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ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2025;14(3):706-10

Prognostic value of RDW/albumin ratio in sepsis patients in intensive care units

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Received 28 February 2025; Accepted 08 April 2025
Available online 25 August 2025 with doi: 10.5455/medscience.2025.02.062

Abstract

Sepsis is a multifaceted disease with a high mortality incidence. It was aimed that the RAR calculated using the red blood cell distribution and albumin levels that change as a result of inflammation and increased apoptosis of the disease can be used to show prognostic significance. 95 patients who met sepsis-3 diagnostic criteria were included in the study. Mortality incidence was analyzed. RAR, albumin and RDW values were found to be high in patients who lost their lives. In the RAR quartile analysis and regression analysis model, while the increase in RAR value increased the mortality incidence, it was seen that the mortality incidence decreased with the decrease in RAR quartile in the surviving patient group. A cut-off value of 5.27 and the analysis of the area under the curve showed that the predictive value of RAR value compared to RDW and albumin was high. It is seen that the increasing values are related to the mortality incidence with the analysis of RAR quartiles. Cross-examination showed that increasing values of RAR quartiles in the surviving patient group led to a decrease in mortality incidence. Examining the prognosis of patients with sepsis and related factors will always be among the current approaches. The advantages of the RAR value in sepsis-3 patients, such as having a high prognostic value, being easily applied and not showing additional costs, will facilitate clinical use.

Keywords: Red blood cell distrubution width, albumin, RDW/albumin ratio, intensive care

Introduction

Sepsis is a disease that can cause high mortality and morbidity. Abnormal host response to microorganisms present in the body and organ dysfunctions are among the most important findings. It causes the death of approximately 30 million people worldwide every year [1]. According to some sources, it directly affects the mortality rate with a rate of over 50%. However, these mortality rates may vary due to geographical and genetic characteristics [2].

Due to the high mortality rate and the lack of data in developing countries, many studies are still in their tracks. In addition to organ dysfunctions developing in patients diagnosed with sepsis, parameters in predicting mortality in sepsis are always among the current approaches [3]. Many parameters can be used to determine the increased mortality risk. Among these, the selection of practical, easy-to-use and applicable parameters is a suitable option. Red blood cell distribution (RDW) and albumin values are easily applicable and easy parameters in the clinic [4].

RDW, which is checked in routine blood count, expresses the variability in the volume occupied by erythrocytes. Most of the time, impaired erythropoiesis and abnormal survival during a period cause the distribution width to increase [5]. Albumin has an important function in maintaining plasma osmolarity and antioxidant system. It has prognostic importance in critically ill patients [6]. The prognostic importance of RDW/albumin ratio (RAR) gives clearer results compared to the use of these two parameters alone. [7]. Although RAR increases in some inflammatory disorders [8], it was hypothesized that it may affect the severity of disease and mortality incidence in sepsis patients in clinical use. Our study aimed to examine the prognostic value of RDW/albumin ratio in patients diagnosed with sepsis and its relationship with mortality incidence. In addition, a study was conducted in which the quarterly parts of RAR value were examined among themselves and their ability to predict mortality was analyzed.

CITATION
Duran HT, Cam BM, Akdogan MA et al. Prognostic value of RDW/albumin ratio in sepsis patients in intensive care units. Med Science. 2025;14(3):706-10.

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DOI: 10.5455/medscience.2025.02.062

Material and Methods

Study Data and Settings

A total of 95 consecutive patients over the age of 18 who were hospitalized in a level 3 intensive care unit between December 2021 and December 2024 and diagnosed with sepsis were included in the study. The study was initiated after the approval of the Amasya University ethics committee (Decision Number: 2025000007, Date: 17.02.2025). According to the sepsis-3 criteria, patients with Organ Failure Assessment (SOFA) score of ≥2 after being admitted to the sepsis intensive care unit were included. Patients under the age of 18, pregnant, with a history of acute/chronic hematological disease, chronic alcohol use, diagnosed with cancer, liver failure and kidney failure, and patients who died within 24 hours of admission to the intensive care unit were excluded from the study.

