



Journal of Acute Disease

Original Article



jadweb.org

doi: 10.4103/jad.jad_95_25

Effectiveness of qSOFA and NEWS in predicting mortality in sepsis patients presenting in emergency department: A prospective study

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ABSTRACT

Objective: Early sepsis can be treated if recognised early, but progression to severe sepsis and septic shock and multiple organ dysfunction syndrome substantially increases mortality. The objectives of our study were to assess morbidity and mortality of patients with sepsis and to compare the effectiveness of a simple bedside satisfiable Quick Sequential Organ Failure Assessment (qSOFA) score with National Early Warning Score (NEWS) in prognosticating sepsis.

Methods: This prospective observational study was conducted among patients >18 years old presenting with sepsis at B.J. Medical College. The SOFA, qSOFA and NEWS scores were calculated. The effectiveness in predicting mortality was evaluated using receiver operating characteristic curve analysis.

Results: A total of 200 patients were evaluated (56% male) with a mean age of 51.7 years. The mortality rate was 23%. Patients categorized under high risk according to SOFA score >8, qSOFA score of 2-3 and NEWS >7 had a mortality rate of 33.3%, 27.5% and 28.4%, respectively. AUC for mortality prediction was 0.695 using SOFA score, 0.665 using qSOFA and 0.725 using NEWS. At a cut off of 7.50, NEWS demonstrated a sensitivity of 97.8% with a specificity of 28.0% and outperformed both SOFA and qSOFA which yielded a sensitivity of 43.5% and 91.3% and a specificity of 77.9% and 27.9%, respectively.

Conclusions: The NEWS score outperforms SOFA and qSOFA in predicting mortality among sepsis patients. However, qSOFA is more helpful in identifying high risk patients and performs better in intensive care setting.

KEYWORDS: Sepsis; Emergency department; qSOFA; NEWS; Mortality predictor

Summary

Question: Is NEWS a better predictor of mortality in patients with sepsis compared to qSOFA?

Findings: Both qSOFA score and NEWS score were fairly accurate in prediction of in-hospital mortality in patients with severe sepsis. But NEWS had a higher sensitivity (97.8%) than qSOFA (91.3%).

Meaning: NEWS score is a better predictor of mortality of sepsis patients and identifying patients at risk for sepsis in the emergency setting. But qSOFA is more helpful in confirming the high risk patients and better suited for ICU setting. They may serve as an effective tool in emergency medicine for the management and risk stratification of sepsis patients and follow up in ICU.

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How to cite this article: Gosai JB, Arunjith G, Ginoya SK. Effectiveness of qSOFA and NEWS in predicting mortality in sepsis patients presenting in emergency department: A prospective study. J Acute Dis 2026; 15; 1.

Article history: Received 23 June 2025; Revision 15 July 2025; Accepted 25 December 2025; Available online 23 January 2026

1. Introduction

Sepsis is a life-threatening and time-dependent organ dysfunction caused by a dysregulated host response to infection[1]. Sepsis affects millions of people each year, and is a leading cause of morbidity and mortality among hospitalized patients[2]. Despite the recent advancements in therapeutics and management, sepsis patients have high risk of in hospital mortality, accounting for approximately 20% among all deaths and representing one of the most common causes of death for patients presenting to the emergency department (ED)[3-5].

Early sepsis can be treated properly if recognised early, but as sepsis progresses to severe sepsis and septic shock and MODS the mortality rate substantially increases. The higher mortality associated with sepsis and its complications necessitates rapid diagnosis and treatment of the underlying cause. Several scoring systems have been designed for use in the emergency medicine department and intensive care unit (ICU). These scores provide prognostic models for sepsis, aiding in clinical decision-making regarding early goal-directed therapy, predicting organ dysfunction, and facilitating early referral from resource-limited settings.

According to the third international consensus on sepsis and septic shock (Sepsis-3 bundle), sepsis should be suspected in patients with infections stemming from any infective source. In these subjects, a bedside tool called the Quick Sequential Organ Failure Assessment (qSOFA) score was introduced as a risk-stratification tool for those presenting to the ED[6,7]. The qSOFA can be calculated rapidly in the ED without need for laboratory or advanced testing, which makes it useful in emergency settings. A score of ≥ 2 indicates a high risk of in-hospital mortality. However, the 2021 sepsis guidelines added new early warning tools like National Early Warning Score (NEWS), which is used to promptly identify and respond to patients at risk of clinical deterioration, including sepsis. Several studies regarding the qSOFA and NEWS and its validation as a tool for predicting the severity of sepsis and mortality has been studied in developed countries. Very few studies have been published so far validating qSOFA as a tool to predict mortality in western India where patient profiles, comorbidity patterns and healthcare workflows may differ significantly. Therefore, the objectives of our study were to assess the morbidity and mortality of patients with sepsis and to compare the efficacy of a simple bedside satisfiable qSOFA score with the NEWS score in prognosticating sepsis[8-13].

