 DOI: 10.35382/TVUJS.16.1.2026.159

ASSOCIATION BETWEEN RED BLOOD CELL DISTRIBUTION WIDTH AND ORGAN DYSFUNCTION IN PATIENTS WITH SEPSIS

Thach Cao Nhan[1*], Nguyen Vu Quy[1], Nguyen Hong Phuong[1]

Abstract – *This study aimed to investigate the association between red blood cell distribution width and the severity of organ dysfunction in patients with sepsis. A retrospective analytical study was conducted in 320 patients with sepsis admitted to the Intensive Care Unit of University Medical Center Ho Chi Minh City between 2022 and 2023. Clinical characteristics, laboratory findings, and red blood cell distribution width were collected at multiple time points for correlation analysis. Red blood cell distribution width at admission, 48 hours, and 72 hours showed weak but statistically significant positive correlations with the sequential organ failure assessment score. At 48 hours, red blood cell distribution width was also weakly positively correlated with blood lactate. In contrast, red blood cell distribution width showed a weak negative correlation with procalcitonin and no significant correlation with renal function, liver enzymes, or arterial blood gas indices. These findings suggest that red blood cell distribution width is associated with the severity of organ dysfunction and metabolic derangement in patients with sepsis and may serve as an adjunctive marker for severity assessment.*

Keywords: red blood cell distribution width, sepsis patient, sequential organ failure assessment.

I. INTRODUCTION

Sepsis is a life-threatening syndrome characterized by organ dysfunction resulting from a dysregulated host response to infection [1]. Despite advances in modern critical care, sepsis remains associated with substantial morbidity and mortality, particularly in patients with septic shock. Early identification of patients at risk of severe organ dysfunction is therefore essential to optimize treatment and improve outcomes.

Several biomarkers, including procalcitonin (PCT), C-reactive protein (CRP), and blood lactate, are commonly used in sepsis assessment. However, their use may be limited by cost, turnaround time, and inconsistent sensitivity in the early phase of disease. Consequently, there is increasing interest in simple, widely available laboratory parameters that may provide additional information about disease severity. Red blood cell distribution width (RDW), a routine component of the complete blood count, has been associated with inflammation, oxidative stress, metabolic disturbance, and mortality in sepsis [2–5]. Because RDW may reflect impaired erythropoiesis and altered erythrocyte survival under systemic inflammatory stress, it has been proposed as a practical adjunctive biomarker in critically ill patients.

Previous studies have mainly emphasized the prognostic value of RDW for mortality, whereas evidence regarding its association with organ dysfunction severity and its temporal profile during the early phase of sepsis remains limited, including in Vietnam [2–5]. Therefore, this study aimed to investigate the association between RDW measured at admission and during the first 72 hours and organ dysfunction severity in patients with sepsis. This study evaluates serial RDW measurements in relation to SOFA score and selected biochemical parameters in a Vietnamese intensive care population, thereby clarifying the potential role of RDW as a simple and cost-effective adjunctive marker for severity assessment.

[1]Tra Vinh University, Vietnam
*Corresponding author: tcnhan@tvu.edu.vn
Received date: 16 January 2026; Revised date: 28 March 2026; Accepted date: 30 March 2026

II. LITERATURE REVIEW

Current evidence suggests that the clinical interpretation of RDW in sepsis should be placed within the broader context of patient characteristics and infection profile [6–10]. Bu et al. [6] reported a substantial burden of comorbidities, including diabetes mellitus in 23.4% of septic patients, suggesting that chronic inflammatory and metabolic disorders may influence RDW independently of acute infection. Nguyen et al. [7] reported that 65.7% of patients with sepsis were aged $\geq$ 65 years, supporting the predominance of older adults in septic cohorts. In the same year, Vo Van Duc Khoi et al. [8] revealed that respiratory infections accounted for 17% of cases, while Ta Thi Dieu Ngan et al. [9] found a corresponding proportion of 19.7%. Alhamyani et al. [10] noted that aging is closely associated with immunosenescence and impaired hematopoietic reserve, both of which may contribute to RDW elevation. Taken together, these findings indicate that RDW should be interpreted not only in relation to acute inflammatory stress but also in the context of baseline patient characteristics, comorbidity burden, and infection profile.

