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Impact of Red Cell and Platelet Distribution Width in High Risk Septic Patients and Their Prognostic Value

Sherif Medhat Sabry[1], Mohamed Abdelkader Abo Hamila[1], Mohamed Abd Elmonaem Mohamed[1], Ahmed Yassein Mohamed[1]

[1]Critical Care Medicine department, Faculty of Medicine, Beni-Suef University, Beni-Suef 62511, Egypt

Abstract:

Background: The red blood distribution width (RDW) and Platelet distribution width (PDW) are useful in predicting morbidity and mortality in sepsis. **Objectives:** to evaluate the prognostic importance of RDW and PDW, and detect the correlation between RDW, PDW and Sequential Organ Failure Assessment (SOFA) score in predicting mortality, length of stay in ICU and need for mechanical ventilation (MV) in septic patients. **Methods:** In this observational cohort prospective study, 49 patients admitted to the Critical Care Unit at Beni-Suef University Hospital were defined on the basis of qSOFA greater than 2. Upon admission, all patients underwent a series of sepsis monitoring and assessments. CBC, platelet, PDW, RDW and SOFA score were evaluated. **Results:** The average number of days that septic patients spent in the ICU was 17.94. There is a statistically significant relationship between SOFA score on admission and after 48 hours with the outcome data of mortality, need for ventilation, PDW and RDW, but not with ICU stay days. RDW revealed a specificity of 31.30% and a sensitivity of 82.40%. PDW, revealed a specificity of 68.8% and a sensitivity of 94.1%. The AUC for SOFA was 0.809; the optimal cutoff value was 4.5, with a specificity of 43.80% and a sensitivity of 88.20%. **Conclusion:** RDW and PDW were found as significant indicators for need for MV, mortality in sepsis. PDW is the gold standard for predicting mortality in high-risk septic patients; better than RDW.

Keywords: Red cell distribution width, Platelet distribution width, Septic Patients, Sequential organ failure assessment score.

1. Introduction:

Sepsis is a status of organ dysfunction caused by a dysregulated host response to infection and is a leading cause of mortality and morbidity worldwide [1]. Unfortunately, no good diagnostic tool is available for early identification of patients with sepsis and a golden diagnostic standard does not exist. In clinical practice, prognostic sepsis scores are often used to identify patients in need of immediate treatment [2].

The Systemic Inflammatory Response Syndrome (SIRS) score introduced in 1992 and updated in 2001 proved to be insufficiently specific to correctly identify patients most at risk of dying [2].

The prognostic quick Sequential Organ Failure Assessment (qSOFA) score, introduced in 2016 to overcome this problem, lacks sensitivity to identify all patients that are the most at risk of developing sepsis and thus require immediate treatment [2].

The prediction of outcome for patients with sepsis may be conductive to early aggressive interventions [3].

Sequential organ failure assessment (SOFA) is a scale widely used in emergency, internal medicine, surgery, and ICU to evaluate the disease condition and prognosis of patients with multiple organ failure, which can dynamically reflect the changes of organ function [4].

The red blood cell distribution width (RDW) and platelet distribution width (PDW) are parts of a routine complete blood count [5]. Red blood cell distribution width is a measure of the spectrum of discrepancy in red blood cell volume and is commonly assessed as part of a complete blood count. The normal reference range for red cell distribution width in adults is 11.5% and upper limit around 15% [6].

Platelt Distribution Width (PDW) is an index of variation in the size of platelet, Normal range for PDW is 10 to 17%. There is always a change in the morphology on activation of platelet in the process of inflammation. Platelets with greater number of large size pseudopodia will cause variation in PDW [7].

Recent studies have investigated the clinical utility of RDW in prognostic stratification in patients with sepsis and septic shock, and demonstrated that high RDW is associated with an increased risk of mortality in patients with sepsis [6]. Elevated RDW was proposed to be associated with inflammatory processes and oxidative stress increase, resulting in the suppression of RBC maturation and release of large premature RBCs [1].

2. Patients and Methods:

2.1. Study design:

During the study period, a total of 60 patients were initially included. Of them, 11 patients were excluded because of need for blood transfusion. Therefore, 49 patients were included into the final analysis.

Researchers from Beni-Suef University Hospital used an observational cohort prospective design to analyze 49 critically ill septic patients admitted to the hospital's intensive Care Unit. This study aimed to evaluate the predictive value of RDW and PDW in relation to mortality, length of intensive care unit stay, and mechanical ventilation requirements in septic patients diagnosed with a qSOFA score greater than 2.

Our goal was to see how well RDW and PDW predicted outcomes compared to the sofa score.

2.2. Inclusion criteria:

- Adult aged 18 years old or older.
- Enrollment of all patients admitted in ICU with qSOFA score greater than 2.

2.3. Exclusion criteria:

- Patients aged less than 18 years old.
- Pregnancy, lactation.
- Hematological malignancies (leukemia, myelodysplastic syndrome).
- Patients had recent blood transfusion.
- Anemia (HB less than 8gm/dl).

2.4. Upon admission, all patients underwent a series of procedures:

A comprehensive medical history was collected from the patients or their close relatives, which included personal details and medical background. Special attention was given to factors that could potentially heighten the risk of sepsis. Thorough evaluation includes monitoring of vital signs such as blood pressure, heart rate, respiration rate, and temperature.

Common laboratory tests include:

- Hematology panel.
- Liver function tests include measurements of total and direct

bilirubin levels, as well as ALT and AST levels.

.• kidney function tests: serum creatinine and blood urea levels are measured .

.• Electrolytes: - Sodium (Na) - Potassium (K).

• Arterial blood gas • Analyzing arterial blood gas, particularly the p/f ratio which measures the partial pressure of arterial oxygen in relation to the fraction of inspired oxygen.

