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Benchmarking Sepsis Severity: Evaluating Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) Scores Against Biomarkers, Comorbidities, and Outcomes in Rural Intensive Care Unit (ICU) Patients

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Abstract

Introduction: Sepsis and septic shock remain major contributors to morbidity and mortality in intensive care units (ICUs), with these challenges being amplified in rural settings, where limited resources and delayed access to specialized care can affect patient outcomes. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score and the Sequential Organ Failure Assessment (SOFA) score are currently considered crucial tools for assessing illness severity. However, comparative analyses linking these scores to specific clinical variables in rural ICUs remain scarce.

Objective: This study evaluates the relationships between APACHE II and SOFA scores and a broad range of clinical parameters in septic ICU patients. Associations with demographic characteristics, comorbidities, inflammatory markers of sepsis (CRP, WBC count, and PCT), lactate levels, vasopressor requirements, and 28-day mortality were examined, with particular attention to factors influencing score performance in resource-limited rural settings.

Method: A retrospective review of adult patients admitted with sepsis and septic shock to the ICU of Hatta Hospital over a five-year period (2021-2025) was conducted. Data were analyzed using correlation testing, regression models, and receiver operating characteristic (ROC) curve analysis.

Results: Day 1 lactate levels and vasopressor use had the highest predictive values for 28-day mortality. Their ability to discriminate between survivors and non-survivors was assessed using the area under the curve (AUC), which was 0.74 for day 1 lactate levels and 0.81 for vasopressor use. Meanwhile, PCT, CRP, and WBC counts demonstrated poor discriminatory ability. Non-survivors had higher day 1 lactate levels (5.08 ± 4.41 mmol/L; 95% CI: 4.03-6.13) than survivors (2.26 ± 1.71 mmol/L; 95% CI: 2.01-2.51; $p < 0.001$). Vasopressor use demonstrated a sensitivity of 83.8%, specificity of 78.1%, positive predictive value (PPV) of 59.4%, negative predictive value (NPV) of 92.7%, and an AUC of 0.810.

Conclusion: Higher lactate levels within the first 24 hours and vasopressor use showed highly significant associations with 28-day mortality. PCT, CRP, and WBC counts demonstrated no significant associations. Our findings support the use of APACHE II and SOFA scores, together with these readily available and straightforward clinical variables, for early risk stratification and prognostic assessment, particularly in resource-limited and rural ICUs.

Categories: Other, Internal Medicine, Infectious Disease
Keywords: apache ii score, lactate, mortality prediction, rural icu, sofa score, vasopressors

Introduction

The Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) scoring systems are currently considered reliable tools for assessing illness severity, predicting mortality, and improving clinical decision-making. APACHE II incorporates physiological parameters, age, and chronic health conditions to estimate mortality risk. Meanwhile, SOFA evaluates organ dysfunction across six systems: respiratory, cardiovascular, hepatic, coagulation, renal, and neurological [1,2].

Rural intensive care units (ICUs) often operate under resource constraints, including limited diagnostic tools, fewer ICU beds, and reduced access to specialized care. These limitations can affect the timely

recognition and management of sepsis, contributing to higher mortality rates compared with those in urban centers. Studies have shown that rural patients with sepsis are more likely to experience delays in diagnosis and treatment, which can compromise the effectiveness of severity scoring systems such as APACHE II and SOFA [3].

Numerous studies have consistently supported the prognostic utility of both the APACHE II and SOFA scores in critically ill patients. Both scoring systems have been shown to reliably distinguish survivors from non-survivors in sepsis populations and correlate with illness severity, organ dysfunction, and ICU outcomes. Their widespread validation across diverse clinical settings underscores their value as objective tools for mortality prediction and risk stratification [4].

Despite their widespread use, gaps remain in understanding how these scores relate to specific clinical variables, such as inflammatory biomarkers (PCT, CRP, and WBC count), markers of organ dysfunction (serum lactate), and therapeutic interventions (vasopressor use). These variables are routinely monitored in ICU settings and may provide additional prognostic insights when analyzed alongside established scoring systems [4,5].