Within this clinical context, initial observations made between 2013 and 2014 suggested an association between red blood cell size variability and poor outcomes in severe sepsis, and subsequent studies have further clarified the prognostic role of RDW in sepsis [11, 12]. Regarding the prognostic value of RDW for mortality in sepsis, early evidence was provided by Sadaka et al. [11], who reported an association between elevated RDW and adverse outcomes in patients with septic shock. Kim et al. [13] subsequently demonstrated that RDW had moderate discriminative ability for early mortality in elderly patients with severe sepsis and septic shock. Later, Uffen et al. [14] conducted a larger prospective cohort study of 1,046 patients presenting to the emergency department with suspected infection and showed that RDW was an independent predictor of 30-day mortality. In multivariable analysis, each 1% increase in RDW was associated with a higher risk of mortality, with an odds ratio of 1.15 and a 95% confidence interval from 1.04 to 1.28, while the model showed moderate discriminative performance with an area under the receiver operating characteristic curve of 0.66 [14]. Jain et al. [15] identified RDW as a predictor of mortality in patients with clinical sepsis in a single-center study published in 2022. Chaurasia et al. [16] further reported in 2023 that patients with RDW $\geq$ 13.45% had a 2.5-fold higher risk of 28-day mortality than those with lower RDW values. Collectively, these findings support the role of RDW as a statistically significant marker for short-term mortality risk stratification in sepsis.

In addition, research has increasingly focused on the relationship between RDW and disease severity, organ dysfunction, and dynamic changes during sepsis. Lorente et al. [12] demonstrated that RDW values remained consistently higher in non-survivors throughout the first week of sepsis and were positively correlated with sequential organ failure assessment (SOFA) scores, suggesting that RDW reflects persistent systemic dysfunction rather than only baseline risk. Moreno-Torres et al. [17] further emphasized RDW as a prognostic factor in sepsis and proposed that it may serve as a classical but underused marker of disease severity in critical care. Expanding this perspective to organ-specific complications, Ramires et al. [18] reported an association between RDW and acute kidney injury in septic patients, indicating that RDW may also reflect specific end-organ injury beyond overall mortality risk. In septic shock, Singh et al. [4] likewise found that increased RDW correlated positively with both the severity of organ failure and mortality, reinforcing the concept that anisocytosis may mirror the magnitude of systemic inflammation and multiorgan dysfunction in acute infection.

Another line of research has focused on the biological mechanisms underlying these clinical observations. Salvagno et al. [2] highlighted the versatility of RDW and suggested that this index warranted further in-depth investigation in severe infection. Mechanistically, systemic inflammation in sepsis triggers a massive release of proinflammatory cytokines and enhances oxidative stress, both of which impair erythroid maturation in the bone marrow and shorten the lifespan of circulating erythrocytes. These processes lead to increased heterogeneity in red blood cell size and provide a plausible biological explanation for the observed association between elevated RDW and poor clinical outcomes. Consistent with this mechanism, Wang et al. [3] reported in a study of patients with sepsis that RDW was significantly higher in non-survivors than in survivors and that RDW showed prognostic value for in-hospital mortality, supporting its role as a readily available marker reflecting the severity of systemic inflammation and adverse outcomes.

At the evidence-synthesis level, Wu et al. [19] published a 2022 meta-analysis that consolidated prior findings and provided higher-level evidence supporting the robust prognostic value of RDW in sepsis. This meta-analytic evidence strengthens the overall consistency and generalizability of the association observed across individual studies.

In the Vietnamese medical context, studies on RDW in critical care remain limited, but the available evidence appears consistent with the international literature. Notably, Bui Thi Le Giang [20] investigated pediatric sepsis and examined the relationship between RDW and clinical characteristics. The study reported a median RDW of 15.8% in children with sepsis, exceeding the physiological threshold, and found significantly higher RDW values in non-survivors than in survivors. These preliminary data further support the association between RDW elevation, disease severity, and mortality risk, while also providing an important foundation for establishing context-specific reference values in the Vietnamese population.

Despite these important achievements, the current literature still has several limitations, including heterogeneity in study populations, RDW cut-off values, outcome definitions, and limited data from low- and middle-income settings, particularly in Vietnam. In this context, the present study contributes new evidence by clarifying the prognostic significance of RDW in a local clinical population and helping to bridge the gap between international evidence and Vietnamese practice. This contribution is expected to strengthen the scientific basis for integrating RDW into early risk stratification models in sepsis and to support the development of more context-appropriate prognostic tools.

III. RESEARCH METHODS

A. Setting, participants, and study period

This study was conducted in the Intensive Care Unit (ICU) of the University Medical Center Ho Chi Minh City. Data were retrospectively collected from the medical records of patients admitted between January 2022 and December 2023. Eligible participants were adults aged $\geq$ 18 years diagnosed with sepsis upon ICU admission, according to Sepsis-3 criteria. Exclusion criteria included incomplete medical records, hematologic malignancies, blood transfusion within the first 72 hours, and death within 24 hours of admission.