We also obtained CBC along with the platelet count. PDW and RDW were obtained from the Coulter report of a complete blood count using the Sysmex XP 300 instrument. The blood samples were collected in tubes containing EDTA. The probe extracts a volume of 50 microliters from the sample, and the resulting data is displayed within one minute. These values are known as RDW1 and PDW1. The GCS and parameters included in the SOFA score were thoroughly evaluated, and the SOFA score on admission (SOFA1) was Calculated . RDW and PDW measurements were taken 48 hours later (RDW2 and PDW2), and the SOFA score (sofa2) was calculated.

2.5. Study outcomes:

A comprehensive analysis was performed to investigate the correlation between RDW and PDW and various outcomes, including the length of stay in the intensive care unit, utilization of mechanical ventilator, and mortality.

2.6. Statistical analysis:

The data were entered and analyzed using IBM SPSS 20.0. Armonk, NY: IBM statistics were given as numbers and percentages. The Kolmogorov-Smirnov test verified distribution normality. Range, mean, standard deviation, and median describe quantitative data. The results were evaluated using a 5% significance criterion.

We used these tests: Chi-square tests, The Mann-Whitney test, T2-sample test, Spearman's correlation calculates Pearson's correlation coefficient from data ranking values, Univariate regression analysis examines the relationship between one independent and one dependent variable. P-values determine the relationship's statistical significance. A statistically significance occurs if p-value < 0.05.

2.7. Ethical consideration:

The Beni-Suef University Faculty of Medicine ethics council approved the project. After discussing the study goals, all participants had to provide informed written consent before being recruited. Database confidentiality was assured.

3. Results:

Table (1): Demographic and basic clinical data distribution in all study population

All septic patients (N=49)	**Mean\median**
Age	
Median	60
Sex	
Male	18 (36.73%)
Female	31 (63.27%)
History	
Diabetes Mellitus	
No	29 (59.18%)
Yes	20 (40.82%)
Hypertension	
No	29 (59.18%)
Yes	20 (40.82%)

In table (1): the study included a total of 49 septic patients. Age: The median age of the study population was 60 years. Gender: Among the study population, 36.73% (18 patients) were males, while 63.27% (31 patients) were females. This indicates a higher representation of female patients in the study population. Based on the history data distribution in the cases 40.82% (20 patients) had a history of Diabetes Mellitus and 40.82% (20 patients) had a history of Hypertension. These comorbidity data show a diverse range of underlying conditions present in the septic patients.

Table (2): RDW, PDW, SOFA Score and Outcomes in all study population

All septic patients (N=49) Laboratory Data	**Mean± SD**
Red Cell Distribution Width (RDW)	
On admission(RDW1)	16.73±2.61
After 48hr of admission(RDW2)	16.86±2.52
Platelet Distribution Width (PDW)	
On admission(PDW1)	16.6±2.07
After 48hr of admission(PDW2)	17.04±2.93
Outcome Data	
Mortality	
Discharge	32 (65.31%)
Died	17 (34.69%)
Need for vent.	
No	28 (57.14%)
Yes	21 (42.86%)
ICU stay Days	
Mean± SD	17.94±10.44

In table (2): Red Cell Distribution Width (RDW): On admission, the mean RDW was 16.73 with a standard deviation of 2.61. After 48 hours of admission, the mean RDW increased slightly to 16.86 with a standard deviation of 2.52. Platelet Distribution Width (PDW): On admission, the mean PDW was 16.6 with a standard deviation of 2.07. After 48 hours of admission, the mean PDW increased slightly to 17.04 with a standard deviation of 2.93. It appears that both RDW and PDW showed slight increases after 48 hours of admission, but the differences are relatively small. Based on the outcome data distribution in the study population of septic patients: Mortality: Among the septic patients, 65.31% (32 patients) were discharged. 34.69% (17 patients) died during the course of the study. Need for Ventilation: Among the septic patients, 57.14% (28 patients) did not require ventilation. 42.86% (21 patients) required ventilation. ICU Stay Days: The mean ICU stay for the septic patients was 17.94 days, with a standard deviation of 10.44.

Table 3: Relations between PDW on admission and after 48h with outcome data

	PDW1 (Normal)	**PDW1 (High)**	**P value**	**Statistically significant**
	N=7	**N=42**		
On admission				
Mortality				
discharged	7(14.29%)	25(51.02%)	0.0373	Sig.
died	0(0%)	17(34.69%)		
Need for vent.				
No	7(14.29%)	21(42.86%)	0.0133	Sig.
Yes	0(0%)	21(42.86%)		
ICU stay Days				
Mean± SD	14±6.43	18.6±10.89	0.2858	N. S
After 48hr of admission	PDW2 (Normal)	PDW2 (High)	P value	Statistically significant
	N=11	38		
Mortality				
dischage	11(22.45%)	21(42.86%)	0.006	Sig.
died	0(0%)	17(34.69%)		
Need for vent.				
No	9(18.37%)	19(38.78%)	0.0604	N. S
Yes	2(4.08%)	19(38.78%)		
ICU stay Days				
Mean± SD	14.55±6.46	18.92±11.22	0.2247	N. S
Statistical test used: Tow sample T-test & Chi-square test				
p-value≤0.05 considered statistically significant (95% confidence interval).				

In table (3); concerning the relationship between PDW on admission and mortality was as: there is a statistically significant association between PDW and mortality. Patients with higher PDW levels on admission seem to have a higher risk of mortality compared to those with PDW levels within the normal range. Concerning the relationship between PDW on admission and need for ventilation: there is a statistically significant association between PDW and the need for ventilation. Patients with high PDW levels on admission are more likely to require ventilation compared to those with PDW levels within the normal range. Concerning the relationship between PDW on admission and ICU stay days; there is no statistically significant association between PDW and the length of ICU stay, as showed in figure (1).

