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A study of the utility of red cell distribution width to predict the mortality in patients with sepsis visiting Rajah Muthiah Medical College and Hospital

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Abstract

Background: Sepsis is defined as a systemic inflammatory response to infectious and non-infectious causes which elicits same response. Currently available gold standard scoring system for assessment of sepsis is the Acute Physiology and Chronic Health Evaluation. It is useful in intensive care unit and is not widely adopted for patients with sepsis outside of the intensive care setting. Red cell distribution width is an independent prognostic marker, it has been used in many pathological conditions such as cardiovascular diseases, respiratory diseases, and other inflammatory conditions. Inflammation and oxidative stress reduce RBC survival and suppress their maturation and leads to a release of premature RBC into circulation contributing to elevated RDW. It is an inexpensive, routinely available and rapidly measurable prognostic tools.

Objective: The aim of this study is to estimate the utility of red cell distribution width to predict the mortality in patients with sepsis visiting Rajah Muthiah Medical College and Hospital.

Methods: We conducted a single centre hospital based cross sectional study of 50 random patients with sepsis admitted to the Intensive Care Unit of Rajah Muthiah Medical College and Hospital from November 2019 to October 2021.

Results: RDW among non-survivors was 17.1% compared to survivors which was 15.1%. RDW was found to have a significant graded association with APACHE II score at admission showing progressively increasing score along with rising RDW. Thirty-day mortality showed a significant relationship with RDW at admission.

Conclusion: RDW can be used as a parameter to predict mortality in patients with severe sepsis.

Keywords: Red cell distribution width, APACHE II score, Glasgow coma scale, sepsis

Introduction

Sepsis, a complex physiological and metabolic response to infection is a common reason for admission to intensive care unit [1]. With advances in intensive care, increased awareness and dissemination of evidence-based guidelines, clinicians have taken large strides in reducing the risk of imminent death associated sepsis. Severe sepsis and sepsis are sometimes used interchangeably used to describe the syndrome of infection complicated by acute organ dysfunction [2]. Sepsis is a common condition in the emergency department that is associated with high mortality [6].

Red blood cell distribution width (RDW) can be used as a simple prognostic predictor for patients with community-acquired pneumonia, gram-negative bacteremia and severe sepsis and septic shock. To evaluate the performance of RDW to predict in-hospital mortality among septic patients by conducting a hospital based cross-sectional study in an emergency department of a tertiary teaching hospital. The use of severity scoring methods when dealing with septic patients was recommended as an adjunctive tool to assess mortality [3]. RDW is compared with other commonly used clinical prediction scores; APACHE (Acute Physiology and Chronic Health Evaluation) score [5]. The RDW is compared between the mortality and survival groups in septic patients to evaluate the performance of RDW as a potential parameter in predicting mortality among septic patients.

Materials and Methods

The study was a single centre hospital based cross sectional study conducted in the medical

Intensive Care Unit of Rajah Muthiah Medical College and Hospital between November 2019 to October 2021. A total of 50 adult patients [greater than 18 years old] with diagnosis of severe sepsis admitted to the Intensive Care Unit were included in the study after obtaining informed consent based on the inclusion and exclusion criteria. After the patients were received in ICU, Blood was collected for complete hemogram, culture and sensitivity.

We compared clinical and lab investigations, severity of illness, duration of hospital stays, requirement of vasoactive agents with patients having high red cell distribution width against low red cell distribution width.

We compared the number of patients who died having High/Normal red cell distribution width as against their acute physiology and chronic health evaluation score for sepsis.

We compared number of patients who survived having Normal/High red cell distribution width as against their acute physiology and chronic health evaluation score for sepsis.

RDW was provided along with complete blood count and the reports were obtained using System automated analyzer.

Statistical analysis

Quantitative data were entered in MS Excel and was compared and analysed using SPSS version 25. Statistical significance was analysed with Independent T test and repeated measures ANOVA test. Qualitative data were compared and significance was analysed with Pearson Chi square test.

Results

We divided the patients into survivor and non-survivor with elevated RDW and normal RDW as depicted in table number 1.

Table 1: RDW in survivor and non-survivor groups

S. No.	Age Groups	Survivors	Non- Survivors	Total
1	<40	5 (22.7%)	5 (17.9%)	10 (20%)
2	40-60	16 (72.7%)	16 (57.1%)	32 (64%)
3	>60	1 (4.5%)	7 (25%)	8 (16%)
4	Total	22 (100%)	28 (100%)	50 (100%)
5	Mean	46.18	53.79	Significant
6	SD	9.059	12.653	
7	p-value	0.021		

Around 57.1% of the non-survivors and 72.7% of survivors were in the age group of 40-60 years.