Data Collection and Measurements

The RDW/albumin ratio from laboratory parameters was accepted as the RAR value. RAR median values were listed as quartiles in 95 patients. Data were recorded as first quartile (RARQ1): <4.64, second quartile (RARQ2): 4.65-5.26, third quartile (RARQ3): 5.26-5.94 and fourth quartile (RARQ4): >5.95. Demographic characteristics of the patients such as age, gender, and comorbidities were recorded. Laboratory parameters taken during intensive care admission included hemoglobin, (Hb) red cell distribution width (RDW), RAR:RDW/Alvumine, C-reactive protein (CRP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), albumin, d-dimer, calcium, SOFA score and procalcitonin values. 28-day and 90-day mortality rates were calculated after intensive care admission. Patients accepted as exitus as a result of 28-day mortality were defined as group 1. Patients who survived at 28-day mortality were defined as group 2. Cases in which the International Classification of Diseases, Tenth Revision (ICD-10) code specifically mentioned sepsis (for example, cases with an ICD-10 code were defined as sepsis).

Outcomes

Our primary outcomes was to determine 28-day mortality and the prognostic value of the RDW/albumin ratio. Our secondary outcomes was to examine the effect of other laboratory tests and quartiles of the RDW/albumin ratio.

Statistical Analysis

IBM SPSS Statistics (version 23.0; SPSS, Chicago, IL, USA) were used to analyze the data. Statistical significance was defined as a two-sided P<0.05. Kolmogorov-Smirnov/Shapiro-Wilk tests were used to examine the normal distribution of the data. Continuous numerical data were expressed as standard deviation and median range. Demographic characteristics were summarized as frequency percentages. Independent simple T-test was used to analyze some demographic data and laboratory parameters. Chi-square test was used to analyze the RAR quartile value between groups. One-way anova analysis was performed in the analysis of quartiles, and post-hoc Bonferroni correction was used. Regression analysis was used to determine the relationship between some laboratory results and mortality rate. ROC analysis was performed by creating a cut-off value to show the use of RAR value as an indicator of mortality rate. A cut-off value of RAR 5.27 was calculated by calculating the area under the curve (AUC) and its value in mortality pre-stressing was analyzed according to the Youden index. A statistically significant level was considered as p<0.05.

Results

A total of 95 sepsis patients were evaluated. The median age of the patients in the study group was 66 years. And 59.7% of the patients were male. The most common comorbidities were diabetes mellitus and hypertension. The rate of individuals with hypertension was 31.6%, while the rate of those with diabetes mellitus was 33.6%. The median RDW levels of the patients in the study group were 13.6%, albumin levels were 25.9 g/dL, and the median RAR value was 5.26% gr/dL. The 28-day mortality rates were 44.2% and 90-day mortality rates were 51.6%.

Comparison of some demographic characteristics and laboratory parameters between the groups is presented in Table 1. When Group 1 and Group 2 data were compared, it was seen that there was a statistical difference in Hb, RDW, albumin, CRP, AST, ALT D-dimer, SOFA score and RAR levels in Table 1.

Table 1. Comparison of some demographic characteristics and laboratory parameters of group 1- group 2

Variable	Total (n=95)	Group 1 (n=42)	Group 2 (n=53)	p
Age	66.61±6.24	69.28±6.22	66.28±5.99	0.19
Hb	11.5±1.06	11.01±1.17	11.89±0.79	<0.001
RDW	13.95±1.34	15.1±1.18	13.05±0.55	<0.001
Albumine	26.4±3.2	24.1±1.7	28.2±3	<0.001
RAR	5.4±1.07	6.31±0.87	4.67±0.51	<0.001
CRP	15.15±5.1	18.66±4.7	12.32±3.43	<0.001
AST	63.97±31.74	87.21±32.44	45.56±14.48	<0.001
ALT	40.82±10.97	48.88±10.54	34.44±5.99	<0.001
D-dimer	6.55±2.48	8.2±2.58	5.25±1.41	<0.001
Calcium	2.03±0.09	2.01±0.08	2.05±0.05	0.84
Procalsitonine	14.22±9.91	18.43±11.66	17.87±6.69	0.53
SOFA	6.95±3.87	10.69±2.58	4±1.3	<0.001

Hb: hemoglobluline, RDW: red cell distrubution width, RAR: RDW/Alvumine, CRP: C-reactive protein, AST: aspartate aminotransferase, ALT: alanine aminotransferase

DOI: 10.5455/medscience.2025.02.062

In the analysis of RAR quartiles, a statistically significant difference was observed between the mortality incidence and expected values are presented Table 2. In Group 1, the RARQ1 section value was lower than expected but higher in RARQ4. In Group 2, the RARQ1 section was higher than expected, while the RARQ4 section was lower than expected.

