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Investigation of red cell distribution width as a prognostic criterion in severe burns

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Abstract

This study was conducted to examine red cell distribution width (RDW) as a prognostic criterion in severe burns. The study is a descriptive correlational study and was carried out retrospectively. Patients with high RDW and low albumin values among severe burn injuries in the burn unit of a university hospital constituted half of the sample. Severe burns with RDW within normal range and a prognostic criterion for which albumin level normal and closest to normal accounted for the other half. RDW and albumin values were compared with the clinical results of patients with severe burns. IBM SPSS (Statistical Package for the Social Sciences) Statistics 25 was used for data analysis. Of the burn patients, 38.33% were between the age of 65–80, 51.67% were men, and 92.5% had third-degree burns. The mean albumin level of the patients was 2.39 ± 0.34 g/dL, and the mean RDW level was 18.47 ± 6.15%. The length of the stay in the intensive care unit was 13.45 ± 7.83 days, and the duration of central venous catheter use was 23.41 ± 8.25 days. High RDW and low albumin values were found to be associated with death, length of stay in the intensive care unit, and more blood transfusion. High RDW and hypoalbuminemia significantly affect the clinical results of severe burns. Both parameters are effective in determining the clinical course of burn patients, the length of hospital stay, presence of catheters and medication treatment protocol.

KEYWORDS
albumin, prognostic criterion, red cell distribution width, severe burns

Key Messages
- RDW just as albumin can be used predicting the clinical course of patients as a prognostic criterion.
- RDW is easier to use as a clinical parameter than albumin.
- For the normalisation of RDW new clinical applications are needed in burn patients.

1 | INTRODUCTION

According to the reports of the World Health Organisation (WHO), American Burn Association, and Centers for Disease Control and Prevention (CDC), 1.1 million people were injured annually due to burns[1,2] and 3500 people died from burn injuries.[3]

A burn is a trauma requiring the highest level of attention and requires a multidisciplinary approach. The need for erythrocyte transfusion in the acute phase of the burn should be considered simultaneously or immediately after resuscitation, due to symptomatic anaemia and acute blood loss. Increased red cell destruction, decreased erythropoiesis, iron deficiency with resistance to erythropoietin, and frequent phlebotomy lead to the development of anaemia.[4,5]

Red cell distribution width (RDW) is the variability of the size of circulating red blood cells and is routinely measured in complete blood count (CBC). RDW is used in the differential diagnosis of many haematological diseases, especially anaemia. RDW is obtained from the red cell histograms. The red blood cell size shows its distribution, namely anisocytosis. Before anaemia occurs, the RDW level is first detected. It is most commonly used in practice to distinguish between iron deficiency anaemia and thalassemia carriage.[4-6] RDW is normal in thalassemia carriage and high in anaemia. It is calculated by two different methods. In these methods, the normal value is 14.5% to 15% in the method given as a percentage, and 45 fL in the other method. RDW is found as 15% to 25% in iron deficiency anaemia, 12% to 15% in thalassemia carriage, and 25% to 35% in thalassemia major. The clinical experience suggests that if RDW is 17% to 20% with high mean corpuscular haemoglobin concentration (MCHC), hereditary spherocytosis is likely, but if RDW is in the range of 20% to 25%, congenital dyserythropoietic anaemias (CDA) come to mind.[6] If the RDW is higher than 25% in unresolved severe microcytic anaemias, sideroblastic anaemia may be considered in the differential diagnosis.

One of the noteworthy points in fluid resuscitation in burns is the "use of colloids". Increased capillary permeability is seen more and over a longer period of time in burned tissues while simultaneously occurring at a lower degree and in a shorter time in undamaged tissue.[7,8] In this context, clinicians emphasised that the most appropriate solution to reduce capillary permeability is the use of colloid, namely albumin, for both reducing oedema and increasing oncotic pressure, but it should be performed simultaneously with fluid.[9,10] However, current studies have been conducted on the intensive care patient group and do not include burn patients.[9,10]

Erythrocyte transfusion is a routine practice in major burn injuries. Red cell transfusion is required due to blood loss, postoperative bleeding, red cell destruction that begins during the acute burn process and continues during the recovery period, and reduced red cell production.[11] One of the most important complications in burn cases is infection and hypoalbuminemia, which significantly affects survival. We think that RDW, like albumin, may be a prognostic criterion in predicting the clinical condition of the patient in severe burns. In this study, we aimed to examine the red cell distribution width as a prognostic criterion in severe burns.

