



The Value of Red Cell Distribution Width (RDW) and Trauma-Associated Severe Hemorrhage (TASH) in Predicting Hospital Mortality in Multiple Trauma Patients

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ABSTRACT

Objective: To investigate the role of red cell distribution width (RDW) in comparison with Trauma-Associated Severe Hemorrhage (TASH) system in predicting the mortality of multiple trauma patients, referred to the hospital emergency department.

Methods: This follow-up study was conducted on multiple trauma patients (age ≥ 18 years) with Injury Severity Scores (ISS) of ≥ 16 , who were referred to the emergency department from March 1, 2017, to December 1, 2017. First, all patients were evaluated based on the Advanced Trauma Life Support (ATLS) guidelines, and then, their blood samples were sent for RDW measurements at baseline and 24 hours after admission. The ISS, Revised Trauma Score (RTS), and TASH were measured in the follow-ups and recorded by third-year emergency medicine residents. Hospital mortality was considered as the outcome of the study.

Results: In this study, 200 out of 535 multiple trauma patients were recruited. The frequency of hospital mortality was 19 (9.5%). In the univariate analysis, there was no significant relationship between hospital mortality and RDW at baseline, RDW on the first day, and Δ RDW (RDW at baseline - RDW on the first day), unlike ISS, RTS, TASH ($p=0.97$, $p=0.28$, and $p=0.24$, respectively). On the other hand, in the multivariate analysis, ISS, RTS, and TASH showed a significant relationship with hospital mortality. The greatest area under the ROC curve (AUC) was attributed to TASH and RTS systems (0.94 and 0.93, respectively).

Conclusion: TASH scoring system, which was mainly designed to predict the need for massive transfusion, may be of prognostic value for hospital mortality in multiple trauma patients, similar to ISS and RTS scoring systems.

Keywords: Multiple trauma; Red cell distribution width (RDW); Hospital mortality.

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Introduction

According to statistics, 10 000 people die every day due to severe traumatic injuries worldwide.

Based on global reports, 20% of patients with multiple traumas die within two to three hours after the injury, while 40% die within 48 hours. Therefore, rapid diagnosis of these patients with

proper diagnostic modalities can increase their survival and reduce mortality [1, 2]. Red cell distribution width (RDW) laboratory test is one of the components of the complete blood count (CBC), expressing different sizes of red blood cells (RBC) during circulation. This cost-effective test is indicative of inflammation, oxidative stress, and arterial underfilling in severe cases. Inflammation is known to increase RDW by inhibiting erythropoiesis and reducing erythropoietin production by releasing immature RBC. On the other hand, oxidative stress reduces RDW by decreasing the survival of RBC and releasing immature RBC into the bloodstream. Arterial underfilling improves RBC production and eventually increases RDW through activation of the renin-angiotensin-aldosterone system, as well as the sympathetic nervous system. In fact, increased arterial underfilling has been observed in inflammatory and infectious processes, malignancies, and acute/chronic diseases; therefore, it can act as a predictive factor for mortality. Therefore, RDW is an independent predictor of mortality in patients with infection and inflammation process [3-8]. In the primary diagnostic assessment of traumatic patients, RDW and its changes may be useful as a univariate system and can play a predictive role in determining the outcomes of patients [3, 9]. Nevertheless, considering the scarcity of studies on multiple trauma patients, the role of RDW in determining the prognosis of these patients remains unknown.

In contrast, there are several scoring systems, including Trauma-Associated Severe Hemorrhage (TASH) system, which consists of the following parameters: hemoglobin level, positive FAST for intraabdominal fluid, base excess, heart rate, gender (male), clinically unstable pelvic fracture, and severe femoral fracture [10, 11]. This system is used to assess the need for blood transfusion in trauma patients. However, its prognostic role in determining the mortality of multiple trauma patients is still ambiguous and unclear. The purpose of this study was to investigate the role of RDW and TASH in determining the hospital mortality of multiple trauma patients, referred to the emergency department, in order to reduce the rate of the hospital mortality in severe cases through rapid diagnosis.

Materials and Methods

Study Population

This follow-up study was conducted on multiple trauma patients (age ≥ 18 years) with Injury Severity Scores (ISS) of ≥ 16 , who were referred to the emergency department of Bahaonar Hospital (a level II trauma center) in Kerman, Southeast of Iran from March 1, 2017, to December 1, 2017. The exclusion criteria were as follows: ISS <16 ; age <18 years; death under 24 hours; delayed hospital admission (more than one hour); receiving

blood units before hospital admission; pregnancy; history of anemia; non-hemorrhagic shocks; blood malignancies; and autoimmune diseases. Finally, in the follow-ups, hospital mortality was evaluated as the outcome of the study. This study was designed based on the Declaration of Helsinki guidelines in 1975, which were revised in 1989 in Hong Kong. It was also approved by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1396.1336). Oral consents were obtained from the patients before inclusion in the study.