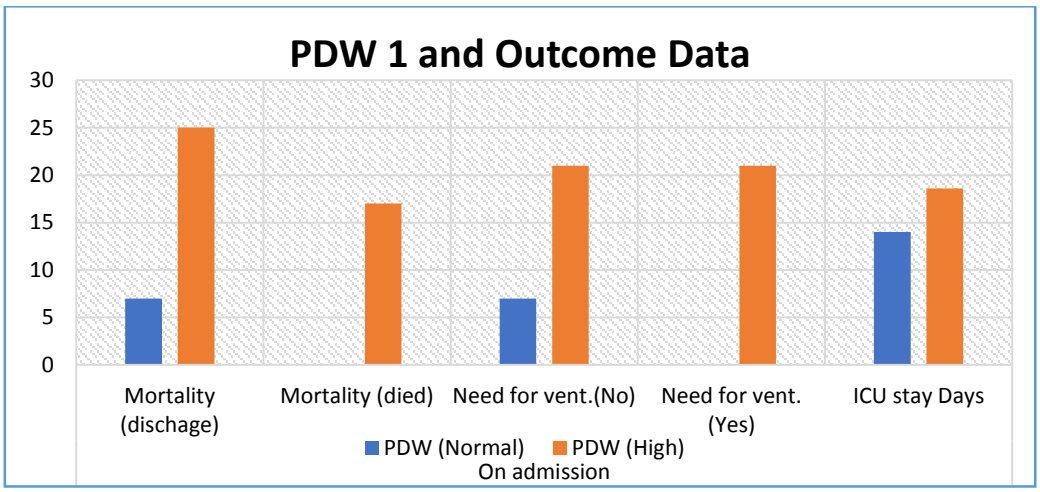


Figure 1: Relations between PDW on admission and Outcome data.

In table (3): Concerning the relationship between PDW after 48 hours of admission and mortality; there is a statistically significant association between PDW and mortality. Patients with higher PDW levels after 48 hours of admission seem to have a higher risk of mortality compared to those with PDW levels within the normal range. Concerning the relationship between PDW after 48 hours of admission and need for ventilation: there is no statistically significant association between PDW and the need for ventilation. The p-value is close to the significance threshold, indicating a potential trend but not a strong statistical association. Concerning the relationship between PDW after 48 hours of admission and ICU stay days; there is no statistically significant association between PDW and the length of ICU stay, as showed in figure (2).

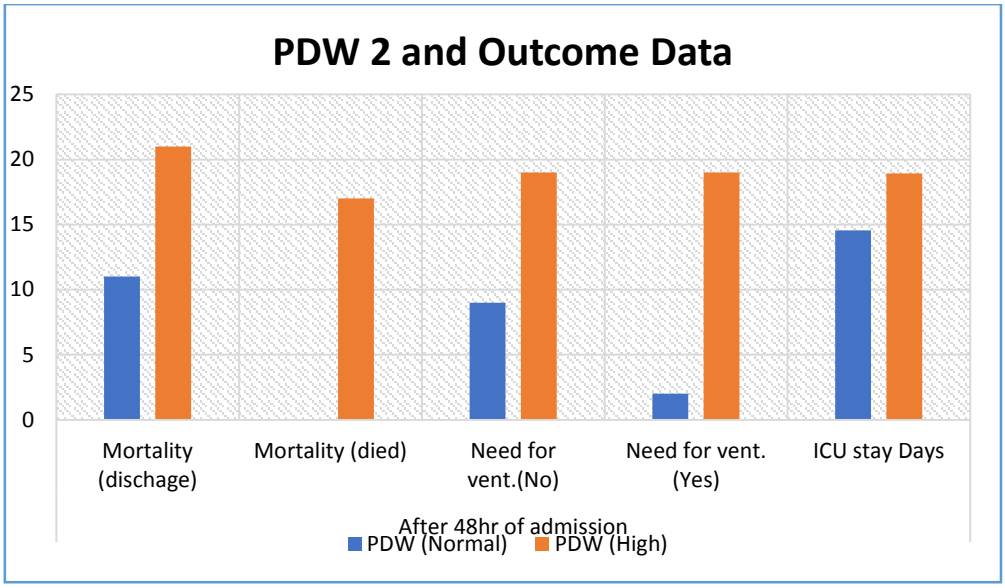


Figure 2: Relations between PDW After 48hr of admission and Outcome data

Table 4: Relations between RDW on admission and after 48h with outcome data

Outcome Data	**RDW1 (Normal)**	**RDW1 (High)**	**P value**	**Statistically significant**
	N=14	**N=35**		
On admission				
Mortality				
Discharge	13 (92.86%)	19 (54.28%)	0.01	Sig.
Died	1 (7.14%)	16 (45.72%)		
Need for vent.				
No	12 (85.72%)	16 (45.72%)	0.011	Sig.
Yes	2 (14.28%)	19 (54.28%)		
ICU stay Days				
Mean± SD	13.43±5.08	19.74±11.51	0.019	Sig.
After 48hr of admission	RDW2 (Normal)	RDW2 (High)	P value	Statistically significant
	N=12	37		
Mortality				
Discharged	11 (91.67%)	21 (56.76%)	0.027	Sig.
Died	1 (8.33%)	16 (43.24%)		

Need for vent.				
No	11 (91.67%)	17 (45.94%)	0.005	Sig.
Yes	1 (8.33%)	20 (54.06%)		
ICU stay Days				
Mean± SD	13.5±5.45	19.38±11.30	0.042	Sig
Statistical test used: T-test & Chi-square test				
p-value≤0.05 considered statistically significant (95% confidence interval).				

