



Original Article

Predictors of Mortality in Sepsis: SOFA vs QSOFA vs NEWS2 vs Lactate

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ABSTRACT

Background: Sepsis is a life-threatening condition associated with significant morbidity and mortality. Early identification of patients at high risk of death is essential for timely intervention and optimal resource utilization. Several prognostic tools, including the Sequential Organ Failure Assessment (SOFA), quick Sequential Organ Failure Assessment (qSOFA), National Early Warning Score 2 (NEWS2), and serum lactate, are commonly used; however, their comparative predictive performance remains uncertain.

Objectives: To compare the predictive performance of SOFA, qSOFA, NEWS2, and serum lactate in predicting in-hospital mortality among patients with sepsis and to identify independent predictors of mortality.

Materials and Methods: This prospective observational study included 150 adult patients with sepsis admitted to a tertiary care teaching hospital between January 2024 and December 2024. SOFA, qSOFA, NEWS2, and serum lactate were assessed within 24 hours of admission. Receiver operating characteristic (ROC) curve analysis was performed to compare prognostic accuracy. Multivariate logistic regression was used to identify independent predictors of mortality.

Results: The mean age of the study population was 58.4 ± 15.2 years, and 61.3% were males. Overall in-hospital mortality was 26.0% (39/150). Non-survivors had significantly higher SOFA, qSOFA, NEWS2, and serum lactate levels than survivors (all $p < 0.001$). SOFA demonstrated the highest predictive performance with an AUC of 0.921, followed by NEWS2 (0.887), serum lactate (0.861), and qSOFA (0.819). On multivariate logistic regression, SOFA score (adjusted OR=1.54, $p < 0.001$), serum lactate (adjusted OR=1.39, $p = 0.001$), NEWS2 score (adjusted OR=1.21, $p = 0.008$), and increasing age (adjusted OR=1.03, $p = 0.017$) were independent predictors of mortality.

Conclusion: SOFA score demonstrated the highest accuracy for predicting in-hospital mortality in patients with sepsis and remained the strongest independent predictor. NEWS2 and serum lactate also showed excellent prognostic utility and may complement SOFA for early risk stratification, whereas qSOFA exhibited comparatively lower predictive performance.

Keywords: Sepsis; Sequential Organ Failure Assessment; qSOFA; NEWS2; Serum lactate.

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INTRODUCTION

Sepsis is a life-threatening syndrome characterized by a dysregulated host response to infection, resulting in organ dysfunction and high morbidity and mortality worldwide [1]. Despite advances in antimicrobial therapy, critical care, and organ support, sepsis remains a major public health challenge and is one of the leading causes of death among hospitalized patients [2]. According to the Sepsis-3 consensus, sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection, emphasizing the importance of early recognition and prompt intervention to improve patient outcomes [3,4].

Timely risk stratification is essential in patients with sepsis to facilitate appropriate triage, guide treatment decisions, optimize resource utilization, and predict clinical outcomes [5]. Several clinical scoring systems have been developed for this purpose. The Sequential Organ Failure Assessment (SOFA) score is widely regarded as the reference standard for assessing organ dysfunction and predicting mortality in critically ill patients [6]. However, its routine application may be limited by the requirement for multiple laboratory parameters. To overcome these limitations, the quick Sequential Organ Failure Assessment (qSOFA) score was introduced as a simplified bedside screening tool based on altered mental status, respiratory rate, and systolic blood pressure [7,8]. Similarly, the National Early Warning Score 2 (NEWS2) has gained widespread acceptance for the early identification of deteriorating patients by incorporating physiological parameters that can be rapidly assessed in emergency and ward settings [9,10].

Serum lactate has also emerged as an important biomarker in sepsis, reflecting tissue hypoperfusion and the severity of circulatory dysfunction [11]. Elevated lactate levels have consistently been associated with increased organ failure, intensive care unit admission, and mortality, even in patients without overt hypotension [12]. While numerous studies have independently evaluated SOFA, qSOFA, NEWS2, and serum lactate, direct comparisons among these prognostic tools have yielded variable results across different healthcare settings and patient populations [13]. Identifying the most accurate and practical predictor of mortality is therefore crucial for improving early clinical decision-making and patient management.

