point; P < 0.001).

**Conclusion:** SOFA showed better discrimination, stronger risk stratification, and lower prediction error than PIRO for in-hospital mortality in patients with cardiogenic shock and sepsis, although discrimination was not significantly different. PIRO remained independently associated with mortality after age adjustment, suggesting complementary information. External validation is needed before applying exploratory cutoffs in practice.

**Keywords:** Cardiogenic shock; sepsis; SOFA; PIRO; in-hospital mortality; prognosis

**How to cite this article:** Fogar GF, Alkatiri AH, Muzakkir AF, Kabo P, Amir M, Zainuddin AA., Comparison of SOFA and PIRO Scores as Predictors of Mortality in Patients with Cardiogenic Shock and Concomitant Sepsis. Int J Drug Deliv Technol. 2026; 16(7): 2139-2149. DOI: 10.25258/ijddt.16.7.219

**Source of support:** Nil.

**Conflict of interest:** None

## INTRODUCTION

Sepsis is a life-threatening syndrome characterized by organ dysfunction resulting from a dysregulated host response to infection and remains a major cause of in-hospital morbidity and mortality worldwide [1]. Cardiogenic shock is a critical state of circulatory failure caused by inadequate cardiac output, resulting in systemic hypoperfusion and progressive end-organ dysfunction, most commonly in the setting of acute myocardial infarction or other severe cardiac disease [2]. When sepsis

and cardiogenic shock coexist, the interaction between systemic inflammatory response, myocardial dysfunction, and impaired tissue perfusion creates a particularly high-risk clinical phenotype in which early and accurate prognostic assessment is essential [3,4].

The Sequential Organ Failure Assessment (SOFA) score was developed to provide an objective assessment of dysfunction across six major organ systems and has subsequently become an established tool for evaluating disease severity in critically ill patients [5]. However,

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because SOFA primarily quantifies organ dysfunction, it may not fully capture differences in patient predisposition or the characteristics of the underlying infection. The Predisposition, Infection, Response, and Organ Dysfunction (PIRO) framework was developed to address this heterogeneity by integrating baseline susceptibility, infection characteristics, host response, and organ dysfunction into a structured prognostic model [6–8]. Subsequent studies demonstrated that PIRO could provide meaningful mortality stratification in patients with sepsis and septic shock, although its performance has varied across clinical settings and populations [9–11].

This variability is particularly relevant in patients with concomitant cardiogenic shock and sepsis, in whom cardiovascular dysfunction may substantially influence prognosis beyond the infection-related phenotype. Although PIRO has demonstrated strong prognostic performance in several sepsis populations, including emergency department and septic shock cohorts, its comparative performance against SOFA in patients dominated by cardiogenic shock has not been adequately established [12,13]. Therefore, this study aimed to compare the discriminatory and risk-stratification performance of PIRO and SOFA for predicting in-hospital mortality among patients with cardiogenic shock concomitant with sepsis treated in a cardiovascular intensive care setting.

## MATERIALS AND METHODS

### *Study Design and Setting*

This study employed a retrospective cohort design to compare the prognostic performance of the PIRO and Sequential Organ Failure Assessment (SOFA) scores for predicting in-hospital mortality among patients with cardiogenic shock concomitant with sepsis. The study was conducted at the Cardiovascular Care Unit (CVCU) of the Integrated Cardiac Center, Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia. Medical records of eligible patients admitted between January 2025 and January 2026 were retrospectively reviewed. Clinical and laboratory variables available at the initial hospitalization were extracted from the medical records and used to calculate the two prognostic scores. The study objective and analytic framework were based on direct comparison of the two scores in relation to in-hospital mortality.

### *Study Population and Patient Selection*

The target population consisted of patients admitted to the CVCU with cardiogenic shock concomitant with sepsis or septic shock. During the study period, 156 patients fulfilled the eligibility criteria and constituted the final study cohort. The final cohort comprised both patients who survived and those who died during hospitalization, allowing the discriminatory performance of the prognostic scores to be evaluated against a binary in-hospital mortality outcome. In

the final cohort, 114 of 156 patients (73.1%) died during hospitalization, whereas 42 (26.9%) survived.

Patients were eligible if they had a documented clinical diagnosis of cardiogenic shock with concomitant sepsis or septic shock and had been admitted to the CVCU during the study period. Patients were excluded when the diagnosis of sepsis had not been established or when the medical record did not contain sufficient information to determine the relevant clinical variables or outcome. Patients with incomplete components of either prognostic score were not excluded from the overall cohort; instead, score-specific analyses were performed according to data availability. The number of observations therefore varied across individual variables and analyses according to the availability of the relevant clinical and laboratory data.

### *Sample Size*

The required sample size was initially estimated based on a retrospective cohort design, assuming an alpha level of 0.05 and a statistical power of 80%. The expected proportions used for the calculation were 21.4% and 10.0%, respectively, resulting in a minimum target sample size of 156 patients. During the study period, 149 medical records were screened, and 124 patients met the predefined eligibility criteria and were included in the final analysis.

