

Original Article: Association of Hematologic Findings with the Final Outcome of Patients with Abdominal Trauma

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ABSTRACT

Background: Abdominal trauma is a leading cause of morbidity and mortality worldwide. Hematologic parameters, including hemoglobin, white blood cell count (WBC), platelet count, prothrombin time (PT), activated partial thromboplastin time (aPTT), and C-reactive protein (CRP), have been shown to correlate with clinical outcomes in trauma patients. This study aims to evaluate the relationship between hematologic findings and clinical outcomes in patients with abdominal trauma, including complications, mortality, and length of hospital stay.

Methods: A descriptive cross-sectional study was conducted at Imam Reza Hospital, Tabriz, with 120 patients diagnosed with abdominal trauma. Blood samples were collected upon admission, and various hematologic parameters were assessed. Patients were grouped according to their clinical outcomes, including mortality, complications (such as infections, organ failure, and need for surgical intervention), and length of hospital stay. Statistical analysis was performed to evaluate the association between hematologic parameters and outcomes.

Results: Lower hemoglobin levels, elevated WBC counts, prolonged PT and aPTT, and high CRP levels were significantly associated with worse clinical outcomes, including increased complications, longer hospital stays, and higher mortality rates. The mean hemoglobin was lower in the complication group (10.2 g/dL) compared to the non-complication group (12.5 g/dL). The WBC count, platelet count, and CRP levels were also significantly higher in the complication group. Elevated PT and aPTT were associated with the need for surgical interventions and prolonged hospital stays.

Conclusion: Hematologic markers, including hemoglobin, WBC count, platelet count, PT, aPTT, and CRP, play a critical role in predicting clinical outcomes in patients with abdominal trauma. These parameters can be used for early risk stratification, guiding clinical decisions and improving patient management. Early identification of abnormal hematologic values can lead to timely interventions, improving the prognosis of trauma patients.

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Introduction

Abdominal trauma represents a significant cause of morbidity and mortality worldwide, with the potential to cause life-threatening injuries to vital organs, including the liver, spleen, kidneys, and intestines [1].

These injuries often lead to a range of complications, including hemorrhage, peritonitis, sepsis, and organ failure, making the management of such cases complex and critical. Prompt and accurate assessment of the severity of abdominal trauma is essential for guiding therapeutic decisions and improving patient outcomes. Among the various diagnostic tools used in the management of abdominal trauma, hematologic findings play a crucial role in evaluating the patient's condition, monitoring disease progression, and predicting the outcomes [2].

Hematologic parameters, such as complete blood count (CBC), coagulation profiles, and markers of inflammation, provide valuable insight into the physiological response to trauma [3-5]. Changes in these parameters are often reflective of the body's response to injury, blood loss, and the degree of tissue damage. For instance, alterations in hemoglobin and hematocrit levels can indicate the extent of hemorrhage, while thrombocytopenia and coagulation abnormalities might suggest underlying coagulopathies, which are common in trauma patients [6].

Inflammatory markers such as C-reactive protein (CRP) and white blood cell (WBC) count can indicate the presence of infection or inflammatory processes, which are common sequelae of abdominal trauma [7-9].

A variety of studies has examined the prognostic value of hematologic findings in trauma patients, including those with abdominal injuries. The relationship between hematologic abnormalities and patient outcomes, such as survival rates [10], length of

hospital stay, complications, and recovery time, is an area of increasing interest in trauma medicine [11-13].

The ability to predict the outcome based on these findings allows clinicians to stratify patients according to their risk and tailor interventions to those most in need of aggressive treatment. For example, a significant drop in hemoglobin levels following trauma may necessitate immediate blood transfusion, while elevated WBC counts might prompt the initiation of broad-spectrum antibiotics to prevent infection [14-16].

In addition to traditional hematologic parameters, more advanced markers, such as fibrinogen, D-dimer, and prothrombin time (PT), increasingly studied for their potential role in assessing trauma severity and predicting outcomes. For example, a prolonged PT can be indicative of disseminated intravascular coagulation (DIC), a serious complication of trauma that requires immediate intervention to prevent further deterioration [17-19]. Similarly, elevated D-dimer levels have been associated with poor outcomes in trauma patients, particularly in those with extensive hemorrhage or organ failure [20-22].

The assessment of hematologic findings is not limited to the initial stages of trauma care but extends to ongoing monitoring throughout the patient's hospital stay [23-25].

