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# Analysis of the hemogram and biochemistry parameters of patients with trauma

Fatih Ahmet Kahraman[1], Havva Şahin Kavaklı[1], Ferhat İçme[1], Yavuz Otal[2], Alp Şener[1]

[1]*Department of Emergency Medicine, Ankara Bilkent City Hospital, Ankara, Turkiye*
[2]*Department of Emergency Medicine, Ankara Etlik City Hospital, Ankara, Turkiye*

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**Corresponding Author:** Fatih Ahmet Kahraman, fahmetkahraman@gmail.com

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## ABSTRACT

**Aims:** Trauma-related deaths remain a significant public health concern, with organ complications in over 30% of multitrauma patients leading to high morbidity and mortality. This study aims to understand the changes and reliability of hemoglobin, hematocrit, AST, and ALT levels in trauma cases and their impact on treatment planning.

**Methods:** A retrospective analysis was conducted on 259 multitrauma patients admitted to Ankara Atatürk Training and Research Hospital between July and December 2012. Data on demographic details, trauma types, laboratory parameters, physical and tomographic examinations, treatment modalities, and outcomes were analyzed using SPSS software.

**Results:** The study group predominantly comprised males (74.9%) with a mean age of 42.15 years. Various trauma types were analyzed, including traffic accidents and falls. Significant fluctuations in hemoglobin and hematocrit levels were observed post-fluid resuscitation, regardless of bleeding status. Notably, AST and ALT levels were reliable indicators of hepatic injury. The study also highlighted the effects of fluid hydration volumes on hemoglobin and hematocrit levels.

**Conclusion:** IThe findings challenge the conventional understanding that drops in hemoglobin and hematocrit levels primarily indicate bleeding in multitrauma patients. Instead, these changes might also result from fluid resuscitation. The study underscores the importance of considering both bleeding and resuscitation efforts when interpreting these laboratory parameters. This study provides new insights into the interpretation of hemoglobin, hematocrit, AST, and ALT levels in trauma patients. It suggests a more nuanced approach in treatment planning, considering the significant impact of fluid resuscitation on these parameters, alongside bleeding.

**Keywords:** Trauma, emergency service, retrospective study, blood tests, demograph

## INTRODUCTION

Trauma-related death cases are still a major public health issue and efforts to reduce its impact are crucial.[1] Serious organ complications occur in a significant proportion (greater than 30%) of multitrauma patients, which lead to a high morbidity and, in some cases, death.[2,3] Traffic accidents (in-vehicle and out-of-vehicle), falls from a height, and battery are the main causes of multitrauma.

While bleeding and monitoring hemorrhagic shock dictates fluid and blood transfusions in trauma patients, hemoglobin and hematocrit levels are the main parameters that are taken into account in clinical practice. However, these laboratory tests are affected both by the endocrinological response to trauma and the resuscitation efforts. In addition, evaluations of the liver, which is frequently injured in abdominal trauma, are mainly driven by physical examination and radiological tests. However, there are several studies indicating that hepatic function tests (AST and ALT are studied in the emergency biochemistry panel) guide management of hepatic injuries.[1-3]

Therefore, we designed the present study to seek the answers to several questions such as how do the parameters like hemoglobin, hematocrit, AST, and ALT change, how reliable are they, and by which situations are they affected in trauma cases. We aimed to make objective recommendations to clinicians by investigating whether these parameters may contribute to treatment planning.

## METHODS

This study was produced from the thesis, it prepared at Ankara Research Hospital on 30/07/2013. Institutional approval was obtained. All procedures were carried out in

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accordance with the ethical rules and the principles of the Declaration of Helsinki

This study retrospectively analyzed the data of 259 patients who were admitted to the emergency department of Ankara Atatürk Training and Research Hospital after in-vehicle traffic accident, out-of-vehicle traffic accident, motorcycle accident, fall from a height, and battery between 01.07.2012 and 31.12.2012.