Moreover, the dynamic nature of sepsis and its heterogeneous presentation across patient populations necessitate the continuous evaluation of scoring tools. By comparing APACHE II and SOFA scores with real-world clinical data, this study aims to refine risk stratification models and enhance the precision of clinical care. The findings may inform targeted interventions, optimize resource allocation, and support evidence-based protocols in critical care settings.

Materials And Methods

This study was a five-year retrospective observational review of all adult patients admitted to the ICU of Hatta Hospital with sepsis or septic shock. All patients aged 18 years or older were included in this study, in accordance with the hospital's ICU admission criteria.

The APACHE II score was derived from data obtained from the electronic medical records (EMR). Acute physiological parameters included heart rate, respiratory rate, mean arterial pressure (MAP), oxygenation, temperature, serum creatinine, serum sodium, serum potassium, arterial pH, WBC count, and hematocrit. Age, chronic health conditions, and Glasgow Coma Scale (GCS) scores were also considered.

The SOFA score was calculated using parameters obtained from the EMR. These included the PaO_2/FiO_2 ratio, Glasgow Coma Scale (GCS) score, MAP, serum creatinine, serum bilirubin, and platelet count.

Patient outcomes were categorized as survivors and non-survivors according to 28-day survival status. Routine laboratory investigations, including serum lactate, CRP, PCT, WBC count, and platelet count, were recorded. Additionally, demographic data and comorbidities were documented.

Definitions of terms

For the purposes of this study, the following terms, scoring systems, and diagnostic criteria were used: (i) APACHE II score [1]; (ii) SOFA [2]; (iii) sepsis: defined as life-threatening organ dysfunction caused by a dysregulated host response to infection; the quick SOFA criteria were applied, consisting of three bedside parameters: systolic blood pressure ≤100mmHg, respiratory rate ⩾22 breaths/min, and altered mental status (GCS <13). Patients meeting at least two of these criteria were classified as having sepsis [6]; and (iv) septic shock: defined as a subset of sepsis characterized by persistent hypotension requiring vasopressors to maintain a MAP ⩾65mmHg and a serum lactate level >2mmol/L despite adequate fluid resuscitation [6].

Population, sample, and data sources

The study population consisted of adults admitted to the ICU with sepsis or septic shock. The study sample comprised 246 septic patients who met the inclusion criteria and were admitted to the ICU at Hatta Hospital between January 1, 2021, and December 31, 2025. Data were retrospectively collected through a review of the patients' electronic medical records.

Data analysis strategies

Data analysis was performed using IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as means ± standard deviations (SDs), whereas categorical variables were presented as frequencies and percentages. Paired-samples t-tests were used to compare continuous variables across two time points. Continuous variables between survivors and non-survivors were compared using the independent-samples Student's t-test, with results reported as t-statistics and p-values. Associations between categorical variables and 28-day survival were evaluated using the Pearson chi-square (χ^2) test, and the strength of these associations was expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Relationships between continuous variables were assessed using Pearson's correlation coefficient (r) for normally distributed variables. Receiver operating characteristic (ROC) curve analysis was

performed to evaluate the predictive performance of continuous variables and determine optimal cutoff values. Statistical significance was defined as a two-sided p-value of <0.05.

Results

A total of 246 patients were included in this study. Males accounted for 56.1% of the cohort (n = 138), while females accounted for 43.9% (n = 108). Comorbidities were common, with 52.8% of patients having diabetes mellitus (n = 130), 62.2% having hypertension (n = 153), 42.3% having ischemic heart disease (n = 104), 23.9% having heart failure (n = 59), 22.8% having chronic obstructive pulmonary disease (COPD) (n = 56), 26.8% having chronic kidney disease (n = 66), and 17.1% having obesity (n = 42) (Table *1*).

Variable	n (%)
Male	138 (56.1%)
Female	108 (43.9%)
Obesity	42 (17.1%)
Diabetes mellitus	130 (52.8%)
Hypertension	153 (62.2%)
Ischemic heart disease	104 (42.3%)
Heart failure	59 (23.9%)
Chronic obstructive pulmonary disease	56 (22.8%)
Chronic kidney disease	66 (26.8%)
Vasopressor use	96 (39.0%)
Survivors at 28 days	178 (72.4%)