2 | MATERIAL AND METHOD

Patients exposed to severe burn trauma and treated in the Burn Unit of Diyarbakır Dicle University Medical Faculty Hospital from 2010 to 2020 were included in the sample. Stratified sampling method was used in sample selection. Half of the total n = 120 severe burn patient sample consisted of severe burn patients with albumin level less than 2.5 gram/decilitre (g/dL) and RDW value greater than 15% after burn, and the other half with severe burn patients above these values.

Inclusion criteria were as follows:

 i Not having any chronic disease/comorbidity before the burn.
 ii Being over the age of 18.
 iii Not having any blood disorders before the burn.
 iv Not exposed to any trauma during the burn.

Exclusion criteria were as follows:

 i Before burn comorbidity/chronic disease presence (renal, lung and liver failure, malignancy, etc.).
 ii Presence of trauma other than burns, falling from height, hitting, accident or any other reason.
 iii Being under the age of 18.
 iv Presence of thalassemia, anaemia or similar haematological disease in the past.

Patient data were analysed retrospectively using past computer records, patient files and burn unit records, and recorded in a data form developed by the researchers. Parameters such as sociodemographic characteristics, burn aetiology, mortality rates, intervention, hospitalisation period, blood values of the patients were recorded.

Statistical analysis of the results obtained in the study was performed with IBM SPSS (Statistical Package for the Social Sciences) Statistics 25. Descriptive statistics (frequency, standard deviation, mean) were used in data evaluation. Independent samples t test, analysis of variance (ANOVA) and post hoc analysis were performed in order to determine the statistical significance of the differences between the means of the groups. Correlation

and regression analyses were implemented. Kolmogorov-Smirnov and Shapiro-Wilk tests were performed to find the normal distribution assumptions. The results were evaluated at 95% confidence interval and $P < 0.05$

significance level. Ethical approval prior to the start of the study, the requisite legal approvals will be obtained from Diyarbakir Dicle University Ethics Committee (Decision No: 04.02.2021–103).

3 | RESULTS

3.1 | Burn patient information form

The characteristics of burn patients are shown in Table 1 in terms of number and percentage. Exactly 38.33% of burn patients are between the age of 65 and 80, and 51.67% of them are male patients. It was determined that 92.5% of the patients had third-degree burns, 81.7% of them had a burn percentage of 41% to 50%. When the burn areas were examined, 83.3% of the patients developed left upper extremity, 66.66% right lower extremity and 67.5% left lower extremity burn.

3.2 | Clinical outcomes of burn patients

The minimum, maximum and mean values of the clinical outcomes of burn patients are shown in Table 2.

TABLE 1 Distribution of burn patients by descriptive characteristics (n = 120)

Features	n	%
Age		
31-45	32	26.67
46-64	34	28.33
65-80	46	38.33
81 and above	8	6.67
Age (Mean ± SD) 59.04 ± 15.55 (min 34, max 88)		
Gender		
Female	58	48.33
Male	62	51.67
Type of burn		
Hot liquid	60	50
Electrical	24	20
Flame	32	26.66
Contact	4	3.34
Degree of burn		
Second degree	9	7.5
Third degree	111	92.5
Percentage of burn		
21%-40%	20	16.67
41%-50%	98	81.7
51% and above	2	1.7
Location of burn		
Head-neck	16	13.33
Anterior trunk	52	43.33
Posterior trunk	52	43.33
Right upper extremity	79	65.83
Left upper extremity	100	83.33
Right lower extremity	80	66.66
Left lower extremity	81	67.5
Intervention applied		
Operation	93	77.5
Medical treatment	27	22.5
Neuropsychiatric symptom		
Yes	23	19.16
No	97	80.84
Result		
Discharged	107	89.17
Death	13	10.83

TABLE 2 The Minimum, maximum and mean values of clinical outcomes of burn patients (n = 120)

Clinical Outcomes	Mean ± SD	Min	Max
Albumin (g/dL)	2.39 ± 0.34	1.8	3.10
Haemoglobin (g/dL)	9.91 ± 1.01	8.5	13.38
Haematocrit (%)	30.23 ± 2.71	25.5	40.64
Red blood cell (million/μL)	3.68 ± 0.51	2.6	4.8
Red cell distribution (%)	18.47 ± 6.15	11.29	29
Length of stay in intensive care unit (days)	13.45 ± 7.83	3	33
Number of days spent in clinic	9.26 ± 7.83	0	46
Number of albumin or FFP transfusion	1.85 ± 0.88	0	4
Number of red blood cell transfusions	3.76 ± 2.35	0	9
Duration of antibiotic therapy in days	16.72 ± 9.34	5	48
Duration of analgesic use in days	15.91 ± 8.01	5	48
Duration of Foley Catheter use in days	15.55 ± 7.67	3	38
Duration of central venous catheter use in days	23.41 ± 8.25	7	44