The patients' age, sex, trauma type, hemoglobin, hematocrit, AST, and ALT levels at first admission, physical examination findings in the head, thorax, abdomen, and extremities, findings in the tomographic examination, hydration and blood transfusion status and volumes, status of alcohol ingestion before trauma, treatment type (surgical intervention, medical follow-up), length of hospital stay, and outcome (death, intensive care unit admission) were analyzed. Patients who were older than 16 years, who were admitted after a traffic accident (in-vehicle or out-of-vehicle), fall from a height, or battery, whose hemogram (hemoglobin and hematocrit) and biochemistry (AST and ALT) parameters were measured, whose control hemogram (hemoglobin and hematocrit) parameters were measured, and among cases with abdominal injury, those who had solid organ injury (liver, spleen, kidney) were included.

The forensic files and the emergency department follow-up charts of the patients were reviewed, and the physical examination findings, sociodemographic characteristics, trauma type, hemogram and biochemistry results, tomographic findings, treatment type, and outcome of each patient were recorded on the study forms. The patients' hemogram (hemoglobin and hematocrit) and biochemistry parameters (AST and ALT) taken within a 48-hour period after trauma were included in the study whereas blood tests taken later were excluded. Patients with a missing emergency department follow-up chart were also excluded due to possibly missing data.

The findings on abdominal tomography were defined as hepatic injury, renal injury, splenic injury, and pancreatic injury (solid organ injury). The findings on thorax tomography were defined as rib fracture, hemothorax, pneumothorax, and contusion. The findings on limb tomography were defined as lower extremity and upper extremity findings. Bone, joint, soft tissue, and vascular injuries were included in the lower and upper extremity injuries. Alcohol blow test and blood ethanol level were used to detect alcohol ingestion. Blood transfusion and hydration were defined as the treatments that were administered to the patients. Hydration was defined as the administration of crystalloid or colloid fluids at a volume of at least 1000 cc. Blood transfusion was defined as the transfusion of at least 1 unit of erythrocyte suspension or whole blood.

### Statistical Analysis

The data obtained from this study were recorded on a computer and analyzed using SPSS (Statistical Package for Social Sciences) Windows 19.0 software.

## RESULTS

This study included 259 multitrauma patients who presented to the adult emergency department. The mean age of the patients was 42.15±1.80 years. Seventy-four point nine percent of patients were male and 25.1% were female. Fifty-nine point eight percent of them had an in-vehicle traffic accident (IVTA), 8.5% out-of-vehicle traffic accident (OVTA), 2.3% motorcycle accident, 25.5% fell from a height, and 3.9% were battered. The outcomes of patients included discharge from the emergency department (35.0%), admission to the ward (46.7%), admission to the intensive care unit (11.3%), and death (7.0%) (Table 1).

**Table 1. Distribution of the patients by sex, cause of trauma, and patient outcome**

| Variables | | n | % |
|---|---|---|---|
| **Sex** | Female | 65 | 25.1 |
| | Male | 194 | 74.9 |
| **Cause of trauma** | IVTA | 155 | 59.8 |
| | OVTA | 22 | 8.5 |
| | Motorcycle accident | 6 | 2.3 |
| | Fall from a height | 66 | 25.5 |
| | Battery | 10 | 3.9 |
| **Outcome** | Discharge from the emergency department | 90 | 35.0 |
| | Admission to ward | 120 | 46.7 |
| | Intensive care | 29 | 11.3 |
| | Death | 18 | 7.0 |
| **Total** | | 259 | 100 |

IVTA: In-vehicle traffic accident, OVTA: Out-of-vehicle traffic accident

According to the results of the Wilcoxon Signed Rank Test, there was a significant difference between the admission and control hematocrit levels among patients who did not receive hydration (Z: -2.341, $p<0.05$). According to a hydration volume of 1000 cc, there was a significant difference between the admission and control hemoglobin levels (Z: -6.065, $p<0.05$). According to a hydration volume of 1000 cc, there was a significant difference between the admission and control hematocrit levels (Z:-5.334, $p<0.05$). According to a hydration volume of 1500 cc, there was a significant difference between the admission and control hemoglobin levels (Z: -2.945, $p<0.05$). According to a hydration volume of 1500 cc, there was a significant difference between the admission and control hematocrit levels (Z:-3.041, $p<0.05$). According to a hydration volume of 2000 cc, there was a significant difference between the admission and control hemoglobin levels (Z:-4.336, $p<0.05$). According to a hydration volume of 2000 cc, there was a significant difference between the admission and control hematocrit levels (Z: -4.866, $p<0.05$) (Table 2).