### *Clinical Definitions*

#### **Cardiogenic Shock**

Cardiogenic shock was defined as a state of severe cardiac dysfunction resulting in reduced cardiac output, systemic tissue hypoperfusion, and end-organ hypoxia. In the source study, the operational criteria included a systolic blood pressure below 90 mmHg or the requirement for pharmacological support to maintain adequate blood pressure, accompanied by evidence of tissue hypoperfusion such as cold extremities, reduced urine output, and/or elevated serum lactate. The diagnostic classification was determined from the clinical documentation and physiological and laboratory findings recorded during hospitalization. The operational definition used in the study was based on the presence of both circulatory compromise and evidence of hypoperfusion rather than hypotension alone.

#### **Sepsis and Septic Shock**

Sepsis was defined as infection associated with clinically relevant organ dysfunction, while septic shock represented the severe circulatory phenotype of sepsis. Patients were considered eligible when sepsis or septic shock had been clinically established by the treating physicians and documented in the medical record. The study specifically evaluated patients with cardiogenic shock occurring concomitantly with sepsis rather than patients with isolated cardiogenic shock or isolated septic shock. This clinical

phenotype constituted the population represented in the study's conceptual framework and final cohort.

#### ***Assessment of SOFA and PIRO Scores***

SOFA was calculated using six organ-system domains comprising respiratory, coagulation, hepatic, cardiovascular, neurological, and renal function. Each domain was scored according to the corresponding physiological or laboratory abnormality, and the total score was obtained by summing the individual domain scores. The study used variables routinely available in the medical record, including blood pressure and cardiovascular support, platelet count, bilirubin, creatinine, Glasgow Coma Scale, and respiratory parameters. The conceptual framework of the study positioned SOFA as an organ-dysfunction-based prognostic measure.

PIRO was calculated using four domains representing predisposition, infection, response, and organ dysfunction. The predisposition domain incorporated patient characteristics and comorbid conditions, the infection domain represented the infectious component, the response domain incorporated systemic physiological and inflammatory responses, and the organ-dysfunction domain represented the severity of physiological impairment. The PIRO and SOFA scores were calculated independently and subsequently compared in relation to in-hospital mortality.

Because this was a retrospective study, score components were calculated only from information documented in the medical records. Some components of PIRO were unavailable in the source records; in particular, the bands/leukocytosis component was not collected and was assigned a value of zero for all patients. Similarly, the original infection-source documentation required for a planned sensitivity analysis was unavailable. These limitations were applied consistently across the cohort and were considered in the interpretation of PIRO performance.

#### ***Data Collection and Outcome Definition***

Demographic characteristics, comorbidities, clinical variables, physiological measurements, and laboratory parameters relevant to the two scoring systems were extracted retrospectively from the medical records. Variables included, among others, blood pressure, mean arterial pressure, heart rate, Glasgow Coma Scale, lactate, bilirubin, creatinine, platelet count, respiratory parameters, and variables related to infection and comorbidity. The source dataset showed that several laboratory and physiological variables were not available for all patients; therefore, the number of observations contributing to each analysis was reported according to variable availability. The primary outcome was in-hospital mortality, defined as death occurring during the hospitalization in which the patient was treated in the CVCU. Patients who remained alive through hospital discharge were classified as

survivors, whereas patients who died during hospitalization were classified as non-survivors.

#### ***Statistical Analysis***

Continuous variables were summarized as median and interquartile range (Q1–Q3), and categorical variables as frequencies and percentages. Differences between survivors and non-survivors were assessed with the Wilcoxon rank-sum test for continuous variables and Fisher's exact test for categorical variables. SOFA and PIRO scores were compared by outcome, including components. In-hospital mortality discrimination was assessed by receiver operating characteristic (ROC) analysis. Areas under the ROC curves (AUCs) for SOFA and PIRO were compared with the DeLong test. Optimal cutoffs were determined using the Youden index and considered exploratory because they were derived and evaluated in one population. Sensitivity, specificity, predictive values, accuracy, and likelihood ratios were calculated.

Risk stratification used tertiles. Trends in mortality across tertiles were evaluated with the Cochran–Armitage test for trend. Prediction error was assessed with the Brier score. Decision curve analysis evaluated net benefit across probabilities. Association between PIRO score and in-hospital mortality was evaluated using Firth penalized logistic regression adjusted for age. SOFA was not entered with PIRO because the scores overlap in dysfunction. A sensitivity analysis assigned zero to missing components and was considered supportive. Statistical analyses used  $P < 0.05$ .

#### ***Ethical Considerations***

The study was conducted using retrospective data obtained from the medical records of patients treated in the CVCU at Dr. Wahidin Sudirohusodo Hospital, Makassar. Patient confidentiality was maintained by anonymizing personal identifiers during data extraction and analysis. The study protocol was reviewed and approved by the Biomedical Research Ethics Committee for Human Subjects Research, Faculty of Medicine, Hasanuddin University, under protocol number UH26060675 and ethical approval number 807/UN4.6.4.5.31/PP36/2026, dated 30 June 2026, with approval valid until 30 June 2027. The study received an expedited ethical review.

## **RESULTS**

#### ***Patient Characteristics and Hospital Outcome***

A total of 156 patients with cardiogenic shock concomitant with sepsis were included in the analysis. Among them, 114 (73.1%) died during hospitalization and 42 (26.9%) survived. The number of observations varied for individual variables according to data availability.