B. Data collection methods

This was a retrospective observational analytical study. Sample size was calculated using Equation (1), Equation (2), and Equation (3) based on the area under the receiver operating characteristic curve for mortality prediction, which was considered the most severe and clinically relevant outcome in sepsis and was therefore selected for sample size determination [21].

$$n_d = 4\left(Z_{\alpha/2} \times \frac{\sigma}{\omega}\right) \quad (1)$$

$$\sigma = \frac{e^{-A^2/4}}{2\sqrt{\pi}}\sqrt{1+\frac{1}{R}+\frac{5A^2}{8}+\frac{A^2}{8R}} \quad (2)$$

$$A = z_{1-FPR} - z_{1-TPR} \quad (3)$$

Where:

n_d: Total required sample size;

$Z_{(\alpha/2)}$: Critical value from the normal distribution, α = 0.05, 95% confidence, Z = 1.96;

ω: Desired width of the confidence interval (ω = 0.07);

σ: Standard deviation of index A (σ = 0.296);

A: Index measuring the discriminatory ability of RDW between non-survivors and survivors, calculated from Equation (3). e = 2.72. π = 3.14;

R: Ratio of survivors to non-survivors, R = (1 - mortality rate)/ mortality rate;

TPR (true positive rate): Sensitivity;

FPR (false positive rate): 1 – Specificity.

Based on Wu et al. [19], sensitivity was 0.81 and specificity was 0.63, corresponding to Z_{1-TPR} = -0.88 and Z_{1-FPR} = 0.39, where w was set at 0.07 in the present study. The mortality rate was estimated at 0.27 based on Ghimire et al. [22]. Therefore, R was calculated as 0.73/0.27 = 2.70.

After substitution of these values, A was 1.27, and σ was 0.296, yielding a minimum required sample size of 275. From January 1, 2022, to December 31, 2023, medical records of patients treated in the ICU at University Medical Center Ho Chi Minh City with a confirmed diagnosis of sepsis were reviewed. A total of 523 patients were screened for eligibility during the study period. Of these, 203 were excluded, including 92 whose families declined participation, 91 with incomplete data, and 20 who had received blood transfusions. Ultimately, 320 patients were included in the final analysis.

Study variables

Baseline variables included demographic characteristics, body mass index (BMI), and comorbidities. BMI was calculated and classified according to the World Health Organization criteria for Asian populations, including underweight < 18.5 kg/m^2, normal 18.5–22.9 kg/m^2, overweight 23.0–24.9 kg/m^2, and obesity $\geq$ 25.0 kg/m^2 [23].

Infection status was classified according to established epidemiological definitions. Hospital-acquired infection was defined as an infection occurring $\geq$ 48 hours after hospital admission, while community-acquired infection was defined as an infection present on admission or developing within the first 48 hours of hospitalization [24–25].

Organ dysfunction was assessed using the SOFA score at admission across six organ systems, including respiratory, coagulation, hepatic, cardiovascular, central nervous system, and renal. RDW was collected at admission (T0), 24 hours (T24), 48 hours (T48), and 72 hours (T72).

Other laboratory indices included white blood cell (WBC) count, hemoglobin (Hb), platelets, blood lactate, CRP, PCT, liver function parameters including AST and ALT, kidney function parameters including urea and creatinine, and arterial blood gas parameters including pH, pCO_2, pO_2, HCO_{3-}, and PaO_2/FiO_2.

Data collection

Patient information was collected from electronic medical records and recorded in a structured data collection form. Laboratory values were retrospectively extracted from routine clinical records. For each predefined time point (admission, 24, 48, and 72 hours), the value closest to the target time within a prespecified window was selected. When multiple results were available within the same window, the first measurement was used. If no value was available within the window, the data point was recorded as missing and was not imputed.

Statistical analysis

Data were managed and processed using SPSS software version 27.0. The normality of quantitative variables was tested using the Shapiro-Wilk test. Normally distributed variables are presented as mean $\pm$ standard deviation (SD) and compared using the independent Student's t-test. Non-normally distributed variables are presented as median (interquartile range - IQR) and compared using the Mann-Whitney U test. Qualitative variables are presented as frequencies and percentages, compared using the Chi-square or Fisher's exact test. Correlations between quantitative variables were assessed using Pearson or Spearman correlation coefficients. A p-value < 0.05 was considered statistically significant.

Ethical statement

The study was approved by the Biomedical Research Ethics Committee of the University of Medicine and Pharmacy at Ho Chi Minh City under Decision No. 3061/HĐĐĐ-ĐHYD. All data and information collected from medical records were used solely for research purposes, were not used for any other purpose, and were kept strictly confidential.

