Research Article

A Prospective Observational Study of qSOFA Score Combined With Initial Red Cell Distribution Width as a Diagnostic Indicator of 30 Days Mortality in Patients With Infection at Emergency Department

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Introduction: Sepsis is a major cause of morbidity and mortality in emergency settings. Quick Sequential Organ Failure Assessment (qSOFA) is a bedside tool used to identify high-risk patients. Red cell distribution width (RDW), a routinely available haematological parameter, has been linked to adverse outcomes in various critical conditions. This study explores the association between qSOFA combined with RDW and 30-day mortality in infected patients presenting to the emergency department.

Methods: A prospective observational study was conducted from 2023 to 2024 in the Emergency Department of Rajiv Gandhi Government General Hospital, Chennai. A total of 100 adult patients with suspected infection or sepsis were enrolled. Patients with nutritional anaemia, red blood cell disorders, immune compromised states, or terminal malignancy were excluded. Vital signs and Glasgow Coma Scale were recorded t calculate qSOFA. RDW was stratified into three groups: 12–14%, 14–14.9%, and ≥15%. Patients were followed for 30 days, and outcomes were categorized as discharged or expired. Statistical analysis including chi-square, t-tests, sensitivity/specificity, and ROC curves was performed using SPSS.

Results: Among 100 patients, 82% expired, and 18% were discharged. Higher qSOFA scores (score 3: 91% mortality) and elevated RDW (>15%: 93.3% mortality) were significantly associated with poor outcomes. The combinationof qSOFA ≥2 and RDW >15% showed the highest predictive value for mortality (97% mortality, $p<0.05$). ROC curve analysis yielded an AUC of 0.52 for the combined score, indicating limited but suggestive predictive value.

Conclusion: qSOFA score combined with RDW is significantly associated with 30-day mortality in patients presenting with infection. While RDW alone had moderate predictive strength, its integration with qSOFA enhanced mortality prediction. Given its availability and cost-effectiveness, RDW may serve as a valuable adjunct in early sepsis risk stratification.

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Introduction

Sepsis is defined as a life-threatening organ dysfunction caused by a dysfunctional immune response to an infection. Sepsis starts with an infection somewhere in the body, like the lungs, urinary tract, skin, or gastrointestinal system enters the bloodstream. When the immune system reacts to the infection, it becomes deregulated, resulting in systemic inflammation. Sepsis is one of the most important challenges in modern emergency care, and despite advances in intensive care, it produces a significant raise of global morbidity and mortality. Therefore, it is important to assess potential increases in severity in the emergency room and predict 30-day mortality rates immediately in the emergency room to promote timely treatment of Sepsis patients.[1,2]

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) introduced the quick Sequential Organ Failure Assessment (qSOFA) score as a useful bedside tool to detect high-risk patients & it has three clinical criteria of hypotension, altered sensorium and increased RR of > 22/min. Quick Sequential Organ Failure Assessment Score (qSOFA Score) was designed to streamline early sepsis detection in resource-limited settings such as emergency departments (EDs).[3]

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The Sequential Organ Failure Assessment (SOFA) score is used to assess the severity of organ dysfunction and to assess the function of several organ systems. It comprises the PaO_2/FiO_2 ratio, blood pressure, Glasgow Coma Scale, serum creatinine, platelet count, and bilirubin levels. Due to its complexity and laboratory requirements, it cannot be used outside of intensive care units, such as emergency rooms. Because of its simplicity, qSOFA can be used outside the ICU especially in emergency departments. However, while qSOFA demonstrates high specificity for mortality prediction, its sensitivity has been widely criticized, particularly in heterogeneous ED populations where subtle presentations of sepsis may evade detection. This limitation highlights the urgent need for additional biomarkers that can increase the prognostic accuracy and underscores the pressing need for adjunctive biomarkers that can increase qSOFA's prognostic accuracy without compromising its simplicity.[4,5]

In recent years, Red Cell Distribution Width (RDW), a routinely reported component of complete blood counts, has emerged as a compelling candidate for sepsis risk stratification (6). RDW quantifies variability in erythrocyte volume, with elevated values reflecting underlying pathophysiological disturbances such as impaired erythropoiesis, chronic inflammation, and oxidative stress—processes intrinsically linked to sepsis progression.[7] A growing body of evidence suggests that RDW independently predicts adverse outcomes in critical illness, including sepsis-associated mortality.[8] Nevertheless, despite its prognostic potential, the combined utility of qSOFA and RDW in ED-based sepsis screening remains inadequately explored, leaving a critical gap in risk stratification protocols.