In table (4); concerning the relationship between RDW on admission and mortality was as: there is a statistically significant association between RDW and mortality. Patients with higher RDW levels on admission seem to have a higher risk of mortality compared to those with RDW levels within the normal range. Concerning the relationship between RDW on admission and need for ventilation: there is a statistically significant association between RDW and the need for ventilation. Patients with high RDW levels on admission are more likely to require ventilation compared to those with RDW levels within the normal range. Concerning the relationship between RDW on admission and ICU stay days; there is a statistically significant association between RDW and the length of ICU stay, as showed in figure 3.

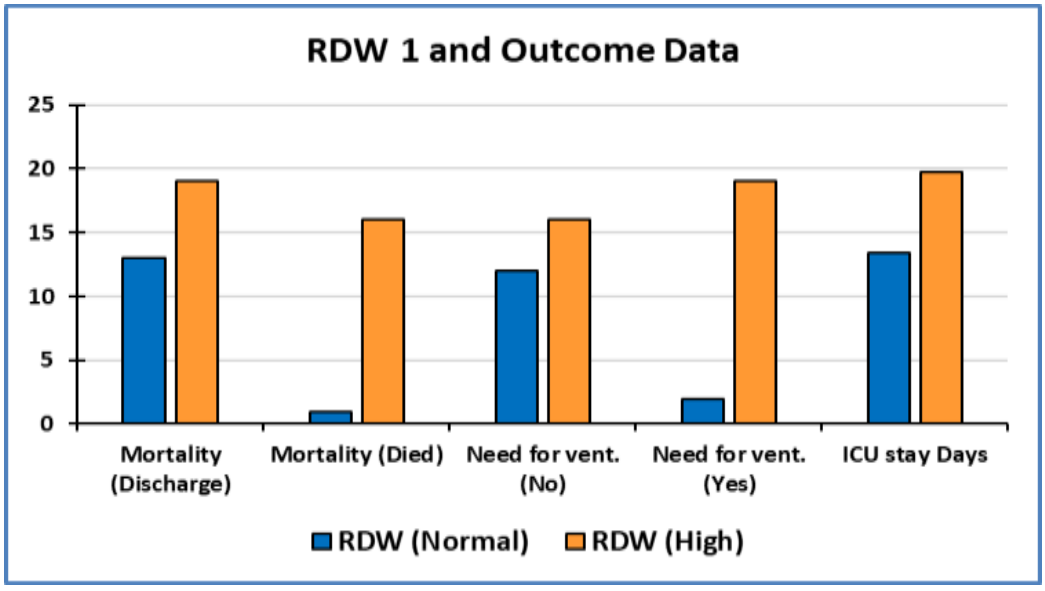


Figure 3: Relations between RDW on admission and Outcome data.

In table (4); concerning the relationship between RDW after 48 hours of admission and mortality was as: there is a statistically significant association between RDW and mortality. Patients with higher RDW levels after 48 hours of admission seem to have a higher risk of mortality compared to those with RDW levels within the normal range. Concerning the relationship between RDW after 48 hours of admission and need for ventilation: there is a statistically significant association between RDW and the need for ventilation. Patients with high RDW levels after 48 hours of admission are more likely to require ventilation compared to those with RDW levels within the normal range. Concerning the relationship between RDW after 48 hours of admission and ICU stay days; there is a statistically significant association between RDW and the length of ICU stay, as showed in figure 4.

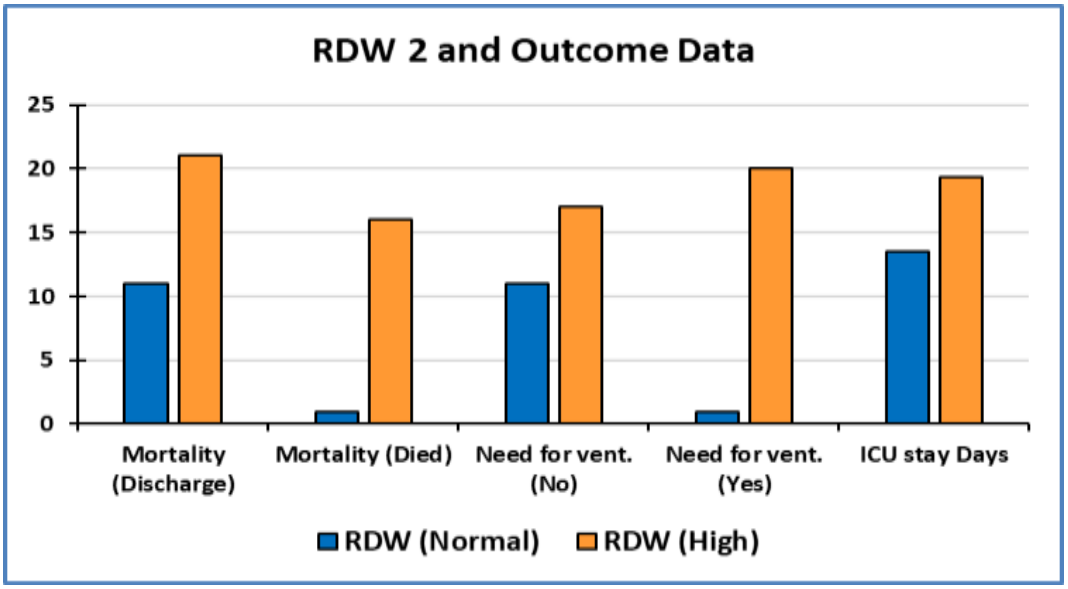


Figure 4: Relations between RDW after 48 hours of admission and Outcome data

Table (5): Relations between SOFA on admission and After 48 hours with outcome data