Compared with survivors, non-survivors demonstrated greater physiological instability and organ dysfunction. Non-survivors had a higher median heart rate (103 vs. 87

beats/min;  $P < 0.001$ ) and respiratory rate (24 vs. 22 breaths/min;  $P = 0.034$ ), as well as lower systolic blood pressure (93 vs. 112 mmHg;  $P < 0.001$ ) and mean arterial pressure (73 vs. 83 mmHg;  $P = 0.032$ ). Lactate, creatinine, and bilirubin concentrations were also higher among non-survivors. In addition, non-survivors had lower Glasgow Coma Scale scores (10 vs. 15;  $P < 0.001$ ) and lower P/F ratios (233 vs. 305;  $P = 0.041$ ).

No statistically significant differences were observed between survivors and non-survivors in age, sex, acute coronary syndrome type, diabetes, chronic kidney disease, or hypertension. The median SOFA score was significantly higher among non-survivors than survivors (11 vs. 7;  $P < 0.001$ ), as was the median PIRO score (13 vs. 9;  $P < 0.001$ ). Detailed characteristics are presented in Table 1.

#### ***SOFA Components According to Hospital Outcome***

The distribution of individual SOFA components differed between survivors and non-survivors. The largest differences were observed in the central nervous system and renal components, both of which were significantly higher among non-survivors (both  $P < 0.001$ ). Significant differences were also observed in the respiratory component ( $P = 0.005$ ), cardiovascular component ( $P = 0.022$ ), and hepatic component ( $P = 0.044$ ). In contrast, the coagulation component did not differ significantly between groups ( $P = 0.664$ ). Although the cardiovascular component was statistically different between groups, the median score was 3 in both survivors and non-survivors, indicating that this component was already close to its maximum value in both groups. The total SOFA score was significantly higher among non-survivors than survivors (11 vs. 7;  $P < 0.001$ ) (Table 2).

#### ***PIRO Components According to Hospital Outcome***

Several PIRO components demonstrated different distributions between survivors and non-survivors. A heart rate  $>120$  beats/min was more frequent among non-survivors than survivors (19% vs. 5%;  $P = 0.040$ ). Similarly, the distribution of systolic blood pressure categories differed significantly between groups ( $P < 0.001$ ), with hypotensive categories occurring more frequently among non-survivors. Lactate  $>4$  mmol/L was also more frequent among non-survivors than survivors (39% vs. 17%;  $P = 0.007$ ).

Respiratory rate  $>20$  breaths/min, respiratory failure, BUN  $>20$  mg/dL, platelet count  $<150 \times 10^3/\mu\text{L}$ , COPD, chronic liver disease, nursing home residence, cancer, and infection source did not demonstrate statistically significant differences between outcome groups. The band neutrophil component was unavailable in the study database and therefore contributed zero points to all patients.

The median total PIRO score was significantly higher among non-survivors than survivors (13 vs. 9;  $P < 0.001$ ) (Table 3).

#### ***Discriminatory Performance of SOFA and PIRO***

The discriminatory performance of SOFA and PIRO for in-hospital mortality was evaluated using receiver operating characteristic (ROC) analysis. SOFA demonstrated an AUC of 0.793 (95% CI, 0.703–0.884), whereas PIRO demonstrated an AUC of 0.707 (95% CI, 0.601–0.814). The AUC difference for PIRO minus SOFA was  $-0.086$  (95% CI,  $-0.200$  to  $0.027$ ). Although the point estimate favored SOFA, the confidence interval crossed zero and the difference was not statistically significant according to the paired DeLong test ( $P = 0.159$ ) (Table 4; Figure 1).

The exploratory Youden-derived cutoff was 9.5 for SOFA and 10.5 for PIRO. At these cutoffs, SOFA showed 61.4% sensitivity and 90.3% specificity, whereas PIRO showed 76.2% sensitivity and 61.3% specificity. The positive likelihood ratio was higher for SOFA than PIRO (6.34 vs. 1.97), while the negative likelihood ratio was similar (0.43 vs. 0.39) (Table 4).

#### ***Risk Stratification and Clinical Performance***

Both SOFA and PIRO demonstrated significant graded risk stratification across score tertiles. Observed mortality across SOFA tertiles increased from 50% in the lowest tertile to 84% in the intermediate tertile and 96% in the highest tertile ( $P$  for trend  $< 0.001$ ). For PIRO, mortality increased from 57% to 84% and 89% across the lowest, intermediate, and highest tertiles, respectively ( $P$  for trend  $< 0.001$ ). (Figure 2)

Although both scores demonstrated significant trends, the mortality gradient appeared steeper across SOFA tertiles, particularly between the lowest and highest risk groups. These findings indicate that both scoring systems were able to stratify patients according to observed mortality risk, with numerically greater separation using SOFA (Figure 2).

The Brier score was 0.144 for SOFA and 0.161 for PIRO, indicating slightly lower overall prediction error for SOFA within the study sample. Decision curve analysis demonstrated that SOFA provided comparable or greater net clinical benefit than PIRO across most of the evaluated range of threshold probabilities (Figure 3).

