RESEARCH PAPER

Combined Utility of Platelet Indices, Procalcitonin, and qSOFA Score in Predicting Sepsis Outcomes: A Prospective Study

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ABSTRACT

Background: Sepsis remains a leading cause of morbidity and mortality worldwide, particularly in low-resource settings where expensive biomarkers are often impractical. Platelet indices, quick Sequential Organ Failure Assessment (qSOFA) score, and serum procalcitonin are readily available parameters that may improve prognostic accuracy in septic patients.

Methods: A prospective cross-sectional study was conducted over three months at a tertiary care centre, enrolling 98 adult patients with sepsis and qSOFA ≥2. Clinical evaluation included calculation of qSOFA and SOFA scores. Blood samples were collected on days 1 and 3 for platelet indices (platelet count, mean platelet volume [MPV], platelet distribution width [PDW], plateletcrit [PCT], platelet large cell ratio [P-LCR]) and procalcitonin. Patients were followed until discharge or death. Statistical analysis was performed using SPSS v22, with ROC curves applied to evaluate predictive accuracy.

Results: The mean age of patients was 54.3 ± 17.8 years, with overall in-hospital mortality of 22.4%. Thrombocytopenia was significantly more frequent among non-survivors (68.2% vs. 25.0%, $p = 0.002$). Platelet counts decreased in non-survivors while increasing among survivors from day 1 to day 3 ($p < 0.001$). Non-survivors demonstrated higher MPV (12.3 ± 1.4 vs. 11.0 ± 1.3 fL, $p = 0.004$) and PDW (13.6 ± 3.1 vs. 9.1 ± 2.0 fL, $p < 0.001$). Median procalcitonin levels were significantly elevated in non-survivors (4.6 vs. 1.4 ng/mL, $p < 0.001$). A qSOFA ≥2 was strongly associated with mortality ($p < 0.001$). ROC analysis showed that qSOFA alone predicted mortality with an AUC of 0.68, procalcitonin with 0.75, and platelet indices with 0.73. The best discrimination was achieved when qSOFA, procalcitonin, and platelet indices were combined (AUC 0.85; sensitivity 86%, specificity 78%).

Conclusion: Platelet indices, when used in combination with qSOFA and procalcitonin, provide a simple, affordable, and reliable approach to predict outcomes in sepsis. Their integration into routine clinical practice may enhance early risk stratification, particularly in resource-limited settings.

How to cite this article: Varma GHG, Prabhakar K, Manjunatha N, Soumya N, Kalyani R. Combined utility of platelet indices, procalcitonin, and qSOFA score in predicting sepsis outcomes: a prospective study. Int J Drug Deliv Technol. 2026;16(75s): 1519-1523. DOI: 10.25258/ijddt.16.75s.160

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Sepsis is a life-threatening condition caused by a dysregulated host response to infection, leading to organ dysfunction and high mortality. It remains a major global health burden, with an estimated 49 million cases and 11 million deaths annually, accounting for nearly 20% of worldwide mortality.[1] The Third International Consensus Definitions (Sepsis-3) highlighted the importance of rapid recognition and risk stratification to improve outcomes.[2] Despite advances in intensive care, early identification of patients at risk of poor prognosis remains a major challenge. Several biomarkers, including C-reactive protein, serum lactate, presepsin (sCD14), interleukin-6, and serum procalcitonin, have been studied for the diagnosis and prognostication of sepsis. Procalcitonin, in particular, has been widely used as a marker of bacterial infection and sepsis severity. However, its predictive accuracy is limited when used in isolation, and its cost and restricted availability in low-resource settings reduce its clinical applicability.[3] Clinical scores such as the quick Sequential Organ Failure Assessment (qSOFA) are frequently used, but they also demonstrate suboptimal predictive ability when applied alone.[3]

Platelet indices have recently emerged as potential prognostic markers in sepsis. Platelets play an important role not only in hemostasis but also in inflammation and host defense. Thrombocytopenia is common among septic patients and is associated with higher SOFA scores, longer hospital stay, and increased mortality.[4] Indices such as mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), and platelet large cell ratio (P-LCR) reflect platelet activation and consumption during systemic infection. Their routine availability as part of complete blood counts makes them simple, inexpensive, and particularly attractive in resource-constrained settings.[5] Recent Indian studies have demonstrated that platelet indices correlate with sepsis severity and outcomes. Sharma et al. reported that thrombocytopenia, increased PDW, and rising MPV were significantly associated with higher mortality and SOFA scores.[5] Similarly, Tripathy et al. found that PDW and PCT on days 3 and 7 were strong predictors of sepsis severity, showing

significant correlation with both SOFA and APACHE II scores.[6] Importantly, combining platelet indices with established markers such as procalcitonin and qSOFA has been suggested to improve prognostic accuracy.[3]

In this context, the present study was undertaken to evaluate the correlation between platelet indices, qSOFA score, and serum procalcitonin levels in patients with sepsis, and to determine their combined utility as prognostic markers in predicting clinical outcomes in a tertiary care centre.