IV. RESULTS AND DISCUSSION

A. General characteristics of the study population

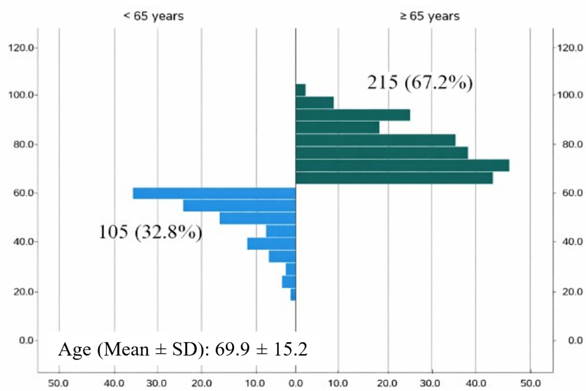

Fig. 1: Age distribution of the study population

Figure 1 illustrates the age characteristics of the study population, in which the mean age was 69.9 ± 15.2 years, and patients aged ≥ 65 years accounted for 67.2%. The predominance of elderly patients in this study is comparable to that of Nguyen et al. [7], where 65.7% of sepsis patients were aged ≥ 65 years. Advanced age is a well-recognized determinant of sepsis severity due to immunosenescence, characterized by impaired innate and adaptive immune responses and dysregulated inflammatory signaling. These alterations not only increase susceptibility to infection and organ dysfunction but also disrupt erythropoiesis, leading to greater heterogeneity in red blood cell size and, consequently, elevated RDW values. Therefore, RDW in elderly patients may partly reflect age-related impairment in hematopoietic reserve in addition to acute disease severity [10].

The baseline characteristics and comorbidities of the study population are presented in Table 1. Male patients predominated, accounting for 54.7%. The mean BMI was 23.2 ± 8.3 kg/m^2, with overweight and obesity comprising 43.1%. Cardiovascular and metabolic comorbidities were common, including hypertension (57.5%), diabetes mellitus (47.5%), ischemic heart disease (30.6%), and chronic kidney disease (18.8%).

Table 1: Baseline characteristics and comorbidities

Characteristic		Frequency (n)	Percentage (%)
Gender	Male	175	54.7
	Female	145	45.3
BMI group	Underweight	38	11.9
	Normal	144	45.0
	Overweight	66	20.6
	Obese	72	22.5
BMI (Mean ± SD)			23.2 ± 8.3
Hypertension		184	57.5
Ischemic heart disease		98	30.6
Heart failure		42	13.1
Diabetes mellitus		152	47.5
Chronic kidney disease		60	18.8
Cirrhosis		19	5.9
Renal replacement therapy		5	1.6
Cancer		41	12.8

The burden of comorbidities in this cohort is consistent with the study conducted by Bu et al. [6], in which diabetes mellitus was present in 23.4% of sepsis patients. The higher prevalence of metabolic and cardiovascular diseases observed in the present study suggests a population with substantial baseline inflammatory and oxidative stress burden. Chronic low-grade inflammation, endothelial dysfunction, and altered iron metabolism associated with these conditions can impair erythrocyte maturation and shorten red blood cell lifespan, thereby increasing RDW independently of acute infection. This supports the concept that RDW reflects cumulative physiological stress rather than acting solely as a marker of acute inflammatory response.

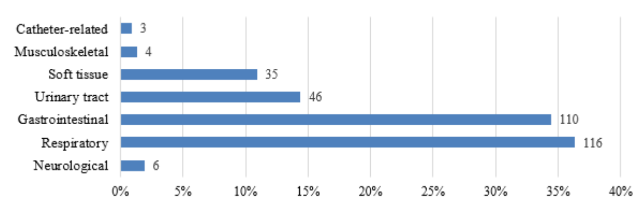

Fig. 2: Distribution of infection sites

The distribution of infection sites is depicted in Figure 2. The respiratory tract (36.3%) and gastrointestinal tract (34.4%) were the most common infection sites, followed by the urinary tract (14.4%).

As depicted in Figure 3, the vast majority of infections were community-acquired at 86.3%,

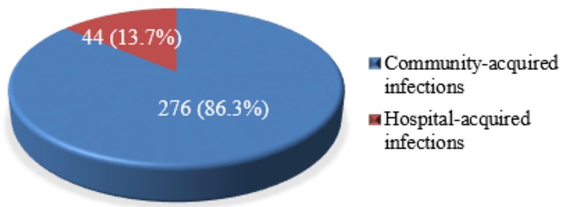

Fig. 3: Distribution of infection sources

while hospital-acquired infections represented only 13.7%.

Regarding infection sources, the predominance of respiratory infections is higher than that reported by Vo Van Duc Khoi et al. [8] (17%) and Ta Thi Dieu Ngan et al. [9] (19.7%), but is consistent with ICU populations characterized by a high proportion of critically ill and mechanically ventilated patients. Respiratory and intra-abdominal infections are known to trigger pronounced systemic inflammatory responses, endothelial injury, and microcirculatory dysfunction, which are central mechanisms in the development of multiorgan failure. These processes are closely linked to RDW elevation through cytokine-mediated suppression of erythropoiesis, oxidative stress–induced membrane damage, and reduced erythrocyte deformability.