These findings should be interpreted as measures of performance within the study cohort. External calibration and transportability could not be assessed because an independent validation cohort was not available.

#### ***PIRO as an Independent Prognostic Factor***

In Firth penalized logistic regression adjusted for age, each one-point increase in PIRO score was significantly associated with higher odds of in-hospital mortality (OR,

1.24 per point;  $P < 0.001$ ). Age was not significantly associated with mortality in the adjusted model ( $P = 0.88$ ).

Because the regression model included age as the only adjustment variable, the association between PIRO score and mortality should not be interpreted as evidence that all potential confounding factors were controlled. SOFA was not included simultaneously with PIRO because both scores incorporate overlapping information related to organ dysfunction.

### **Sensitivity Analysis**

In the sensitivity analysis, missing score components were assigned a value of zero. Under this assumption, the AUC was 0.82 for SOFA and 0.72 for PIRO, with a statistically significant difference between the two scores according to the DeLong test ( $P = 0.032$ ). However, assigning a score of zero to missing components assumes the absence of organ dysfunction and may therefore introduce misclassification. Accordingly, the complete-case analysis was considered the primary analysis, while the sensitivity analysis was interpreted as supportive evidence that the overall direction of the findings was preserved.

### **DISCUSSION**

This study suggests that SOFA may be better suited than PIRO for prognostic assessment in patients with cardiogenic shock concomitant with sepsis, although the difference in discrimination was not statistically significant. This finding is clinically plausible because the dominant pathophysiology in this population is characterized by circulatory failure, tissue hypoperfusion, and progressive multiorgan dysfunction, which are directly reflected by the domains assessed by SOFA. Thus, an organ-dysfunction-based score may be particularly informative when cardiovascular failure is a major determinant of short-term outcome.

These findings are in line with Nishimoto et al. (2022) and Schoe et al. (2020) [14,15], who demonstrated good prognostic performance of SOFA in critically ill cardiovascular and post-cardiac surgery populations, respectively. Similarly, Álvarez-Avello et al. (2022) reported clinically relevant prognostic performance of severity scores in cardiogenic shock, while Bouchlarhem et al. (2024) showed that qSOFA could identify patients with acute coronary syndrome at increased risk of adverse outcomes in a cardiovascular intensive care setting [16,17]. Jentzer et al. (2018) further demonstrated a graded association between SOFA severity and mortality in a contemporary cardiac intensive care population [18]. Collectively, these studies support the relevance of organ dysfunction as a central determinant of prognosis in cardiovascular critical illness.

The comparatively weaker performance of PIRO may reflect a mismatch between its sepsis-oriented structure and

the dominant clinical phenotype of cardiogenic shock. Previous studies have demonstrated favorable prognostic performance of PIRO in community-acquired sepsis, septic shock, and intra-abdominal sepsis. Chen and Li (2013) reported useful mortality stratification in community-acquired sepsis [19], while Khwannimit et al. (2013) and Posadas-Calleja et al. (2018) demonstrated prognostic utility in septic shock and intra-abdominal sepsis, respectively [20,21]. Macdonald et al. (2014) further reported that PIRO performed favorably compared with SOFA in emergency department patients with severe sepsis and septic shock [22]. These findings suggest that the prognostic value of PIRO may be context-dependent and influenced by the underlying clinical phenotype.

The present findings are also consistent with de Groot et al. (2014) [23], who reported variation in PIRO performance according to baseline risk. In patients dominated by severe cardiovascular dysfunction, the prognostic contribution of predisposition and infection-related characteristics may be less discriminative than the immediate consequences of circulatory failure and organ dysfunction. Therefore, the lower performance observed here should not be interpreted as a lack of prognostic value of PIRO, but rather as evidence that its multidimensional structure may be less closely aligned with the dominant mechanisms driving mortality in cardiogenic shock with concomitant sepsis.

Importantly, PIRO retained prognostic relevance after adjustment for age, indicating that its association with mortality was not explained by age alone. This finding supports the potential complementary role of PIRO, particularly because it incorporates clinical dimensions that are not fully represented by SOFA. Chen and Li (2014) similarly demonstrated that PIRO could provide prognostic stratification beyond conventional severity assessment in septic patients [19]. Thus, the two scores may capture partially distinct aspects of risk, with SOFA more closely reflecting the severity of acute organ dysfunction and PIRO providing additional information related to the broader clinical phenotype.

The clinical implication is that SOFA may be preferentially used as the primary bedside prognostic framework in patients with cardiogenic shock concomitant with sepsis, particularly when deterioration is driven by circulatory and multiorgan dysfunction. PIRO may serve as a complementary assessment rather than an alternative, allowing additional consideration of predisposition and infection-related characteristics. Accordingly, the present findings support a complementary rather than interchangeable role for the two scores in prognostic assessment.