TABLE 3 Comparison of laboratory data, clinical results and descriptive characteristics (n = 120)

		Laboratory data		RDW related laboratory data		
Features	N	RDW (%)	Albumin (g/dL)	HGB (g/dL)	RBC (million/μL)	HCT (%)
Age		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
31-45	32	16.85 ± 5.25	2.42 ± 0.29	10.48 ± 1	3.74 ± 0.47	31.73 ± 2.43
46-64	34	16.45 ± 4.44	2.42 ± 0.37	9.78 ± 0.99	3.88 ± 0.36	30.32 ± 2.87
65-80	46	19.42 ± 6.63	2.35 ± 0.29	9.79 ± 0.91	3.60 ± 0.55	29.83 ± 2.17
81 and above	8	28.14 ± 0.86	2.27 ± 9.51	8.82 ± 0.2	3.03 ± 0.28	26.25 ± 0.59
F		11.214	0.610	8.045	0.014	11.929
P		0.000**	0.610	0.000**	0.0989	0.000**
Post hoc		4 > 1, 2 and 3 (P = 0.000**)	-	4 > 3 > 2 and 1 (P = 0.000**)	-	4 > 3 > 2 and 1 (P = 0.000**)
Gender		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Female	58	18.05 ± 6.23	2.47 ± 0.35	9.91 ± 0.78	3.74 ± 0.43	39.65 ± 1.84
Male	62	18.87 ± 6.09	2.31 ± 0.32	9.9 ± 1.19	3.62 ± 0.57	29.85 ± 3.30
T		−0.730	2.717	0.021	1.207	1.629
P		0.467	0.008**	0.983	0.230	0.106
Type of burn						
Hot liquid	60	18.55 ± 6.37	2.34 ± 0.36	9.94 ± 0.93	3.72 ± 0.53	30.06 ± 2.85
Electrical	24	17.60 ± 5.76	2.40 ± 0.31	10.36 ± 0.90	3.64 ± 0.47	31.14 ± 2.34
Flame	32	18.96 ± 6.08	2.43 ± 0.30	9.42 ± 1.08	3.66 ± 0.48	29.76 ± 2.69
Contact	4	18.69 ± 7.43	2.72 ± 0.35	10.6 ± 0.69	3.51 ± 0.66	31.24 ± 1.98
F		0.229	1.899	5.095	0.304	1.499
P		0.876	0.134	0.002**	0.823	0.219
Post hoc		-	-	3 and 4 > 1 and 2 (P = 0.012*)	-	-
Burn level		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Second degree	9	14.08 ± 2.40	2.39 ± 0.35	10.72 ± 1.85	4.10 ± 0.52	32.90 ± 4.74
Third degree	111	18.83 ± 6.23	2.30 ± 0.29	9.84 ± 0.89	3.64 ± 0.49	30.02 ± 2.39
T		−2.265	−0.801	2.544	2.660	3.172
P		0.000*	0.425	0.012*	0.009**	0.002**
Percentage of burn		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
21%-40%	20	18.55 ± 6.37	2.38 ± 0.39	10.43 ± 1.44	3.72 ± 0.56	31.27 ± 3.74
41%-50%	98	18.41 ± 5.9	2.39 ± 0.33	9.8 ± 0.88	3.67 ± 0.5	30.02 ± 2.45
51% and above	2	27.70 ± 1.27	2.51 ± 0.77	9.87 ± 1.76	3.51 ± 0.21	30.40 ± 1.85
F		2.448	0.211	3.330	0.171	1.792
P		0.091	0.810	0.039*	0.843	0.171
Post hoc		-	-	2, 3 > 1 (P = 0.021*)	-	-
Location of burn		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Head-neck	16	17.45 ± 4.95	2.52 ± 0.34	10.1 ± 1.26	3.7 ± 0.6	31 ± 3.40
Anterior trunk	52	17.88 ± 5.54	2.37 ± 0.32	10.02 ± 0.85	3.71 ± 0.43	30.64 ± 2.18
Posterior trunk	52	18.39 ± 6.06	2.53 ± 0.38	10.11 ± 0.78	3.71 ± 0.44	30.36 ± 2.12
Right upper extremity	79	18.27 ± 6.08	2.38 ± 0.35	10.07 ± 1.03	3.68 ± 0.51	30.80 ± 2.51
Left upper extremity	100	18 ± 5.76	2.35 ± 0.30	9.86 ± 1.02	3.67 ± 0.52	30.23 ± 2.61
Right lower extremity	80	19.59 ± 6.72	2.42 ± 0.39	9.89 ± 0.99	3.66 ± 0.47	30.56 ± 2.47
Left lower extremity	81	18.97 ± 6.38	2.43 ± 0.37	9.72 ± 0.94	3.64 ± 0.56	29.79 ± 2.64
F		0.016	2.621	0.632	0.183	4.756
P		0.900	0.108	0.428	0.989	0.031*