Table 2. Mortality incidence of RAR quartiles in groups 1-2

Variables	Total (n=95)	RARQ1 (n=24)	RARQ2 (n=24)	RARQ3 (n=24	RARQ4 (n=23)	p
Group1	42	0 (10.6)	4 (10.6)	15 (10.6)	23 (10.2)	0.001[a]
Group2	53	24 (13.4)	20 (13.4)	9 (13.4)	0 (12.8	

a: Pearson Chi-Square test

In the analysis of RAR quartiles, it is seen that RARQ4 section has a statistically higher mortality incidence rate than other sections. RARQ3 section has a higher mortality incidence rate compared to RARQ1 and RARQ2 sections. It was seen that the patients who lost their lives were 0-4-15-23 in quartiles, respectively in Table 3.

Table 3. Mortality incidence of RAR quartiles

Variable	N	ss	sd	f	p
RARQ1	24	0.01	3-91	49.007	0.001
RARQ2	24	0.38			
RARQ3	24	0.49			
RARQ4	23	0.01			

RARQ: RDW/Albumine ratio quertifile

Multiple regression analysis of some laboratory parameters created with Group 1 and Group 2 is presented in Table 4. It was observed that they were associated with RDW, albumin, SOFA score, CRP, AST, ALT and RAR values.

Table 4. The relationship of some laboratory parameters with the incidence of mortality

Variables	N	sd	t	β	p
Hb	95	0.026	1.005	0.056	0.318
Rdw	95	0.094	-3.854	-0.979	<0.001
Albumine	95	0.478	4.847	1.504	<0.001
RAR	95	0.252	2.928	1.581	0.004
CRP	95	0.01	-4.856	-0.49	<0.001
AST	95	0.001	-4.202	-0.291	<0.001
ALT	95	0.003	-4.447	-0.34	<0.001
Ddimer	95	0.033	5.988	0.985	<0.001
Ca	95	0.359	-0.531	-0.037	0.597
Procalsitonine	95	0.004	0.084	0.007	0.933
SOFA score	95	0.008	-5.23	-0.325	<0.001

Hb: hemogloblulin, RDW: red cell distrubution width, RAR: RDW/alvumine, CRP: C-reactive protein, AST: aspartate aminotransferase, ALT: alanine aminotransferase

The RAR value was analyzed as a mortality indicator with a cut-off value of 5.27, and the Receiver operating characteristic curve (ROC) curve was created. The area under the ROC curve was 75.3% (p: <0.001), specificity was 72.1%, and sensitivity was 71.2% in Figure 1.

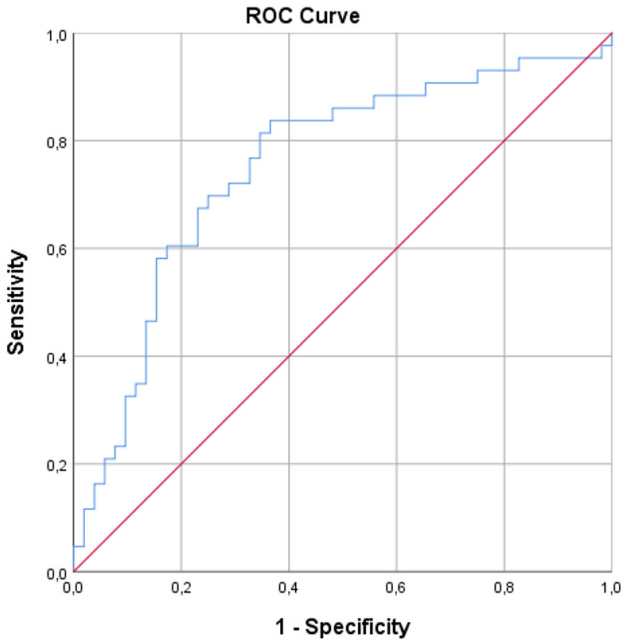

Figure 1. Receiver operating characteristic curve analysis for mortality of RAR

Discussion

The results of our study show that the prognostic value of RAR is confirmed. In addition, the higher the RAR value, the higher its prognostic importance. When compared with RDW and albumin values, the fact that its increasing value increases in proportion to the mortality incidence reveals the difference of this value. The fact that RDW and albumin are both parameters applied in routine intensive care clinics and are a simple and useful value in terms of cost shows that Table 1. It is a parameter that is easily applied and guiding in patients who meet the sepsis-3 criteria. The examination of RAR quartiles in terms of mortality incidence in both groups is presented in Table 2. It is observed that the mortality incidence increases with the increase in RAR quartile in group 1 patients who lost their lives. In the analysis conducted between the groups, it is seen that RAR quartiles create a statistical difference between both groups.