**Table 2. Testing the difference between the admission and control levels by the volume of hydration (Wilcoxon Signed Rank Test)**

| Volume of Hydration | Levels | Median (Min-Max) | Negative Mean Rank | Positive Mean Rank | Wilcoxon | p |
|---|---|---|---|---|---|---|
| 0 | Hemoglobin | 14 (8.1 - 16.9) | 47.98 | 39.92 | -1.837 | 0.066 |
| | Control hemoglobin | 13.7 (8.4 - 17) | | | | |
| | Hematocrit | 41.9 (24.1 - 51.2) | 43.11 | 44.23 | -2.341 | 0.055 |
| | Control hematocrit | 40.45 (24.1 - 51) | | | | |
| 1000 | Hemoglobin | 14.1 (8.1 - 18.8) | 37.61 | 48.83 | -6.065 | 0.000 |
| | Control hemoglobin | 13.2 (7.1 - 18.3) | | | | |
| | Hematocrit | 41.6 (23.8 - 53.3) | 37.77 | 43.30 | -5.334 | 0.000 |
| | Control hematocrit | 38.35 (24 - 49) | | | | |
| 1500 | Hemoglobin | 13.8 (6.9 - 16) | 13.23 | 15.00 | -2.945 | 0.003 |
| | Control hemoglobin | 12.8 (7.7 - 15.8) | | | | |
| | Hemotokrit | 40.3 (20.4 - 47.6) | 13.41 | 14.00 | -3.041 | 0.002 |
| | Control hematocrit | 38.2 (23.1 - 45) | | | | |
| 2000 | Hemoglobin | 13.8 (5.2 - 16.1) | 26.20 | 32.29 | -4.336 | 0.000 |
| | Control hemoglobin | 12.2 (2.7 - 16.4) | | | | |
| | Hematocrit | 40.1 (15.6 - 47.7) | 27.50 | 23.71 | -4.866 | 0.000 |
| | Control hematocrit | 35.4 (8.4 - 45.8) | | | | |

Wilcoxon Signed Rank Test. The correlation is statistically significant at the $p<0.05$ level. Min: Minimum, Max: Maximum

According to the results of the Wilcoxon Signed Rank Test, there was a significant difference between the admission and control hemoglobin levels in patients who had no finding on abdominal tomography (Z: -6.762, $p<0.05$). There was a significant difference between the admission and control hematocrit levels in patients who had no finding on abdominal tomography (Z: -6.621, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels in patients with splenic injury on abdominal tomography (Z: -2.685, $p<0.05$). There was a significant difference between the admission and control hematocrit levels in patients with splenic injury on abdominal tomography (Z: -2.072, $p<0.05$). There was a significant difference between the admission and control AST levels in patients with splenic injury on abdominal tomography (Z: -2.175, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels in patients with hepatic injury on abdominal tomography (Z: -2.395, $p<0.05$). There was a significant difference between the admission and control hematocrit levels in patients with hepatic injury on abdominal tomography (Z: -3.294, $p<0.05$). There was a significant difference between the admission and control AST levels in patients with hepatic + splenic injury on abdominal tomography (Z: -2.505, $p<0.05$) (Table 3).

According to the results of the Wilcoxon Signed Rank Test, there was a significant difference between the admission and control hemoglobin levels in patients with hemothorax (Z: -6.258, $p<0.05$). There was a significant difference between the admission and control hematocrit levels in patients with hemothorax (Z: -5.347, $p<0.05$). There was a significant difference between the admission and control AST levels in patients with hemothorax (Z: -2.153, $p<0.05$). (Table 4)