TABLE 1: Demographic and clinical characteristics of the study population

The mean APACHE II score was 17.89 ± 7.88 (range: 2-43), while the mean SOFA score within the first 24 hours was 5.99 ± 3.67 (range: 1-16). The mean age was 75.62 ± 22.01 years (range: 18-112). Biomarker levels showed a mean PCT level of 13.81 ± 41.64 ng/mL (range: 0.6-268), CRP level of 133.25 ± 111.84 mg/L (range: 0.3-548), WBC count of 11.96 ± 7.51 × 10^9/L (range: 0.4-66), and platelet count of 229.87 ± 111.76 × 10^9/L (range: 16-711). The highest lactate level recorded on ICU day 1 averaged 3.04 ± 3.01 mmol/L (range: 0.60-19.40). Vasopressor infusion was required in 39% of patients (n = 96). By day 28, 72.4% of the cohort (n = 178) had survived. The mean ICU length of stay was 13.34 ± 13.39 days (range: 1-83) (Table *2*).

Variable	Mean ± SD
Age (years)	75.62 ± 22.01
APACHE II score	17.89 ± 7.88
SOFA score	5.99 ± 3.67
ICU-LOS (days)	13.34 ± 13.39
PCT	13.81 ± 41.64
CRP	133.25 ± 111.84
WBC count	11.96 ± 7.51
PLT count	229.87 ± 111.76
Serum lactate (highest value on day 1)	3.04 ± 3.01

TABLE 2: Mean and standard deviation of APACHE II score, SOFA scores, age, and laboratory biomarkers on day 1 admission

APACHE II: Acute Physiology and Chronic Health Evaluation II, SOFA: Sequential Organ Failure Assessment, ICU-LOS: intensive care unit-length of stay, PCT: procalcitonin, CTP: C-reactive protein, WBC: white blood cells, PLT: platelets.

APACHE II scores were significantly higher among non-survivors than among survivors (21.85 ± 7.61 vs. 16.38 ± 7.49, respectively; t = -5.06, p < 0.001). Similarly, SOFA scores were significantly higher among non-survivors than among survivors (8.65 ± 4.16 vs. 4.97 ± 2.89, respectively; t = -6.69, p < 0.001) (Table *3*).

Metric	Survivors (mean ± SD)	Non-survivors (mean ± SD)	Mean difference (S - NS)	95% CI lower	95% CI upper	t-test	p-value
APACHE II	16.38 ± 7.49	21.85 ± 7.61	-5.47	-8.964	-1.976	-5.06	<0.001
SOFA	4.97 ± 2.89	8.65 ± 4.16	-3.68	-5.416	-1.944	-6.69	<0.001

TABLE 3: Comparison of values of APACHE II and SOFA scores among the survivor and non-survivor groups

S: survivors, NS: non-survivors, APACHE II: Acute Physiology and Chronic Health Evaluation II, SOFA: Sequential Organ Failure Assessment.

The APACHE II score demonstrated a sensitivity of 61.8%, specificity of 76.4%, positive predictive value (PPV) of 50.0%, and negative predictive value (NPV) of 84.0%, with a cutoff value of 22, suggesting an increased risk of mortality at scores above this threshold. However, a notable proportion of non-survivors had APACHE II scores below 22, reflecting the moderate sensitivity of the score. The area under the curve (AUC) was 0.709, indicating moderate discriminatory ability in predicting survival (Figure *1*, Table *4*).