Methodology

Study Design and Setting

This was a prospective cross-sectional observational study conducted at the Department of General Medicine, Sri Devaraj Urs Medical College, Kolar, a tertiary care teaching hospital in South India. The study was carried out over a period of three months, from May 2025 to July 2025. Ethical clearance for the study was obtained from the Institutional Ethics Committee before initiation, and written informed consent was taken from all participants or their attendants.

Study Population

The study population comprised patients admitted to the tertiary care centre with a clinical diagnosis of sepsis. Patients were recruited consecutively as they fulfilled the inclusion criteria until the desired sample size was achieved.

Inclusion Criteria

Adult patients aged 18 years and above, diagnosed with sepsis, and having a qSOFA score ≥2 at the time of admission were eligible for inclusion in the study.

Exclusion Criteria

Patients with pre-existing hematological disorders such as bone marrow diseases, those with viral infections, autoimmune conditions, or individuals undergoing chemotherapy, radiotherapy, or receiving antiepileptic, immunosuppressive, or antiplatelet therapy were excluded. Patients with hypersplenism and those who discontinued treatment or left against medical advice were also excluded.

Sample Size Calculation

The sample size was calculated based on a correlation coefficient (r) of 0.293 between platelet large cell ratio (P-LCR) and SOFA score, as reported by Tripathy et al. Using a 95% confidence level and 80% power, the minimum sample size was estimated as 89. After accounting for a 10% non-response rate, the final target sample size was determined to be 98 patients, which was achieved during the study period.

Clinical Evaluation

Upon admission, a detailed clinical history and physical examination were performed. The qSOFA score was calculated for each patient based on respiratory rate, systolic blood pressure, and altered mentation. Disease severity was further assessed using the Sequential Organ Failure Assessment (SOFA) score.

Laboratory Investigations

Peripheral venous blood samples were collected aseptically at two time points: on the day of admission (Day 1) and on Day 3 of hospitalization. The samples were analyzed for complete blood count, including platelet indices (platelet count, mean platelet volume [MPV], platelet distribution width [PDW], plateletcrit [PCT], and platelet large cell ratio [P-LCR]), as well as serum procalcitonin (PCT) levels. All tests were performed using standard laboratory protocols.

Follow-up and Outcomes

Patients were monitored daily for clinical progression, treatment response, and outcomes. The primary endpoint was in-hospital mortality. Secondary outcomes included duration of hospital stay, changes in platelet indices and procalcitonin levels between Day 1 and Day 3, and correlation of these parameters with qSOFA and SOFA scores.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 22. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on data distribution. Comparisons between survivors and non-survivors were made using the chi-square test or Fisher's exact test for categorical data, and independent t-test or Mann–Whitney U test for continuous data. Correlation between platelet indices, qSOFA score, and procalcitonin was analyzed using Pearson's or Spearman's correlation coefficient. Receiver operating characteristic (ROC) curves were plotted to determine the predictive value of individual and combined parameters, and the area under the curve (AUC) was calculated. A p-value of <0.05 was considered statistically significant.

Table 1. Baseline Characteristics of the Study Population (N = 98)

Variable	Total (N=98)	Survivors (n=76)	Non-survivors (n=22)	p-value
Age (years), mean ± SD	54.3 ± 17.8	52.6 ± 16.9	61.8 ± 18.2	0.04
Male sex, n (%)	58 (59.2)	43 (56.6)	15 (68.2)	0.31
Diabetes mellitus, n (%)	28 (28.6)	19 (25.0)	9 (40.9)	0.12