(Continues)

TABLE 3 (Continued)

Features	N	Laboratory data		RDW related laboratory data		
		RDW (%)	Albumin (g/dL)	HGB (g/dL)	RBC (million/μL)	HCT (%)
Intervention applied		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Operation	93	18.41 ± 5.92	2.40 ± 0.35	9.93 ± 0.94	3.68 ± 0.51	29.95 ± 2.62
Medical treatment	27	18.69 ± 6.98	2.36 ± 0.31	9.81 ± 1.24	3.68 ± 0.49	31.22 ± 2.83
T		0.203	0.480	0.558	−0.014	−2.181
P		0.839	0.900	0.634	0.989	0.031*
Neuropsychiatric symptom		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Yes	23	23.12 ± 6.09	2.28 ± 0.44	9.68 ± 0.98	3.29 ± 0.47	29.29 ± 3.13
No	97	17.37 ± 5.66	2.40 ± 0.32	9.96 ± 1.02	3.09 ± 0.31	30.46 ± 2.57
T		4.310	−0.550	−1.229	−4.418	−1.874
P		0.000**	0.583	0.229	0.000	0.063
Result		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Discharged	107	17.52 ± 5.62	2.42 ± 0.35	10.01 ± 1.01	3.75 ± 0.48	30.62 ± 2.56
Death	13	26.33 ± 4.56	2.15 ± 0.43	9.07 ± 0.56	3.09 ± 0.31	29.92 ± 3.03
T		−5.426	2.700	3.260	4.758	4.847
P		0.000**	0.008**	0.001**	0.000**	0.000**

Note: *$P < 0.05$, **$P < 0.01$.

Abbreviations: HCT, haematocrit; Hg, haemoglobin; One-Way ANOVA, One-way analysis of variance; RBC, red blood cell; RDW, red cell distribution width; SD, standard deviation; t, independent sample t test.

In this study, serum albumin value was 2.39 ± 0.34 g/dL (min 1.8, max 3.10), haemoglobin (HGB) level obtained in CBC was 9.91 ± 1.01 (min 8.5, max 13.38), and haematocrit (HCT) value was 30.23% ± 2.71% (min 25.5, max 40.64). In addition, RDW was found to be 18.47% ± 6.15% (min 11.29, max 29), red blood cell (RBC) 3.68 ± 0.51 million/μL (min 2.6, max 4.8). It was determined that the length of stay in the intensive care unit was 13.45 ± 7.83 (min 3, max 33) days, the length of stay in the clinic was 9.26 ± 7.83 (min 0, max 46) days, the duration of Foley catheter use was 15.55 ± 7.67 (min 3, max 38) days, the duration of central venous catheter use was 23.41 ± 8.25 (min 7, max 44) days. Transfusion was determined as 1.85 ± 0.88 (min 0, max 4) for albumin or fresh frozen plasma (FFP) and 3.76 ± 2.35 (min 0, max 9) for erythrocyte suspension. The duration of days was found to be 16.72 ± 9.34 (min 5, max 48) for antibiotic therapy and 15.91 ± 8.01 (min 5, max 48) for analgesic use. In addition, the mean age of the patients was determined as 59.04 ± 15.55 (min 34, max 88).

3.3 | Comparisons of blood test parameters, clinical results and descriptive characteristics

In Table 3, the descriptive characteristics of burn patients and the comparisons of their clinical results are shown.