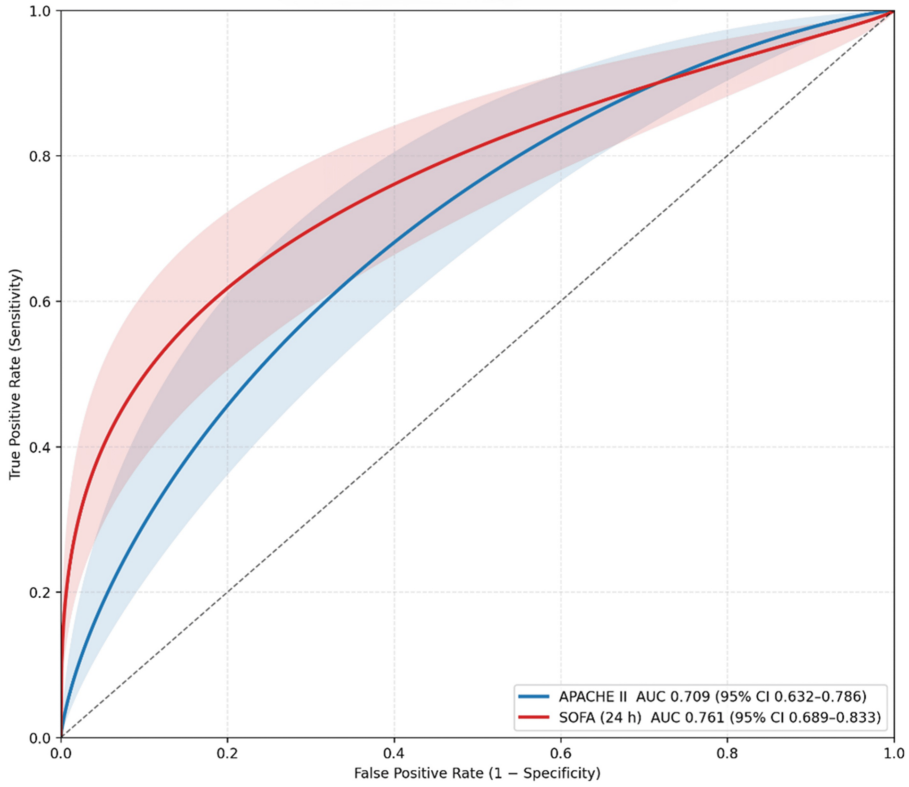


FIGURE 1: Receiver operating characteristic (ROC) curves for APACHE II and SOFA scores in predicting 28-day mortality

APACHE II: Acute Physiology and Chronic Health Evaluation II, SOFA: Sequential Organ Failure Assessment.

Variable	AUC	Cutoff value	Sensitivity	Specificity	PPV	NPV
APACHE II	0.709	22.00	0.618	0.764	0.500	0.840
SOFA	0.761	7.00	0.647	0.787	0.537	0.854

TABLE 4: Comparison between APACHE II and SOFA scores' diagnostic test performance metrics (AUC, cutoff value, sensitivity, specificity, PPV, and NPV)

AUC: area under the curve, PPV: positive predictive value, NPV: negative predictive value, APACHE II: Acute Physiology and Chronic Health Evaluation II, SOFA: Sequential Organ Failure Assessment.

The SOFA score demonstrated a sensitivity of 64.7%, specificity of 78.7%, PPV of 53.7%, and NPV of 85.4%, with a cutoff value of 7, suggesting an increased risk of mortality at scores above this threshold. The AUC was 0.761, indicating good discriminatory ability in predicting survival. In our cohort, the SOFA score demonstrated a slightly better discriminatory performance than the APACHE II score (Figure *1*, Table *4*).

The APACHE II score showed significant positive correlations with the highest lactate level recorded on ICU day 1 ($r = 0.365$, $t = 6.18$, $p < 0.0001$), vasopressor use ($r = 0.331$, $t = 5.49$, $p < 0.0001$), age ($r = 0.310$, $t = 5.12$, $p < 0.0001$), sex ($r = 0.333$, $t = 5.55$, $p < 0.001$), PCT levels ($r = 0.235$, $t = 3.80$, $p = 0.00019$), heart failure ($r = 0.206$, $t = 3.29$, $p = 0.0012$), WBC count ($r = 0.176$, $t = 2.79$, $p = 0.0055$), and ischemic heart disease ($r = 0.146$, $t = 2.30$, $p = 0.022$). In contrast, the APACHE II score was negatively correlated with 28-day survival status ($r = -0.310$, $t = -5.06$, $p < 0.0001$), indicating that higher APACHE II scores were associated with increased mortality (Table *5*).

Variable correlated with APACHE II	Correlation coefficient (r)	Student's t-test	p-value
Highest lactate on ICU day 1	0.365	6.18	<0.0001
Sex	0.333	5.55	<0.0001
Vasopressors	0.331	5.49	<0.0001
Age	0.31	5.12	<0.0001
PCT	0.235	3.80	0.00019
Survivor 28 days	-0.310	-5.06	<0.0001
Heart failure	0.206	3.29	0.0012
WBC	0.176	2.79	0.0056
Ischemic heart disease	0.146	2.30	0.022

TABLE 5: Statistically significant values in correlation to APACHE II score

APACHE II: Acute Physiology and Chronic Health Evaluation II, ICU: intensive care unit, PCT: procalcitonin, WBC: white blood cell.