In sepsis patients, iron use decreases as a result of the increased inflammatory response and causes changes in erythrocyte morphology. Increased destruction and apoptosis affect erythrocyte morphology and RDW value [9,10]. The regression model we conducted in our study was found to support this phenomenon (Table 4). In addition, the RAR quartile analysis

DOI: 10.5455/medscience.2025.02.062

shows that its prognostic value increases with increasing values (Table 3). Intravascular permeability of albumin changes due to changes in vascular permeability in sepsis patients [11]. Our study is consistent with previous studies [12]. Our study shows that increasing values increase this importance in addition to the prognostic value of RAR. In a study examining the non-thyroidal causes of diseases associated with sepsis, it was shown that RDW and albumin values were associated with sespsis [13]. Another study conducted on patients with sepsis investigated its prognostic value in predicting mortality and showed that Apache 2, neutrophil lymphocyte ratio, CRP albumin ratio and RDW values were in a positive correlation in these patients [14]. RAR is a significant indicator of hypoalbuminemia and hematological dysfunction. The effects of changing intravascular permeability and increased inflammatory response on erythrocyte morphology cause changes in RDW [15]. In our study, the effect of RAR value on clinical outcomes is clearly seen. According to the results of RAR-related mortality analysis, our study shows that a RAR cut-off value of 5.27 gives significant results according to the use of RDW and albumin alone (Figure 1). It was observed that the mortality incidence increased with the increase in the RAR value. In addition, in the examination of the surviving patient group, the decrease in the mortality incidence with the increase in the quartile in the RAR quartile analysis supports this opinion. These findings and especially the analysis of RAR values in sepsis patients hospitalized in the intensive care unit make it usable in clinical practice. With these results, we think that the RAR value shows the prognostic feature in the surviving and deceased patient groups. There are many factors associated with mortality in patients with sepsis. Some hematological disorders appear to play a role in this regard [16]. There are many effects of disorders that play a role in the altered vasoactive response and immune stress in sepsis. In addition, some studies suggest that early treatment in sepsis patients may improve clinical outcomes [17]. Some studies discuss early diagnosis and early treatment strategies in patients hospitalized with sepsis. Some of these treatment strategies show that treatment results are more positive with arterial oxygen saturation monitoring and rapid central intravenous fluid resuscitation [18]. Especially the early initiation of crystalloid solutions has positive results in mortality incidence. In addition, crystalloid solutions have more positive results compared to the use of intravenous saline [19].

The limitations of our study were that it was single-centered and the relative number of patients provided insufficient data. However, it is seen that the increasing values are associated with the mortality incidence with the demonstration of the RAR prognostic value and especially with the RAR regression analysis and the analysis of the RAR quartiles. It was observed with cross-examination that the increasing values of the RAR quartiles in the surviving patient group lead to a decrease in the mortality incidence. We think that the RAR value is the largest value that can be used as an indicator of clinical deterioration in patients diagnosed with sepsis. These results may provide benefits such as early antibiotic treatment and appropriate initiation of intravenous fluid therapy. In addition, it is easy to apply and does not create additional costs, which provides clinical benefits for us in using this value. The prognosis of patients with sepsis and the examination of the related factors will always be among the current approaches. Keeping enteral nutrition and inflammation levels limited in critically ill patients will provide a better clinical outcome for the patient.

Conclusion

We suggest that the RAR value, as a continuous or categorical variable, can be used as a potential indicator of clinical prognosis in patients with sepsis in the intensive care unit. Among patients who died, a higher risk of death was strongly associated with a higher RAR level. The mortality incidence was higher in patients in the highest quartile of RAR (RARQ4) than in the other quartiles. Furthermore, the mortality incidence of patients in the first quartile (RARQ1) was lowest. It would be useful to confirm these findings in future studies and measure them in different clinical settings.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Before the study, permission was obtained from the Amasya University Ethics Committee as Ethics Committee (Decision No: 2025000007, Date: 17.02.2025).

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