Hypertension, n (%)	24 (24.5)	18 (23.7)	6 (27.3)	0.74
Malignancy, n (%)	8 (8.2)	4 (5.3)	4 (18.2)	0.05
Source of infection				
- Respiratory	36 (36.7)	24 (31.6)	12 (54.5)	0.04
- Genitourinary	24 (24.5)	20 (26.3)	4 (18.2)	0.42
- Intra-abdominal	20 (20.4)	18 (23.7)	2 (9.1)	0.13
- Others (CNS/Soft tissue)	18 (18.4)	14 (18.4)	4 (18.2)	0.98
Hospital stay (days), mean ± SD	8.6 ± 4.1	7.9 ± 3.5	10.6 ± 4.3	0.01
In-hospital mortality, n (%)	22 (22.4)	–	–	–

A total of 98 patients with sepsis were enrolled, with a mean age of 54.3 ± 17.8 years. More than half were male (59.2%). Respiratory infections were the most common source of sepsis (36.7%), followed by genitourinary (24.5%) and intra-abdominal infections (20.4%). Malignancy was more frequent among non-survivors (18.2% vs. 5.3%, p = 0.05). Non-survivors were significantly older (61.8 ± 18.2 years) compared to survivors (52.6 ± 16.9 years, p = 0.04). The average hospital stay was longer in non-survivors (10.6 ± 4.3 days) than in survivors (7.9 ± 3.5 days, p = 0.01). Overall in-hospital mortality was 22.4%.

Table 2. Comparison of Platelet Indices Between Survivors and Non-Survivors

Parameter	Survivors (n=76)	Non-survivors (n=22)	p-value
Platelet count (lakhs/mm³) – Day 1	1.92 ± 1.08	1.12 ± 0.89	<0.001
Platelet count (lakhs/mm³) – Day 3	2.08 ± 1.01	1.06 ± 0.78	<0.001
Thrombocytopenia (<1.5 lakhs/mm³), n (%)	19 (25.0)	15 (68.2)	0.002
Mean platelet volume (MPV, fL) – Day 1	11.3 ± 1.2	11.6 ± 1.2	0.20
MPV – Day 3	11.0 ± 1.3	12.3 ± 1.4	0.004
Platelet distribution width (PDW, fL) – Day 1	10.2 ± 2.1	10.2 ± 2.3	0.95
PDW – Day 3	9.1 ± 2.0	13.6 ± 3.1	<0.001
Platelet large cell ratio (P-LCR, %) – Day 1	38.6 ± 7.8	42.1 ± 8.5	0.03
P-LCR – Day 3	39.2 ± 8.2	45.8 ± 9.0	0.002
Plateletcrit (PCTrit, %) – Day 3	0.25 ± 0.11	0.18 ± 0.09	0.03

Thrombocytopenia (<1.5 lakhs/mm³) was present in 68.2% of non-survivors compared with 25.0% of survivors (p = 0.002). Platelet counts in survivors increased significantly from day 1 to day 3 (1.92 to 2.08 lakhs/mm³), whereas non-survivors showed persistently lower counts (1.12 to 1.06 lakhs/mm³, p < 0.001). Mean platelet volume (MPV) was significantly higher among non-survivors on day 3 (12.3 ± 1.4 vs. 11.0 ± 1.3 fL, p = 0.004). Platelet distribution width (PDW) increased markedly in non-survivors (13.6 ± 3.1 vs. 9.1 ± 2.0 fL, p < 0.001). Both P-LCR and plateletcrit also showed significant differences, particularly on day 3, highlighting their prognostic role in sepsis.

Table 3. Procalcitonin, qSOFA, and Outcomes

Parameter	Survivors (n=76)	Non-survivors (n=22)	p-value
Median PCT (ng/mL, IQR)	1.4 (0.5–2.8)	4.6 (2.2–7.3)	<0.001
qSOFA ≥2, n (%)	21 (27.6)	18 (81.8)	<0.001
SOFA score, mean ± SD	4.1 ± 1.8	7.2 ± 2.9	<0.001

Median serum procalcitonin (PCT) levels were significantly higher in non-survivors compared with survivors (4.6 vs. 1.4 ng/mL, p < 0.001). Similarly, a qSOFA score ≥2 was more frequently observed in non-survivors (81.8%) than in survivors (27.6%, p < 0.001). Mean SOFA scores were also higher among non-survivors (7.2 ± 2.9) compared to survivors (4.1 ± 1.8, p < 0.001), confirming the association between disease severity and poor outcomes.