The SOFA score showed significant positive correlations with vasopressor use ($r = 0.520$, $t = 9.66$, $p < 0.0001$), the highest lactate level recorded on ICU day 1 ($r = 0.471$, $t = 8.15$, $p < 0.0001$), PCT levels ($r = 0.345$, $t = 5.78$, $p < 0.0001$), WBC count ($r = 0.189$, $t = 3.03$, $p = 0.0028$), age ($r = 0.160$, $t = 2.54$, $p = 0.013$), sex ($r = 0.186$, $t = 2.98$, $p = 0.0032$), and ischemic heart disease ($r = 0.133$, $t = 2.10$, $p = 0.0366$). Conversely, the SOFA score demonstrated a significant negative correlation with 28-day survival status ($r = -0.454$, $t = -6.69$, $p < 0.0001$), indicating that higher SOFA scores were associated with increased mortality (Table 6).

Variable correlated with SOFA	Correlation coefficient (r)	Student's t-test	p-value
Vasopressors	0.520	9.66	<0.0001
Highest lactate on ICU day 1	0.471	8.15	<0.0001
Age	0.16	2.54	<0.013
PCT	0.345	5.78	<0.0001
Survival at 28 days	-0.454	-6.69	<0.0001
WBC count	0.189	3.03	0.0028
Sex	0.186	2.98	0.0032
Ischemic heart disease	0.133	2.1	0.0366

TABLE 6: Statistically significant values in correlation to SOFA score

SOFA: Sequential Organ Failure Assessment, ICU: intensive care unit, PCT: procalcitonin, WBC: white blood cell.

In this study, the length of stay was not included in the analysis because it is considered a consequence of the clinical course rather than a predictor of survival or prognosis.

The next step was to examine the associations between these laboratory and clinical variables and survival outcomes. Among the evaluated biomarkers, only the highest lactate level recorded on ICU day 1 differed significantly between survivors and non-survivors, with non-survivors demonstrating substantially higher lactate levels than survivors (5.08 ± 4.41 vs. 2.26 ± 1.71, respectively; $t = -5.19$, $p < 0.001$) (Table 7).

Variable	Survivors (mean ± SD)	Survivors (95% CI)	Non-survivors (mean ± SD)	Non-survivors (95% CI)	Student's t-test	p-value (survivors vs. non-survivors)
Lactate (day 1, highest)	2.26 ± 1.71	2.01-2.51	5.08 ± 4.41	4.03-6.13	-5.19	<0.001
CRP	132.01 ± 115.54	114.99-149.04	136.46 ± 102.32	112.14-160.78	-0.29	0.769
PCT	11.01 ± 33.47	6.08-15.94	17.38 ± 49.00	5.73-29.03	-0.99	0.326
PLT	230.76 ± 103.16	215.60-245.91	227.54 ± 132.49	196.05-259.03	0.18	0.857
WBC count	12.17 ± 7.68	11.04-13.30	11.42 ± 7.06	9.74-13.10	0.73	0.467

TABLE 7: Comparison of laboratory characteristics among the survivor and non-survivor groups

CRP: C-reactive protein, PCT: procalcitonin, PLT: platelets, WBC: white blood cells.

Other biomarkers, including CRP, PCT, platelet count, and WBC count, did not show statistically significant differences between survivors and non-survivors. CRP levels were comparable between survivors (132.01 ± 115.54 mg/L) and non-survivors (136.46 ± 102.32 mg/L; t = -0.29, p = 0.769). Similarly, PCT levels did not differ significantly between the two groups (11.01 ± 33.47 ng/mL vs. 17.38 ± 49.00 ng/mL, respectively; t = -0.99, p = 0.326). Platelet counts were also comparable between survivors and non-survivors (230.76 ± 103.16 vs. 227.54 ± 132.49 × 10^9/L, respectively; t = 0.18, p = 0.857). Likewise, WBC counts showed no statistically significant difference between the groups (12.17 ± 7.68 vs. 11.42 ± 7.06 × 10^9/L, respectively; t = 0.73, p = 0.467) (Table *7*).