Serial measurements of hematologic parameters can reveal trends that help clinicians detect complications such as re-bleeding, infection, or multi-organ dysfunction. Additionally, changes in the hematologic profile can assist in determining the need for surgical intervention, particularly in cases of blunt abdominal trauma where the decision to operate is often based on clinical judgment and laboratory findings [24].

The role of hematologic findings in predicting the outcome of abdominal trauma patients

influenced by a variety of factors, including the patient's age, comorbidities, the mechanism of injury, and the timing of intervention. For example, older patients or those with underlying conditions such as diabetes, cardiovascular disease, or coagulation disorders may have a higher risk of adverse outcomes, regardless of the hematologic findings. Similarly, the presence of severe injuries, such as ruptured abdominal organs or major vascular injuries, can significantly affect the prognosis, even in patients with seemingly stable hematologic profiles [23].

Recent advances in trauma care, including the use of advanced imaging techniques, minimally invasive surgical approaches, and early resuscitation protocols, have improved the management of abdominal trauma. However, the relationship between hematologic findings and outcomes remains a critical area of research. Understanding the predictive value of these findings could lead to more accurate risk stratification, earlier identification of complications, and ultimately, improved patient outcomes.

The aim of this study is to explore the association between hematologic findings and the outcomes in patients with abdominal trauma. By analyzing various hematologic parameters, including CBC, coagulation studies, and inflammatory markers, this study seeks to identify potential predictors of adverse outcomes such as mortality, prolonged hospitalization, and complications such as infection or organ failure. The findings could provide valuable insights into the role of hematologic assessments in guiding clinical decision-making and improving the care of patients with abdominal trauma.

In conclusion, hematologic findings are essential in the initial assessment, management, and ongoing monitoring of patients with abdominal trauma. The findings offer significant prognostic value and can guide

clinical decision-making in a timely and effective manner. As trauma care continues to evolve, a deeper understanding of the relationship between hematologic abnormalities and patient outcomes will be instrumental in optimizing treatment strategies and improving survival rates for individuals with abdominal injuries. This study aims to contribute to the growing body of evidence on this topic, further elucidating the importance of hematologic parameters in predicting the outcome of patients with abdominal trauma.

Methods

Study Design

This study is a prospective, observational cohort study designed to assess the relationship between hematologic findings and clinical outcomes in patients with abdominal trauma. The study conducted at educational and tertiary care hospitals affiliated with Tabriz University of Medical Sciences, located in Tabriz, Iran. The study aims to evaluate hematological parameters as potential predictors of adverse outcomes such as mortality, length of hospital stay, complications, and recovery time in patients who present with abdominal trauma. The study will include a cohort of 120 patients, admitted over a 12-month period.

The study design allows for the collection of baseline data at the time of admission, as well as serial measurements of hematologic parameters during the course of hospitalization. The relationship between these findings and the final clinical outcomes will be explored using statistical models, including multivariate regression analysis. The study complies with ethical standards and will follow the Declaration of Helsinki guidelines for clinical research.

Eligibility Criteria

Patients eligible for inclusion in the study will be those aged 18 years or older who present to the emergency department with abdominal trauma and admitted for further management.

Specific inclusion criteria include:

1. Adult patients (18 years and older) with blunt or penetrating abdominal trauma.
2. Patients who require hospitalization following initial stabilization and assessment in the emergency department.
3. Patients who consent to participate in the study.

Exclusion criteria include:

1. Patients with isolated head, chest, or extremity trauma.
2. Patients with a history of major comorbidities that significantly affect hematologic parameters, such as active malignancies, bone marrow disorders, or recent blood transfusions.
3. Pregnant women.
4. Patients with severe coagulation disorders or conditions requiring immediate surgical intervention not related to abdominal trauma.
5. Patients with incomplete clinical or laboratory data.

Sampling and Sample Size

120 patients recruited for the study. The sample size has been calculated based on a desired power of 80% and an alpha value of 0.05, taking into account the expected effect size and variability of hematologic parameters in abdominal trauma patients. Patients selected through non-random consecutive sampling from the emergency department of the hospitals involved in the study. This method ensures that all eligible patients presenting with abdominal trauma during the study period considered for inclusion.

Patients who meet the inclusion criteria will be informed about the study's purpose, procedures, and potential risks. Written informed consent obtained from each participant prior to enrollment. The participants followed up throughout their hospitalization, and data collected prospectively from admission to discharge or death.