When the amount of drop in the Hb and Htc levels were analyzed by the volume of fluid hydration in patients who were not considered to have bleeding, statistically significant Hb and Htc drops were found in patients who received fluid replacement with at least 1000 cc fluid volume. According to the results of the Wilcoxon Signed Rank Test, there was a significant difference between the admission and control hemoglobin levels by 1000-cc volume replacement in patients without injury (Z: -4.498, $p<0.05$). There was a significant difference between the admission and control hematocrit levels by 1000 cc volume replacement in patients without injury (Z: -4.388, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels by 1500-cc volume replacement in patients without injury (Z: -3.646, $p<0.05$). There was a significant difference between the admission and control hematocrit levels by 1500-cc volume replacement in patients without injury (Z: -3.634, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels by 2000-cc volume replacement in patients without injury (Z: -3.308, $p<0.05$). There was a significant difference between the admission and control hematocrit levels by 2000-cc volume replacement in patients without injury (Z:-3.308, $p<0.05$) (Table 5).

In patients considered to have bleeding, on the other hand, there was a significant drop in the hematocrit level in the group that did not receive hydration. There was a drop in the hemoglobin level, albeit statistically insignificant. In patients who were hydrated with a fluid volume of at least 1000 cc, on the other hand, both the hemoglobin and hematocrit levels significantly dropped. According to the results of the Wilcoxon Signed Rank Test, there was a significant difference between the admission and control hematocrit levels by 0-cc volume replacement in patients with injury (Z: -2.325, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels by 1000-cc volume replacement in patients with injury (Z: -4.103, $p<0.05$). There was a significant difference between the admission and control hematocrit levels by 1000-cc volume replacement in patients with injury (Z: -3.114, $p<0.05$). There was a significant difference between the admission and control hemoglobin levels by 1500-cc volume replacement in patients with injury (Z: -2.011 $p<0.05$). There was a significant difference between the admission and control hematocrit levels by 1500-cc volume replacement in patients with injury (Z: -2.011 $p<0.05$). There was a significant difference between the admission and control hemoglobin levels by 2000-cc volume of replacement

**Table 3. Testing the difference between the admission and control levels by the results of abdominal CT (Wilcoxon Signed Rank Test)**

| Abdominal CT | Levels | Median (Min-Max) | Negative Mean Rank | Positive Mean Rank | Wilcoxon | p |
|---|---|---|---|---|---|---|
| No finding | Hemoglobin | 13.9 (8.1 - 18.8) | 81.79 | 59.44 | -6.762 | 0.000 |
| | Control hemoglobin | 12.75 (2.7 - 17.7) | | | | |
| | Hematocrit | 41.25 (24.1 - 53.3) | 77.89 | 66.69 | -6.621 | 0.000 |
| | Control hematocrit | 38.2 (8.4 - 51) | | | | |
| | AST | 32 (6 - 321) | 17.63 | 22.42 | -1.721 | 0.085 |
| | Control AST | 49.5 (14 - 232) | | | | |
| | ALT | 24 (2 - 816) | 19.96 | 21.50 | -1.470 | 0.142 |
| | Control ALT | 37.5 (11 - 95) | | | | |
| Splenic injury | Hemoglobin | 14.5 (5.2 - 16.4) | 12.77 | 17.50 | -2.685 | 0.007 |
| | Control hemoglobin | 13.1 (9.3 - 15.5) | | | | |
| | Hematocrit | 41.8 (15.6 - 47) | 11.68 | 23.50 | -2.072 | 0.038 |
| | Control hematocrit | 37.9 (29.1 - 44.7) | | | | |
| | AST | 45 (19 - 308) | 6.50 | 9.17 | -2.175 | 0.030 |
| | Control AST | 97 (57 - 340) | | | | |
| | ALT | 28 (12 - 188) | 7.00 | 10.00 | -0.623 | 0.533 |
| | Control ALT | 68 (29 - 177) | | | | |
| Hepatic injury | Hemoglobin | 15.1 (8.9 - 16.8) | 17.73 | 18.78 | -2.395 | 0.017 |
| | Control hemoglobin | 14 (8.3 - 18.3) | | | | |
| | Hematocrit | 42.8 (25.4 - 47.5) | 18.43 | 16.29 | -3.294 | 0.001 |
| | Control hematocrit | 40.2 (23.5 - 49) | | | | |
| | AST | 111 (15 - 691) | 8.83 | 12.00 | -0.443 | 0.658 |
| | Control AST | 109 (17 - 187) | | | | |
| | ALT | 86 (13 - 571) | 7.70 | 12.56 | -0.725 | 0.468 |
| | Control ALT | 96 (10 - 161) | | | | |
| Hepatic + splenic injury | Hemoglobin | 11.6 (8.1 - 14.4) | 6.10 | 8.50 | -1.741 | 0.082 |
| | Control hemoglobin | 11.5 (7.1 - 13.5) | | | | |
| | Hematocrit | 34.2 (23.8 - 41.1) | 7.00 | 5.50 | -1.337 | 0.181 |
| | Control hematocrit | 34.1 (24 - 39) | | | | |
| | AST | 186 (45 - 309) | 1.50 | 6.50 | -2.505 | 0.012 |
| | Control AST | 204 (77 - 413) | | | | |
| | ALT | 85 (27 - 261) | 4.50 | 6.17 | -0.971 | 0.331 |
| | Control ALT | 81 (58 - 401) | | | | |
| Intraabdominal free fluid | Hemoglobin | 13.55 (6.9 - 15) | 8.67 | 8.00 | -1.867 | 0.062 |
| | Control hemoglobin | 12.4 (7.7 - 14.7) | | | | |
| | Hematocrit | 39.25 (20.4 - 43) | 8.50 | 8.50 | -1.760 | 0.078 |
| | Control hematocrit | 37.1 (23.1 - 42.5) | | | | |
| | AST | 56 (14 - 136) | 3.50 | 8.50 | -0.665 | 0.506 |
| | Control AST | 75 (11 - 92) | | | | |
| | ALT | 33 (6 - 84) | 5.50 | 5.50 | -1.687 | 0.092 |
| | Control ALT | 19 (5 - 61) | | | | |