B. Association between red blood cell distribution width and inflammatory and metabolic response markers

As shown in Table 2, laboratory parameters varied across time points. The analysis revealed a gradual increasing trend in RDW, rising from 14.40 (IQR 2.47) at admission to 14.80 (IQR 2.60) at 72 hours. Inflammatory markers were markedly elevated, with admission PCT and CRP levels of 8.69 (IQR 45.77) ng/mL and 113.80 (IQR 186.00) mg/L, respectively.

RDW showed a modest increase over the first 72 hours. However, this observation was not formally tested using longitudinal statistical models and should therefore be interpreted as a descriptive trend rather than evidence of clinically significant temporal change. Previous studies have reported similar patterns, with persistently higher RDW values observed in patients with more severe disease. In a multicenter study by Lorente et al. [12], RDW values were consistently higher in non-survivors compared to survivors at days 1, 4, and 8 ($p < 0.01$), and were positively correlated with SOFA scores across time points. These findings suggest that RDW reflects ongoing systemic dysfunction rather than rapid dynamic changes during early resuscitation.

Unlike studies that emphasized prognostic discrimination, the present analysis focused on the relationship between RDW and the severity of organ dysfunction. Although prior studies by Sadaka et al. [11] and Kim et al. [13] showed that RDW achieved moderate discriminative ability for mortality prediction (AUC ranging from 0.67 to 0.75) and could improve prognostic accuracy when combined with severity scores, such as those used in predictive analyses, which were not performed in the present study. Accordingly, the present findings are better interpreted as evidence of association rather than prognostic performance.

Table 3 presents the correlation between RDW and WBC count as well as blood lactate levels at various time points, as assessed using Spearman correlation analysis. While white blood cell count did not show a significant association with RDW at any of the assessed time points by Spearman analysis, blood lactate levels demonstrated a weak positive correlation at 48 hours according to Spearman testing ($r = 0.279$, $p < 0.001$). However, this relationship was not statistically significant at the remaining time points in the same analysis ($p > 0.05$).

The observed positive correlation between RDW and lactate at 48 hours in this study is consistent with the role of RDW as a marker of impaired tissue perfusion and metabolic stress. Lactate is a well-established indicator of cellular hypoxia, and its association with RDW supports the hypothesis that erythrocyte heterogeneity may reflect microcirculatory dysfunction. Previous studies have also demonstrated links between RDW and markers of oxidative stress

Table 2: Laboratory parameters at various time points

Index Median (IQR)	Admission	24 hours	48 hours	72 hours
WBC (G/L)	14.14 (10.82)	14.49 (12.86)	14.20 (10.47)	12.60 (7.70)
RDW (%)	14.40 (2.47)	14.6 (2.30)	14.80 (2.48)	14.80 (2.60)
Lactate (mmol/L)	2.65 (3.18)	2.27 (2.62)	2.19 (2.05)	1.99 (1.54)
Hb (g/dL)	114.00 (36.00)	-	-	-
Hct (%)	34.10 (11.05)	-	-	-
CRP (mg/L)	113.80 (186.00)	-	-	-
PCT (ng/mL)	8.69 (45.77)	-	-	-

Table 3: Correlation between red blood cell distribution width and white blood cell count at various time points

Time point	White blood cell count		Blood lactate levels	
	Correlation coefficient (r)	p-value	Correlation coefficient (r)	p-value
Admission	0.013	0.813	-0.042	0.454
24 hours	-0.055	0.334	-0.022	0.724
48 hours	-0.055	0.337	0.279	**<0.001**
72 hours	-0.058	0.311	0.117	0.106

and inflammation. Lorente et al. [12] revealed significant correlations between RDW and malondialdehyde as well as TNF-α levels, suggesting that RDW is closely related to oxidative stress and inflammatory activation in sepsis. In addition, Moreno-Torres et al. [17] identified RDW as a marker associated with inflammation and poor prognosis in septic patients, providing further support for its role as an integrative biomarker in this setting.

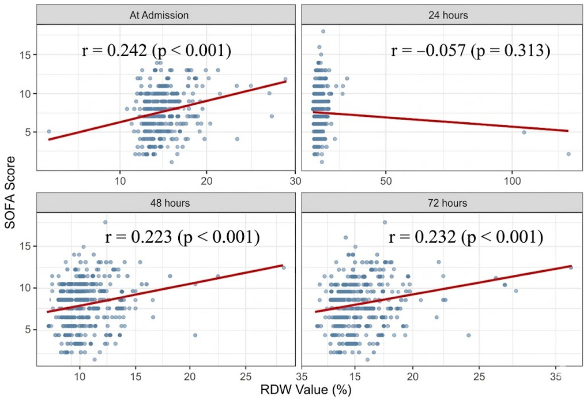

Fig. 4: Correlation between red blood cell distribution width at various time points and admission SOFA score

Correlation analysis using Spearman's method showed weak but statistically significant positive associations between RDW at admission, 48 hours, and 72 hours and the admission SOFA score, with correlation coefficients of 0.242, 0.223, and 0.232, respectively ($p < 0.001$). These findings suggest that higher RDW values are modestly associated with greater organ dysfunction severity at admission, although the strength of the relationship remains limited. Figure 4 illustrates these correlations.