On admission	**SOFA (0-6)**	**SOFA (7-9)**	**SOFA (10-12)**	**SOFA (13-14)**	**P-value**	**Statistically significant**
	N=32	**N=12**	**N=5**	**N=0**		
On admission						
Mortality						
Discharge	25(51.02%)	5(10.2%)	2(4.08%)	-	0.0352	Sig.
Died	7(14.29%)	7(14.29%)	3(6.12%)			
Need for vent.						
No	25(51.02%)	3(6.12%)	0(0%)	-	0.0002	Sig.
Yes	7(14.29%)	9(18.37%)	5(10.2%)			
ICU stay Days						

Mean± SD	16.5±7.81	22.08±16.05	17.2±7.66	-	0.2889	N. S
PDW						
Mean± SD	15.97±1.87	17.63±1.99	18.2±2	-	0.0001	Sig.
RDW						
Mean± SD	15.81±1.86	17.73±2.59	20.16±3.5	-	0.0002	Sig.
After 48 hours of admission						
Mortality						
Discharge	29(59.18%)	3(6.12%)	0(0%)	0(0%)	<0.0001	Sig.
Died	2(4.08%)	3(6.12%)	6(12.24%)	6(12.24%)		
Need for vent.						
No	25(51.02%)	3(6.12%)	0(0%)	0(0%)	<0.0001	Sig.
Yes	6(12.24%)	3(6.12%)	6(12.24%)	6(12.24%)		
ICU stay Days						
Mean± SD	15.06±7.54	21.33±14.14	22.33±10.25	25±15.91	0.074	N. S
PDW						
Mean± SD	15.5±1.99	18.73±2.98	20.7±1.94	18.98±2.14	<0.0001	Sig.
RDW						
Mean± SD	15.66±1.78	18.27±2.23	19.52±2.69	19.65±1.89	<0.0001	Sig.

Table (5): Relations between SOFA on admission and After 48 hours with outcome dataIn table (5): there is a statistically significant relationship observed between SOFA score on admission and the outcome data of mortality, need for ventilation, PDW and RDW. A higher SOFA score category (7-9 and 10-12) is associated with a higher mortality rate, a higher likelihood of requiring ventilation, higher PDW and higher RDW. However, there is no statistically significant relationship observed between the SOFA score on admission and ICU stay days. Based on the previous data, there is a statistically significant relationship observed between SOFA score on admission and the outcome data of mortality, need for ventilation, PDW and RDW. A higher SOFA score category (7-9 and 10-12) is associated with a higher mortality rate, a higher likelihood of requiring ventilation, higher PDW and higher RDW. However, there is no statistically significant relationship observed between the SOFA score after 48 hours of admission and ICU stay days.

Table (6): Comparison of the predictive power and sensitivity of RDW, PDW, and SOFA score in sepsis

Parameter	***AUC***	***Optimal Cutoff***	***Specificity***	***Sensitivity***	***P- value***
On admission					
RDW	0.808	16.55	31.30%	82.40%	<0.0001
PDW	0.872 (Highest AUC)	14.8 (Lowest)	68.80%	94.10% (Highest)	0.0001
SOFA	0.809	4.5	43.80%	88.20%	<0.0001
After 48hr of admission					
PDW	0.949 (Highest AUC)	14.25 (Lowest)	65.60%	100% (Highest)	<0.0001
RDW	0.887	15.6	46.90%	94.10%	0.0001
SOFA	0.961 (Excellent AUC)	4.5	28.10%	94.10%	<0.0001

AUC: Area under the ROC Curve, RDW; Red cell distribution width, PDW: Platelet distribution width, SOFA: Sequential organ failure assessment score.

In table (6): First, we examined RDW, and our findings revealed an AUC of 0.808, indicating that it possesses good discriminatory power in predicting mortality in high-risk septic patients. The p-value was highly significant, indicating that this association is not due to chance ($p < 0.0001$). The optimal cutoff value for RDW was determined to be 16.55, and at this threshold, it demonstrated a specificity of 31.30% and a sensitivity of 82.40%. This suggests that an RDW value above 16.55 may be indicative of a higher risk of mortality, with a notable sensitivity in identifying such cases (Figure 5-A).

Moving on to PDW, our analysis yielded an even higher AUC of 0.872, underlining its strong predictive capability for mortality among high-risk septic patients. The associated p-value remained highly significant at 0.0001, reaffirming the robustness of this relationship.

The optimal cutoff value for PDW was calculated as 14.8, with a specificity of 68.8% and an impressive sensitivity of 94.1% at this threshold (Figure 5-B).

These results suggest that PDW, with its higher sensitivity and specificity, could be an even more reliable prognostic indicator for mortality in this patient population compared to RDW.

Finally, we assessed the prognostic value of the SOFA score on admission. The AUC for SOFA was 0.809, indicating good discrimination, and the associated p-value was highly significant at <0.0001. The optimal cutoff value for SOFA score was determined to be 4.5, with a specificity of 43.80% and a sensitivity of 88.20% at this threshold (Figure 5-C). These findings suggest that the SOFA score, a well-established tool for assessing organ dysfunction, also holds promise as a prognostic indicator for mortality in high-risk septic patients.

Starting with RDW measured 48 hours after admission; our findings reveal a high AUC of 0.887, indicating strong discriminatory power for predicting mortality. The associated p-value was highly significant (<0.0001), confirming the robustness of this association.

The optimal cutoff value for RDW was determined to be 15.6, with a specificity of 46.90% and a sensitivity of 94.10% at this threshold (Figure 6-A).

These results suggest that RDW measured 48 hours after admission is a powerful predictor of mortality in high-risk septic patients, with a notably high sensitivity, making it valuable for identifying patients at risk of poor outcomes.

