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The Predictive Role of Red Cell Distribution Width (RDW) in Blood Transfusion in Multiple Trauma. Is It True?

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Abstract

Background: To reduce mortality in patients with multiple-trauma, rapid diagnosis for blood transfusion is of great importance.
Objectives: The current study aimed at investigating the predictive role of red cell distribution width (RDW) in comparison with other multivariate systems to determine the need for blood transfusions in patients with trauma referred to hospital.
Methods: The follow-up study was conducted on patients with multiple-trauma aged $\geq$ 18 years with the injury severity score (ISS) $\geq$ 16 referred to the emergency department within the nine months of the study period. All patients were evaluated based on the ATLS (the advanced trauma life support) guideline; then, blood samples were taken at arrival and 24 hours later to measure RDW. According to the questionnaire, age, gender, ISS, RTS (the revised trauma score), and TASH (the trauma-associated severe hemorrhage) score were also recorded by a senior emergency medicine resident.
Results: Finally, 200 patients were enrolled in the study, of which 87 patients (43.5%) received the blood transfusion. In the univariate analysis, there was a significant association between the first-day RDW, Δ RDW (RDW on arrival - the first-day RDW), ISS, RTS, and TASH score, and blood transfusion. However, in the multivariate analysis, only TASH had a significant relationship with the need for blood transfusion ($P < 0.0001$).
Conclusions: In multiple trauma patients, rapid diagnosis of hemorrhage and the need for blood transfusion is crucial. Monitoring the patients based on the RDW test is not helpful to predict the need for blood transfusion. Multivariate systems such as TASH score are more valuable to determine the need for blood transfusion.

Keywords: Blood Transfusion, Multiple Trauma, Red Cell Distribution Width, Hospital Mortality

1. Background

Bleeding is a major cause of mortality in multiple trauma patients. It is tried to induce normal blood pressure in such patients with the administration of crystalloid and packed cell transfusion to prevent lethal triad caused by trauma (1). For the rapid diagnosis of hemorrhage and subsequently making a decision for blood transfusion in trauma patients, traditional vital signs have some limitations. For this purpose, multifactorial scoring systems are developed (2). Trauma-associated severe hemorrhage (TASH) score is one of these systems including focused assessment with sonography for trauma (FAST), hemoglobin, base excess, heart rate, male gender, unstable pelvic fracture, and severe femoral fracture (3, 4). This system, in spite of simplicity, may have not high accuracy in all traumatic patients. For example, the impact of aging on these systems can reduce their reliability (2, 5).

Red cell distribution width (RDW) is one of the complete blood count (CBC) components that indicate different sizes of red blood cells in the circulation. This factor can have a predictive role in critically ill patients. It can also indicate high-risk conditions in the referring patients with bleeding (6). By increasing RDW, the rate of hospital mortality increases in critically ill patients (6, 7). In addition to the RDW on admission, Δ RDW may also be helpful to predict hospital mortality in patients (8). Although the exact cause and poor outcome of this increase is not clear (6), it may be due to the increase of red blood cells proliferation under inflammation, oxidative stress, and arterial underfilling conditions in critically ill patients (9, 10). Therefore, given the precisely prognostic role of this test in critically ill patients, it may be helpful to determine the need for blood transfusion in multiple trauma patients.

2. Objectives

The current study aimed at investigating the predictive role of RDW to determine the need for blood transfusions in multiple trauma patients referring to hospital.

3. Methods

The current follow-up study was conducted on patients with multiple trauma ≥ 18 years with injury severity scores (ISS) ≥ 16 referred to Bahonar Academic Hospital, level II trauma center, in southeastern Iran from 01 March 2017 to 01 December 2017. All of the patients referred to the emergency department were first triaged by a nurse. Patients with triage levels 1 and 2 were transferred to the resuscitation room. Then, the patients were visited by a senior emergency medicine resident. The patients were first evaluated based on ATLS guidelines, and then their blood samples were sent to the laboratory to measure CBC including RDW (SYSMEX KX-21N Automated Hematology Analyzer, Japan). After 24 hours, another blood sample was sent to the laboratory to measure RDW. A researcher-made questionnaire including variables such as age, gender, ISS, RTS, and TASH was completed for each patient by the senior emergency medicine resident. Patients with ISS < 16, age < 18 years, or expired under 24 hours of admission, patients with delayed referral after one hour, those who had received packed red blood cells before entering the hospital, pregnant females, patients with the history of anemia, non-hemorrhagic shock, blood malignancies, or autoimmune diseases were excluded from the current study. At the end of follow-up, the need for blood transfusion was investigated as an outcome and the result was recorded for each patient.

For quantitative variables, mean ± SD, and for qualitative variables, the frequency percentage was used. To express the severity of association among the variables, 95% confidence interval (CI) and odds ratio (OR) were used. First, a univariate analysis was used. Then, for variables with P < 0.25, multivariate analysis using the logistic regression model was applied to find significant relationships (P < 0.05) (11). Finally, a ROC curve was plotted for the variables that had a significant relationship with the outcomes of the disease. Data analysis was performed with SPSS version 20.