These findings are consistent with previous studies. Lorente et al. [12] reported that RDW values were consistently higher in non-survivors and were positively correlated with SOFA scores across time points, suggesting that RDW reflects ongoing systemic dysfunction rather than only baseline variation. In addition, Moreno-Torres et al. [17] considered RDW as a marker associated with inflammation and poor prognosis in septic patients, providing further support for its role as an integrative biomarker in this setting. From a pathophysiological perspective, systemic inflammation and oxidative stress in sepsis may impair erythropoiesis and shorten erythrocyte lifespan, leading to increased anisocytosis and contributing to the observed association with organ dysfunction. However, given the weak correlations observed in the present study, this relationship should be interpreted as modest and supportive rather than definitive.

Table 4: Correlation between red blood cell distribution width and biochemical parameters at admission

Index	Correlation coefficient (r)	p-value
Urea (mmol/L)	0.042	0.453
Creatinin (μmol/L)	0.006	0.913
AST (U/L)	0.029	0.602
ALT (U/L)	-0.015	0.784
CRP (mg/L)	-0.027	0.629
PCT (ng/mL)	-0.123	**0.028**
pH	-0.027	0.633
pCO_2 (mmHg)	-0.024	0.672
pO_2 (mmHg)	0.015	0.796
HCO_3- (mmol/L)	0.021	0.710
PaO_2/FiO_2	0.069	0.221

The correlation between RDW and biochemical parameters at admission, as assessed using Spearman correlation analysis, is shown in Table 4. The analysis showed a weak negative correlation between red blood cell distribution width and procalcitonin by Spearman testing ($r = -0.123$, $p = 0.028$). In contrast, no significant correlation was observed between red blood cell distribution width and CRP, urea, creatinine, AST, ALT, or arterial blood gas indices in the same analysis (all $p > 0.05$).

A different pattern was observed for conventional inflammatory biomarkers in the present cohort. RDW in this study demonstrated a weak inverse correlation with procalcitonin and no significant association with CRP or organ-specific biochemical markers. Similar findings have been reported in heterogeneous sepsis populations, where RDW does not consistently correlate with acute-phase inflammatory markers. This discrepancy may reflect the distinct biological pathways and response kinetics captured by these indicators. Procalcitonin is more closely related to the acute inflammatory response to infection, whereas RDW is influenced by slower processes, including altered erythropoiesis, erythropoietin regulation, and erythrocyte turnover. From this perspective, RDW may reflect cumulative physiological burden and hematologic reserve more than the immediate intensity of inflammatory activation [12, 15].

The lack of significant correlation between RDW and renal, hepatic, or arterial blood gas parameters in this study differs from previous reports. Particularly, Ramires et al. [18] observed an association between RDW and acute kidney injury in septic patients, while other studies have suggested links between RDW and organ-specific dysfunction. In addition, Lai et al. [26] reported that RDW improved the prediction of survival in patients with sepsis-induced acute kidney injury, further supporting a link between RDW and renal dysfunction in sepsis. These discrepancies may be attributable to differences in study populations, particularly the high proportion of elderly patients with chronic comorbidities in the present cohort. In such populations, baseline RDW may already be elevated due to chronic inflammation and nutritional deficiencies, thereby attenuating its association with acute organ dysfunction markers at a single time point.

From a pathophysiological perspective, systemic inflammation and oxidative stress in sepsis impair erythropoiesis, disrupt iron metabolism, and reduce erythrocyte lifespan, leading to increased anisocytosis. In addition, reduced deformability of red blood cells may impair microcirculatory flow and oxygen delivery, thereby contributing to organ dysfunction as reflected by SOFA scores [17]. These mechanisms support the interpretation of RDW as an integrative biomarker reflecting the combined effects of inflammation, oxidative stress, and microcirculatory impairment.

This study remains limited. First, the retrospective single-center design may introduce selection bias and limit the generalizability of the findings. Second, laboratory measurements were obtained from routine clinical practice rather than a standardized protocol, which may have resulted in variability in timing and measurement consistency across patients. Third, the study population consisted predominantly of elderly individuals with a high burden of comorbidities, which may have influenced baseline RDW values and attenuated associations with acute organ dysfunction markers. In addition, although the study identified correlations between RDW and organ dysfunction severity, these findings reflect concurrent associations rather than predictive relationships, as no longitudinal or prognostic modeling was performed. Furthermore, systemic inflammation and oxidative stress in sepsis may alter erythropoiesis, iron metabolism, and erythrocyte lifespan, leading to increased RDW independent of acute changes in organ function, which may further confound the observed associations. Despite these limitations, RDW remains a simple, widely available, and cost-effective biomarker that reflects the overall physiological burden in patients with sepsis. Future multicenter studies incorporating longitudinal analyses and predictive modeling are warranted to better define its prognostic value and establish clinically meaningful cutoff thresholds for risk stratification.