Study Protocol

All patients, who were referred to the emergency department, were triaged by nurses. The triage level I and level II patients were transferred to the resuscitation room and visited by third-year emergency medicine resident. The patients were first assessed based on the Advanced Trauma Life Support (ATLS) guidelines, and then, their blood samples were sent for CBC measurements, including RDW (Sysmex KX-21N, Automated Hematology Analyzer, Japan). After 24 hours, blood samples were sent again to the laboratory to measure RDW. The third-year emergency medicine residents completed the prepared questionnaires for the patients, and variables, including age, gender, ISS, Revised Trauma Score (RTS), and TASH, were calculated and recorded.

Statistical Analysis

Mean \pm SD values were measured for quantitative variables, while frequency percentages were estimated for qualitative variables. The odds ratio (OR) and 95% confidence interval (CI) were calculated as measures of association. First, a univariate analysis was carried out, and then, for variables with $p<0.25$, multivariate analysis was performed by the backward conditional method using a logistic regression model to determine significant relationships ($p<0.05$) [12]. Finally, for variables with a significant relationship with the disease outcome, the ROC curve was plotted. Statistical analysis was performed using SPSS version 20.

Results

Of 535 multiple trauma patients, referred to the emergency department, 335 were excluded and 200 were enrolled (Figure 1). The hospital mortality rate was estimated at 19 (9.5%). In total, 161 (80.5%) men and 39 (19.5%) women were recruited for the study (Table 1). In the univariate analysis, there was no significant relationship between hospital mortality and RDW at baseline, RDW on the first day, and Δ RDW (RDW at baseline - RDW on the first day) ($p=0.97$, $p=0.28$, and $p=0.24$, respectively). On the other hand, hospital mortality showed a significant relationship with TASH score ($p<0.0001$). RTS and ISS scoring systems also had a significant relationship

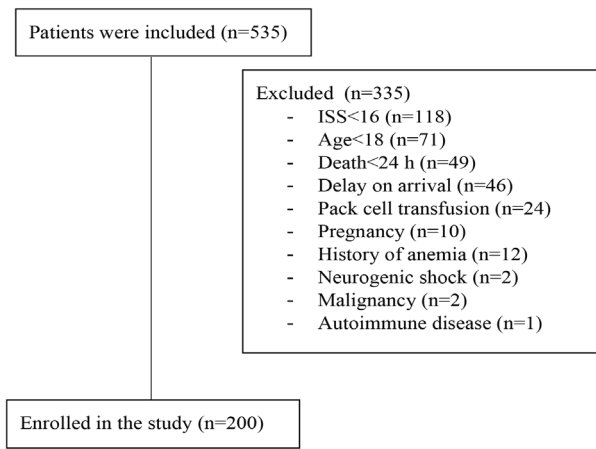


Fig. 1. Flow chart showing enrollment of patients

with hospital mortality ($p < 0.0001$) (Table 2).

Variables with $p < 0.25$ were integrated into the multivariate analysis. Finally, variables including Δ RDW, ISS, RTS, and TASH remained in the model. Based on the backward conditional method, ISS, RTS, and TASH had a significant relationship with hospital mortality (Table 3). For variables with a significant relationship with hospital mortality, the

Table 1. Baseline characteristics for multiple trauma patients.

Variables	N(%)
Age (years), mean \pm SD	33.05 \pm 13.28
Gender	
Male	161 (80.5)
Female	39 (19.5)
RDW ^a on arrival, mean \pm SD	13.83 \pm 1.40
RDW after 24 hours, mean \pm SD	14.20 \pm 1.71
ISS ^b , mean \pm SD	39.34 \pm 11.70
RTS ^c , mean \pm SD	5.92 \pm 1.78
TASH ^d , mean \pm SD	7.54 \pm 5.85
Hospital mortality	19 (9.5)

^aRDW: Red cell distribution width; ^bISS: Injury Severity Score; ^cRTS, Revised Trauma Score; ^dTASH Trauma-Associated Severe Hemorrhage

ROC curve was plotted, and the area under the ROC curve (AUC) was calculated. The greatest AUC was attributed to TASH and RTS scoring systems (0.94 and 0.93, respectively) (Figure 2).

Discussion

In this study, performed on multiple trauma patients

Table 2. Associations with hospital mortality using univariate regression analysis.

Variables	Mortality (mean \pm SD)			
	Yes	No	OR(95% CI)	p value
RDW on arrival	14.05 \pm 1.39	13.83 \pm 1.42	1.00 (0.71-1.40)	0.97
RDW after 24 hours	14.70 \pm 1.87	14.16 \pm 1.69	1.16 (0.90-1.49)	0.28
Δ RDW	0.64 \pm 1.77	0.32 \pm 1.06	1.25 (0.82-1.90)	0.24
ISS	52.93 \pm 9.17	37.66 \pm 10.56	1.15 (1.09-1.22)	<0.0001
RTS	3.39 \pm 1.13	6.22 \pm 1.56	0.18 (0.09-0.37)	<0.0001
TASH	16.93 \pm 3.82	6.52 \pm 5.07	1.42 (1.24-1.63)	<0.0001

Table 3. Associations with hospital mortality using multivariate regression analysis.