The integration of qSOFA with RDW could address several limitations inherent to current sepsis screening tools. While qSOFA relies solely on clinical parameters, RDW provides an objective hematological correlate of systemic dysfunction, potentially capturing high-risk patients missed by qSOFA's threshold-based criteria.[9] RDW's association with chronic comorbidities (e.g., cardiovascular disease, renal insufficiency) may enhance risk stratification in older adults or immunocompromised populations, where sepsis often presents atypically.[10] The combined model could improve prognostic granularity, enabling clinicians to distinguish between patients requiring aggressive resuscitation versus those amenable to outpatient management.

Hence, this study aims to evaluate the role of qSOFA score combined with initial RDW as a diagnostic and prognostic indicator of 30-day mortality in patients presenting with infection to the emergency department.

Materials and Methods

This study was designed as a prospective observational study aimed at evaluating the role of qSOFA score combined with initial RDW as a diagnostic and prognostic indicator of 30-day mortality in patients presenting with infection to the emergency department.

This was a cross-sectional observational study conducted at the Department of Emergency Medicine, Rajiv Gandhi Government General Hospital, Chennai over a period of 1 year, from 2023 to 2024. Prior to the commencement of the study, ethical approval was obtained from the Institutional Ethical Committee, Madras Medical College (IEC Approval Number: 50112023). Adult patients presenting with suspected infection and clinical features of sepsis were enrolled in the study after obtaining informed consent. Patients with nutritional anemia, red blood cell disorders, immunocompromised status, or end-stage cancer were excluded.

For each participant, demographic and clinical data, including vital signs such as blood pressure, pulse rate, respiratory rate, temperature, and oxygen saturation, were recorded. Mental status was assessed using the Glasgow Coma Scale (GCS). The qSOFA score was calculated based on systolic blood pressure <100 mmHg (score 1), altered mental status (GCS<13, score 2), and respiratory rate >22 breaths per minute (score 3). A complete blood count, including red cell distribution width (RDW), was performed at the time of admission. RDW values were divided into three groups: 12–14% (score 1), 14–14.9% (score 2), and ≥15% (score 3), and patients were followed up for 30 days in the ICUs of RGGGH. The sensitivity and specificity of qSOFA alone and qSOFA combined with RDW in predicting 30-day mortality was analyzed. Patients who were discharged or expired within 30 days were taken for this study. Collected data was entered into SPSS software for statistical analysis. There are no conflicts of interest or sponsorships associated with this study.

Results

Most participants belonged to the 30–39 years age group (26%), followed by those aged >60 years (25%). Participants aged 40–49 years and 50–59 years constituted 24 and 16%, respectively, while the <30 years group accounted for 9%. These findings suggest that the condition under investigation predominantly affects individuals in the

30–39 years age range, with a notable impact on those over 60 years. This distribution underscores the importance of focusing on middle-aged and older individuals for preventive and therapeutic strategies (Table 1). Males constituted the majority of the study population (65%), while females accounted for 35%. This suggests that the condition under investigation might be more prevalent among males or that they are more likely to seek medical attention for the issue.

Co-morbidities were present in the majority of the study population, with 68% of patients having at least one associated co-morbid condition, while 32% had no co-morbidities. Type 2 diabetes mellitus (T2DM) was the most common co-morbidity, observed in 49 patients, followed by systemic hypertension (SHTN) in 22 patients. The high prevalence of co-morbidities suggests their possible role in influencing disease severity and patient outcomes (Table 2).