Wilcoxon Signed Rank Test
The correlation is statistically significant at the p<0.05 level.
Min: Minimum, Max: Maximum, AST: Aspartat aminotransferase, ALT: Alanin aminotransferase

**Table 4. Tesing the difference between the admission and control levels by the results of the thorax CT (Wilcoxon Signed Rank Test)**

| Thorax CT | Levels | Median (Min-Max) | Negative Mean Rank | Positive Mean Rank | Wilcoxon | p |
|---|---|---|---|---|---|---|
| Patients with hemothorax | Hemoglobin | 13.8 (6.9 - 16.6) | 55.45 | 40.10 | -6.258 | 0.000 |
| | Control hemoglobin | 12.5 (2.7 - 16.9) | | | | |
| | Hematocrit | 40.05 (20.4 - 47) | 52.85 | 46.59 | -5.347 | 0.000 |
| | Control hematocrit | 36.8 (8.4 - 49.3) | | | | |
| | AST | 63 (6 - 691) | 14.90 | 17.23 | -2.153 | 0.031 |
| | Control AST | 77 (33 - 340) | | | | |
| | ALT | 44 (2 - 571) | 13.50 | 19.50 | -0.899 | 0.368 |
| | Control ALT | 58 (28 - 177) | | | | |

Wilcoxon Signed Rank Test
The correlation is statistically significant at the p<0.05 level
CT: Computed tomography, Min: Minimum, Max: Maximum, AST: Aspartat aminotransferase, ALT: Alanin aminotransferase

**Table 5. Testing the difference between the injury status wih respect to admission and control levels by the volume of hydration (Wilcoxon Signed Rank Test)**