Table 3 provides comparisons of laboratory data, clinical results and descriptive characteristics. According to ANOVA analysis, RDW level in burn patients did not show a statistically significant difference according to burn type, level and percentage. However, as a result of post hoc analysis, it was found that it was higher in people aged 81 years and over (F = 11.214, $P = 0.000$). Similarly, HCT and Hg levels were found to be lower in individuals over 65 years old compared with others ($P = 0.000$).

According to the independent sample t test, it was found that the RDW value in burn patients was higher in third-level burns (−2.265, $P = 0.000$) and was associated with death (t = −5.426, $P = 0.000$). It was found that the albumin value was lower in men (t = 2.717, $P = 0.008$) and was associated with death (t = 2.700, $P = 0.008$).

Table 4 contains the results of the regression analysis between RDW and albumin levels and patient results. Accordingly, it was determined that there was a statistically significant relationship between high RDW level and mortality, the number of erythrocyte suspension transfusions, CVC use, length of stay in ICU and clinic, analgesic and antibiotic use ($P < 0.05$). Similarly, a statistically significant correlation was found between low albumin level and the number of albumin transfusion, mortality and duration of CVC use ($P < 0.05$).

Table 5 shows the results of correlation analysis between RDW and albumin levels and patient results. Accordingly, a positive, strong and statistically significant

TABLE 4 Regression analysis results between RDW and albumin levels and patient results

Regression analysis results between RDW Level and patient results

Items	Unstandardized B	Coefficients std. error	Standardised coefficients beta	t	P
Constant	11.219	1.107		10.134	0.000
Length of stay in ICU (days)	0.721	0.144	0.918	4.993	0.000
Number of days spent in clinic	−0.032	0.073	−0.041	−0.442	0.02*
Number of albumin or FFP transfusion	−0.603	0.790	−0.086	−0.763	0.447
Duration of analgesic use in days	0.501	0.212	0.653	2.365	0.020
Duration of antibiotic therapy in days	−0.366	0.199	−0.555	−1.833	0.049
Duration of Foley Catheter use in days	−0.186	0.153	−0.231	−1.213	0.228
Consequence	9.239	1.197	0.469	7.722	0.000**
Number of ES Transfusions	1.294	0.234	0.494	5.522	0.000**
Duration of CVC use in days	1.716	0.217	0.376	3.442	0.000**

Regression analysis results between albumin level and patient results

Items	Unstandardized B	Coefficients std. error	Standardised coefficients beta	t	P
Constant	2.579	0.153		16.878	0.000
Length of stay in ICU (days)	0.011	0.011	0.251	1.055	0.294
Number of days spent in clinic	−0.007	0.006	−0.160	−1.164	0.247
Number of albumin or FFP transfusion	0.000	0.059	0.000	−0.003	0.000**
Duration of analgesic use in days	0.021	0.016	0.493	1.346	0.181
Duration of antibiotic therapy in days	−0.005	0.015	−0.122	−0.301	0.764
Duration of Foley Catheter use in days	−0.009	0.012	−0.207	−0.810	0.419
Consequence	−0.350	0.120	−0.315	−2.922	0.004**
Number of ES transfusions	0.102	0.022	0.691	4.637	0.998
Duration of CVC use in days	0.101	0.032	0.412	3.611	0.000**

Note: R = 0.381, Adjusted R^2 = 0.180, F = 11.514, P = 0.000, Durbin Watson = 1124.

* $P < 0.05$, ** $P < 0.01$.

Abbreviations: CVC, Central venous catheter; ICU, Intensive care unit; RDW, Red cell distribution width; S, Erythrocyte suspension.

relationship was found between RDW level and the number of erythrocyte suspension transfusions and the length of stay in the ICU ($P < 0.01$). In addition, a moderate, positive and statistically significant correlation was found between RDW level and mortality, duration of CVC use and Foley catheter use, antibiotic and analgesic use ($P < 0.01$). A positive, moderate and statistically significant correlation was found between albumin level and duration of CVC use, use of analgesic and mortality. Additionally, a positive, strong and statistically significant correlation was found with the number of albumin or FFP transfusion ($P < 0.01$).

Figure 1 shows the relationship between RDW and albumin levels with death, length of stay in ICU and duration of CVC use. It is seen in Figure 1A that the majority of deaths occur in patients with RDW level higher than 25%. In Figure 1B, it is seen that the length of stay in the ICU of patients with high RDW is prolonged, and in this sense, patients with RDW values above 14% are more at risk. In Figure 1C, it is seen that deaths occur in patients with an albumin level lower than 2.3 g/dL. In Figure 1D, it is shown that the duration of CVC use of burn patients with albumin level below 2.7 is prolonged.