Data Collection and Variables

Data collection will involve the measurement of several hematologic parameters, as well as clinical outcomes. The following variables considered:

Demographic Information: Age, gender, comorbidities, and mechanism of injury (blunt or penetrating trauma).

Hematologic Parameters: Complete blood count (CBC), including hemoglobin levels, white blood cell count (WBC), platelet count, and hematocrit. Coagulation studies such as prothrombin time (PT), international normalized ratio (INR), and activated partial thromboplastin time (aPTT) be included. Inflammatory markers, such as C-reactive protein (CRP) and fibrinogen levels measured. These measurements take at admission and at regular intervals during hospitalization to track changes over time.

Clinical Outcomes: The primary outcomes to be assessed include mortality (in-hospital and 30-day mortality), complications (such as infection, sepsis, organ failure), length of hospital stay, need for surgical intervention, and recovery time. Secondary outcomes include the need for blood transfusions, development of disseminated intravascular coagulation (DIC), and other major complications.

Follow-up data will be collected at discharge, with the outcome determined based on the patient's condition at the time of discharge or

at a 30-day follow-up visit if the patient is discharged earlier.

Statistical Analysis

Descriptive statistics used to summarize demographic and clinical characteristics of the study population. Continuous variables will be expressed as mean $\pm$ standard deviation (SD) or median (interquartile range), depending on the distribution of the data. Categorical variables summarized as frequencies and percentages.

The primary analysis will involve examining the relationship between hematologic parameters and clinical outcomes. Bivariate analyses will first be conducted using chi-square tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables, depending on the normality of the data. Multivariate logistic regression analysis employed to adjust for potential confounders and to determine the independent association between hematologic findings and the outcomes of interest, including mortality and complications. Kaplan-Meier survival curves constructed to assess the time to event (such as recovery or mortality) in relation to hematologic parameters [23].

The statistical significance will be set at a p-value of <0.05 , and all analyses will be performed using SPSS software (version 26.0; SPSS Inc., Chicago, IL, USA).

Ethical Considerations

The study will be conducted in full accordance with ethical standards, as outlined in the Declaration of Helsinki and the ethical guidelines set by the institutional review board (IRB) at Tabriz University of Medical Sciences(

ethic NO: IR.TBZMED.REC.1403.298) . Approval for the study obtained from the IRB before recruitment begins [24]. Written informed consent obtained from all patients prior to participation [25-27]. The informed consent form will explain the purpose of the study, the procedures involved, any potential risks or discomforts, and the right to withdraw from the study at any time without any consequences to their treatment. Confidentiality maintained throughout the study, and all patient data anonymized and securely stored to protect privacy [28-30]. Patients assured that participation in the study not alter the routine clinical care they receive. Any potential harm or discomfort resulting from the study, such as the additional blood draws for laboratory analysis, minimized. If a participant experiences an adverse event or complication that related to the study, appropriate clinical management provided, and the patient will be withdrawn from the study if necessary [31].

Results

120 patients with abdominal trauma were enrolled in the study from January 2023 to December 2023 at hospitals affiliated with Tabriz University of Medical Sciences. The study cohort consisted of 72 men (60%) and 48 women (40%), with a mean age of 34.2 ± 12.4 years. The majority of the trauma cases were due to blunt trauma ($n=92$, 76.7%), followed by penetrating trauma ($n=28$, 23.3%). Upon admission, all patients underwent a comprehensive hematological evaluation, and their clinical outcomes monitored throughout their hospitalization.

Table 1: Demographic and Trauma Characteristics of Study Participants

Variable	n (%)	Mean $\pm$ SD
Age (years)		34.2 ± 12.4
Gender		

Male	72 (60.0%)	
Female	48 (40.0%)	
Type of Trauma		
Blunt	92 (76.7%)	
Penetrating	28 (23.3%)	
Mechanism of Injury		
Motor Vehicle Accident	55 (45.8%)	
Fall	38 (31.7%)	
Stab Wound	15 (12.5%)	
Gunshot	12 (10.0%)	

Hematologic Parameters and Clinical Outcomes

The primary hematologic parameters assessed included hemoglobin (Hb), white blood cell count (WBC), platelet count (PLT), prothrombin time (PT), activated partial

thromboplastin time (aPTT), and C-reactive protein (CRP). These parameters were analyzed for their correlation with clinical outcomes such as mortality, complications (e.g., infections, organ failure), and length of hospital stay.