V. CONCLUSION AND RECOMMENDATIONS

This study demonstrates that RDW was weakly but significantly correlated with SOFA score at admission, 48 hours, and 72 hours in patients with sepsis. RDW was also weakly correlated with lactate at 48 hours and inversely correlated with procalcitonin, while no significant correlations were observed with other biochemical parameters. RDW may serve as an adjunctive marker of organ dysfunction severity in sepsis. Routine consideration of RDW in the initial and early follow-up assessment of septic patients may provide additional clinically relevant information, especially in resource-limited settings. Future research involving prospective multicenter are recommended to confirm these findings and determine clinically meaningful cutoff values.

REFERENCES

[1] Bauer M, Gerlach H, Vogelmann T, Preissing F, Stiefel J, Adam D. Mortality in sepsis and septic shock in Europe, North America, and Australia between 2009 and 2019 – results from a systematic review and meta-analysis. *Critical Care*. 2020;24(1): 239. https://doi.org/10.1186/s13054-020-02950-2.

[2] Salvagno GL, Sanchis-Gomar F, Picanza A, Lippi G. Red blood cell distribution width: a simple parameter with multiple clinical applications. *Critical Reviews in Clinical Laboratory Sciences*. 2015;52(2): 86–105. https://doi.org/10.3109/10408363.2014.992064.

[3] Wang TH, Hsu YC. Red cell distribution width as a prognostic factor and its comparison with lactate in patients with sepsis. *Diagnostics*. 2021;11(8): 1474. https://doi.org/10.3390/diagnostics11081474.

[4] Singh S, Diwakar N, Jha R, Vatsa P, Ahmad A. Assessing the prognostic accuracy of red cell distribution width for predicting mortality in sepsis patients: a comparative study with serum lactate and the quick sequential organ failure assessment (qSOFA) score. *Cureus*. 2025;17(3): e80056. https://doi.org/10.7759/cureus.80056.

[5] Sukewanti NM, Hartawan INB, Wati DK, Suparyatha IBG, Ryalino C. Correlation of red cell distribution width and serum lactate levels in critically ill pediatric patients. *Bali Journal of Anesthesiology*. 2020;4(3): 104–108. https://doi.org/10.4103/BJOA.BJOA_28_20.

[6] Bu X, Zhang L, Chen P, Wu X. Relation of neutrophil-to-lymphocyte ratio to acute kidney injury in patients with sepsis and septic shock: a retrospective study. *International Immunopharmacology*. 2019;70: 372–377. https://doi.org/10.1016/j.intimp.2019.02.043.

[7] Nguyen HN, Bui THQ. Assessing the appropriateness of antimicrobial therapy in patients with sepsis at a Vietnamese national hospital. *JAC-Antimicrobial Resistance*. 2021;3(2): dlab048. https://doi.org/10.1093/jacamr/dlab048.

[8] Vo Van Duc Khoi, Reth TN, Tran Vu Linh, Tran Van Diep. Study on the Role of qSOFA and SOFA in Predicting mortality in patients with sepsis and septic shock admitted to the emergency department [Nghiên cứu vai trò của qSOFA, SOFA trong tiên đoán tử vong ở bệnh nhân nhiễm khuẩn huyết và sốc nhiễm khuẩn nhập khoa cấp cứu]. *Can Tho Journal of Medicine and Pharmacy [Tạp chí Y Dược học Cần Thơ]*. 2021;41: 239–244. https://tapchi.ctump.edu.vn/index.php/ctump/article/view/783/651.

[9] Ta Thi Dieu Ngan, La Thi Tuyet. Clinical manifestations and antimicrobial sensitivity of bacteria in septicemia patients treated at national hospital for tropical diseases [Đặc điểm lâm sàng và tính nhạy cảm kháng sinh của vi khuẩn gây nhiễm khuẩn huyết ở người bệnh điều trị tại Bệnh viện bệnh nhiệt đới Trung Ương]. *Vietnam Medical Journal [Tạp chí Y học Việt Nam]*. 2023;528(2): 118–123. https://doi.org/10.51298/vmj.v528i2.6094.

[10] Alhamyani AH, Alamri MS, Aljuaid NW, Aloubthani AH, Alzahrani S, Alghamdi AA, et al. Sepsis in aging populations: a review of risk factors, diagnosis, and management. *Cureus*. 2024;16(12): e74973. https://doi.org/10.7759/cureus.74973.