Moving on to PDW, our analysis yielded an even higher AUC of 0.949, demonstrating excellent predictive accuracy for mortality in this patient population. The associated p-value remained highly significant at 0.0001, confirming the strong relationship.

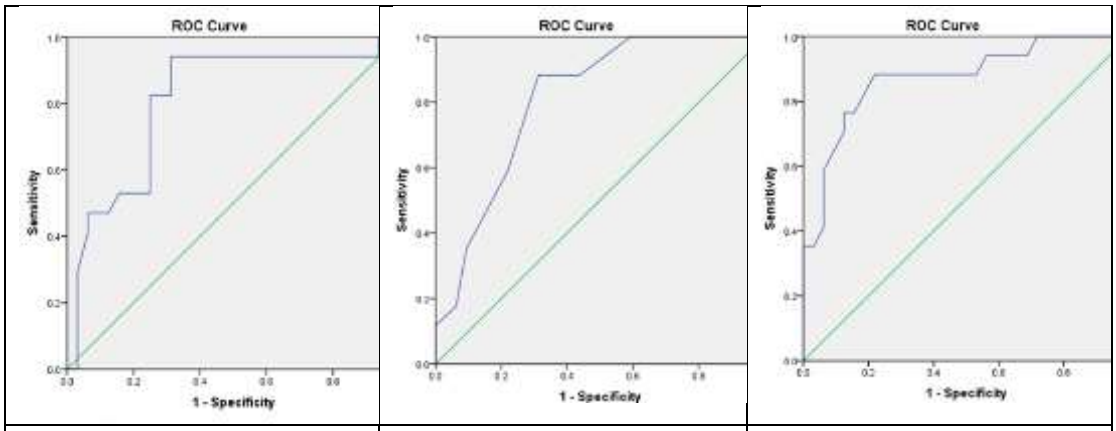
The optimal cutoff value for PDW was calculated as 14.25, with a specificity of 65.6% and an impressive sensitivity of 100% at this threshold (Figure 6-B).

These results indicate that PDW measured 48 hours after admission is an exceptional prognostic indicator for mortality, with an exceptionally high sensitivity, meaning it can accurately identify all patients at risk of mortality.

Lastly, we assessed the SOFA score measured 48 hours after admission. The AUC for SOFA was exceptionally high at 0.961, indicating outstanding discriminatory power for predicting mortality.

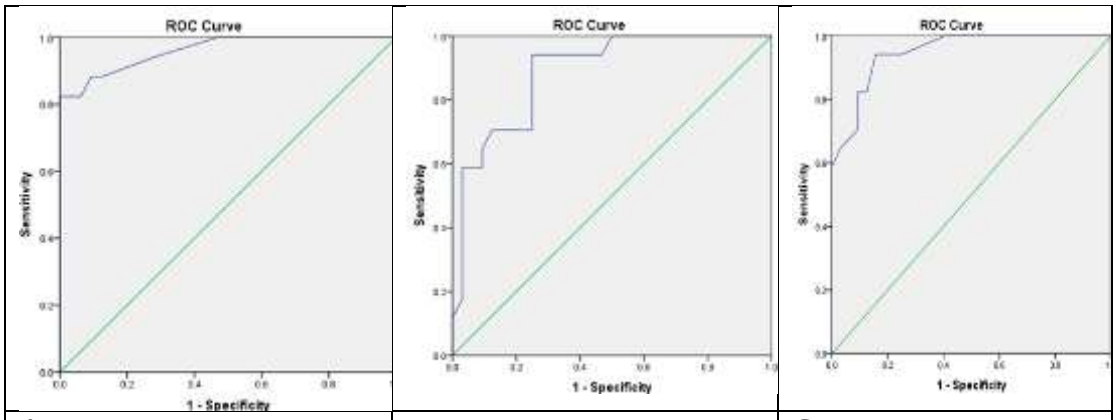
The associated p-value was highly significant at <0.0001. However, it's important to note that the specificity for SOFA at the optimal cutoff of 4.5 was relatively lower at 28.1%, while the sensitivity remained high at 94.10% (Figure 6-C). This suggests that

the SOFA score, although very accurate in identifying patients at risk of mortality, may result in a higher rate of false positives when using the defined cutoff value.



A	B	C

Figure (5): ROC curve analysis for RDW (A), PDW (B) and SOFA score (C) on admission regarding Mortality



A	B	C

Figure (6): ROC curve analysis for RDW (A), PDW (B) and SOFA score (C) After 48hr of admission regarding Mortality

4. Discussion:

The global impact of sepsis, a life-threatening medical condition, is substantial [8]. Sepsis, a severe illness, strikes more than 49 million people every year. An estimated eleven million people have died as a result of this illness, accounting for around 19.7 percent of all deaths worldwide [9].

It may be easier to provide aggressive and rapid treatments to individuals with sepsis if their prognoses could be predicted [10].

In the fields of emergency medicine, internal medicine, surgery, and intensive care units, the SOFA is a frequently used scale. Patients with multiple organ failure might use it to gauge their current health status and future prospects. As organ function varies, the scale reflects those changes dynamically [11].

One part of a routine full blood count is measuring the RDW and PDW [5]. As a quantitative measure of the variation in volume of red blood cells, RDW is important. A CBC usually includes its evaluation. In adults, the red cell distribution width typically falls between 11.5 and 15 percent, with a maximum of around 15 percent [12].

One way to quantify the range of platelet sizes is via the PDW. A PDW of 10% to 17% is considered appropriate. Platelets undergo a constant shape change upon activation during inflammation. A change in PDW will be seen in platelets with an increased number of large-sized pseudopodia. RDW increases are positively correlated with mortality rates in the general population. As of right now, we don't know what triggers this connection [7]. An increase in oxidative stress and inflammatory processes may be associated with the higher RDW. This causes the release of bigger, immature RBCs and the restriction of RBC maturation [13].