The present study aimed to compare the predictive performance of SOFA, qSOFA, NEWS2, and serum lactate in predicting in-hospital mortality among patients with sepsis and to identify the most reliable independent predictors of mortality in this population.

MATERIALS AND METHODS

This prospective observational study was conducted among adult patients diagnosed with sepsis and admitted to the emergency department, intensive care unit (ICU), or medical wards of a tertiary care teaching hospital between January 2024 and December 2024. The study included 150 consecutive patients aged 18 years or older who fulfilled the Sepsis-3 diagnostic criteria. Patients with incomplete clinical data, those discharged against medical advice before completion of evaluation, pregnant women, and patients with known hematological malignancies or terminal illnesses unrelated to sepsis were excluded from the study. Ethical clearance was obtained from the Institutional Ethics Committee before study commencement, and written informed consent was obtained from the patients or their legally authorized representatives. Baseline demographic details including age, sex, comorbidities, source of infection, and clinical presentation were recorded at admission using a structured case record form. Routine laboratory investigations including complete blood count, serum creatinine, total bilirubin, C-reactive protein (CRP), procalcitonin, arterial blood gas analysis, and serum lactate levels were performed as part of standard patient care. Information regarding ICU admission, requirement for mechanical ventilation, vasopressor support, duration of hospital stay, and final hospital outcome (survival or in-hospital mortality) was documented for all patients.

Within the first 24 hours of admission, Sequential Organ Failure Assessment (SOFA) score, quick Sequential Organ Failure Assessment (qSOFA) score, and National Early Warning Score 2 (NEWS2) were calculated for each patient using standard published criteria. Serum lactate concentration measured at admission was recorded simultaneously. The predictive performance of SOFA, qSOFA, NEWS2, and serum lactate for in-hospital mortality was evaluated and compared. Receiver operating characteristic (ROC) curve analysis was performed to determine the discriminative ability of each prognostic tool, and optimal cut-off values were identified using the Youden index. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated for each scoring system.

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD) and compared using the independent samples *t*-test, while categorical variables were presented as frequencies and percentages and compared using the Chi-square test or Fisher's exact test, as appropriate. Receiver operating characteristic (ROC) curves were constructed to compare the prognostic performance of SOFA, qSOFA, NEWS2, and serum lactate using the area under the curve (AUC). Variables showing statistical significance on univariate analysis were entered into a multivariate logistic regression model to identify independent predictors of in-hospital mortality. A *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 150 patients with sepsis were included in the study, of whom 92 (61.3%) were males and 58 (38.7%) were females, with a mean age of 58.4 ± 15.2 years. The most common comorbidities were hypertension (46.0%) and diabetes mellitus (40.7%). Respiratory tract infection was the predominant source of sepsis (38.7%), followed by urinary tract (22.0%) and abdominal infections (16.0%). Overall, 97 (64.7%) patients required ICU admission, 52 (34.7%) required

mechanical ventilation, and 61 (40.7%) received vasopressor support. The mean duration of hospital stay was 9.8 ± 5.6 days, and the overall in-hospital mortality was 26.0% (39/150). (Table 1)

Table 1. Baseline demographic and clinical characteristics of study participants (N = 150)

Variable	Total (N=150)
Age (years), Mean $\pm$ SD	58.4 $\pm$ 15.2
Male	92 (61.3)
Female	58 (38.7)
Diabetes mellitus	61 (40.7)
Hypertension	69 (46.0)
Chronic kidney disease	24 (16.0)
Chronic liver disease	12 (8.0)
COPD	21 (14.0)
Malignancy	17 (11.3)
Immunosuppression	15 (10.0)
Respiratory infection	58 (38.7)
Urinary tract infection	33 (22.0)
Abdominal infection	24 (16.0)
Skin and soft tissue infection	14 (9.3)
Bloodstream infection	12 (8.0)
Central nervous system infection	5 (3.3)
Other infections	4 (2.7)
ICU admission	97 (64.7)
Mechanical ventilation	52 (34.7)
Vasopressor support	61 (40.7)
Hospital stay (days), Mean $\pm$ SD	9.8 $\pm$ 5.6
Mortality	39 (26.0)