The mean Heart Rate was 101.75 beats per minute, with a standard deviation of 14.57 and values ranging from 65 to 140. Systolic Blood Pressure had a mean of 97.52 mmHg (±14.78), while Diastolic Blood Pressure averaged 61.05 mmHg (±12.68). The mean Respiratory Rate was 27.38 breaths per minute, with a range of 16 to 42. Temperature exhibited a mean of 99.4'F. Haemoglobin levels averaged 11.83 g/ dL (±1.50), indicating underlying anaemia among the participants. Platelet counts varied widely, with a mean of 218,549/μL (±123,405) and values ranging from 16,500 to 596,000/μL. The mean white blood cell (WBC) count was 21,557/μL (±26,502.62), indicating potential leukocytosis in some cases. The red cell distribution width (RDW) had a mean of 15.97% (±2.09), ranging from 13.2% to 26%. These findings highlight the significant variability in some parameters, such as temperature and platelet counts. This underscores the heterogeneity of the study cohort and the need to account for these variations in outcome analyses (Table 3).

The mean Glasgow Coma Scale (GCS) score was 11 (±2.64), indicating moderate impairment in consciousness among the study population. Age-wise distribution showed that moderate GCS impairment was more common in patients aged >60 years, while severe GCS scores were observed across all age groups, particularly among middle-aged and elderly patients (Table 4).

The analysis of outcomes among the study participants reveals that the majority, 82.0%, expired during the study period, while only 18.0% were discharged. This indicates a high mortality rate within the study population, reflecting the severity of the condition under investigation.

Table 1: Age Group and Gender Distribution

Category		*Frequency*	*Percent*
Age Group	20–29 years	9	9%
	30–39 years	26	26%
	40–49 years	24	24%
	50–59 years	16	16%
	>60 years	25	25%
Gender	Female	35	35%
	Male	65	65%

Table 2: Co-morbidities and Distribution

Category		*Number of Patients*
Presence of Comorbidities	Yes	68
	No	32
Comorbidity	T2DM	49
	SHTN	22
	CAD	4
	CKD	6
	CVA	3
	DCLD	2
	Hypothyroid	2
	COPD	2

Table 3: Vitals & Lab Parameters Summary Statistics

Variable	*Mean*	*SD*	*Min*	*Max*
Heart Rate	101	14.57	65	140
Systolic BP	97	14.78	60	140
Diastolic BP	60	12.68	40	105
Respiratory Rate	27	6.36	16	42
Temperature	99.4	97.91	97.6	101.5
Hemoglobin	11.83	1.50	8.9	14.8
Platelet Count	218549	123405	16500	596000
WBC Count	21557	26502.62	2600	176000
RDW	15.97	2.09	13.2	26

Table 4: GCS Age-wise Classification

Age	*Mild (GCS>13)*	*Moderate (GCS 9-12)*	*Severe (GCS<8)*
20–29	3	5	1
30–39	9	13	4
40–49	8	11	5
50–59	6	6	4
>60	4	16	5

Mortality was observed across all age groups, with the highest number of deaths seen in patients aged >60 years (23 deaths, 2 discharges). The 30–39 and 40–49 year groups also showed high mortality rates, with 23 and 17 deaths respectively. Even the youngest age group (<29 years) demonstrated considerable mortality, with 6 deaths. This emphasizes the importance of age as a critical prognostic factor in infectious or critical illnesses, supporting more aggressive monitoring and early intervention of co-morbid illnesses across all age groups (Table 5).

The majority of patients had a qSOFA score of 2 (37%), followed by score 3 (32%) and score 1 (31%), indicating that a large proportion of the study population was at moderate to high risk of poor outcomes. Higher qSOFA scores were more common in older patients, particularly those aged >60 years, suggesting increased sepsis severity with advancing age. In contrast, younger patients (<29 years) had fewer score 3 cases, reflecting comparatively lower disease severity. These findings support the usefulness of qSOFA as a simple bedside tool for early risk stratification and identification of high-risk patients. A significant association was observed between higher qSOFA scores and mortality ($\chi^2 = 6.3871$, $p = 0.041$). Patients with a qSOFA score of 1 had a mortality rate of 68%, which increased to 87% in those with a score of 2 and 91% in patients with a score of 3. Correspondingly, discharge rates decreased with increasing qSOFA scores.