[11] Sadaka F, O'Brien J, Prakash S. Red cell distribution width and outcome in patients with septic shock. *Journal of Intensive Care Medicine*. 2013;28(5): 307–313. https://doi.org/10.1177/0885066612452838.

[12] Lorente L, Martín MM, Abreu-González P, Solé-Violán J, Ferreres J, Labarta L, et al. Red blood cell distribution width during the first week is associated with severity and mortality in septic patients. *PLoS One*. 2014;9(8): e105436. https://doi.org/10.1371/journal.pone.0105436.

[13] Kim S, Lee K, Kim I, Jung S, Kim MJ. Red cell distribution width and early mortality in elderly patients with severe sepsis and septic shock. *Clinical and Experimental Emergency Medicine*. 2015;2(3): 155–61. https://doi.org/10.15441/ceem.15.037.

[14] Uffen JW, Oomen P, de Regt M, Oosterheert JJ, Kaasjager K. The prognostic value of red blood cell distribution width in patients with suspected infection in the emergency department. *BMC Emergency Medicine*. 2019;19(1): 76. https://doi.org/10.1186/s12873-019-0293-7.

[15] Jain K, Sharma D, Patidar M, Nandedkar S, Pathak A, Purohit M. Red cell distribution width as a predictor of mortality in patients with clinical sepsis: experience from a single rural center in central India. *Clinical Pathology*. 2022;15: 2632010x221075592. https://doi.org/10.1177/2632010x221075592.

[16] Chaurasia AK, Gupta P, Mathur MK, Pandey V. RDW as a Prognostic Marker of Sepsis and its Comparison with APACHE II Score: A Prospective Observational Cross-sectional Study. *Journal of Clinical and Diagnostic Research*. 2023;17(3): 25–27. https://doi.org/10.7860/jcdr/2023/60101.17674.

[17] Moreno-Torres V, Royuela A, Múñez-Rubio E, Gutierrez-Rojas Á, Mills-Sánchez P, Ortega A, et al. Red blood cell distribution width as prognostic factor in sepsis: A new use for a classical parameter. *Journal of Critical Care*. 2022;71: 154069. https://doi.org/10.1016/j.jcrc.2022.154069.

[18] Ramires MLV, Leite MFB, Lo DZY, Silveira LBD, Ferraz LJR, Pardini A, et al. Relation between red blood cell distribution width and acute kidney injury in patients with sepsis. *Einstein*. 2022;20: eAO6828. https://doi.org/10.31744/einstein_journal/2022ao6828.

[19] Wu H, Liao B, Cao T, Ji T, Huang J, Ma K. Diagnostic value of RDW for the prediction of mortality in adult sepsis patients: A systematic review and meta-analysis. *Frontiers in Immunology*. 2022;13: 997853. https://doi.org/10.3389/fimmu.2022.997853.

[20] Bui Thi Le Giang. *Clinical and laboratory characteristics and red blood cell distribution width (RDW) in pediatric sepsis [Nghiên cứu đặc điểm lâm sàng, cận lâm sàng và độ rộng phân bố hồng cầu (RDW) trong nhiễm khuẩn huyết trẻ em]*. Medical thesis. Hue, Vietnam: Hue University of Medicine and Pharmacy; 2023.

[21] Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology*. 1982;143(1): 29–36. https://doi.org/10.1148/radiology.143.1.7063747.

[22] Ghimire R, Shakya YM, Shrestha TM, Neupane RP. The utility of red cell distribution width to predict mortality of septic patients in a tertiary hospital of Nepal. *BMC Emergency Medicine*. 2020;20(1): 43. https://doi.org/10.1186/s12873-020-00337-8.

[23] WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet*. 2004;363(9403): 157–163. https://doi.org/10.1016/s0140-6736(03)15268-3.

[24] Kelly KN, Monson JRT. Hospital-acquired infections. *Surgery*. 2012;30(12): 640–644. https://doi.org/10.1016/j.mpsur.2012.10.005.

[25] Rhee C, Wang R, Zhang Z, Fram D, Kadri SS, Klompas M. Epidemiology of hospital-onset versus community-onset sepsis in US hospitals and association with mortality: a retrospective analysis using electronic clinical data. *Critical Care Medicine*. 2019;47(9): 1169–1176. https://doi.org/10.1097/ccm.0000000000003817.

[26] Lai H, Wu G, Zhong Y, Chen G, Zhang W, Shi S, et al. Red blood cell distribution width improves the prediction of 28-day mortality for patients with sepsis-induced acute kidney injury: A retrospective analysis from MIMIC-IV database using propensity score matching. *Journal of Intensive Medicine*. 2023;3(3): 275–282. https://doi.org/10.1016/j.jointm.2023.02.005.