### **LIMITATIONS**

This study has limitations. First, its retrospective single-center design limits generalizability and introduces

selection and information bias. Second, the cohort had high mortality and fewer survivors, which may reduce precision and increase overfitting risk, particularly for exploratory cutoff determination. Third, missing data for some variables meant observations varied across analyses. Fourth, band neutrophil data required for the PIRO response component were unavailable and were assigned a score of zero for all patients. This assumption may not reflect patients' physiological state and may have influenced PIRO performance. Fifth, the optimal cutoffs were derived from the same cohort in which performance was assessed and should be considered exploratory. Sixth, no independent external validation cohort was available, preventing assessment of discrimination, calibration, and transportability. Finally, although PIRO remained associated with mortality after adjustment for age, residual confounding cannot be excluded, and the association should not be interpreted as a adjusted causal relationship.

## CONCLUSIONS

SOFA demonstrated numerically better discriminatory performance, more pronounced risk stratification, and lower overall prediction error than PIRO for in-hospital mortality among patients with cardiogenic shock concomitant with sepsis. However, the difference in discrimination between the two scores was not statistically significant. PIRO remained independently associated with mortality after adjustment for age, suggesting that it may provide complementary prognostic information. SOFA may therefore be considered a useful primary prognostic tool in this high-risk population, while PIRO may offer additional contextual information. External validation is required before the exploratory cutoffs identified in this study can be applied in clinical practice.

## DECLARATIONS

### *Consent for Publication*

Not applicable. This study used retrospectively collected and anonymized medical-record data, and no personally identifiable information or individual patient-level images are presented.

### *Availability of Data and Materials*

The datasets generated and/or analyzed during the current study are not publicly available because they contain clinical information derived from patient medical records but may be available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

### *Competing Interests*

The authors declare that they have no competing interests.

### *Funding*

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Authors' Contributions

**GFF:** Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Visualization, and Project Administration.

**AHA:** Conceptualization, Methodology, Supervision, Validation, and Writing – Review & Editing.

**AFM:** Methodology, Supervision, Validation, and Writing – Review & Editing.

**PK:** Supervision, Validation, and Writing – Review & Editing.

**MA:** Supervision, Validation, and Writing – Review & Editing.

**AAZ:** Formal Analysis, Statistical Analysis, Validation, and Writing – Review & Editing.

All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

## Acknowledgements

The authors would like to acknowledge the staff of the Cardiovascular Care Unit of the Integrated Heart Center, Dr. Wahidin Sudirohusodo Hospital, Makassar, for their support in facilitating access to the medical records used in this study.

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## TABLES AND FIGURES

**Table 1.** Baseline characteristics of patients according to in-hospital outcome.

| Characteristic                          | N   | Survived (n = 42) | Died (n = 114)   | P value |
|-----------------------------------------|-----|-------------------|------------------|---------|
| Age, years                              | 156 | 58.5 (52–66)      | 60 (52–67)       | 0.7     |
| Sex, n (%)                              | 156 |                   |                  | 0.2     |
| Female                                  |     | 10 (24%)          | 39 (34%)         |         |
| Male                                    |     | 32 (76%)          | 75 (66%)         |         |
| Temperature, °C                         | 156 | 36.7 (36.6–36.8)  | 36.7 (36.5–36.9) | 0.5     |
| Heart rate, beats/min                   | 156 | 87 (75–100)       | 103 (84–115)     | <0.001  |
| Respiratory rate, breaths/min           | 156 | 22 (20–24)        | 24 (20–27)       | 0.034   |
| Systolic blood pressure, mmHg           | 156 | 112 (103–122)     | 93 (86–112)      | <0.001  |
| MAP, mmHg                               | 156 | 83 (72–89)        | 73 (65–84)       | 0.032   |
| Lactate, mmol/L                         | 156 | 2.5 (2.0–3.5)     | 3.5 (2.5–5.2)    | <0.001  |
| Creatinine, mg/dL                       | 156 | 1.2 (1.0–1.9)     | 1.7 (1.2–3.1)    | 0.014   |
| Bilirubin, mg/dL                        | 156 | 0.6 (0.3–1.6)     | 1.2 (0.6–2.9)    | 0.001   |
| Platelets, / $\mu$ L ( $\times 10^3$ )  | 156 | 207 (133–268)     | 210 (140–310)    | 0.3     |
| BUN, mg/dL                              | 156 | 37 (16–60)        | 48 (22–79)       | 0.13    |
| pH                                      | 156 | 7.4 (7.3–7.5)     | 7.4 (7.3–7.4)    | 0.11    |
| Sodium, mmol/L                          | 156 | 133.5 (130–138)   | 134 (130–137)    | 0.8     |
| Potassium, mmol/L                       | 56  | 4.2 (3.9–4.4)     | 4.5 (3.7–5.0)    | 0.4     |
| Leukocytes, / $\mu$ L ( $\times 10^3$ ) | 156 | 15.1 (12.8–17.8)  | 18.1 (14.4–22.5) | 0.2     |
| GCS                                     | 156 | 15 (15–15)        | 10 (3–15)        | <0.001  |
| PaO <sub>2</sub> , mmHg                 | 156 | 175 (101–195)     | 167 (120–195)    | 0.7     |
| P/F ratio                               | 156 | 305 (194–558)     | 233 (169–335)    | 0.041   |
| ACS type, n (%)                         | 156 |                   |                  | 0.5     |
| STEMI                                   |     | 15 (36%)          | 36 (32%)         |         |
| NSTEMI                                  |     | 4 (9.5%)          | 23 (20%)         |         |
| MINOCA                                  |     | 0 (0%)            | 1 (0.9%)         |         |
| UAP                                     |     | 0 (0%)            | 2 (1.8%)         |         |
| No ACS                                  |     | 23 (55%)          | 52 (46%)         |         |
| Diabetes, n (%)                         | 156 | 16 (38%)          | 30 (26%)         | 0.2     |
| CKD, n (%)                              | 156 | 17 (40%)          | 53 (46%)         | 0.6     |
| Hypertension, n (%)                     | 156 | 15 (36%)          | 39 (34%)         | 0.9     |
| SOFA total                              | 156 | 7 (4.5–8.5)       | 11 (8–13)        | <0.001  |
| PIRO total                              | 156 | 9 (6.5–13)        | 13 (11–15)       | <0.001  |