The study's overarching goal was to determine whether or not RDW and PDW were significantly predictive of mechanical ventilation needs, ICU duration, and mortality rates among surgical ICU patients, post-traumatic patients, and patients at high risk of sepsis.

A total of 49 patients in critical condition, The average RDW was determined to be 16.73 ± 2.61 in the present study on admission. After being admitted for 48 hours, the average RDW slightly increased to 16.86 ± 2.52. This is in line with what Kim et al. [14] found. The mean RDW at baseline was determined to be 14.0 ± 1.6%, and after

72 hours, it exhibited a little increase to 14.1 ± 1.6%.

When patients admitted to the intensive care unit with sepsis were measured, Jiang et al. [15] looked at their RDW%. From 13.5 percent on day 1 to 14.6 percent on day 3, the RDW% rose steadily. This discovery lends credence to the findings of previous studies.

According to the current findings, 65.31 percent of patients were discharged, while 34.69 percent passed away over the course of the investigation. Of the patients diagnosed with sepsis, 42.86 percent required mechanical ventilation. Septic patients stayed in the intensive care unit for an average of 17.94 days, with a standard variation of 10.44.

This study's results are in line with those of Takegawa and colleagues [16], who discovered that septic patients were in the hospital for an average of 17 days and that around 18.4% of the patients who part of the study, were died. LOS in the current study was greater than the 11-day ICU average LOS that, Chen et al. [17] had previously identified. Additionally, Abu-Humaidan and colleagues [18] showed that patients with sepsis had a shorter ICU stay, averaging 5.8 to 6.12 days. Similarly, Brink et al. [19] found that the mortality rate in patients with sepsis was lower; 3.5 percent died after 10 days and 6.6 percent died within 30 days.

A large majority of sepsis patients (78%), according to Lie et al., were treated in settings other than ICUs. Out of the total number of patients diagnosed with sepsis, 99 (or 22%) passed away [20].

In a 2023 study by Li et al., [21], all forty participants tested positive for sepsis. The referenced study found a mortality rate of 37.5%.

The average SOFA score at admission for the individuals included in this study was 5.47 ± 2.99. A score of 5.88 ± 4.25 was recorded as the average after 48 hours of hospitalization.

In 2023, Elkholy et al. [22] reported identical results. After the first evaluation, they discovered that sepsis patients had an average SOFA score of 6.56 ± 1.59, and after about one week, it increased to 7.13 ± 3.35.

Patients whose SOFA scores were higher (7-9 and 10-12) both before admission and after 48 hours were more likely to die and need mechanical ventilation, according to the current study. However, there was a very weak association between the SOFA score at admission, the score 48 hours later, and the length of time spent in the ICU.

The findings of the study by Taha et al. [23] might lend credence to this claim. At admission, patients with sepsis had a higher average SOFA score (10.0 vs. 6.0, respectively). Innocenti et al. [24] looked at a large sample of septic patients who weren't on ventilators in their research. A higher SOFA score was associated with a poorer outcome for patients, as measured by events like mortality within 28 days or the requirement for intensive care unit admission. One possible explanation for the discrepancy in results between our research and the one conducted by Innocenti et al. [24] is that the former used a much larger sample size (765 patients) than the latter (49 individuals). A greater SOFA score was associated with higher levels of PDW and RDW, according to this investigation.

This corroborates the findings of the study by Jo et al. [25] Patients with sepsis saw an increase in their SOFA score when the RDW tertiles were divided into three categories.

Organ ischemia, impaired microcirculation, or reduced physiological reserve may explain why the high RDW group had a higher SOFA score, which in turn indicates more severe organ failure [26].

In the current study; concerning the relationship between PDW and outcomes mortality: there is a statistically significant association between PDW on admission and after 48 hours with mortality and the need for ventilation, while there is no statistically significant association between PDW on admission after 48 hours with the length of ICU stay. Concerning the relationship between RDW and outcomes, there is a statistically significant association between RDW on admission and 48 hours after with mortality, the need for mechanical ventilation and ICU stay days; also RDW may accurately predict the mortality rate of high-risk septic patients. Its predictive power is rather high. The specificity for predicting death at admission using the RDW cutoff value of 16.55 is 31.30%, and the sensitivity is 82.40%. These results suggest that an RDW value greater than 16.55 might be a dependable predictor of an elevated risk of mortality, especially when it comes to detecting such cases with great sensitivity. We found that RDW had a high AUC of 0.887 after 48 hours after admission, indicating a tremendous capacity to predict death. The extremely significant p-value (0.0001) demonstrated the correlation's strong and reliable

relationship. With a specificity of 46.00% and a sensitivity of 94.10%, the optimal RDW threshold was determined to be 15.6. The results show that in high-risk septic patients, monitoring RDW 48 hours after admission is a substantial predictor of death. It may help identify people at risk of poor outcomes due to its very high sensitivity.

The results of the study by Wang et al. [27] corroborate these observations. Researchers discovered that RDW significantly predicted in-hospital mortality in elderly patients with sepsis. RDW had an AUC of 0.63 for death prediction.

A different study found that RDW, or red cell distribution width, was a significant and independent predictor of the 30-day mortality rate in sepsis patients. Nevertheless, the ROC AUC was a meager 0.66 (0.59–0.73) [28].

Elevated RDW levels were significantly associated with mortality in sepsis, according to a 2020 meta-analysis that synthesized eleven studies. After bringing together all the relevant trials in a meta-analysis, the researchers arrived at a total sensitivity of 0.81 and a specificity of 0.65 [29].