Lactate demonstrated a sensitivity of 50.0%, specificity of 88.8%, PPV of 63.0%, NPV of 82.0%, and an AUC of 0.738, with a cutoff value of 3.6 mmol/L. These findings suggest an increased risk of mortality at lactate levels above this threshold. However, the moderate sensitivity indicates that a considerable proportion of non-survivors had lactate levels below this cutoff.

Procalcitonin demonstrated high sensitivity (91.2%) but low specificity (32.2%), with an AUC of 0.599. This indicates limited discriminatory ability despite its high sensitivity. Other laboratory markers, including CRP and WBC count, also demonstrated poor discriminatory performance as prognostic markers, with AUC values of 0.54 and 0.48, respectively (Table *8*, Figure *2*).

Variable	AUC	Cutoff value	Sensitivity	Specificity	PPV	NPV
Lactate (day 1)	0.738	3.60	0.500	0.888	0.630	0.823
PCT	0.599	0.24	0.912	0.322	0.341	0.905
CRP	0.535	63.00	0.765	0.379	0.321	0.807
WBC count	0.476	15.20	0.324	0.770	0.349	0.749

TABLE 8: Diagnostic performance of sepsis markers for predicting mortality based on ROC curve analysis

AUC: area under the curve, PPV: positive predictive value, NPV: negative predictive value, PCT: procalcitonin, CRP: C-reactive protein, WBC: white blood cell.

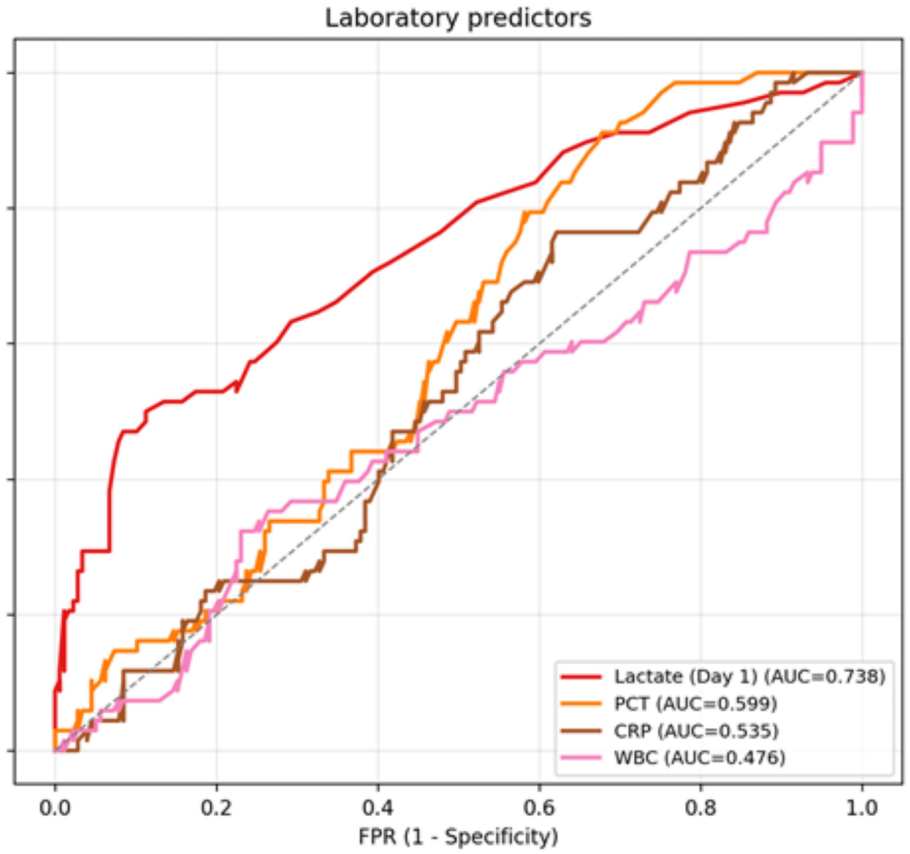


FIGURE 2: Receiver operating characteristic (ROC) curves of laboratory predictors for 28-day survival

Clinical variables were also evaluated in relation to survival. Vasopressor use was significantly associated with an increased risk of mortality. Non-survivors were more likely to require vasopressors than survivors (83.8% vs. 21.9%, respectively; $\chi^2 = 76.68$, $p < 0.001$). Patients who required vasopressors had 18.47 times higher odds of mortality than those who did not require vasopressors (OR = 18.47, 95% CI: 8.93-38.20) (Table 9).