Comparison between survivors and non-survivors demonstrated that patients who died were significantly older than survivors (64.8 ± 15.3 vs. 56.1 ± 14.6 years, $p = 0.002$). Diabetes mellitus and chronic kidney disease were more prevalent among non-survivors, with chronic kidney disease showing a significant association with mortality (30.8% vs. 10.8%, $p = 0.003$). Non-survivors had significantly greater requirements for mechanical ventilation (74.4% vs. 20.7%) and vasopressor support (84.6% vs. 25.2%) (both $p < 0.001$). Laboratory evaluation revealed significantly lower hemoglobin and platelet counts, along with higher leukocyte count, serum creatinine, total bilirubin, C-reactive protein, and procalcitonin levels among non-survivors compared with survivors (all $p < 0.01$). (Table 2)

Table 2. Comparison of demographic, clinical characteristics and laboratory parameters between survivors and non-survivors

Variable	Survivors (n=111)	Non-survivors (n=39)	P value
Age (years)	56.1 $\pm$ 14.6	64.8 $\pm$ 15.3	0.002
Male	66 (59.5)	26 (66.7)	0.431
Diabetes mellitus	40 (36.0)	21 (53.8)	0.049
Hypertension	47 (42.3)	22 (56.4)	0.126
Chronic kidney disease	12 (10.8)	12 (30.8)	0.003
Mechanical ventilation	23 (20.7)	29 (74.4)	<0.001
Vasopressor support	28 (25.2)	33 (84.6)	<0.001
Hemoglobin (g/dL)	11.6 $\pm$ 2.0	10.4 $\pm$ 2.2	0.004
Total leukocyte count ($\times 10^3/\mu\text{L}$)	15.9 $\pm$ 6.2	19.2 $\pm$ 7.4	0.008
Platelets ($\times 10^3/\mu\text{L}$)	198 $\pm$ 78	151 $\pm$ 84	0.002
Serum creatinine (mg/dL)	1.48 $\pm$ 0.92	2.36 $\pm$ 1.24	<0.001
Total bilirubin (mg/dL)	1.21 $\pm$ 0.84	2.18 $\pm$ 1.31	<0.001
CRP (mg/L)	99.2 $\pm$ 56.8	134.1 $\pm$ 67.5	0.002
Procalcitonin (ng/mL)	6.3 $\pm$ 4.7	11.2 $\pm$ 7.4	<0.001

The prognostic scoring systems and serum lactate levels differed significantly between the two outcome groups. Non-survivors exhibited markedly higher mean SOFA scores (11.7 ± 2.8 vs. 6.3 ± 2.4), qSOFA scores (2.4 ± 0.5 vs. 1.3 ± 0.7), NEWS2 scores (11.5 ± 2.3 vs. 7.2 ± 2.6), and serum lactate concentrations (5.9 ± 2.0 vs. 2.8 ± 1.3 mmol/L) compared with survivors. All four parameters demonstrated highly significant associations with mortality ($p < 0.001$). (Table 3)

Table 3. Comparison of prognostic scores between survivors and non-survivors

Variable	Survivors (n=111)	Non-survivors (n=39)	P value
SOFA score	6.3 ± 2.4	11.7 ± 2.8	<0.001
qSOFA score	1.3 ± 0.7	2.4 ± 0.5	<0.001
NEWS2 score	7.2 ± 2.6	11.5 ± 2.3	<0.001
Serum lactate (mmol/L)	2.8 ± 1.3	5.9 ± 2.0	<0.001