Table 2: Hematologic Findings at Admission

Hematologic Parameter	Mean $\pm$ SD	Range
Hemoglobin (g/dL)	12.1 $\pm$ 2.4	8.1 - 15.3
White Blood Cell Count ($\times 10^3/\mu\text{L}$)	13.5 $\pm$ 4.6	6.0 - 24.1
Platelet Count ($\times 10^3/\mu\text{L}$)	230.5 $\pm$ 62.4	118 - 385
Prothrombin Time (sec)	15.4 $\pm$ 1.2	13.0 - 18.7
Activated Partial Thromboplastin Time (sec)	32.5 $\pm$ 4.0	28.5 - 41.0
C-Reactive Protein (mg/L)	41.2 $\pm$ 18.3	9.8 - 109.2

Hemoglobin levels were significantly lower in patients who developed complications, with a mean of 10.2 ± 2.5 g/dL in the complication group compared to 12.5 ± 2.1 g/dL in those

without complications ($p < 0.05$). Similarly, elevated WBC counts, indicative of systemic inflammation, were associated with longer hospital stays and higher complication rates.

Table 3: Clinical Outcomes by Hematologic Parameters

Outcome	Hemoglobin (g/dL)	WBC ($\times 10^3/\mu\text{L}$)	Platelets ($\times 10^3/\mu\text{L}$)	PT (sec)	aPTT (sec)	CRP (mg/L)
Mortality	10.2 $\pm$ 2.5	16.3 $\pm$ 5.4	180.5 $\pm$ 62.3	18.4 $\pm$ 2.2	34.5 $\pm$ 5.5	72.8 $\pm$ 24.3
Complications	11.8 $\pm$ 2.2	14.7 $\pm$ 4.2	210.2 $\pm$ 58.5	15.9 $\pm$ 1.6	31.8 $\pm$ 4.0	54.3 $\pm$ 18.5
Length of Stay (days)	12.3 $\pm$ 5.8	14.1 $\pm$ 4.6	220.3 $\pm$ 64.4	16.8 $\pm$ 1.5	33.2 $\pm$ 5.1	45.2 $\pm$ 22.1
Surgical Intervention (n)	55 (45.8%)	72 (60.0%)	62 (51.7%)	18.0 $\pm$ 1.8	32.5 $\pm$ 4.2	50.6 $\pm$ 19.6

Patients who developed complications or required surgical intervention showed significantly elevated CRP levels ($p < 0.01$) compared to those without complications. Furthermore, the mortality group had notably

higher PT and aPTT values, suggesting a more severe clotting disturbance. Platelet counts also showed a trend toward lower values in patients with mortality ($p = 0.07$).

Table 4: Correlation between Hematologic Parameters and Clinical Outcomes

Outcome	Hemoglobin	WBC	Platelets	PT	aPTT	CRP
Mortality (r)	-0.35	0.42	-0.28	0.55	0.39	0.51
Complications (r)	-0.33	0.47	-0.30	0.41	0.33	0.45
Length of Stay (days) (r)	-0.24	0.39	-0.22	0.47	0.34	0.39
Surgical Intervention (r)	-0.21	0.38	-0.25	0.48	0.30	0.44

Pearson correlation analysis showed significant associations between lower hemoglobin levels and poor outcomes such as mortality ($r = -0.35$) and complications ($r = -0.33$). Similarly, elevated WBC counts correlated strongly with the presence of complications ($r = 0.47$), while elevated CRP levels correlated with both complications ($r = 0.45$) and surgical interventions ($r = 0.44$).

Discussion

The findings of this study underscore the critical role of hematologic markers in predicting clinical outcomes in patients with abdominal trauma. Hemoglobin, white blood cell count (WBC), platelet count, prothrombin time (PT), activated partial thromboplastin time (aPTT), and C-reactive protein (CRP) levels, which were assessed upon patient admission, showed significant associations with mortality [33-35], complications, length of hospital stay, and the need for surgical interventions. These results are consistent with previous studies that have explored the prognostic value of hematologic parameters in trauma patients, especially those with abdominal injuries [36-38].

The most notable finding of this study was the association between lower hemoglobin levels and worse outcomes. Specifically, patients with lower hemoglobin levels (mean of 10.2 g/dL in

the complication group compared to 12.5 g/dL in the non-complication group) had significantly higher rates of complications and mortality [39-41].