Variable	Survivors, n (%)	Non-survivors, n (%)	χ^2	Odds ratio (95% CI)	p-value
Vasopressor use	39/178 (21.9%)	57/68 (83.8%)	76.683	18.47 (8.93-38.20)	<0.001
Sex	85/178 (47.8%)	32/68 (47.1%)	0.38	1.00 (0.57-1.75)	0.825
Obesity	32/178 (18.0%)	3/68 (4.4%)	9.44	0.16 (0.05-0.55)	0.002
Diabetes mellitus	67/178 (37.6%)	27/68 (39.7%)	0.00	1.05 (0.60-1.84)	0.982
Hypertension	94/178 (52.8%)	25/68 (36.8%)	3.89	0.53 (0.29-0.96)	0.049
Ischemic heart disease	45/178 (25.3%)	26/68 (38.2%)	4.47	1.91 (1.09-3.36)	0.034
Heart failure	31/178 (17.4%)	17/68 (25.0%)	1.44	1.54 (0.83-2.88)	0.230
Chronic obstructive pulmonary disease	28/178 (15.7%)	11/68 (16.2%)	0.00	1.06 (0.55-2.06)	0.994
Chronic kidney disease	40/178 (22.5%)	12/68 (17.6%)	0.81	0.71 (0.37-1.35)	0.368

TABLE 9: Association between clinical variables and 28-day survival

In addition, ischemic heart disease was significantly associated with increased odds of mortality ($\chi^2 = 4.47$, p

= 0.034; OR = 1.91, 95% CI: 1.09-3.36). Conversely, obesity (χ^2 = 9.44, p = 0.002; OR = 0.16, 95% CI: 0.05-0.55) and hypertension (χ^2 = 3.89, p = 0.049; OR = 0.53, 95% CI: 0.29-0.96) were associated with lower odds of mortality. Other variables, including COPD, diabetes mellitus, heart failure, and sex, showed no statistically significant association with survival (Table 9).

In our cohort, the SOFA score demonstrated slightly better performance than the APACHE II score in predicting 28-day mortality, with marginally higher sensitivity and specificity. Among the laboratory variables, the highest serum lactate level during the first 24 hours demonstrated the best discriminatory performance for survival. Among the clinical variables, vasopressor use showed the strongest association with survival.

Discussion

In this five-year retrospective cohort study conducted in a rural ICU, the highest serum lactate level and vasopressor use within the first 24 hours demonstrated the best predictive performance for 28-day mortality. The highest day 1 lactate level had an AUC of 0.738, while vasopressor use had an AUC of 0.810. These values were numerically higher than those of the APACHE II score (AUC = 0.709) and SOFA score (AUC = 0.761). In contrast, inflammatory biomarkers, including CRP, WBC count, and PCT, demonstrated limited discriminatory ability. Non-survivors had significantly higher Day 1 lactate levels than survivors (5.08 ± 4.41 vs. 2.26 ± 1.71, respectively; t = -5.19, p < 0.001).

The optimal cutoff values for the highest day 1 lactate level (3.6 mmol/L; specificity = 0.888, sensitivity = 0.500) and vasopressor use (sensitivity = 0.838, specificity = 0.781) further highlighted their potential clinical relevance. Collectively, these findings support a risk-stratification approach that focuses on perfusion and hemodynamic indicators, particularly in resource-limited settings.

Consistent with findings from several previous studies, the APACHE II and SOFA scores demonstrated utility in predicting mortality, although their discriminatory performance may vary across heterogeneous sepsis populations. A single-center study involving 165 patients at a tertiary hospital in Turkey reported a higher AUC for the SOFA score (0.873) than for the APACHE II score (0.803) [4].

More recent evidence further supports our findings. A Chinese retrospective study involving 139 patients with sepsis reported similar performance for the two scoring systems, with an AUC of 0.809 for SOFA and 0.806 for APACHE II, indicating nearly equivalent predictive ability [7].