Table 5: Outcome by Age Group

Age	*Discharged*	*Expired*
<29	3	6
30–39	3	23
40–49	7	17
50–59	3	13
>60	2	23
Total	18	82

Table 6: qSOFA Score Age-wise Distribution and Outcomes

Category		*Score 1*	*Score 2*	*Score 3*
Age Group	20–29	2	4	3
	30–39	8	9	9
	40–49	8	9	7
	50–59	5	6	5
	>60	8	9	8
Outcome	Discharged	10	5	3
	Expired	21	32	29
Total		31	37	32

These findings highlight the prognostic value of qSOFA in identifying high-risk sepsis patients (Table 6).

Comparison between discharged and expired patients showed significantly higher RDW values in the expired group (16.22 vs 14.86; $p = 0.0119$), suggesting its role as a predictor of mortality. Respiratory rate was also significantly higher among expired patients (28.04 vs 24.39; $p = 0.0134$). WBC count was significantly higher in discharged patients (33,822 vs 18,865; $p = 0.0294$), indicating an association with better survival outcomes. However, heart rate, blood pressure, temperature, haemoglobin, platelet count, and GCS scores did not show statistically significant differences between the two groups ($p > 0.05$) (Table 7).

A comparison between RDW levels and patient outcomes showed a significant association. Patients with RDW > 15%, only 5 out of 75 were discharged, and a striking 93.3% (70 out of 75) expired. These findings suggest that a higher RDW value is associated with increased mortality in the study population, indicating its potential role as a prognostic marker in sepsis patients . There is a significant association between elevated RDW (>15%) and patient mortality. High RDW shows high sensitivity (82.35%) and PPV (93.33%), indicating it reliably predicts poor outcomes. However, low NPV (40%) suggests a normal RDW does not rule out risk. RDW can be a useful prognostic marker but should be used alongside other clinical factors such as qSOFA score (Table 8).

Analysis of combined RDW and QSOFA scores revealed significant prognostic value. Among patients with RDW ≤ 15% and QSOFA ≤ 1, 61.5% (8 out of 13) were discharged, while 38.5% expired. In stark contrast, patients with RDW > 15% and QSOFA ≥ 2 had a discharge rate of just 3% (2 out of 67), with 97% (65 out of 67) succumbing to their illness. This stark difference underscores the predictive power of combining RDW

Table 7: t-Tests for Outcome Groups

Variable	*Discharged*	*Expired*	*p-value*
Heart Rate	98.28	102.51	0.2663
Systolic BP	96.17	97.82	0.6701
Diastolic BP	60.28	61.22	0.7770
Respiratory Rate	24.39	28.04	0.0134
Temperature	99.07	99.9	0.6466
Hemoglobin	12.24	11.74	0.1983
Platelet Count	212689	219835	0.8252
WBC Count	33822	18865	0.0294
RDW	14.86	16.22	0.0119

Table 8: RDW Age-wise Distribution and Outcome

Category		*RDW ≤ 15%*	*RDW > 15%*
Age Group	20–29	5	4
	30–39	8	18
	40–49	11	13
	50–59	5	11
	>60	7	18
Outcome	Discharged	10	5
	Expired	15	70

Sensitivity: 82.35%
Specificity: 66.67%
PPV: 93.33%
NPV: 40.00%

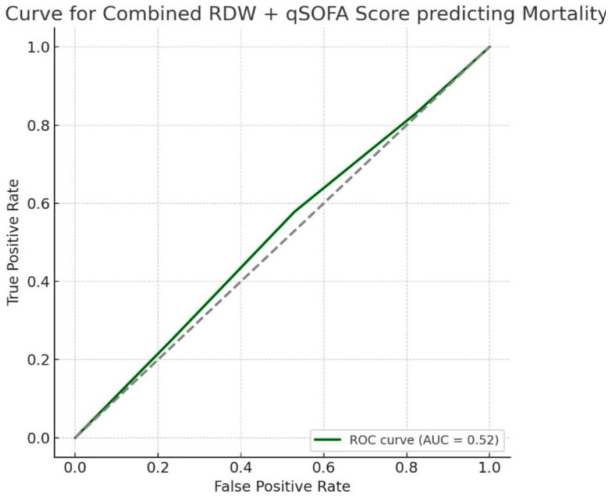

Figure 1: ROC Analysis

and QSOFA scores to identify high-risk patients in sepsis (Table 9).