Data are presented as median (Q1–Q3) for continuous variables and n (%) for categorical variables. The number of observations may vary according to data availability. The Wilcoxon rank-sum test was used for continuous variables

and Fisher's exact test for categorical variables. MAP, mean arterial pressure; BUN, blood urea nitrogen; GCS, Glasgow Coma Scale; P/F, PaO<sub>2</sub>/FiO<sub>2</sub>; ACS, acute coronary syndrome; CKD, chronic kidney disease.

**Table 2.** SOFA components according to in-hospital outcome.

| SOFA Component               | Survived (n = 42) | Died (n = 114) | P value |
|------------------------------|-------------------|----------------|---------|
| Respiratory (0–4)            | 1 (0–2)           | 2 (1–2)        | 0.005   |
| Coagulation (0–4)            | 0 (0–1)           | 0 (0–1)        | 0.664   |
| Liver (0–4)                  | 0 (0–1)           | 1 (0–2)        | 0.044   |
| Cardiovascular (0–4)         | 3 (3–3)           | 3 (3–4)        | 0.022   |
| Central nervous system (0–4) | 0 (0–0)           | 2 (0–4)        | <0.001  |
| Renal (0–4)                  | 1 (0–1)           | 2 (1–3)        | <0.001  |

|                   |               |           |        |
|-------------------|---------------|-----------|--------|
| Total SOFA (0–24) | 7 (4.75–8.25) | 11 (8–13) | <0.001 |
|-------------------|---------------|-----------|--------|

Data are presented as median (Q1–Q3). The Wilcoxon rank-sum test was used for comparisons between groups. The values in parentheses following each component indicate the possible score range (0–4).

**Table 3.** PIRO components according to in-hospital outcome (n = 156)

| PIRO Component             | Survived (n = 42) | Died (n = 114) | P value          |
|----------------------------|-------------------|----------------|------------------|
| Predisposition             |                   |                |                  |
| Age group                  |                   |                | 0.810            |
| <65 years (0)              | 29 (69%)          | 74 (65%)       |                  |
| 65–80 years (+1)           | 12 (29%)          | 34 (30%)       |                  |
| >80 years (+2)             | 1 (2%)            | 6 (5%)         |                  |
| COPD (+1)                  | 0 (0%)            | 3 (3%)         | 0.564            |
| Chronic liver disease (+2) | 0 (0%)            | 0 (0%)         | 1.000            |
| Nursing home resident (+2) | 10 (24%)          | 35 (31%)       | 0.433            |
| Cancer (+2)                | 1 (2%)            | 5 (4%)         | 1.000            |
| Infection (source)         |                   |                |                  |
| Source of infection        |                   |                | 0.253            |
| Skin/soft tissue (0)       | 14 (33%)          | 24 (21%)       |                  |
| Other infection (+2)       | 6 (14%)           | 16 (14%)       |                  |
| Pneumonia (+4)             | 22 (52%)          | 74 (65%)       |                  |
| Response                   |                   |                |                  |
| Respiratory rate >20 (+3)  | 25 (61%)          | 78 (70%)       | 0.335            |
| Heart rate >120 (+2)       | 2 (5%)            | 21 (19%)       | <b>0.040</b>     |
| Band neutrophils >5% (+1)  | 0 (0%)            | 0 (0%)         | 1.000            |
| Organ dysfunction          |                   |                |                  |
| Systolic blood pressure    |                   |                | <b>&lt;0.001</b> |
| >90 mmHg (0)               | 39 (95%)          | 66 (59%)       |                  |
| 70–90 mmHg (+2)            | 2 (5%)            | 42 (38%)       |                  |
| <70 mmHg (+4)              | 0 (0%)            | 3 (3%)         |                  |
| Respiratory failure (+3)   | 21 (50%)          | 76 (67%)       | 0.065            |
| BUN >20 (+2)               | 30 (71%)          | 91 (80%)       | 0.284            |
| Lactate >4 (+3)            | 7 (17%)           | 45 (39%)       | <b>0.007</b>     |
| Platelets <150k (+2)       | 12 (29%)          | 28 (25%)       | 0.679            |
| Total PIRO (0–24)          | 9 (6.75–13)       | 13 (11–15)     | <b>&lt;0.001</b> |

Data are presented as n (%) for categorical variables and median (Q1–Q3) for the total PIRO score. Fisher's exact test was used for categorical variables and the Wilcoxon rank-sum test for the total score. Values in parentheses following component names indicate the points assigned when the

corresponding criterion is met. Band neutrophil data were unavailable and were therefore assigned a score of 0 for all patients. COPD, chronic obstructive pulmonary disease; BUN, blood urea nitrogen.