2. Patients and methods

2.1. Study setting

This was a prospective, single-center observational study involving sepsis patients admitted to the Department of Emergency Medicine at B. J. Medical College, Civil Hospital, Ahmedabad, India between March 2023 to March 2024.

2.2. Inclusion and exclusion criteria

All the patients aged 18 years and older presenting to the ED diagnosed with sepsis or septic shock based on the Sepsis-3 definition (suspected or confirmed infection with evidence of organ dysfunction) were included in the study. A diagnosis of sepsis was confirmed in the case of a qSOFA score ≥ 2 . All components of the qSOFA score (altered mental status, systolic blood pressure ≤ 100 mmHg, and respiratory rate ≥ 22 /min) were assessed at the time of presentation and a minimum qSOFA value 1 was required for inclusion. Each criterion was assigned 1 point, and organ dysfunction was suspected for score more than 2[9,10]. Vital signs, respiratory rate, oxygen saturation, supplemental oxygen, temperature, systolic blood pressure, heart rate and level of consciousness were noted and points assigned and NEWS calculation was done at the time of presentation. Patients presenting with conditions that mimic sepsis but were not related to infection, such as trauma, burns, heart failure or pancreatitis without infection were excluded. The enrolled patients were assessed and followed up throughout the hospital stay till discharge to assess the clinical status. After an initial evaluation at admission the patient was followed up till discharge or death.

2.3. Procedures

All patients were subjected through a detailed questionnaire and clinical examination at inclusion and necessary clinical details were obtained. A detailed history was elicited from the patient or a reliable relative. Data collection included patient demographic data, comorbidities, vital signs, source of infection, initial management in ED. Evidence of infection was confirmed through relevant laboratory investigations, radiological tests and microbiological parameters. After an initial evaluation at admission the patient was followed up till discharge or death. The progress of the patient the management and the outcome were monitored throughout the hospital stay. The need for supportive management was noted. This

included inotropic support, hemodialysis, ventilator support and ICU care. The outcome of the patient in terms of morbidity (length of ICU stay, need for ventilator support, inotropic support, and dialysis) and mortality was documented. Alongwith the calculated Sequential Organ Failure Assessment (SOFA) score, NEWS Score and qSOFA score.

2.4. Statistical analysis

All patient characteristics were summarized as counts and percentages for categorical variables and mean and standard deviation or median and inter-quartile range for the quantitative variables. Group comparisons were conducted using χ^2 tests for equal proportions, t-tests for normally distributed data. Discriminatory power was determined by comparing the area under the receiver operating characteristic curve (AUROC) for each score individually (unadjusted analysis) and in conjunction with a baseline risk model (adjusted analysis). Data were entered into Microsoft excel data sheet and were analyzed using SPSS 22 version software (IBM SPSS Statistics, Somers NY, USA). SOFA, qSOFA and NEWS score were further analyzed using the receiver operating characteristic (ROC) and optimal cut-off points were chosen for the calculation of sensitivity and specificity. A test that predicted an outcome no better than chance had an area under the ROC curve of 0.5. An area under the ROC curve above 0.8 indicated fairly good prediction. Graphical representation of data:

MS Excel and MS word was used to obtain various types of graphs. P value of $<.05$ was considered as statistically significant after assuming all the rules of statistical tests.

3. Results

3.1. Patient characteristics

In this study, a total of 224 patients were initially enrolled, of which 200 were included in the final analysis. The patient disposition flowchart is shown in Figure 1. The age distribution of the patients showed that the majority were in the age group of <65 years (81.5%) with mean age of 51.7 years. The study included 112 (56%) males and 88 (44%) females. The most common symptom among patients was fever (75.0%), followed by cough (43.5%) and breathlessness (36.0%) (Table 1).

The overall mortality at discharge was 23% (46/200), with 154 patients surviving. The highest mortality rate was observed in 28 patients with lower respiratory tract infection (LRTI) (60.8%), followed by 6 patients with LRTI with ARDS (13%). The lowest mortality rate was seen in 4 patients with urosepsis (8.6%), 4 patients with meningitis (8.6%), 3 patients with cellulitis (6.5%) and 1 patient with acute gastroenteritis (2.1%).