| Injury | Volume of hydration | Levels | Median (Min-Max) | Negative Mean Rank | Positive Mean Rank | Wilcoxon | p |
|---|---|---|---|---|---|---|---|
| Absent | 0 | Hemoglobin | 13.6 (8.1 - 16.9) | 32.36 | 28.22 | -1.128 | 0.259 |
| | | Control hemoglobin | 13.4 (8.4 - 17) | | | | |
| | | Hematocrit | 41.8 (24.1 -51.2) | 29.06 | 30.17 | -1.251 | 0.211 |
| | | Control hematocrit | 40.6 (24.1 - 51) | | | | |
| | 1000 | Hemoglobin | 14.1 (8.3 - 18.8) | 21.00 | 21.00 | -4.498 | 0.000 |
| | | Control hemoglobin | 12.7 (9.3 - 17.7) | | | | |
| | | Hematocrit | 41.1 (24.7 -53.3) | 20.78 | 23.00 | -4.388 | 0.000 |
| | | Control hematocrit | 38.2 (27.9 - 49) | | | | |
| | 1500 | Hemoglobin | 14.3 (10.5 - 16) | 9.00 | 0.00 | -3.646 | 0.000 |
| | | Control hemoglobin | 12.8 (10.4 -15.8) | | | | |
| | | Hematocrit | 41.2 (37.6 -47.6) | 9.00 | 0.00 | -3.634 | 0.000 |
| | | Control hematocrit | 38.2 (33.3 - 45) | | | | |
| | 2000 | Hemoglobin | 13.9 (10.1 -15.9) | 7.50 | 0.00 | -3.308 | 0.001 |
| | | Control hemoglobin | 11.8 (2.7 - 13.1) | | | | |
| | | Hematocrit | 41.2 (29.5 -47.7) | 7.50 | 0.00 | -3.308 | 0.001 |
| | | Control hematocrit | 34.1 (8.4 - 37.9) | | | | |
| Present | 0 | Hemoglobin | 14.5 (10.8 - 16) | 16.47 | 11.45 | -1.755 | 0.079 |
| | | Control hemoglobin | 13.9 (11.5 -16.9) | | | | |
| | | Hematocrit | 42.3 (33.3 -45.9) | 14.52 | 14.43 | -2.325 | 0.020 |
| | | Control hematocrit | 40.3 (34.7 -49.3) | | | | |
| | 1000 | Hemoglobin | 14.3 (8.1 - 16.8) | 17.12 | 32.50 | -4.103 | 0.000 |
| | | Control hemoglobin | 13.5 (7.1 - 18.3) | | | | |
| | | Hematocrit | 41.9 (23.8 - 47.5) | 17.41 | 20.83 | -3.114 | 0.002 |
| | | Control hematocrit | 39.4 (24 - 49) | | | | |
| | 1500 | Hemoglobin | 13.8 (6.9 - 15.7) | 6.20 | 3.50 | -2.011 | 0.032 |
| | | Control hemoglobin | 12.5 (7.7 - 14.4) | | | | |
| | | Hematocrit | 38.7 (20.4 - 46.5) | 6.20 | 3.50 | -2.011 | 0.002 |
| | | Control hematocrit | 36.5 (23.1 -42.9) | | | | |
| | 2000 | Hemoglobin | 13.45 (5.2 - 16.1) | 18.75 | 25.71 | -2.934 | 0.003 |
| | | Control hemoglobin | 12.6 (8.3 - 16.4) | | | | |
| | | Hematocrit | 40 (15.6 - 46.1) | 20.06 | 19.71 | -3.518 | 0.000 |
| | | Control hematocrit | 36.7 (23.5 -45.8) | | | | |

Wilcoxon Signed Rank Test
The correlation is statistically significant at the p<0.05 level.

in patients with injury (Z: -2.934, p<0.05). There was a significant difference between the admission and control hematocrit levels by 2000-cc volume replacement in patients with injury (Z: -3.518, p<0.05) (Table 5).

## DISCUSSION

Hemoglobin and hematocrit levels, as well as ALT and AST levels, are commonly used in the follow-up of trauma patients.[4] A drop in the hemoglobin and hematocrit levels are important for monitoring bleeding while elevated AST and ALT levels are important because that they indicate hepatic injury.[5]

In our study, the drop in both the hemoglobin and hematocrit levels was statistically significant in patients who were administered only fluids. In addition, when we analyzed the hemoglobin and hematocrit levels by examining patients with hemorrhagic, we still observed a significant drop in both parameters. Hence, it will be more prudent to consider the drop in the Hb and Htc levels as a sign of primarily bleeding in multi-trauma patients. Our study also shows that AST and ALT levels are useful for indicating hepatic injury in multitrauma patients.