In addition, a large Canadian retrospective cohort study involving 4,794 ICU admissions used APACHE II scores automatically calculated from EMR data. The results demonstrated strong discriminatory performance for APACHE II (AUC = 0.83). However, this study included all ICU admissions rather than exclusively patients with sepsis, supporting the utility of APACHE II as a mortality prediction tool across a broader ICU population [8].

Evidence from Pakistan and Iran highlights how healthcare system context and patient case mix may influence the performance of these scoring systems. In a large Pakistani multicenter study involving 1,368 patients, APACHE II demonstrated the highest sensitivity (77.5%), specificity (94.3%), and accuracy (85.5%) compared with SOFA [9]. In contrast, an Iranian mixed-ICU cohort involving 300 patients reported better discriminatory performance with APACHE II (AUC = 0.737) but better calibration with SOFA (AUC = 0.634). However, the study recommended SOFA because of its simplicity and practicality at the bedside [10].

An Indian cohort study conducted in a rural area of western India reported lower-than-expected AUC values for APACHE II and SOFA (0.64 and 0.57, respectively). These findings differed from those reported in most similar studies [11].

Our observation that the highest day 1 lactate level is a strong prognostic indicator is consistent with findings from studies conducted in different settings. In a study involving 12,213 pediatric ICU admissions, the incidence of mortality increased with each 1 mmol/L increase in serum lactate at admission, reaching up to 14%, particularly at levels above 3 mmol/L. Although this study involved a pediatric population, its findings support our observation regarding the prognostic value of lactate and help explain why lactate, as a marker of circulatory failure, may be more informative than other inflammatory and sepsis-related indices [12].

A large Chinese study involving more than 2,000 patients demonstrated a statistically significant association between serum lactate trajectories during the first three days and mortality, particularly in the presence of vasopressor use. This finding is consistent with our results. Moreover, integrating the SOFA score with these findings could significantly improve the accuracy of these prognostic indicators [13].

Authoritative reviews emphasize that severity scoring systems were primarily designed for benchmarking, research-related risk adjustment, and quality improvement rather than for individual admission decisions [14]. In rural and resource-limited settings, structural challenges, including limited infrastructure, staffing

shortages, supply chain difficulties, and overcrowding, complicate the implementation of complex scoring systems and may affect their reliability. Qualitative evidence from rural hospitals in eight countries demonstrated that these challenges negatively affected infection prevention and control and, consequently, the care of patients with sepsis. These findings support the use of rapid and simple risk-stratification indicators, such as serum lactate and vasopressor use, alongside more complex scoring systems, particularly in rural and resource-limited settings [15].

The strengths of this study include data collection over a five-year period involving septic ICU admissions, standardized documentation of important clinical variables, and the identification of potentially useful thresholds through ROC curve analysis. However, its limitations include the single-center rural setting, possible referral bias, and the absence of external validation. As noted in previous reviews, these factors may limit the generalizability of the findings and highlight the need for local recalibration when applying prognostic scores.

Our study highlights the importance of incorporating day 1 lactate levels and vasopressor use into sepsis care pathways as practical, rapid, and simple risk-stratification indicators. These variables may complement the APACHE II and SOFA scores in the initial assessment of patients with sepsis.

Collectively, these findings support the view that, although both APACHE II and SOFA are clinically validated scoring systems, their discriminatory performance varies across settings, with neither consistently demonstrating superiority. These differences underscore the importance of local validation and recalibration before implementing these scores in clinical pathways, particularly in rural and resource-limited settings.

Conclusions

This study evaluated the relationship between APACHE II score, SOFA score, clinical biomarkers, comorbidities, vasopressor use, and 28-day survival among patients with sepsis and septic shock admitted to a rural ICU. APACHE II and SOFA scores were significantly associated with mortality and demonstrated good predictive performance. In addition, elevated serum lactate levels and the requirement for vasopressor support were strongly associated with adverse outcomes and showed good discriminatory ability for predicting mortality. These findings support the utility of established severity scoring systems while highlighting the prognostic value of serum lactate levels and vasopressor requirements as complementary clinical indicators. Further multicenter prospective studies are warranted to validate these findings and assess their applicability across different patient populations.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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