TABLE 5 Correlation analysis results between RDW and albumin levels and patient results

| Items		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
RDW (a)	Pearson correlation	1	0.168	0.488	0.582	0.588	0.762	0.447	0.580	0.197	0.685	0.368
	Sig. (two-tailed)		0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.000	0.000
	N	120	120	120	120	120	120	120	120	120	120	120
Albumin (b)	Pearson correlation	0.168	1	0.258	0.306	0.301	0.429	−0.241	0.242	0.181	0.286	−0.037
	Sig. (two-tailed)	0.067		0.004	0.001	0.001	0.000	0.008	0.008	0.048	0.002	0.685
	N	120	120	120	120	120	120	120	120	120	120	120
Number of albumin or FFP transfusion (c)	Pearson correlation	0.488	0.558	1	0.748	0.685	0.608	−0.066	0.746	0.334	0.794	0.228
	Sig. (two-tailed)	0.784	0.004**		0.000	0.000	0.000	0.475	0.000	0.000	0.000	0.012
	N	120	120	120	120	120	120	120	120	120	120	120
Duration of antibiotic therapy in days (d)	Pearson correlation	0.582	0.306	0.748	1	0.964	0.764	−0.033	0.916	0.553	0.880	0.244
	Sig. (two-tailed)	0.000**	0.001**	0.000		0.000	0.000	0.721	0.000	0.000	0.000	0.007
	N	120	120	120	120	120	120	120	120	120	120	120
Duration of analgesic use in days (e)	Pearson correlation	0.588	0.301	0.685	0.964	1	0.757	−0.003	0.902	0.605	0.832	0.237
	Sig. (two-tailed)	0.000**	0.001**	0.000	0.000		0.000	0.973	0.000	0.000	0.000	0.009
	N	120	120	120	120	120	120	120	120	120	120	120
Number of ES Transfusions (f)	Pearson correlation	0.762	0.229	0.608	0.764	0.757	1	0.103	0.724	0.405	0.813	0.169
	Sig. (two-tailed)	0.000**	0.070	0.000	0.000	0.000		0.261	0.000	0.000	0.000	0.064
	N	120	120	120	120	120	120	120	120	120	120	120
Consequence (g)	Pearson correlation	0.447	−0.341	−0.066	−0.033	−0.003	0.103	1	0.098	−0.411	0.104	0.486
	Sig. (two-tailed)	0.000**	0.008**	0.475	0.721	0.973	0.261		0.288	0.000	0.260	0.000
	N	120	120	120	120	120	120	120	120	120	120	120
Duration of Foley Catheter use in days (h)	Pearson correlation	0.580	0.242	0.746	0.916	0.902	0.724	0.098	1	0.475	0.888	0.311
	Sig. (two-tailed)	0.000**	0.008**	0.000	0.000	0.000	0.000	0.288		0.000	0.000	0.001
	N	120	120	120	120	120	120	120	120	120	120	120
Number of Days Spent in Clinic (i)	Pearson correlation	0.197	0.181	0.334	0.553	0.605	0.405	−0.411	0.475	1	0.315	−0.240
	Sig. (two-tailed)	0.031*	0.048*	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.008
	N	120	120	120	120	120	120	120	120	120	120	120
Length of Stay in ICU (days) (j)	Pearson correlation	0.785	0.286	0.794	0.880	0.832	0.813	0.104	0.888	0.315	1	0.302
	Sig. (two-tailed)	0.000**	0.002**	0.000	0.000	0.000	0.000	0.260	0.000	0.000		0.001
	N	120	120	120	120	120	120	120	120	120	120	120
Duration of CVC use in days (k)	Pearson correlation	0.368	−0.337	0.228	0.244	0.237	0.169	0.486	0.311	−0.240	0.302	1
	Sig. (two-tailed)	0.685	0.012*	0.007	0.009	0.064	0.000	0.001	0.008	0.001	0.302	
	N	120	120	120	120	120	120	120	120	120	120	120

Note: $*P < 0.05$, $**P < 0.01$.