The study was approved by the Ethics Committee of Kerman University of Medical Sciences [IR.KMU.REC.1396.2086]. Oral consent was taken from all patients for participation in the study.

4. Results

Of the 585 patients with multiple-trauma referred to the emergency department, 385 were excluded and 200 were enrolled (Figure 1). The hospital mortality rate was 19 (9.5%). A total of 87 patients (43.5%) received the blood transfusion. Of the 161 males, 69 (42.9%) subjects and of the 39 females, 18 (46.2%) subjects received the blood transfusion (Table 1). In the univariate regression analysis, there was no significant relationship between RDW on arrival and the need for blood transfusion (P = 0.58), while this relationship was significant with the first-day RDW and Δ RDW (RDW on arrival-RDW on the first-day) (P = 0.02 and P = 0.01, respectively). The relationship between blood transfusion and ISS, RTS, and TASH score was significant (Table 2). In the multivariate regression analysis by the backward conditional method, the only variable of TASH score remained in the final model (P < 0.0001), which had a significant relationship with the need for blood transfusion (Table 3). For the TASH score that had a significant relationship with the prediction of blood transfusion, the ROC curve was plotted, the area under curve (AUC) for this scoring system was 0.93 (Figure 2).

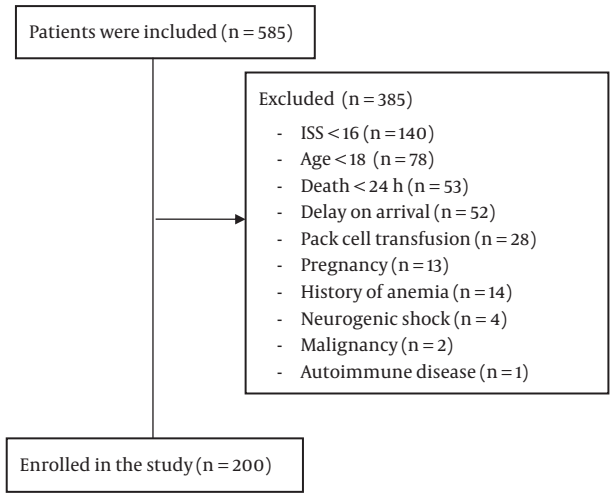

Figure 1. Flow chart showing enrollment of patients

5. Discussion

In the current study performed on patients with multiple-trauma referred to the emergency department, it was found that RDW on arrival, RDW on the first-day, and Δ RDW cannot help with the prediction of the need for blood transfusion in such patients. It seems that TASH scoring

Table 1. Baseline Characteristics

Variables	Value[a]
Age, y	37.59 ± 18.59
Gender	
Male	161 (80.5)
Female	39 (19.5)
RDW on arrival	13.83 ± 1.40
RDW after 24 hours	14.20 ± 1.71
△ RDW	0.35 ± 1.13
ISS	39.34 ± 11.70
RTS	5.92 ± 1.78
TASH	7.54 ± 5.85
Blood transfusion	87 (43.5)

Abbreviations: ISS, injury severity score; RDW, red cell distribution width; RTS, revised trauma score; TASH, trauma-associated severe hemorrhage.
[a] Values are expressed as mean ± SD or No. (%).

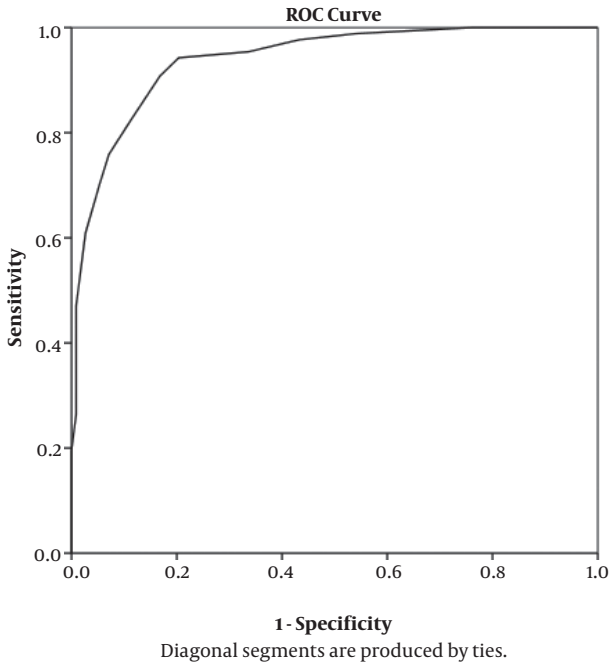

Figure 2. Receiver operating characteristic curve for TASH predicting blood transfusion

system can play a pivotal role in predicting the need for blood transfusion in multiple trauma patients.