Combined analysis of RDW and qSOFA scores showed that higher qSOFA scores and elevated RDW (>15%) were associated with increased mortality. Among patients with RDW ≤15%, mortality increased progressively from 82% in qSOFA score 1 to 88% in score 3, demonstrating the prognostic value of qSOFA alone. In patients with RDW >15%, mortality remained consistently high (78–84%) across all qSOFA categories. Notably, even patients with qSOFA score 1 and RDW >15% had a high mortality rate of 78%, suggesting that elevated RDW may identify high-risk patients even with mild clinical deterioration. Overall, the combined RDW + qSOFA scoring system correlated well with mortality and may serve as a simple bedside tool for early risk stratification in sepsis patients (Table 10).

ROC analysis of the combined RDW and qSOFA score showed an Area Under the Curve (AUC) of 0.52, indicating a mild correlation with 30-day mortality. Although the predictive value was modest, higher combined scores were associated with an increased likelihood of mortality. These findings suggest that integrating RDW with qSOFA may improve early risk stratification in sepsis patients, though its predictive ability remains limited when used alone. Further studies with larger sample sizes and additional clinical parameters such as age, co-morbidities, and laboratory markers may improve the diagnostic utility of this combined approach (Figure 1).

Figure 1: ROC Curve for Combined RDW + qSOFA Score Predicting Mortality AUC (Area Under Curve) = 0.52 (Figure 1).

Table 9: Combined RDW and qSOFA vs Outcome

Category	*Discharged*	*Expired*
RDW ≤15% & qSOFA ≤1	8 (61.5%)	5 (38.5%)
RDW >15% & qSOFA ≥2	2 (3%)	65 (97%)

Table 10: RDW + qSOFA Score Outcome

Category	*Total*	*Discharged %*	*Expired %*
<15% & 1	17	17%	82%
<15% & 2	12	16%	83%
<15% & 3	8	12%	88%
>15% & 1	14	21%	78%
>15% & 2	24	16%	80%
>15% & 3	25	16%	84%

Discussion

This study aimed to evaluate the association of the qSOFA score combined with red cell distribution width (RDW) with 30-day mortality in patients with suspected sepsis in the Department of Emergency Medicine (EM). The findings demonstrate that both qSOFA and RDW are valuable prognostic tools, and their combination enhances the ability to predict 30- day mortality in this patient population. The results align with the previous research by Sang yun kim *et al*[11] highlighting the utility of RDW as an inexpensive and readily available biomarker for risk stratification in critically ill patients. This discussion will elaborate on the key findings, their clinical implications, and the mechanisms underlying the observed associations, while also addressing the limitations of the study and suggesting directions for future research.

The age distribution of the study population revealed that a significant proportion of participants were older

adults, with 25.0% aged >60 years and 26.0% in the 30–40 years age group. This demographic distribution is particularly relevant, as older adults are more vulnerable to infections and sepsis due to age-related physiological changes and co morbidities. The gender distribution showed a higher representation of males (65.0%), which may reflect gender-specific differences in sepsis prevalence or healthcare-seeking behaviour. Additionally, 68.0% of participants had at least one co morbidity, emphasizing the importance of considering co morbid conditions in sepsis management and prognosis.

The study revealed that the initial RDW quartile showed a stepwise association with 30-day mortality, with the highest quartile (>15%) associated with a mortality rate of 93%. High RDW (>15%) shows high sensitivity (82.35%) and positive predictive value (PPV) of (93.33%), indicating it reliably predicts poor outcomes. However, low Negative predictive value (NPV) of (40%) suggests a normal RDW does not rule out risk. RDW can be a useful prognostic marker but should be used alongside other clinical factors. This finding is consistent with prior studies that have linked elevated RDW levels to increased mortality in various clinical settings, including sepsis, cardiovascular disease, and pneumonia [12-15]. The multivariable analysis further confirmed that a qSOFA score ≥ 2 was a strong independent predictor of 30-day mortality. However, the combination of qSOFA and RDW improved the predictive power, as evidenced by the ROC curve analysis. This finding underscores the potential of integrating RDW into existing risk assessment tools to enhance their prognostic accuracy.