Abbreviations: CVC, central venous catheter; ES, erythrocyte suspension; ICU, intensive care unit; RDW, red cell distribution width.
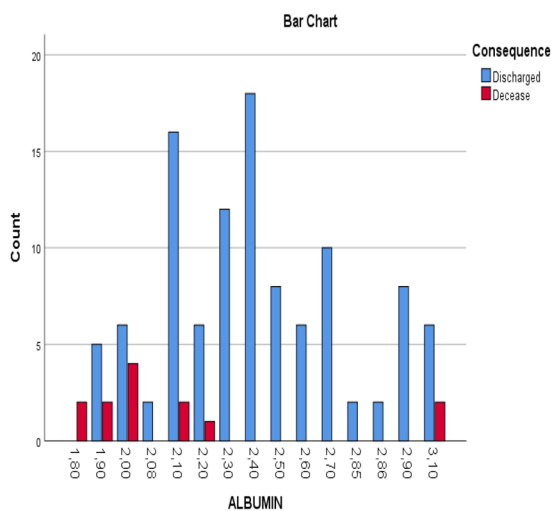
(A) **The Relationship Between RDW Level and Death**
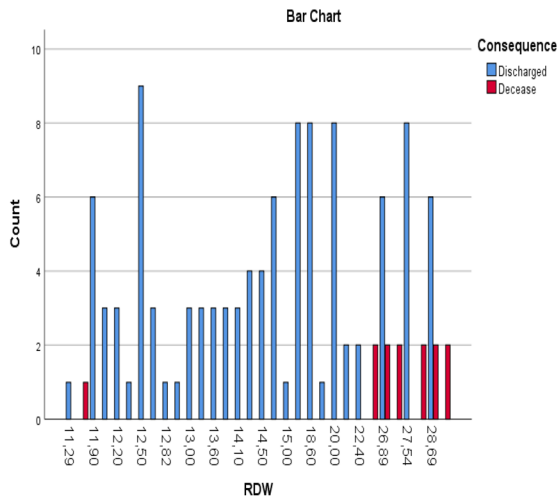
(B) **The Relationship Between RDW Level and Length of Stay in ICU**
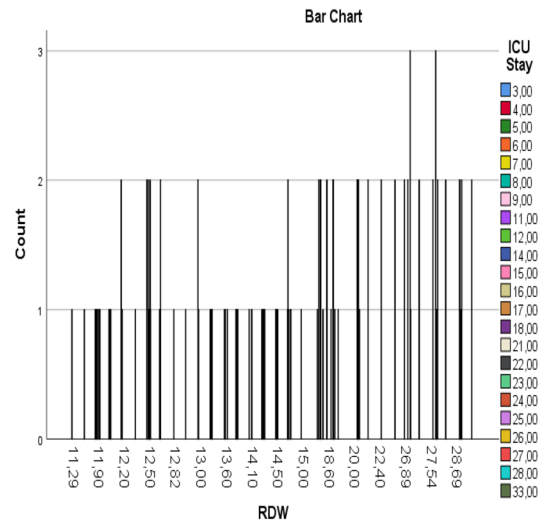
(C) **The Relationship Between Albumin Level and Death**

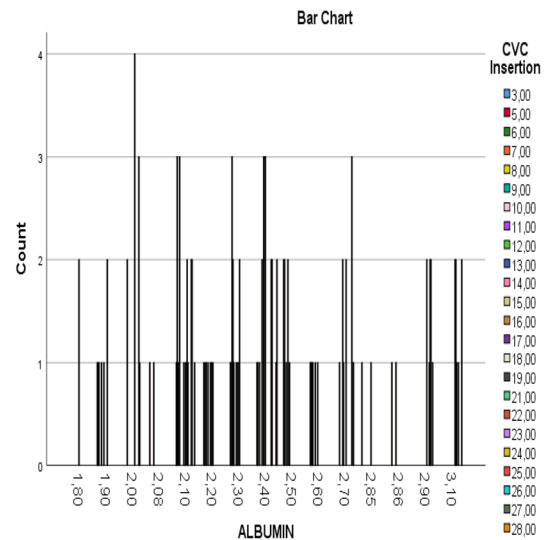(D) **The Relationship Between Albumin Level and duration of CVC use**

FIGURE 1 The relationship of RDW and albumin level with death, length of stay in ICU and duration of CVC use, A, The relationship between RDW level and death, B, The relationship between RDW level and length of stay in ICU, C, The relationship between albumin level and death, D, The relationship between albumin level and duration of CVC use

4 | DISCUSSION

In our study, RDW and its associated RBC, HGB and HCT values as well as serum albumin values and their effect on patient outcomes were examined from CBC data of severe burn patients. In this study, 38.33% of burn patients were between 65 and 80 years old and 51.67% were male patients. It was determined that 92.5% of the patients had third-degree burns, 81.7% had a burn percentage of 41% to 50%.