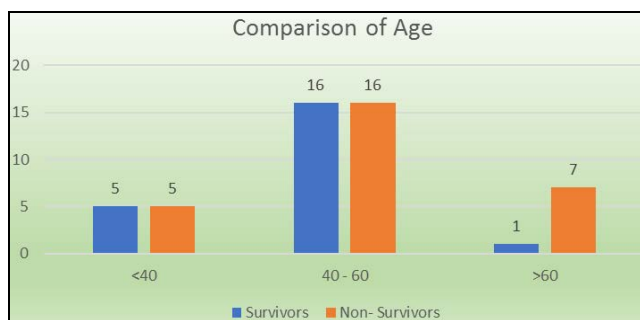


Fig 1: Age among the study population

Male preponderance of 57.1% was noted among non-survivor compared to 42.9% non-survivor in female as depicted in figure number 1 below.

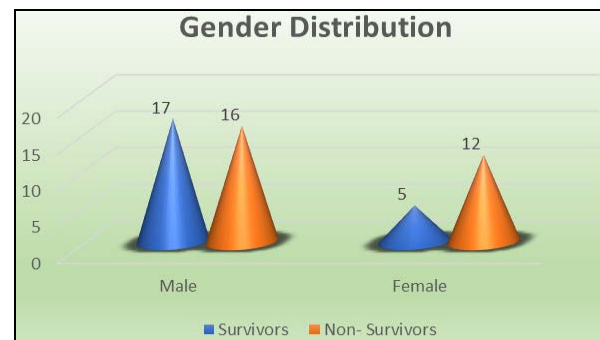


Fig 2: Gender distribution among the study population

Site of sepsis, respiratory system often increased in frequency among non-survivor 42.9% compared to survivors 40.9%. Urinary tract infections were increased in non-survivor compared to survivor. Abdomen and skin infections equally present in both survivor and non-survivor as depicted in table number 2.

Table 2: Site of sepsis among the study population

S. No.	Site of Sepsis	Survivors	Non-Survivors	Total
1.	Respiratory	9 (40.9%)	12 (42.9%)	21 (42%)
2.	Urinary Tract	6 (27.3%)	9 (32.1%)	15 (30%)
3.	Abd. Infection	4 (18.2%)	4 (14.3%)	8 (16%)
4.	Skin	3 (13.6%)	3 (10.7%)	6 (12%)
5.	Total	22 (100%)	28 (100%)	50 (100%)

Comorbidities like chronic kidney disease, chronic liver disease, chronic obstructive pulmonary disease, cardiovascular disease and diabetes was present in both survivor and non-survivor. But diabetes was most common among non-survivors as depicted in table number 3. Smoking didn't have any impact on mortality among both survivor and non-survivor.

Table 3: Co-morbidities among the study population

S. No.	Comorbidities	Survivors	Non-Survivors	Total
1.	DM	10 (45.5%)	17 (60.7%)	27 (54%)
2.	CVD	5 (27.3%)	14 (14.3%)	9 (18%)
3.	COPD	1 (4.5%)	1 (3.6%)	2 (4%)
4.	CKD	4 (18.2%)	3 (10.7%)	7 (14%)
5.	CLD	2 (9.1%)	3 (10.7%)	5 (10%)
6.	Total	22 (100%)	28 (100%)	50 (100%)

Glasgow Coma Scale at presentation was 11.25% among non-survivor compared to survivor which was 13.14% as depicted in table number 4.

Table 4: GCS among the study population

S. No.	GCS	Survivors	Non-Survivors	Total
1.	<13	13 (59.1%)	24 (85.7%)	37 (74%)
2.	≥13	9 (40.9%)	4 (14.3%)	13 (26%)
3.	Total	22 (100%)	28 (100%)	50 (100%)
4.	Mean	13.14	11.25	
5.	S.D	1.283	1.936	
6.	p-value	< 0.001		Significant

Study population was divided into two groups based on RDW at admission-normal RDW group (RDW ≤14.5%) and raised RDW group (RDW >14.5%). Ten patients in the study population had normal RDW and remaining had raised RDW at presentation. Thirty-day mortality was significantly higher in raised RDW group. Red Cell Distribution Width among non-survivor was 17.1% compared to 15.1% among survivors as depicted in table number 5.