Receiver operating characteristic (ROC) curve analysis demonstrated that SOFA score had the highest discriminative ability for predicting in-hospital mortality with an AUC of 0.921 (95% CI: 0.876–0.966), followed by NEWS2 (AUC = 0.887), serum lactate (AUC = 0.861), and qSOFA (AUC = 0.819). Using optimal cut-off values, SOFA score (≥ 9) achieved the highest sensitivity (89.7%) and specificity (84.7%), with an overall diagnostic accuracy of 86.0%. All four prognostic tools demonstrated statistically significant predictive performance ($p < 0.001$). (Table 4)

Table 4. Diagnostic performance of SOFA, qSOFA, NEWS2 and serum lactate in predicting mortality

Parameter	SOFA	qSOFA	NEWS2	Lactate
Area under ROC curve (AUC)	0.921	0.819	0.887	0.861
95% Confidence Interval	0.876–0.966	0.744–0.894	0.831–0.943	0.799–0.923
Optimal cut-off	≥ 9	≥ 2	≥ 9	≥ 4.0 mmol/L
Sensitivity (%)	89.7	71.8	84.6	79.5
Specificity (%)	84.7	81.1	79.3	76.6
Positive predictive value (%)	67.3	57.1	58.9	53.4
Negative predictive value (%)	95.9	89.2	93.6	91.5
Overall accuracy (%)	86.0	78.7	80.7	77.3
P value	<0.001	<0.001	<0.001	<0.001

On univariate logistic regression analysis, increasing age, diabetes mellitus, chronic kidney disease, requirement for mechanical ventilation, vasopressor support, higher SOFA score, higher qSOFA score, higher NEWS2 score, and elevated serum lactate were significantly associated with mortality. After multivariate adjustment, SOFA score remained the strongest independent predictor of mortality (adjusted OR = 1.54, 95% CI: 1.28–1.87, $p < 0.001$), followed by serum lactate (adjusted OR = 1.39, 95% CI: 1.15–1.68, $p = 0.001$), NEWS2 score (adjusted OR = 1.21, 95% CI: 1.05–1.39, $p = 0.008$), and increasing age (adjusted OR = 1.03, 95% CI: 1.01–1.06, $p = 0.017$). qSOFA score, diabetes mellitus, chronic kidney disease, mechanical ventilation, and vasopressor use were not independent predictors after adjustment. (Table 5)

Table 5. Univariate and multivariate logistic regression analysis for predictors of mortality

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age	1.04 (1.02–1.07)	0.001	1.03 (1.01–1.06)	0.017
Diabetes mellitus	2.08 (1.01–4.28)	0.046	1.27 (0.61–2.64)	0.518
Chronic kidney disease	3.67 (1.49–9.06)	0.005	1.82 (0.68–4.89)	0.231
Mechanical ventilation	11.18 (4.89–25.56)	<0.001	2.41 (0.88–6.61)	0.086
Vasopressor support	16.18 (6.37–41.09)	<0.001	2.79 (0.97–8.01)	0.057
SOFA score	1.72 (1.43–2.08)	<0.001	1.54 (1.28–1.87)	<0.001
qSOFA score	3.94 (2.18–7.13)	<0.001	1.28 (0.74–2.22)	0.381
NEWS2 score	1.46 (1.26–1.69)	<0.001	1.21 (1.05–1.39)	0.008
Serum lactate	1.67 (1.34–2.09)	<0.001	1.39 (1.15–1.68)	0.001

Overall comparison of the prognostic tools demonstrated that SOFA score ranked first in predicting mortality, exhibiting excellent discrimination, the highest diagnostic accuracy, and retaining independent significance in multivariate analysis. NEWS2 ranked second, followed by serum lactate, both of which also independently predicted mortality. Although qSOFA showed good discriminative ability and significant association with mortality on univariate analysis, it demonstrated comparatively lower predictive performance and was not an independent predictor after adjustment. These findings indicate that SOFA score is the most reliable prognostic tool among the four evaluated methods for predicting mortality in patients with sepsis. (Table 6)

Table 6. Comparison of prognostic performance of different mortality prediction tools