In our study, HGB was determined as 9.91 ± 1.01 (min 8.5, max 13.38) and HCT as $30.23\% \pm 2.71\%$ (min 25.5, max 40.64). In addition, RDW was found to be $18.47\% \pm 6.15\%$ (min 11.29, max 29) and RBC was found to be 3.68 ± 0.51 million/μL (min 2.6, max 4.8). It was expected that HGB and HCT values were low due to the decrease in RBC after burn injury. This situation is thought to develop due to the hemolysis of RBC.[12]

The increase in RDW value at the end of the seventh day is also added to the trend of change in RBC, HGB and HCT values decreasing after severe burns.[13] Low RBC results in increased homeostasis. RDW increase signals impaired RBC production, RBC deaths and increased oxidative stress.[14] The increase in RDW may be a sign of

increased mortality.[15] In a previous study, high RDW has been shown to be an independent predictor of mortality.[16]

Patients with a burn surface area of more than 10% have a high risk of reduced erythropoiesis and anaemia, and this situation delays wound healing.[17,18] After a burn injury, high hepcidin levels interfere with oral iron absorption. The use of intravenous iron is not preferred due to the risk of infection.[19] Along with the need for more evidence, recent meta-analyses indicate that intravenous iron intake is safe and effective in the acute inflammatory process.[20,21] The routine practice today is ES transfusion when the HGB value is at least 7 g/dL.[12] In our study, it was determined that the number of transfusions was 1.85 ± 0.88 (min 0, max 4) for albumin and 3.76 ± 2.35 (min 0, max 9) for erythrocyte suspension. In addition, there was a positive, strong and statistically significant relationship between RDW level and the number of erythrocyte suspension transfusions ($P < 0.01$).

In our study, it was found that the majority of deaths were in patients with RDW level higher than 25%, and the length of stay in the ICU was prolonged due to RDW higher than 14%. In a similar study, it was stated that high RDW is associated with more transfusion and mortality.[12]

In literature reviews, it is recommended to be cautious in terms of nutritional deficiencies, renal failure, stress, increased neurohormonal activity, cardiac events and heart failure in case of high RDW.[22-24] It is not certain that the above-mentioned problems are caused by high RDW alone, it suggests that high RDW may indicate important problems.

Due to hypoalbuminemia, the decrease in plasma colloid osmotic pressure increases fluid passage to the interstitial area, and oedema takes effect throughout the body after 12 h.[25] In cases where the burn rate is more than 30% of the total body surface, the disturbance of sodium-potassium balance triggers hypovolemic shock and acute renal failure is inevitable. The decrease in intravascular fluid volume causes a decrease in cardiac output and urine output, vascular resistance increases, erythrocyte destruction begins. In our study, hypoalbuminemia was found to be associated with death in severe burn patients (t = 2.700, $P = 0.008$). In addition, according to the results of regression and correlation analysis, a statistically significant relationship was found between hypoalbuminemia and the number of albumin transfusions, mortality, use of analgesic and the duration of CVC use ($P < 0.05$).

In a previous study, it was stated that hypoalbuminemia in the first 24 h of hospitalisation in burn patients is an independent predictor of organ dysfunction but not associated with mortality.[26] In addition, although it is thought that albumin supplements reduce hypoalbuminemia, it has been stated that they have no effect on reducing mortality.[27] On the other hand, in two studies conducted on intensive care patients, it was emphasised that the most appropriate solution to reduce capillary permeability is the use of colloid, namely albumin, for both reducing oedema and increasing oncotic pressure, but it should be done simultaneously with fluid resuscitation.[9,10]

5 | CONCLUSION

According to the results obtained in our study, the change in RDW and albumin can be used as a reference for predicting the clinical course of patients. Although changes in CBC data are mostly known so far, there is little evidence of the effects of RDW on clinical outcomes. In addition, the negative effects of hypoalbuminemia in patients with severe burns have also been based on evidence. In addition to ES transfusion for the normalisation of colloid and CBC parameters, new clinical applications are needed to treat hypoalbuminemia in burn patients, and additional treatment protocols need to be developed. Future research is recommended to focus on these areas.

CONFLICT OF INTEREST
The author declared that there is no conflict of interest.

ETHICS APPROVAL
Ethics approval is applicable.

DATA AVAILABILITY STATEMENT
The data have analysed during the current study are available from the corresponding author on reasonable request.

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