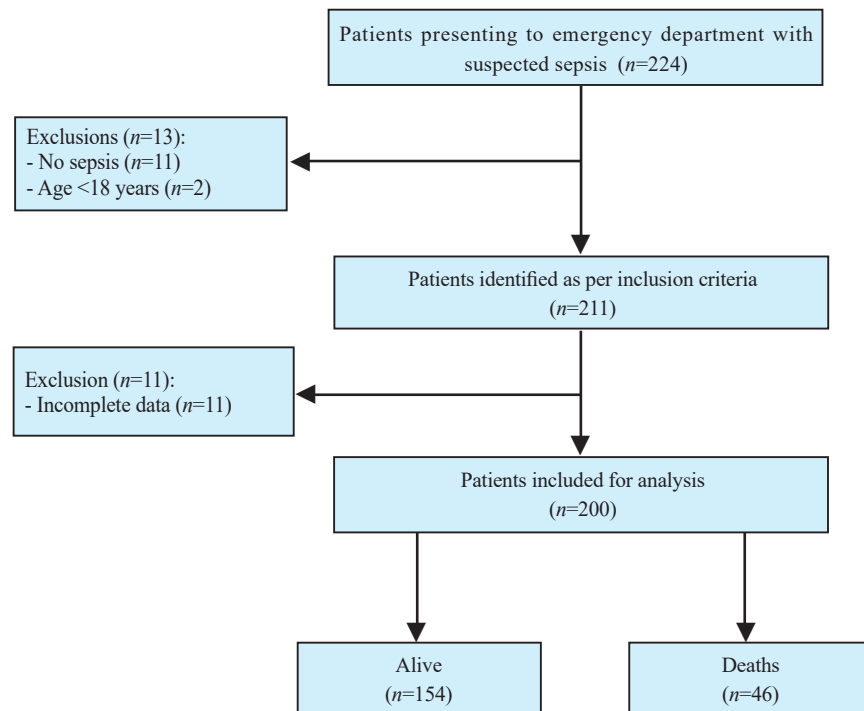


Figure 1. Patient disposition.

Table 1. Patients characteristics.

Variables	n=200
Age, years, mean (SD)	51.7±18.6
≤65 years	163 (81.5)
> 65 years	37 (18.5)
Sex	
Male	112 (56.0)
Female	88 (44.0)
Symptoms	
Abdominal pain	18 (9.0)
Headache	20 (10.0)
Decreases urine output	23 (11.5)
Jaundice	24 (12.0)
Vomiting	25 (12.5)
Altered sensorium	61 (30.5)
Breathlessness	72 (36.0)
Cough	87 (43.5)
Fever	150 (75.0)
Vital parameters	
Mean temperature (SD), °C	37.7 (1.2)
Mean pulse (SD), per minute	108.3 (16.0)
Mean systolic blood pressure (SD), mmHg	103 (28.1)
Mean diastolic blood pressure (SD), mmHg	64.7 (14.3)
Mean respiratory rate (SD), per minute	30.3 (5.6)
Laboratory parameters	
Mean hemoglobin (SD), g/dL	10.7 (2.6)
Mean total WBC Count (SD), cells per mm ³	16075.7 (15127.8)
Mean platelet ×10 ³ (SD), ×10 ⁹ cells per L	244.2 (148.0)
Mean PT (SD), seconds	16.6 (7.5)
Mean INR (SD)	1.4 (0.7)
Mean APTT (SD), seconds	35.2 (10.0)
Mean Total bilirubin (SD), mg/dL	1.9 (3.8)
Mean SGOT (SD), U/L	92.6 (320.8)
Mean SGPT (SD), U/L	117.1 (464.2)
Mean BUN (SD), mg/dL	63.5 (52.9)
Mean Creatinine (SD), mg/dL	1.7 (1.8)
Mean CRP (SD), mg/L	51.57 (34.9)
Diagnosis	
LRTI	95 (47.5)
Urosepsis	29 (14.5)
LRTI - ARDS	24 (12.0)
Cellulitis	20 (10.0)
Acute gastroenteritis	18 (9.0)
Meningitis	14 (7.0)
Ventilator support	
No	82 (41.0)
Yes	118 (59.0)

Numbers are expressed as *n* (%), unless otherwise specified. APTT: Activated partial thromboplastin time. ARDS: Acute respiratory distress syndrome. BUN: Blood urea nitrogen. CRP: C- reactive protein. INR: International normalized ratio. LRTI: Lower respiratory tract infection. PT: Prothrombin time. SGOT: Serum glutamic oxaloacetic transaminase. SGPT: Serum glutamic pyruvic transaminase. SD: Standard deviation. WBC: White blood cell.