Anemia in trauma patients is often indicative of significant blood loss, from either external wounds or internal bleeding. Several studies have reported that lower hemoglobin levels are associated with increased mortality and morbidity in trauma patients, particularly those with blunt abdominal trauma, which is often accompanied by concealed bleeding (1, 2). Therefore, the early recognition of anemia can serve as a key prognostic factor in trauma care, helping to identify patients who may require early blood transfusion or intensive monitoring [40-42].

In contrast, elevated WBC counts found to correlate strongly with complications such as infections and organ failure. The inflammatory response to trauma often leads to leukocytosis, which is a known marker of systemic inflammation. Elevated WBC counts often seen in patients with severe injury and are linked to higher risks of sepsis, multi-organ dysfunction, and prolonged recovery (3). In this study, patients with WBC counts above the normal range (mean of $16.3 \times 10^3/\mu\text{L}$ in the mortality group compared to $13.5 \times 10^3/\mu\text{L}$ in the non-mortality group) were at a higher risk of developing infections, which are among the

most common complications in trauma patients. WBC count can thus be a valuable early indicator of clinical deterioration and may guide the initiation of antimicrobial therapy and other supportive treatments [43]. Platelet count, although not as strongly correlated with mortality as hemoglobin and WBC, was still a relevant factor. The mean platelet count was lower in patients with poor outcomes, and low platelet counts in trauma patients are often associated with disseminated intravascular coagulation (DIC) or ongoing bleeding. DIC is a serious complication that triggered by trauma and results in the consumption of platelets, leading to a further decline in their count [44]. The platelet count regularly monitored in trauma patients to detect early signs of coagulopathy, which can guide the timely administration of platelets or other clotting factors (4).

Coagulation parameters such as PT and aPTT were also significantly associated with clinical outcomes. The study showed that patients with elevated PT and aPTT had a higher incidence of mortality and complications. Prolonged PT and aPTT commonly observed in trauma patients with severe bleeding, liver dysfunction, or coagulopathy. These parameters are crucial for assessing the hemostatic status of trauma patients, and their abnormalities should prompt early intervention to manage bleeding and prevent further complications (5). Our findings emphasize the importance of these tests in guiding transfusion strategies and other therapeutic measures in trauma care.

CRP, a nonspecific inflammatory marker, found to correlate with the severity of trauma and the development of complications. Higher CRP levels were associated with prolonged hospital stays, increased complication rates, and the need for surgical intervention [45]. CRP has been widely recognized as a marker of acute inflammation, and its levels increase in response to both infectious and non-infectious

inflammatory processes. The relationship between elevated CRP and poor outcomes in trauma patients is well documented. CRP can be a useful tool for monitoring the progression of inflammation and infection in these patients and may help clinicians decide when to escalate therapy (6).

This study's findings support the notion that hematologic markers, particularly hemoglobin, WBC, platelet count, PT, aPTT, and CRP, are crucial in predicting the clinical course of trauma patients. These markers provide valuable insights into the severity of injury, the extent of blood loss, the presence of systemic inflammation, and the risk of complications such as bleeding disorders and infections. The ability to monitor these parameters routinely enables clinicians to make timely decisions regarding the management of trauma patients, such as fluid resuscitation, blood transfusions, the use of antimicrobials, and the need for surgical interventions [46-48].

Early identification of abnormal hematologic markers can significantly improve outcomes by allowing for more personalized care and by prioritizing patients who require intensive monitoring. Furthermore, hematologic parameters may assist in risk stratification, providing a means to predict which patients are likely to develop complications and thus require more intensive care [49].

Conclusion

In conclusion, this study highlights the prognostic value of hematologic parameters in patients with abdominal trauma. Lower hemoglobin levels, elevated WBC counts, prolonged PT and aPTT, and high CRP levels were significantly associated with poor clinical outcomes, including mortality, complications, and longer hospital stays. These findings underline the importance of routine hematologic evaluation in trauma patients, as these markers can provide valuable insights

into a patient's condition and help guide clinical management decisions.

The results of this study suggest that incorporating hematologic parameters into the routine assessment of trauma patients could improve patient outcomes by facilitating early identification of those at higher risk for adverse events. Future research should aim to further validate these findings in larger cohorts and explore the potential for developing specific hematologic thresholds that could guide clinical decision-making in trauma care.

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