Variables	OR(95% CI)	Variables	OR(95% CI)
TASH	1.80(1.16-2.04)	0.01	0.94
RTS	0.07(0.01-0.48)	0.007	0.93
ISS	1.19(1.01-1.42)	0.03	0.88

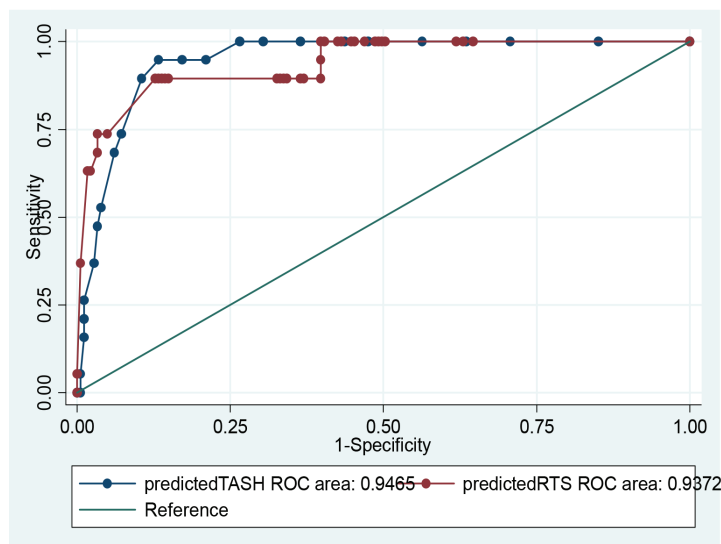


Fig. 2. Receiver operating characteristic curve for TASH and RTS predicting hospital mortality.

referred to the emergency department, the role of RDW and its changes in the prediction of hospital mortality was not significant. However, a predictive system, such as TASH, could be more effective in predicting hospital mortality. The previous studies on patients with chronic diseases show that RDW can play a prognostic role and predict hospital mortality; in fact, its prognostic value is similar to that of lactate and other predictive systems. The increase in RDW has been linked to physiological mechanisms, including oxidative stress, inflammation, and damage to organs, including cardiovascular and pulmonary damages [13-18]. These studies have also shown that assessment of RDW in conjunction with other scoring systems can have a higher prognostic value in predicting the mortality of patients with trauma [19, 20]. On the other hand, in some controversial studies, its predictive role in-hospital mortality has been questioned; even serial serum RDW measurements have been shown to have no significant association with hospital morbidity; these findings suggest contradictions concerning the prognostic role of RDW [21-23]. Our findings also revealed that RDW at baseline, RDW on the first day, and even RDW changes could not predict the mortality of trauma patients, and the role of this parameter was questioned.

In trauma patients, the injury is classified using different scoring systems, such as ISS and RTS, which are correlated with the survival of patients [24, 25]. Besides, there are systems to determine and predict the need for blood transfusion in the early stages of severe trauma. These systems, by integrating several variables, can reduce the mortality of patients through the rapid diagnosis of hemorrhage. In various studies, the important role of these scoring systems in determining the need for blood transfusion has been established. However, these systems do not have any specific or reliable application in classifying trauma severity, and to the best of our knowledge, there are no studies on the role of these systems in predicting the mortality of trauma patients. TASH scoring system is a simple predictive system, including seven independent laboratory and clinical parameters [26-30]; in fact, it seems to be preferable to simple univariate models. Optimal models must trade accuracy with simplicity. Complex and accurate scores such as TASH may

be useful for resource benchmarking but become cumbersome when applied clinically. Simple models such as RDW are of greater benefit in resource-poor environments, can be readily calculated, can function as stratifying tools and can be incorporated into guidelines in hospitals with limited expertise in receiving injured patients [29]. Our study showed that in patients with multiple traumas, TASH scoring system (prognostic system) had significant relationships with hospital mortality while this relationship was not significant with RDW.

The prognostic role of the anatomical ISS system and physiological RTS system has been well established; these systems are helpful in determining the prognosis of trauma patients [31, 32]. In a study by Kuhls *et al.*, [33] the predictive value of physiological systems was found to be equivalent to anatomical systems in determining the mortality of trauma patients. In addition, Akbari *et al.*, [34] concluded that the prognostic value of ISS scoring system was higher than that of the RTS system in determining mortality. Our study showed that both systems had prognostic significance in multiple trauma patients, although the sensitivity and specificity of the RTS system were higher than the ISS system.

One of the limitations of this study is its single-center design. Also, all the tests were carried out in one single hospital laboratory. Since our hospital is a referral center, patients who were referred to the delay or had already received cell units, were excluded from the study. Similarly, trauma patients below 18 years of age, patients with ISS < 16, and pregnant women were eliminated from the study. In addition, measurement of RDW-standard deviation (RDW-SD) was not possible, and the cause of mortality was not established (it was not determined whether the cause of mortality was trauma or other conditions).

TASH scoring system, which was mainly designed to predict the need for massive transfusion, may be of prognostic value for hospital mortality in multiple trauma patients, similar to ISS and RTS systems. These systems, in comparison with RDW as a univariate model, can have significant prognostic values for multiple trauma patients. However, further studies with a larger sample size are recommended in this area.

Conflicts of Interest: None declared.

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