3.2. Mortality risks of sepsis patients according to the scoring systems

The majority of patients (55.5%) fell into the intermediate risk category of the SOFA score, indicating moderate organ dysfunction. 25.0% of patients were in the low-risk category,

while 19.5% were in the high-risk category, showing severe organ dysfunction. The majority of patients (76.5%) are categorized as high risk (qSOFA 2-3), suggesting a high severity of illness and a correspondingly high mortality. A smaller portion (23.5%) were in the low-risk category (qSOFA 1), indicating a less severe presentation and better prognosis. The vast majority of patients (81.0%) were classified as high risk (NEWS >7), indicating having a high likelihood of adverse outcomes, including mortality. A smaller portion of patients (11.0%) fell into the low-risk category. The intermediate risk category (8.0%) represented a modest number of patients, indicating moderate severity.

In qSOFA category low-risk patients with value <1 had a low mortality rate of 8.5%, and discharge rate of 91.5%, indicating better outcomes for this group. High-risk patients had a significant mortality rate of 27.5%, demonstrating that qSOFA is effective in identifying patients in sepsis who are at higher risk. In NEWS category all patients classified as low risk and medium risk survived and were discharged, High-risk patients according to NEWS had a substantial mortality rate of 28.4%, reinforcing the utility of NEWS in identifying patients who are critically ill and require urgent medical attention. All *P* values were below the significance threshold of .05, indicating a significant association between the scores and mortality. Among these, the NEWS score had the most significant *P* value, suggesting a strong association with mortality risk. (Table 2)

3.3. ROC curve analysis for mortality

The AUC for SOFA was 0.695. At a cut-off value of 7.50, it achieved a specificity of 77.9% but a sensitivity of only 43.5%. At lower cut-offs (i.e., ranging from -1.00 to 2.50), sensitivity reached 100%, albeit with a higher false positive rate. As the cut-off increased, sensitivity decreased while specificity improved. At a cut-off of 7.50, the false positive rate (1-specificity) was 0.221, indicating a more favorable balance between sensitivity and specificity. The qSOFA score had an AUC of 0.665. At a cut-off of 1.50, it yielded a high sensitivity of 91.3% but a low specificity of 27.9%. When the cut-off was raised to 2.50, both the sensitivity and the false positive rate decreased.

The AUC for the NEWS score was 0.725. At a cut-off of 7.50, it demonstrated sensitivity of 97.8% with specificity of 28.0%. NEWS maintained a sensitivity of 100% at several cut-off points, even as the false positive rate began to decline (Figure 2). NEWS and SOFA appeared to have the most consistent performance across multiple cut-off points, suggesting they may be more reliable in practice, but they also had significant false positive rates at lower cut-offs.

Table 2. Mortality risks of sepsis patients according to the scoring systems.

Scoring system	Risk category	N (%)	At discharge		P
			Dead	Alive	
SOFA	Low risk <4	50 (25.0)	5 (10.0)	45 (90.0)	.02
	Intermediate risk 4-8	111(55.5)	28 (25.2)	83 (74.8)	
	High risk >8	39 (19.5)	13 (33.3)	26 (66.7)	
qSOFA	Low risk 1	47 (23.5)	4 (8.5)	43 (91.5)	.007
	High risk 2-3	153 (76.5)	42 (27.5)	111 (72.5)	
NEWS	Low risk 1-4	22 (11.0)	0 (0.0)	22 (100.0)	.001
	Medium risk 5-7	16 (8.0)	0 (0.0)	16 (100.0)	
	High risk >7	162 (81.0)	46 (28.4)	116 (71.6)	

SOFA: Sequential Organ Failure Assessment. qSOFA: Quick Sequential Organ Failure Assessment. NEWS: National Early Warning Score.

4. Discussion

Sepsis is one of the major causes of death in the world. Early detection and prediction of mortality from sepsis in ED remains the priority. But even after several advances, this remains difficult due to certain peculiarities of ED as less attention times and overcrowding. Hence there is a need of prediction tool that is quick and easy to apply. Early identification of patients at high risk of death from sepsis helps in timely intervention and likely improve the mortality.

