ORIGINAL ARTICLE

Analysis of anatomical localization and severity of injury in patients with blood transfusion in urban terrain hospital

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ABSTRACT

BACKGROUND: Blood loss is the most significant cause of mortality in trauma cases. In injured patients, rapid evaluation and appropriate transfusion is lifesaving. The present study aims to analyze the blood/blood products requirement based on available data and find any associations between the transfusion requirements and injury severity scores (ISS) and anatomical locations of injuries of transfused patients.

METHODS: Between 30 July 2014 and 30 July 2016, casualties admitted to the urban terrain hospital (UTH) and transfused at least one unit of red blood cell (RBC) were included. UTH Transfusion Record Notebook data included patients' age, mechanism and anatomical location(s) of the injury, admission hemoglobin (g/dL) level, injury severity score (ISS), transfused units of erythrocyte suspension (ES), warm fresh whole blood (WFWB), fresh frozen plasma (FFP), and massive transfusion (MT) rate.

RESULTS: In this study, all patients were male; the mean age was 28.7±7.8 years. Overall, 59 of 579 (10%) patients were transfused 458 units of RBC (ES+WFWB). Torso (thorax ± abdomen) injury was present in 61% of the casualties who underwent transfusion, and 93% of these patients underwent massive transfusion. In 71% of patients, the ISS was >15, and there was statistically significant high blood/blood products use and MT rate in these patients, respectively (p=0.021, p=0.006).

CONCLUSION: Anatomical location of injuries and ISS are valuable in the rapid determining of MT and survival rates of casualties. Especially in torso injuries, bleeding control is difficult and transfusion requirement and mortality rates are high. This study presents the trauma of urban terrain conflict-related transfusion data from a UTH.

Keywords: Fresh whole blood; hemorrhage; transfusion; trauma.

INTRODUCTION

Hemorrhage is the leading cause of trauma-related mortality in both military and civilian settings.[1,2] Further data stratification shows that 90% of potentially preventable mortalities are also due to bleeding.[3] Thus, planning for blood and blood component resources for trauma care purposes is inevitably one of the most critical elements for both civilian and military planners. Urban terrain hospitals (UTH) and other institutions in the health system need to reassess their blood

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bank capabilities and adequacy of their blood/blood products reserves according to lessons learned from past terrorist attack incidents or military campaigns against those terrorist targets.

Trauma and transfusion data derived from recent urban terrain conflict casualties are important in means of evaluations and future estimations of blood transfusion requirements in similar situations. This may enable expedited access of health care professionals to blood bank reserves that were reinforced accordingly.

Since 1984, despite the years of fight against terrorism and medical expertise gained during the trauma care of casualties in this period, relatively few scientific analyses on combat injuries have been reported.[4–6] However, after many years of anecdotal trauma transfusions that relied on huge amounts of fresh whole blood in UTHs, only one trauma-transfusion study was reported.[7]

Between 2014 and 2016, Şırnak became a center of urban combat against the terrorist organization and Şırnak UTH was located in the middle of this conflict. The present study aims to analyze the blood/blood products consumption based on available data and find any associations between the transfusion requirements and injury severity scores (ISS), and anatomical locations of injuries of transfused patients.

MATERIALS AND METHODS

Gülhane Training and Research Hospital Ethics Committee approval (2018/11, 18/235, 16 October 2018) was received for the retrospective descriptive study. This study comprised patients injured during urban combat and admitted to the Şırnak CHS between 01 August 2014 and 01 August 2016.

The casualties were the military and the police special operations team personnel and the civilian guards. The UTH had three operating tables, an advanced Intensive Care Unit (ICU), and subspecialty care capabilities. The casualties with severe injuries typically underwent lifesaving interventions, damage control resuscitation, and evacuated to a higher-level military hospital at the earliest convenience. Data were collected from the Blood/Blood Product Transfusion Record Notebook and files of the casualties. The recorded data included the patients' ID, age, mechanism of injury, anatomical location of the injury, admission hemoglobin (g/dL) level, amount of transfused blood/blood product(s), and early mortality rate. The recorded time to mortality after arrival <24 hours was accepted as early mortality. In addition, injury severity score (ISS) was evaluated and recorded in all transfused patients. ISS is an anatomical scoring system used in patients with multiple injuries. An injury scale score is assigned to each of the six body regions. The scores of the three most severely injured body parts are squared, and the totals are taken to generate the ISS score.[8]

In Turkey, blood/blood products are kept in hospitals. A minimum of twenty ES and FFP from all blood groups which were procured from the Turkish Red Crescent were stored properly at Şırnak UTH. On the other hand, warm fresh whole blood (WFWB) was also available and all walking blood (bank) donors were military personnel that complied with donor eligibility criteria according to the National Blood and Blood Products Guide.[9] Blood groups of all possible donors were determined previously. Walking blood donors were gathered for donation at the UTH when required.

Microbiological screening tests (HbsAg, anti-HCV, anti-HIV and anti-syphilis Ab) were examined by EIA Acess2 (Beckman Coulter, Brea, CA, USA) and confirmatory blood grouping was performed by the column agglutination technique (DiaClon Bio-Rad, DiaMed GmbH, Cressier FR, Switzerland). In case of emergency blood supply demands, microbiological screening tests were performed using rapid testing kits (Laboquick kits, Koroglu Medical Devices, İzmir, Turkey). Cross-match tests were performed using the indirect antiglobulin test (IAT) gel technique on commercial LISS/Coombs cards (DiaClon, BioRad, DiaMed GMbH, Cressier FR, Switzerland). In case of unfavourable test results, the untransfused ES was retrieved. O Rh (-) ES and AB (+) FFP was used under contingency situations when blood products were needed for transfusion in less than 15 minutes. As soon as the microbiological screening and cross-match tests results were obtained, transfusion was continued with the patient's own blood group. WFWB and/or ES+FFP were used and the sequence of the above-mentioned blood/blood products depended exclusively on the availability of blood resources and choice of military medical personnel. Massive transfusion (MT) was defined as transfusion ