Cohort Study

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Association of red blood cell distribution width with mortality among multiple trauma patients

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Background: Identifying the severity of trauma to provide timely and adequate treatment and predict the prognosis are some of the significant challenges in trauma management. Increased red blood cell distribution width (RDW) is associated with several pathologies and associated mortality. This study aims to evaluate the RDW in predicting 24 h and 30-day mortality among multiple trauma patients.

Methods: In this retrospective study, multiple trauma patients with ISS ≤ 16 were included. Blood samples of the patients were collected at 1 h and 24 h of the referral to determine RDW. Demographic data, 24 h and 30-day mortality, injury severity score (ISS), and RDW outcomes were evaluated for all the patients.

Results: Of the 300 patients included in the study, 52 patients died in the first 24 h, and 85 patients within 30 days. One hour and 24 h RDW were not significantly different in 30-day mortality patients, $P = 0.104$ and $P = 0.156$, respectively. RDW in 30-day mortality patients was not significantly different at 1 h and 24 h, P-value $= 0.875$. The means ISS in 24 h, 30-day mortality and survivors was significantly different, $P < 0.001$.

Conclusion: Our study does not report a significant increase in RDW among 24 h and 30-day mortality and survivor patients. ISS was significantly different among the two groups.

Keywords: injury severity score (ISS), mortality, RDW, trauma

Introduction

Trauma is one of the leading causes of death, particularly in patients below 65 years of age, and referral to the emergency department[1]. While modern strategies for trauma management have made significant strides in reducing mortality, morbidity, and disability, the quest for novel tools to assess trauma severity and predict patient outcomes remains an ever-urgent[2].

The complexity of trauma-related pathophysiological processes, as well as the existence of established scoring systems, including the widely recognized injury severity score (ISS), underscores the need for a thorough exploration of novel parameters such as red blood cell distribution width (RDW).

HIGHLIGHTS

- Severity of trauma to provide timely and treatment and predict the prognosis in trauma management.
- Increased red blood cell distribution width is associated with several pathologies and associated mortality.
- Does not report significant increase in red blood cell distribution width among 24 h and 30-day mortality and survivor patients.
- Injury severity score was significantly different among the two groups.

In this context, RDW, a metric extracted from a standard complete blood count, presents itself as a promising area for investigation. This cost-effective laboratory test reveals variations in the sizes of red blood cells within the bloodstream and offers valuable insights into the patient's physiological status.

Notably, RDW has been linked to inflammation, oxidative stress, and alterations in atrial filling pressure. Inflammation increases RDW by inhibiting erythropoiesis reducing erythropoietin production and increasing the release of immature red blood cells. On the other hand, oxidative stress reduces RDW by reducing the half-life of red blood cells and releasing immature red blood cells. Inadequate blood flow increases RBC production and RDW through the renin-angiotensin-aldosterone and sympathetic nervous systems. Furthermore, inadequate blood flow to the artery is associated with inflammatory and infectious diseases and malignancies and chronic and acute diseases and can act as a predictor of mortality[3,4]. RDW has also garnered attention as the marker in several diseases such as stroke, atherosclerosis,

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Table 1

Descriptive statistics related to demographic information

Variable	Count	Mean	Standard error of mean
ISS	300	56	1
rdw1	300	6.96	0.04
rdw24	300	7.04	0.05
D_rdw	300	0.08	0.05

cerebral embolism[5], severe acute pancreatitis[6], and anemia[7]. In this context, RDW's utility in early diagnostic assessments of trauma patients and its potential impact on patient outcomes become subjects of inquiry[8,9]. This study aims to evaluate the role of RDW in predicting 24 h and 30-day mortality among multiple trauma patients referred to the emergency department, shedding light on its place within the broader landscape of trauma assessment and management.

Methods

In this retrospective study, adult trauma patients aged ≥ 18 years referred to the emergency departments of Shohada Ashayer Hospital and Shahid Chamran Hospital, Khorramabad, Iran, within 1 h of the trauma with ISS ≤ 16 were included. Our sample size included all the patients who met inclusion criteria during the study period. Patients who died before the referral to the hospital or were referred after 1 hour of the trauma, and those with blood and cardiopulmonary disorders were excluded from the study.

Multiple trauma patients were triaged based on the nature and the extent of the injury. Advanced trauma life support (ATLS) protocols were used to treat all the patients, initially. The blood samples of all the patients were collected for complete blood count and RBW (reference range: 11.3–15.6%) analysis at the time of referral and 24 h after their referral. Trained surgical residents collected data regarding sex, gender, ISS, mortality status, and results from the biochemical analysis.

Statistical analysis

Statistical indicators such as relative frequency, mean, and SD were used to describe RDW in the first-hour and 24 h, ISS, mortality of adults with severe bleeding, age, and sex. Analysis of variance (ANOVA) was used to evaluate the relationship between RDW (first and 24 h and their difference) and ISS with 30-day mortality. Statistical calculations were performed using SPSS version 24. The significance level was considered 0.05.

Table 2

Mean and SD of red blood cell distribution width at different hours

Sex

	Frequency (Percent)	Valid percent	Cumulative percent
Valid			
Male	231 (76.7)	77.0	77.0
Female	69 (22.9)	23.0	100.0
Total	300 (99.7)	100.0	
Missing			
System	1 (0.3)		
Total	301 (100.0)		

Table 3

Mortality rates at different times

Died

	Frequency (Percent)	Valid percent	Cumulative percent
Valid			
In 24 h	52 (17.3)	17.3	17.3
In 30 days	85 (28.2)	28.3	45.7
No	163 (54.2)	54.3	100.0
Total	300 (99.7)	100.0	
Missing			
System	1 (0.3)		
Total	301 (100.0)		

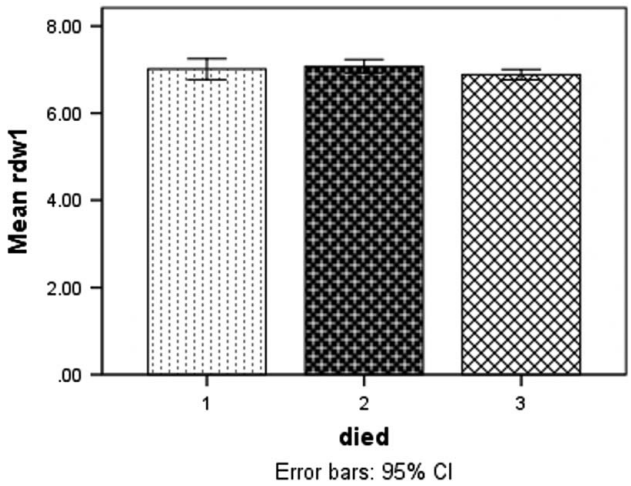

Figure 1. Evaluation of the relationship between RDW in the first-hour blood sample, with 30-day mortality.

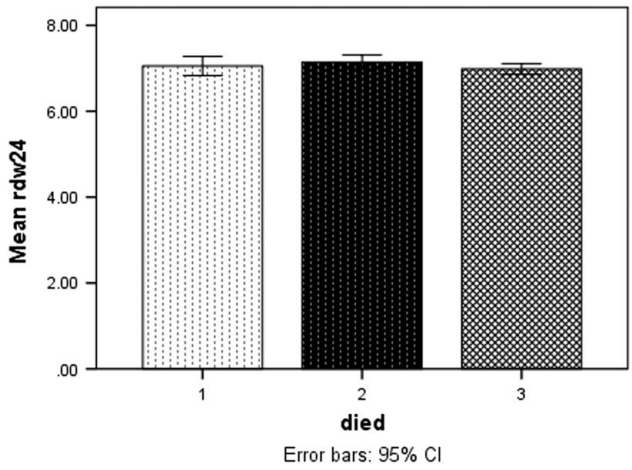

Figure 2. Evaluation of the relationship between RDW in a 24 h blood sample and 30-day mortality.

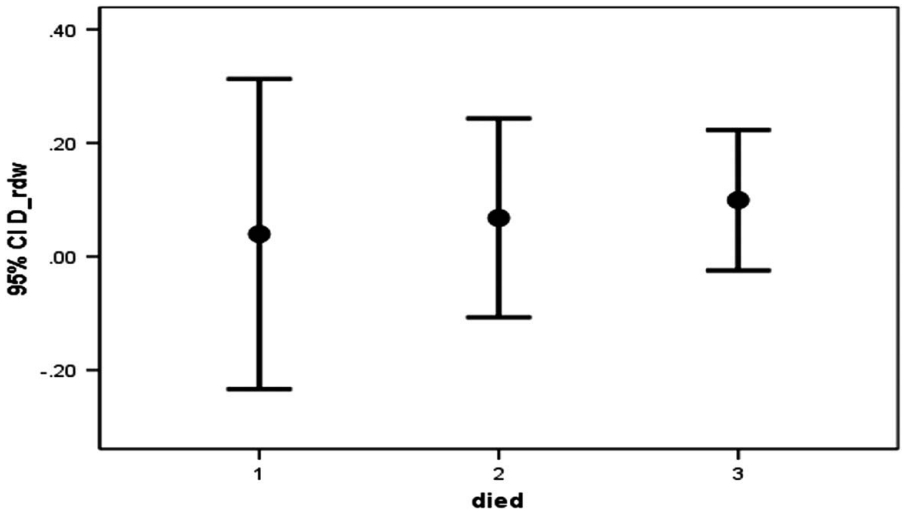

Figure 3. Evaluation of the relationship between RDW difference (DRDW) in first- and 24 h blood samples with 30-day mortality.

This study was approved by the Research Ethics Board of Lorestan University of Medical Sciences (IR.LUMS.REC.1399.072).

The work has been reported in line with the strengthening the reporting of cohort, cross-sectional, and case–control studies in Surgery (STROCSS) criteria[10].

Results

Of 300 patients included in the study, 231)76.7%) were male and 69 (22.9%) were female. The mean age of all the patients included in the study was 40.5 years (Table 1).

There were 52 patients (17.3%) with mortality in the first 24 h and 85 patients (28.2%) with 30-day mortality (Table 2).

The mean RDW among patients who died in the first 24 h was 7.01 ± 0.86% and that in patients who died within 30 days was 7.08 ± 0.72% (Table 3).

The mean RDW among survivors was 6.89 ± 0.77%. The RDW among the 1 h RDW and 30-day mortality groups were not significantly different ($P = 0.104$) (Fig. 1).

The mean and SD of RDW in the 24 h blood sample were reported by mortality (24 h, 30 days, and without mortality). The results showed that there was no significant relationship between RDW in a 24 h blood sample and 30-day mortality (P-value = 0.156) (Fig. 2).

The mean and SD of the RDW difference in the blood samples of the first and 24 h, by mortality (24 h, 30 days and without mortality) were reported. The results showed that there was no significant relationship between RDW in 1 h and 24 h blood samples and 30-day mortality (P-value = 0.875) (Fig. 3).

The means ISS in 24 h, 30 days mortality and survivors were 67 ± 1.00, 63 ± 1.00, and 49 ± 1.00, respectively. The ISS was significantly related to 30 days mortality $P < 0.001$ (Table 4).

Discussion

In this study, 1 h and 24 h RDW percentage was not associated with 24 h and 30 days mortality among trauma patients, respectively. However, increased ISS was positively correlated with 30 days mortality.

Majercik, Fox[11,12] evaluated the incidence of 30-day and 1-year mortality among adult trauma patients based on RDW. The results of the study showed that reduced RDW percent is a significant predictor of 30-day mortality in males only and 1-year mortality in both, males and females. Zhang and Zhao[13] conducted a study on 122 patients presented with traumatic brain injury to evaluate RDW as a predictor of mortality. The study showed a significant increase in RDW in nonsurvival groups. The cut-off value of RDW as a predictor of mortality was reported to be greater than 12.85%. The mean of RDW in the patients included in the study who died within 24 h and 30 days was 7.01 and 7.08%, respectively. We did not show any significant differences in RDW among patients who died and survivors. Our mean was lesser than the cut-off presented in the study by Zhang *et al*. and Şenol, Saylam[6]. A recent study by Lorente, Martín[14] showed similar findings among traumatic brain injury patients. Kong, Park[15] also reported that increased RDW can predict 1-day, 2-day, and 28-day mortality among trauma patients. Furthermore, serial increase in RDW increases the risk of 28-day mortality. Sadaka, Doctors[16] showed that RDW might not be a significant predictor of 1-day mortality. Our findings are in parallel with does presented in this study. Habibpour, Torabi[17]

Table 4

Evaluation of the relationship between ISS in the first-hour blood sample with 30-day mortality

ANOVA

ISS

	Sum of squares	df	Mean square	F	Sig.
Between groups	5492.189	1	5492.189	35.838	0.000
Within groups	45 668.728	298	153.251		
Total	51 160.917	299			

study also concluded that RDW might not be a significant predictor of mortality in trauma patients whereas, the ISS scoring system is better in predicting the mortality in these patients. These outcomes are also similar to our study.

The results of our study are not stratified based on demographic factors and other hematological parameters. Future studies could benefit from additional biochemical parameters that can predict the severity of injury in trauma patients. Additionally, we suggest that several pathological conditions can affect RDW value, which should also be evaluated in trauma patients. Type of trauma, location and mechanism can also add to discrepancies in the findings, which is recommended to be evaluated or adjusted in future studies.

Conclusion

The study concludes that RDW, at 1 h and 24 h intervals, does not appear to be a significant predictor of mortality in trauma patients. However, ISS is found to be a more reliable predictor of mortality in this patient population.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional Lorestan University of Medical Sciences (IR.LUMS.REC.1399.080) research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from the patient for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

Dr M.K.S. and Dr H.P.: conceptualized, designed the study, drafted the initial manuscript, reviewed, and revised the manuscript; Dr P.K.F. and Dr. M.B.: designed the data collection instruments, collected data, carried out the initial analyses, reviewed, and revised the manuscript; Dr M.S.: coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

Conflicts of interest disclosures

The authors deny any conflict of interest in any terms or by any means during the study.

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researchregistry8635. This study was approved by the Research Ethics Board of Lorestan University of Medical Sciences (IR.LUMS.REC.1399.080). https://ethics.research.ac.ir/ProposalCertificateEn.php?id=140021&Print=true&NoPrintHeader=true&NoPrintFooter=true&NoPrintPageBorder=true&LetterPrint=true.

Guarantor

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Availability of data and materials

All relevant data and materials are provided within manuscript.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Human and Animal Rights

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.
Approval of the research protocol: N/A.

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