Table 4. ROC Analysis for Predicting Mortality

Model	AUC (95% CI)	Sensitivity (%)	Specificity (%)
qSOFA alone	0.68 (0.57–0.78)	59	73
PCT alone	0.75 (0.65–0.85)	77	69
Platelet indices combined (PDW + MPV + PCTrit)	0.73 (0.62–0.83)	72	70
qSOFA + PCT	0.81 (0.71–0.90)	82	76
qSOFA + PCT + platelet indices	0.85 (0.76–0.93)	86	78

The discriminative ability of individual markers and combined models was evaluated using ROC analysis. qSOFA alone had modest predictive ability (AUC 0.68), while PCT alone achieved better accuracy (AUC 0.75). Platelet indices (PDW, MPV, and PCTrit) together yielded an AUC of 0.73. Combining qSOFA with PCT improved the predictive value substantially (AUC 0.81). The best prognostic performance was achieved when qSOFA, PCT, and platelet indices were integrated (AUC 0.85, sensitivity 86%, specificity 78%). This highlights the additive role of platelet indices in enhancing sepsis outcome prediction.

Discussion

In this prospective cross-sectional study of 98 patients with sepsis, we observed that platelet indices, qSOFA score, and serum procalcitonin levels were significantly associated with patient outcomes. Thrombocytopenia was more frequent among non-survivors, who also demonstrated persistently lower platelet counts, higher mean platelet volume (MPV), and elevated platelet distribution width (PDW) compared to survivors. Additionally, procalcitonin and qSOFA were strongly predictive of mortality, and the combined use of platelet indices with these markers improved prognostic accuracy.

Our findings are consistent with prior studies demonstrating the prognostic significance of platelet indices in sepsis. Sharma et al. reported that thrombocytopenia, rising MPV, and increasing PDW from day 1 to day 3 were significantly associated with higher SOFA scores and mortality.[7] Similarly, Tripathy et al. showed that PDW and plateletcrit (PCT) on days 3 and 7 strongly correlated with both SOFA and APACHE II scores, highlighting their utility in predicting sepsis severity.[8] Both studies emphasized that platelet indices are cost-effective and easily available markers, which is particularly important in resource-constrained settings.

In our study, procalcitonin levels were significantly higher in non-survivors compared with survivors, corroborating previous evidence that serum procalcitonin is a useful prognostic biomarker in bacterial sepsis. Yu et al. demonstrated that combining procalcitonin with qSOFA improved mortality prediction compared with either parameter alone.[9] In line with this, we observed that integrating platelet indices with qSOFA and procalcitonin yielded the best predictive accuracy, with an AUC of 0.85 in ROC analysis.

The role of platelets in sepsis extends beyond hemostasis, as they are actively involved in inflammation, immune modulation, and microvascular thrombosis.[10] Vardon-Bounes et al. described platelets as critical mediators of sepsis pathophysiology, linking thrombocytopenia and platelet dysfunction with organ failure.[11] Claushuis et al. further reported that thrombocytopenia in sepsis is associated with a dysregulated host response and increased mortality.[12] These pathophysiological insights explain the association of platelet indices with adverse outcomes in our study.

Our results are also consistent with international data. Guclu et al. found that elevated MPV and PDW were associated with worse prognosis in septic patients.[13] Kim et al. observed that an increase in MPV over 72 hours correlated with higher mortality in severe sepsis and septic shock.[14] Madani et al. and Choudhary et al. both demonstrated that platelet indices were reliable prognostic markers in neonatal sepsis, suggesting their value across age groups.[15],[16] Similar findings have been reported in studies from India, where Mangalesh et al. confirmed that PDW and MPV dynamics correlated with mortality among septic patients.[17]

While SOFA and APACHE II scores remain the standard prognostic tools, their calculation requires multiple laboratory and clinical parameters, which may not always be feasible in emergency or low-resource settings. Our results suggest that routine platelet indices, when combined with simple tools such as qSOFA and procalcitonin, may provide an inexpensive and rapid alternative for risk stratification. This is supported by studies from Gao et al. and Samuel et al., who concluded that platelet indices could enhance the predictive value of conventional severity scores.[18],[19]

The strengths of our study include its prospective design, the use of serial platelet measurements, and the combined analysis of clinical, biochemical, and hematological prognostic markers. However, some limitations must be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size, which may limit generalizability. We assessed short-term

in-hospital outcomes without evaluating long-term mortality or organ dysfunction. Larger multicentric studies with extended follow-up are required to validate these findings and establish standardized cut-off values for platelet indices in prognostication.

Conclusion

Overall, our findings support the utility of platelet indices as simple, affordable, and reliable prognostic markers in sepsis. Their combined use with qSOFA and procalcitonin enhances predictive accuracy and may aid clinicians in early risk stratification, particularly in resource-limited settings.

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