Many studies are performed on the role of RDW in predicting mortality in critically ill patients, and their results show that the increase in this factor in many diseases can play an alarming role for the physician. In such patients, due to stressful and inflammatory conditions, the production of red blood cells is increased, which subsequently increases their size differences and creates anisocytosis. RDW increase in critically ill patients indicates severe inflammation and high stress, and finally increased the rate of mortality (9, 10). Therefore, in many diseases, this laboratory test can be used as a prognostic factor for mortality (12-18). In some studies, the prognostic role of this test in delayed referrals was also reported positive (19). Some studies showed that adding RDW to other predictive systems can improve their sensitivity and specificity (7, 20). In addition to many studies highlighting the predictive role of RDW in patients' mortality, according to our knowledge, one limited study is conducted on the role of RDW to determine the need for blood transfusion in trauma patients (21). RDW is a simple laboratory test and a component of CBC can be easily deployed in emergency departments. In traumatic patients, the delay in this test and its changes compared with the arrival values may predict the need for blood transfusion. This test, in spite of simplicity, is rapid, which doubles its value in multiple trauma patients. Of course, there are other available tests, such as lactate and BD, but they may not be able to predict the need for blood transfusion within the first 24 hours of admission to hospitals (7, 22). In the current study, although in the univariate model, the first-day RDW and its changes, unlike RDW on arrival, was helpful to predict the need for blood transfusion in patients with multiple-trauma, it was not statistically significant in the multivariate model. We have expected that RDW has been increased for multifactorial causes in patients who needed the blood transfusion, but our study did not confirm this. Paulus et al. showed that RDW could be a novel predictor of massive transfusion after injury (21). Our study surveyed the role of RDW for the need to blood transfusion, not for massive transfusion. It seems that the patients in that study had critically situations more than our study. The role of RDW in need of blood transfusion can not helpful in multiple trauma patients, but it may predict massive transfusion due to major bleeding.

Several systems are defined to determine and predict the need for blood transfusion. These systems include several parameters that can reduce mortality with rapid diagnosis of hemorrhage and the need for blood transfusion. TASH score is a predictive system for the need for blood transfusion, which includes seven laboratory and clinical parameters (2, 3, 23). In different studies, the role of this scoring system was well understood, and the current study also confirmed previous results.

The ISS and RTS systems are known as prognostic systems anatomically and physiologically used to assess traumatic patients (24, 25), but their roles to determine the

Table 2. Associations with Predicting Blood Transfusion Using Univariate Regression Analysis

Variables	Mortality (Mean ± SD)		OR (95% CI)	P Value
	Yes	No		
RDW on arrival	13.94 ± 1.32	13.79 ± 1.48	1.05 (0.86 - 1.28)	0.58
RDW after 24 hours	14.55 ± 1.89	13.94 ± 1.52	1.24 (1.03 - 1.50)	0.02
Δ RDW	0.61 ± 1.53	0.15 ± 0.66	1.54 (1.11 - 2.15)	0.01
ISS	42.78 ± 11.53	35.93 ± 10.06	1.06 (1.03 - 1.09)	< 0.0001
RTS	5.37 ± 1.86	6.46 ± 1.43	0.65 (0.55 - 0.78)	< 0.0001
TASH	12.16 ± 4.99	3.76 ± 2.87	1.71 (1.48 - 1.98)	< 0.0001

Table 3. Associations with Predicting Blood Transfusion Using Mutivariate Regression Analysis

Variable	OR (95% CI)	P Value	ROC Curve
TASH	1.72 (1.47 - 2.01)	< 0.0001	0.93

need for blood transfusion in patients with trauma are not clearly known. According to the current study findings, ISS and RTS cannot play a prognostic role to determine the need for blood transfusion in patients with trauma. It seems that these systems, along with the TASH scoring system have a diminutive role in this regard.

One of the limitations of the study was its single-centered design. Traumatic patients aged < 18 years with ISS < 16 as well as pregnant subjects were excluded from the study. Due to the fact that the understudy hospital was a referral center, patients that were referred from other hospitals with the delay or received a packed cell before arrival were excluded. All the laboratory tests were performed by a laboratory located in the hospital that was not equipped for RDW-SD measurement.

5.1. Conclusions

It is very important to rapidly diagnose hemorrhage and determine the need for blood transfusion in trauma patients. Monitoring patients based on the RDW test is not helpful to predict the need for blood transfusion. Multivariate systems such as TASH score seem more valuable to determine the need for blood transfusion.

Footnotes

Authors' Contribution: Mehdi Torabi: Design of research, research implementation, preparation of initial drafting, review and editing the manuscript; Sedigheh Afshari: Design of research, data collection and research implementation; Moghadameh Mirzaee: Design of research, research implementation and data analysis.

Conflict of Interests: None declared.

Ethical Considerations: The study was approved by the Ethics Committee of Kerman University of Medical Sciences [IR.KMU.REC.1396.2086].

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Patient Consent: Oral consent was taken from all patients for participation in the study.

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