According to Wang and Hsu's study [12], the mortality rate for sepsis patients was 20.7% when the average RDW was less than 14.5% and 32% when it was larger than 14.5%. Chen et al. [30] demonstrated that RDW is an independent predictor of mortality in people with septic shock. RDW had an AUC of 0.75 for death prediction. Furthermore, a value of 0.631 was found for the RDW in patients with sepsis by Li and colleagues [10].

The sensitivity and negative predictive value of RDW were discovered to be inversely related to one another according to Kim et al. [31]. However, when the fraction of RDW increased, there was an increasing trend in the degree of specificity and positive predictive value. A 30-day mortality rate increased by 15% for every 1% increase in RDW level as a continuous variable, according to a univariate Cox proportional hazard analysis.

The exact mechanisms that contribute to the association between high RDW and an increased risk of death have not been thoroughly investigated. A number of hypotheses have been advanced to explain why high RDW has such a detrimental impact on sepsis patients. RDW levels going up has been linked to a number of acute phase reactants, including CRP, ESR, IL-6, and TNF receptors I and II [32]. Based on these findings, RDW might be an indicator of an inflammatory response,

which can harm bone marrow function, iron metabolism, and red blood cell balance [33]. Consequently, this has the ability to cause anemia, which is a decrease in the formation of red blood cells, and it has a major impact on the progression of many human disorders, including sepsis [34].

RBCs may have a shorter lifetime, and immature RBCs may be released into the circulation as a consequence of sepsis, a medical illness marked by significant oxidative stress [35]. Increases in RDW are directly attributable to this. As an added bonus, sepsis may change the morphology of RBCs by modifying ion channels and glycoproteins in their membranes [36]. In addition, renal failure—a syndrome closely associated with inflammation and malnutrition—has been shown to be associated with RDW [37].

Our study showed that the PDW at admission had a strong predictive potential for mortality in high-risk septic patients, with an AUC of 0.872. As before, the p-value was very significant. The optimal PDW threshold, with a specificity of 68.8% and an impressive sensitivity of 94.1%, was found to be 14.8. With an AUC of 0.949 after 48 hours, the PDW demonstrated exceptional predictive accuracy for mortality in this particular group of patients. As evidence of the association's persistence, the p-value associated with the data stayed at a very significant 0.0001. The optimal PDW cutoff value that was calculated is 14.25. Here, we have a remarkable 100% sensitivity and 65.6% specificity. Statistical analysis by Mangalesh and colleagues [38] revealed a significant difference in the PDW between those who survived sepsis and those who did not. Adult septic patients' PDW levels differed significantly ($p = 0.00$) between those with a good prognosis and those without, according to research by Tiro et al. [39]. Samuel et al. [40] found that, compared to critically ill patients with normal platelet indices, those with larger PDW values were significantly more likely to die.

According to research by Guclu et al., [41] a sensitivity of 59.31% and a specificity of 76.22% were observed when the PDW% was above the threshold of 17.9. Both the positive and negative predictive values were 71.7% and 64.9%, respectively and AUC of 0.733.

With an AUC of 0.809, SOFA shows a significant predictive capacity when it comes to the prognostic importance of the SOFA score upon admission. The associated p-value was also very

significant, coming in at less than 0.0001. With a specificity of 43.8 percent and a sensitivity of 88.1 percent, the optimal SOFA score cutoff was determined to be 4.5. The SOFA score has an extremely high AUC of 0.961 after 48 hours. What this means is that you have an incredible knack for predicting which patients will live and which will not. With a value lower than 0.0001, the p-value was highly significant. While the sensitivity was high at 94.10%, it is important to note that the specificity for SOFA was much lower at 28.1% while adopting the optimum threshold of 4.5.

Khwannimit et al. [42] showed that the SOFA score reliably predicts hospital mortality in sepsis patients, with an AUC of 0.880, so these results corroborate their findings. According to Qui et al.'s meta-analysis [43], the SOFA score had a high sensitivity of 0.89 and a specificity of 0.69 for predicting in-hospital mortality among sepsis patients. The SOFA score had good sensitivity (0.97 for 28/30 day mortality prediction) but low specificity (0.14 for the same time period). With higher AUC, sensitivity, and specificity values, PDW stands out as the most predictive measure. For the purpose of determining which septic patients pose the greatest threat of death, it is the strongest candidate. While PDW has a slightly higher AUC and specificity, RDW is still a useful indicator. Still, it's a great tool for risk assessment because of its high sensitivity. Similarly, the SOFA score is highly predictive, but its lower specificity means it may produce more false positives. Still, it's a useful tool for estimating the risk of mortality in sepsis patients, especially when combined with other variables.

While PDW had a sensitivity of 43.3 and a specificity of 95.8, Santosa et al. [34] discovered that RDW had a higher sensitivity of 86.7 and a lower specificity of 80.3 in sepsis patients. Orsini

The AUC of the RDW in Wang and Hsu's study [12] was 0.71, which is comparable to the 0.73 AUC of the SOFA score, another measure of organ failure that the researchers determined. This comparison yielded a p-value of 0.72.

5. Conclusion:

After comparing it to other tools, the PDW stands head and shoulders above the competition when it comes to predicting death in high-risk septic patients. Its AUC is the greatest, its specificity is the best, its sensitivity is the highest, and it has the lowest suggested cutoff value. While retaining

a reasonable level of performance, RDW has a much lower AUC, specificity, and sensitivity compared to PDW. Due to its usage as a diagnostic tool for evaluating organ failure, the SOFA score has a high AUC but low specificity and has a different cutoff value. Although it may produce more false positives, its sensitivity to RDW is similar.

6. Conflict of interest:

Nil

6. References:

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