This study included 200 patients with 112 males (56.0%) and 88 females (44.0%) within commonest age group between 45 to 65 years (41.5%) with mean age of 51 years. Male preponderance was seen that was similar to study by Abhinandan *et al.* and Ferreira *et al.* having 65% male preponderance[14,30]. Mean age of study was almost similar to Saravu *et al.* and Abhinandan *et al.* as 51.85 years and 48.36 years respectively. A total 23% mortality was

noted in present study which was comparable with other studies done by Abhinandhan *et al.* and Saravu *et al.* with 36% and 34% respectively, slightly higher to the present study[30,31]. Mortality in sepsis ranges between 13% and 50% in numerous large clinical trials.

Respiratory infection was the most common cause of sepsis in the study (47.5%). Urinary tract infection (UTI) accounted for 14.5% (29 cases) of patients, followed by cellulitis in 20 patients. These findings are comparable to those reported by Saravu *et al.* with 48% respiratory causes and 26.5% in Lavranou *et al.* Genitourinary causes were 30.8% in Lavranou *et al.* and 20% in Saravu *et al.*[31,32].

Proportion of the patients with SOFA score of <4 in our study (25%) was similar to the study done by Ferreira *et al.*, whereas it was higher in study by Hewett *et al.* (35.5%). When compared with the two studies referenced above, this study exhibited a 55.5% higher proportion of cases with a SOFA score in the range of 4 to 8. In this study SOFA score of >8 was seen in 19.5% patients. While it was 48% in the study done by Ferreira *et al.* and 33% in study by Hewett *et al.*[14,15]. In our study, higher SOFA score showed maximum percentage of mortality (33%) compared to low SOFA score (10%). The study done by Abhinandhan *et al.* also had statistically significant correlation with high SOFA score and mortality. Martin-Loeches *et al.* included 117 patients with sepsis and concluded the changes in SOFA score closely related to the outcome in ICU patients with sepsis[30,33].

Predictive value of SOFA score above 11 was 88% in our study which is comparable to the above mentioned studies done at Nepal and Belgium. Mean SOFA score of above 7 had 87% mortality predictive value. Highest SOFA score of 11 had 85.7% mortality predictive value in study. While in the study by Acharya *et al* and Ferreira *et al* the highest SOFA score had a mortality predictive value of 87.5% and 85%, respectively[14,16].

The SOFA score across various studies demonstrates consistent patterns in mortality risk. Our study (2024) aligns closely with

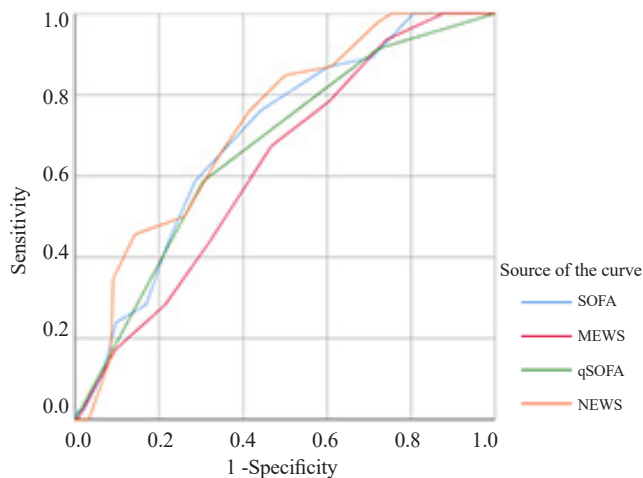


Figure 2. ROC curve of SOFA, MEWS, qSOFA and NEWS for the prediction of mortality in sepsis patients. SOFA: Sequential Organ Failure Assessment. MEWS: Modified Early Warning Score. qSOFA: Quick Sequential Organ Failure Assessment. NEWS: National Early Warning Score.

existing research, showing a progressive increase in mortality with higher SOFA scores. The mortality rates in the low, intermediate, and high-risk categories in our study (10%, 25.2%, 33.3%) are comparable to those observed by Freund *et al.* and Raith *et al.*, Kaukonen *et al.*, Giamarellos-Bourboulis *et al.*[17-20].

In our study, the qSOFA scores showed that 23.5% of the patients had low risk (score of 1), while a significant majority, 76.5%, were in high risk category (score between 2-3). Ruan *et al.* with a larger cohort of 35 756 patients suspected of infection, found that 30 % were in low risk category, and 70% were in high risk category, Herwanto *et al.* examined a substantial population of patients with sepsis and reported 35% as low risk and 65% as high risk category. This study shows a higher percentage of low-risk patients relative to our findings and Ruan *et al.*, similarly Song *et al.* and Herwanto *et al.* assessed a very large sample of 146 551 and 1 716 017 sepsis patients, with 32% categorized as low risk and 68% as high risk[26-28].