**Table 4.** Prognostic performance of SOFA and PIRO for in-hospital mortality (n = 156)

| Metric                                    | SOFA                                    | PIRO                              |
|-------------------------------------------|-----------------------------------------|-----------------------------------|
| AUC (95% CI)                              | 0.793 (0.703–0.884)                     | 0.707 (0.601–0.814)               |
| Optimal cutoff (Youden)*                  | 9.5 (bootstrap 95% CI, 7.5–10.5)        | 10.5 (bootstrap 95% CI, 9.5–13.5) |
| Sensitivity                               | 61.4%                                   | 76.2%                             |
| Specificity                               | 90.3%                                   | 61.3%                             |
| PPV†                                      | 95.4%                                   | 86.5%                             |
| NPV†                                      | 41.8%                                   | 44.2%                             |
| Accuracy                                  | 68.2%                                   | 72.7%                             |
| LR+                                       | 6.34                                    | 1.97                              |
| LR–                                       | 0.43                                    | 0.39                              |
| AUC difference (PIRO – SOFA); DeLong test | <b>–0.086 (95% CI, –0.200 to 0.027)</b> | <b>P = 0.159</b>                  |

The Youden-derived cutoffs are exploratory because they were determined and evaluated in the same study population. PPV and NPV are influenced by the prevalence of mortality in the analyzed population and should therefore

be interpreted together with likelihood ratios. CI, confidence interval; LR, likelihood ratio; PPV, positive predictive value; NPV, negative predictive value.

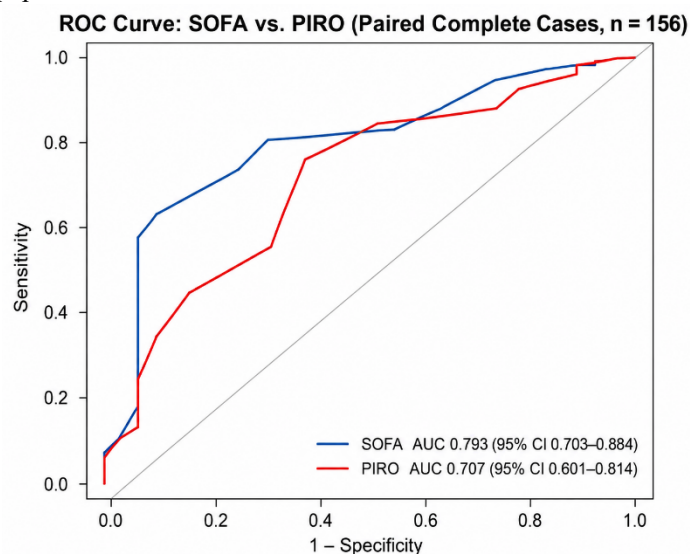


**Figure 1.** Receiver operating characteristic curves of SOFA and PIRO scores for prediction of in-hospital mortality. SOFA demonstrated an AUC of 0.793 (95% CI, 0.703–0.884), whereas PIRO demonstrated an AUC of 0.707 (95% CI, 0.601–0.814).