In patients admitted to the emergency department, the administration of 1-2 liters of isotonic crystalloid solution is considered the standard treatment. Vital signs and hemoglobin level are used to detect bleeding during patient monitoring.[6] Studies in the literature that demonstrated the amount of hemoglobin drop resulting from the infusion of 1-2 liters of isotonic saline have been conducted in small patient groups. Grathwohl et al.[7] examined the effect of IV volume loading on blood count parameters in healthy volunteers; they reported no significant difference in the leukocyte and thrombocyte series but significant drops in the hemoglobin and hematocrit levels. However, they reported that those levels returned to baseline over time. In

a study conducted by Lobo et al.[8], the subjects were given 2 L isotonic saline or 2 L 5% Dextrose within a hour, and the their body weight, hemoglobin, serum albumin, serum and urine biochemistry, and bioelectrical impedance were measured on an hourly basis for 6 hours before and after the infusion. In patients who were administered isotonic saline, the hematocrit and hemoglobin levels dropped by 7.5%. The same study also drew attention to a Hb drop of about 12% after fluid replacement, and advocated that a sudden increase in intravascular volume was the main reason for the Hb drop. Lobo et al.[9] also compared volume loading with 2000 cc 5% dextrose and isotonic saline; the authors reported that the Hb level significantly dropped in both groups within an hour (Hct 7.5%), and the levels tended to re-surge after the infusion was stopped. Karaaslan et al.[10] reported that isotonic saline replacement after 2 Units of blood was drawn caused Hb and Hct levels to drop.

Thoraon et al.[11] reported that the changes in Htc were the single most reliable test demonstrating blood loss in trauma patients undergoing fluid replacement. In that study, it was found that a Hct change of 6 or greater was highly suspicious of blood loss while smaller Hct changes may be a warning sign. Studies on this subject have shown that the Hb and Hct levels that dropped after fluid treatment were stabilized or even slightly increased after some time. Our study included no evaluation or test that would corroborate this finding.

Our study revealed a significant drop in both the Hb and Hct levels in patients who were administered 1000 cc or larger fluid volumes. Our study evaluated hydration volumes separately and found similar results in all of those groups. It was found that the liquid volumes in previous studies are generally constant.[9,10]

Here, the potential hemorrhagic conditions of these patients will naturally lead to a drop in those levels, which ultimately cause a question mark. Thus, when we separately evaluated patients without hemorrhagic injuries and looked at their hemoglobin and hematocrit levels, we still observed a significant drop in their levels. Here, that question mark cannot be eliminated. While the hemoglobin level dropped by an average of 10% in the group without injury, that 6% drop occurred in the group having injury. Theoretically, the opposite of this calls to mind. To our opinion, this contradiction can be explained by the changes in the fluid-electrolyte balance. In this case, interpreting Hb and Hct drops in multitrauma patients as a sign of bleeding would be more prudent.[12]

In the systematic evaluation conducted by Quispe-Cornejo and colleagues,[13] they found that there was a decrease in hemoglobin values with fluid administration and they had difficulty in determining the reason for this. Across 63 studies suitable for meta-analysis, the Hb decreased significantly by a mean of 1.33 g/dl after fluid administration: in non-acutely ill subjects, the mean decrease was 1.56 g/dl, and in acutely ill patients 0.84 g/dl.

In our study, the patients who had injuries on tomographic imaging but did not receive fluid replacement between Hb and Hct controls had a mean Hb drop of 4.1% and a mean Htc drop of 4.7%. While even such decreases lead to injury outcomes, we believe that it would not be safe to give an average level for these Hb and Htc drops.