Table 5: RDW among the study population

S. No.	RDW	Survivors	Non-Survivors	Total
1.	≤15	6 (27.3%)	0 (0%)	6 (12%)
2.	>15	16 (72.7%)	28 (100%)	44 (88%)
3.	Total	22 (100%)	28 (100%)	50 (100%)
4.	Mean	15.114	17.107	
5.	S.D	0.6756	0.8317	
6.	p-value	<0.001	Significant	

Mean APACHE II score at admission was significantly higher in raised RDW group. APACHE score among non-survivor was 26.18% compared to 17.73% in survivor as depicted in table number 6.

Table 6: APACHE score among the study population

S. No.	Apache Score	Survivors	Non-Survivors	Total
1.	≤20	21 (95.5%)	0 (0%)	21 (42%)
2.	>20	1 (4.5%)	28 (100%)	29 (58%)
3.	Total	22 (100%)	28 (100%)	50 (100%)
4.	Mean	17.73	26.18	
5.	S.D	2.414	3.611	
6.	p-value	< 0.001	Significant	

We further subdivided the study group into three groups using RDW values 14.5%, and 17.3% Group one: ≤14.5%, Group two 14.6%-17.3% and Group three >17.3%.; RDW was also found to have significant association with APACHE II score at admission showing progressively increasing score along with rising RDW as depicted in table number 7. Thirty-day mortality showed a significant graded relationship with RDW at admission across these three groups.

Table 7: APACHE score among different RDW groups of the study population

S. No.	Apache Score	Group I	Group II	Group III	Total
1	≤20	3 (100%)	16 (59.3%)	2 (10%)	21 (42%)
2	>20	0 (0%)	11 (40.7%)	18 (90%)	29 (58%)
3	Total	3 (100%)	27 (100%)	20 (100%)	50 (100%)
4	Mean	15.67	20.89	25.60	
5	S.D	1.155	4.509	4.706	
6	p-value	< 0.0001	Significant		

Various parameters including demographic, clinical, laboratory and other variables such as organ dysfunction, severity of illness scores, and length of hospital stay were compared between survivors and non-survivors. Mean age, APACHE II score; PaO2/FiO2 ratio and duration of hospital stay were significantly lower in non-survivors as compared to survivors.

Discussion

In our study the common age group was 40 to 60 years, and the common gender observed were males (57.1%) which

was similar to the study done by Uffen JW *et al.* [7] which revealed that the median age was 61 years with a male (53.8%) preponderance.

In our study the most common site of sepsis was respiratory system which was similar to the study done by Afessa B *et al.* [5] in our study APACHE score was 26.18% among non survivors which was similar to the study done by Huda AQ [9] *et al.* which also showed an elevated score.

Sepsis syndrome influences erythropoiesis through various mechanisms. Elevated inflammatory markers affect the RBC survival and maturation. Early release of immature, larger RBCs into the circulation results in elevated RDW. Pro-inflammatory state in sepsis syndrome also leads to decreased erythropoietin production; resistance to its effect; as well as decreased iron bioavailability. Erythroid precursor activity is thus suppressed in the bone marrow; Elevated RDW is seen in states of high oxidative stress. It occurs by decreased RBC survival and release of large premature RBCs into circulation.

Although the mechanism of elevated RDW in these patients is yet to be elucidated, an association of inflammation and oxidative stress with elevated RDW has been suggested.

An increase in RDW from baseline during the first 72 hours after hospitalization is significantly associated with adverse clinical outcomes. Therefore, a combination of baseline RDW value and an increase in RDW can be a promising independent prognostic marker in patients with severe sepsis or septic shock. In our study it was observed that among the non-survivor group, the mean RDW was 17.107 which was similar to the study done by kim, C.H *et al.* [8]. Hence an increase in red blood cell distribution width from baseline predicts mortality in patients with severe sepsis or septic shock [8].

Conclusion

Higher sepsis scores were associated with higher RDW levels suggesting more sick patients have higher RDW levels. Even though this suggests an association between RDW and higher scores, RDW still remained an independent predictor for mortality after correction for disease severity. RDW was relatively found to be an independent predictor of Thirty-day mortality. At admission APACHE II score PaO2/FiO2 ratio were observed to be independent predictors of thirty-day mortality in cohort of severe sepsis patients admitted to emergency medical services. Hence combination of RDW with APACHE-II increases the predictive ability of the scoring model in relation to mortality.

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