In the current study mortality with initial qSOFA with minimum value of 1 score was 5.25%, while the study by Rudd *et al.* with qSOFA of 1 had mortality of 8%. In their study, qSOFA score of 3 was associated with only 30% mortality whereas current study has 70.7% mortality with similar score[29].

The qSOFA score comparison reveals that in our study with low-risk mortality was slightly higher at 8.5% compared to Ruan *et al.*, Herwanto *et al.* and Song *et al.*, which reported 5%, 6%, and 7% respectively. High-risk mortality in our study (27.5%) was slightly lower than in Ruan *et al.* (29%), Herwanto *et al.* (30%), and Song *et al.* (28%). Our study still demonstrates that qSOFA is a valuable tool for assessing mortality risk in sepsis, aligning closely with findings from larger studies[26-28].

The proportion of patients with NEWS in the high-risk category (>7) was significantly higher in the current study (81%) compared to Sabir *et al.* (67%), Almutary *et al.* (54.2%), and Roberts *et al.* (65.1%)[21-23]. This suggests that the patient population in present study was severely ill or that the scoring threshold was more stringent. Conversely, the lower representation in the low-risk category indicates that fewer patients were classified as less likely to deteriorate, which may point to a higher acuity level among the sepsis patients included in present study. This finding aligns with the critical role of NEWS in the early identification and management of sepsis. The comparison supports the utility of NEWS in our patient population while also highlighting potential differences in patient acuity compared to other studies.

In NEWS score patient group comes under high-risk category had the maximum mortality of 28.4% and is comparable with the other studies like Sabir *et al.* 40%, Kostakis *et al.* 37% and Brink *et al.*

35%[21,24,25]. Low risk and medium risk category group had zero mortality noted in our study.

The AUC for qSOFA was 0.665. At a cut-off of 1.50, it demonstrated a sensitivity of 91.3% (95% CI: 0.85–0.95) and a specificity of 27.9% (95% CI: 0.21–0.33). The AUC for NEWS was 0.725. At a cut-off of 7.50, it showed a sensitivity of 97.8% (95% CI: 0.93–1.03) and a specificity of 28% (95% CI: 0.22–0.32). The meta-analysis by Wang *et al.* of 62 338 patients from 26 studies showed qSOFA had a specificity of 0.82 (95% CI: 0.76–0.86) and a sensitivity of 0.46 (95% CI: 0.39–0.53). While NEWS had both an intermediate sensitivity and specificity with a sensitivity of 0.73 (95% CI: 0.63–0.81) and a specificity 0.52 (95% CI: 0.39–0.65). qSOFA showed higher overall prognostic accuracy than NEWS by comparing ROC curves[36].

In conclusion, sepsis is associated with high mortality, which was 23% in our study. LRTI was the most frequent cause for severe sepsis in developing countries like India. Prompt identification of patients at risk for developing sepsis and classifying them with score at bedside with only clinical variables helps in priority care to such patients who are at increased risk. qSOFA score, SOFA score and NEWS score showed a fairly accurate prediction of in-hospital mortality in patients with severe sepsis. The initial qSOFA score of 1 and ≥ 2 had mortality rate of 8.5% and 27.5% respectively. Initial SOFA score >8 had mortality rate of 33.3%, higher NEWS group had 28.4% mortality. NEWS score is better in prediction of mortality of sepsis patients with higher sensitivity compared to SOFA and qSOFA in identifying patients at risk for sepsis in ED setting. However, qSOFA remains particularly useful for confirming high-risk status and may be better suited for risk assessment in the ICU.

Therefore, both scoring systems can assist clinicians in prioritizing high-risk patients for ICU admission, monitoring clinical progression, assessing organ dysfunction, predicting mortality, and guiding decisions regarding ICU transfer. They should continue to be employed as effective tools for risk stratification and management of sepsis patients in emergency medicine.

Conflict of interest statement

The authors report no conflict of interest.

Funding

This study received no extramural funding.

Data availability statement

The data supporting the findings of this study are available from the corresponding authors upon request.

Authors' contributions

JG contributed to conceptualisation and supervised the study, provided critical revisions. AG participated in data acquisition and analysis, and assisted in manuscript preparation. SG supported the writing, editing and review of manuscript and assisted in data analysis and manuscript preparation. All authors reviewed and approved the final manuscript for submission.

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Edited by Liu JJ

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