Our study demonstrated a male predominance in the patient population. This is in line with general trauma data in the previous studies.[3]

Tan et al.[14] showed a relationship between hepatic injury and increased hepatic transminase levels after blunt abdominal trauma. They reported that AST and ALT levels that were elevated to two times of the upper limit of normal indicate major hepatic injury and recommended that the case should be managed accordingly. Sola et al.[15] in a study on pediatric trauma patients, reported that AST and ALT measurements proved to be useful markers of intraabdominal injury in blunt abdominal trauma. They also stated that pediatric patients with a negative FAST and liver trasaminases below 100 IU/L could be conservatively managed instead of being sent to tomography that pose radiation risks. Hennes et al.[16] studied pediatric patients with hemodynamically stable blunt abdominal trauma and found that an AST level greater than 450 IU/L and an ALT level greater than 250 IU/L had a sensitivity of 100% and a specificity of 92.8% for hepatic injury. They opined that patients with hepatic enzymes above those levels should be evaluated with tomography.

Kumar et al.[17] found that routine use of amylase and lipase levels alone in blunt trauma to reveal extrapancreatic injury is not appropriate regarding the cost/benefit ratio, but may be useful when used in conjunction with hepatic enzymes. In that study, the urinary lipase level was significant on the first day and the use of the urinary lipase/amylase ratio in conjunction with AST, ALT, and ALP on the first, third, and fifth days was significant in patients with hepatic injury. In splenic injury, on the other hand, it was shown that serum amylase, AST, ALT, Hb, and Hct levels on the first day were significant. In a study, Tian et al.[18] investigated whether AST, ALT, GGT, and LDH levels indicated the presence and the severity of hepatic injury in blunt abdominal trauma. They concluded that ALT >57 U/L and AST >113 U/L strongly indicated hepatic injury although a link between those levels and the severity of hepatic injury could not be established. A study by Bevan et al.[19] studied ALT alone; it reported that ALT was a useful marker for assessing the presence or absence of hepatic injury. It was also stated that hemodynamically stable pediatric patients with an ALT level less than 104 IU/L can be monitored without tomography to avoid unnecessary radiation exposure.

In the study by Da-wei Zhao and colleagues,[20] they evaluated liver function tests in trauma patients, the aspartate aminotransferase and lactate dehydrogenase concentrations and the aspartate aminotransferase/alanine aminotransferase ratio were positively correlated with the grade of liver injury and serum liver enzyme measurement exhibited high consistency with CE-MDCT for both detection and grading of intraparenchymal lesions in blunt liver trauma. The results they found are similar to our study. In the study by Bilgiç and her colleagues,[21] significant increases in AST, ALT and LDH values were detected in patients with liver trauma.

In parallel with the aforementioned studies, our study demonstrated that AST and ALT levels are useful for indicating hepatic injury in multitrauma patients. When we correlated the elevation of any of ALT or AST with the signs of hepatic injury on abdominal tomography, we found that the combined use of AST and ALT had a sensitivity of 91.5% and a specificity of 45.6%. The reason for a low specificity

may be that these tests may be elevated in many other organ injuries. Possible examples include AST elevation in cardiac trauma cases,[22,23] and the elevation of these markers in splenic injury.[17] We did not statistically evaluate AST and ALT individually because both were above the upper limit or both were below the lower limit in all patients. According to the literature data, ALT reflects hepatic injury more sensitively.[24] In our study, AST was found to accompany ALT in all patients. These data may imply that AST is as valuable as ALT as a marker of hepatic injury.

### Limitations

Our study has some limitations. Some of them are the short study period, retrospective study design, and the exclusion of 28 patients with missing data. Other limitations are the inclusion of solely multitrauma patients but no other trauma patients, exclusion of patients admitted with cardiac arrest, and the evaluation of solid organ injuries as present/absent, without staging them. There is a need for prospective, multi-center studies on this subject.

## CONCLUSION

In the present study on multitrauma patients admitted to the emergency department, a significant drop in the hemoglobin and hematocrit levels was recorded as a result of fluid resuscitation of 1000 cc or above; even if the patients without bleeding were analyzed separately, a statistically significant drop was still apparent. No correlation could be established for these hemoglobin and hematocrit changes between patients with and without injury. These data suggest that a drop in the hemoglobin and hematocrit levels in multitrauma patients may not result from bleeding alone, but also fluid resuscitation. To our opinion, it would be more accurate to approach such patients as if they have bleeding.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

This study was produced from the thesis, it prepared at Ankara Research Hospital on 30/07/2013. Institutional approval was obtained.

### Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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