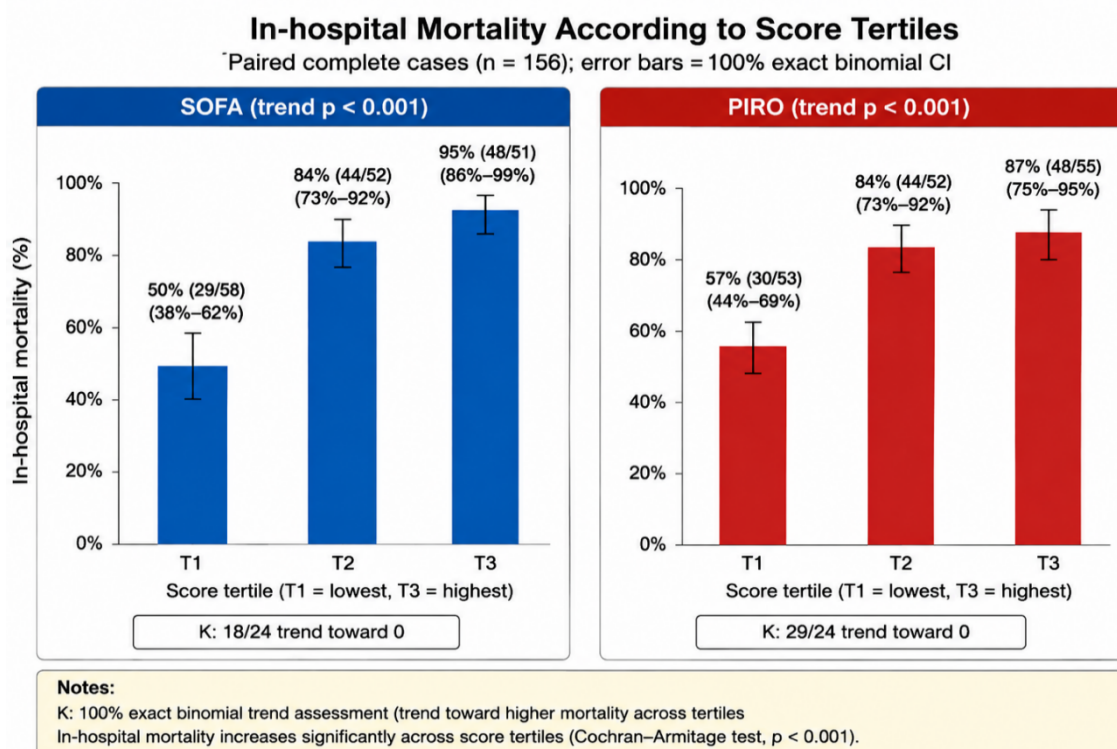


**Figure 2.** Observed mortality according to SOFA (left) and PIRO (right) score tertiles. Mortality increased significantly across tertiles for both SOFA and PIRO ( $P$  for trend  $< 0.001$ ).

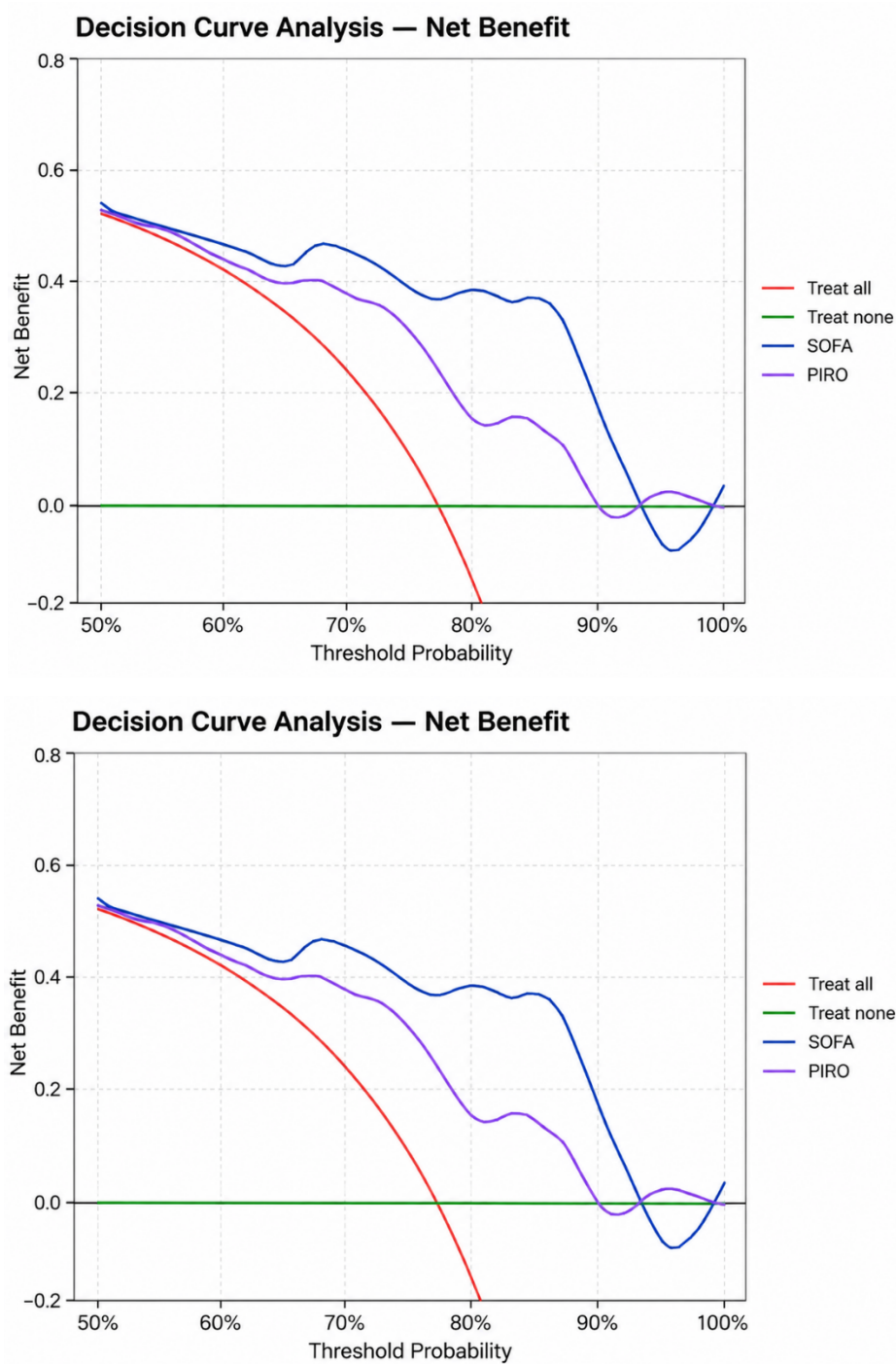


**Figure 3.** Decision curve analysis comparing the net clinical benefit of SOFA and PIRO for prediction of in-hospital mortality.