Parameter	SOFA	NEWS2	Lactate	qSOFA
AUC Rank	1	2	3	4
Discriminative ability	Excellent	Excellent	Good	Good
Independent predictor	Yes	Yes	Yes	No
Clinical usefulness	Excellent	Very good	Very good	Moderate

DISCUSSION

In the present study, the overall in-hospital mortality among patients with sepsis was 26.0%, reflecting the substantial disease burden despite advances in critical care. Non-survivors were significantly older and had a higher prevalence of chronic kidney disease, greater need for mechanical ventilation and vasopressor support, and more severe laboratory abnormalities, indicating greater organ dysfunction. These findings are consistent with previous reports demonstrating that advanced age, underlying comorbidities, and progressive organ failure are major determinants of adverse outcomes in sepsis [14,15]. Similar observations have been reported by Liu et al., who showed that worsening organ dysfunction and elevated lactate levels were independently associated with increased mortality among septic patients, highlighting the importance of early risk stratification [14].

The present study demonstrated that all four prognostic tools—SOFA, qSOFA, NEWS2, and serum lactate—were significantly associated with mortality; however, the SOFA score showed the highest predictive performance (AUC = 0.921), followed by NEWS2, serum lactate, and qSOFA. These findings are in agreement with the study by Mellhammar L et al, who reported that SOFA had the greatest ability to identify sepsis-induced organ dysfunction, while NEWS2 also showed excellent prognostic performance for predicting mortality [16]. Likewise, another observational study reported that NEWS2 consistently outperformed qSOFA in identifying patients with sepsis and organ dysfunction, supporting the superior sensitivity of NEWS2 for early clinical deterioration [15].

Serum lactate was also found to be an independent predictor of mortality in the present study, with significantly higher levels observed among non-survivors. Elevated lactate reflects impaired tissue perfusion and metabolic stress and has long been recognized as a marker of disease severity in sepsis. Our findings are comparable to those of Liu et al., who demonstrated that lactate independently predicted mortality and exhibited prognostic performance similar to SOFA while outperforming qSOFA [14]. Furthermore, studies evaluating the addition of lactate to qSOFA have shown improved discrimination compared with qSOFA alone, suggesting that biochemical markers complement bedside clinical scoring systems [16]. Although qSOFA remains a simple and rapid screening tool, its lower sensitivity limits its use as a standalone predictor of mortality.

Multivariate logistic regression in the present study identified SOFA score, NEWS2 score, serum lactate, and increasing age as independent predictors of in-hospital mortality, whereas qSOFA lost statistical significance after adjustment. These findings emphasize that comprehensive assessment of organ dysfunction provides better prognostic accuracy than simplified bedside screening alone. A recent systematic review and meta-analysis similarly concluded that SOFA remains the most reliable predictor of sepsis mortality, whereas qSOFA demonstrates comparatively lower predictive ability; combining lactate with clinical scores improves prognostic performance and may be particularly useful in resource-limited settings [17]. Overall, our findings support the routine use of SOFA for mortality prediction, while NEWS2 and serum lactate may serve as valuable adjunctive tools for early identification and risk stratification of patients with sepsis.

CONCLUSION

The present study demonstrated that SOFA score is the most accurate and reliable predictor of in-hospital mortality among patients with sepsis, outperforming qSOFA, NEWS2, and serum lactate in terms of overall prognostic performance. Although all four tools were significantly associated with mortality, SOFA exhibited the highest discriminative ability and remained the strongest independent predictor after multivariate analysis. NEWS2 and serum lactate also independently predicted mortality and may serve as valuable adjuncts for early risk stratification, particularly in emergency and critical care settings, whereas qSOFA, despite its simplicity, showed comparatively lower predictive accuracy. Early assessment using these prognostic tools, especially SOFA in combination with NEWS2 and serum lactate, may facilitate timely identification of high-risk patients, guide clinical decision-making, optimize resource allocation, and ultimately improve outcomes in patients with sepsis.

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