However, future studies with a larger sample size and adding extra clinical parameters like age, co morbidities, and laboratory values may increase the chances of early diagnosis. The qSOFA score distribution indicated that 37.0% of participants had a score of 2, followed by 32.0% with a score of 3. This distribution highlights the diverse severity of the condition within the study cohort. The association between higher qSOFA scores and mortality was significant, with 35.37% of participants with a qSOFA score of 3 expiring, compared to 25.61% with a score of 1. This finding reinforces the utility of qSOFA as a risk stratification tool in the ED, particularly when combined with RDW. The comparison of clinical and laboratory variables between discharged and expired groups revealed significant differences in RDW, respiratory rate, and white blood cell (WBC) count. The expired group had a significantly higher mean RDW (16.22 vs. 14.86, p = 0.0119) and respiratory rate (28.04 vs. 24.39, p = 0.0134), while the discharged group had higher WBC counts (18,865 vs 33,822, p = 0.0294). These findings suggest that RDW and respiratory rate are strong predictors of mortality, while elevated WBC counts about 19×10^9 /L are associated with high mortality in patients with sepsis.

The elevation of RDW in critically ill patients is thought to be driven by inflammatory cytokines, such as tumour necrosis factor α, interleukin 1β, and interleukin 6, which inhibit erythro poiesis and disrupt iron metabolism.[16,17] This results in the release of immature erythrocytes into circulation, increasing RDW. The association between high RDW and mortality in sepsis patients has been well-documented, with studies reporting higher mortality rates in the highest RDW quartile.[13] In this study, an RDW value of ≥15% predicted 30-day mortality with further supporting its role as a prognostic marker.

The role of RDW as a predictor of mortality can be attributed to its reflection of underlying inflammatory and oxidative stress processes. In sepsis, the systemic inflammatory response leads to the release of pro inflammatory cytokines, which not only impair erythropoiesis but also74 contribute to endothelial dysfunction and microcirculatory disturbances. These pathophysiological changes are reflected in the increased heterogeneity of red blood cell size, as measured by RDW. Furthermore, RDW has been shown to correlate with the severity of organ dysfunction and the overall burden of disease in critically ill patients, making it a valuable marker for risk stratification.[18,20] One of the key strengths of this study is its focus on combining qSOFA with RDW, a readily available and inexpensive biomarker, to improve the prediction of 30-day mortality in sepsis patients. The inclusion of a diverse age group, particularly older adults, adds to the generalizability of the findings, as this population is at higher risk for sepsis and adverse outcomes. The use of qSOFA as a risk stratification tool is particularly relevant in the Department of Emergency Medicine, where rapid decision-making is critical. However, the low sensitivity of qSOFA alone highlights the need for complementary biomarkers such as RDW to improve early identification of high-risk patients. The combination of qSOFA and RDW provides a practical and cost-effective approach to risk assessment, which can be easily implemented even in resource-limited settings.

The relatively small sample size and assessment of only 30-day outcomes may limit the generalizability of the findings. Factors affecting RDW, such as vitamin B12, folic acid, zinc levels, and prior erythrocyte status, were not evaluated and may have influenced the observed association with mortality. In addition, the effects of interventions such as blood transfusion or erythropoietin

therapy were not studied. Further large-scale prospective studies with longer follow-up and subgroup analysis are needed to better establish the prognostic value of RDW and qSOFA.

Conclusion

This study underscores the potential of combining the qSOFA score with RDW as a simple yet effective prognostic tool for predicting 30-day mortality in patients with suspected sepsis in the Department of Emergency Medicine. By analyzing of qSOFA alone versus qSOFA combined with RDW, we found that levels correlate with sepsis severity, supporting its role in risk assessment and early identification of high-risk patients. Given the widespread availability of RDW as part of routine complete blood count testing, its incorporation into clinical decision-making has the potential to improve early intervention strategies and optimize resource allocation in emergency settings.

Ultimately, integrating RDW with qSOFA may bridge the gap between rapid bedside assessment and more sophisticated prognostic tools, offering a practical, scalable approach for improving sepsis outcomes. This study lays the groundwork for future research that could lead to more effective, evidence-based strategies for risk stratification and personalized management of sepsis in emergency setting.

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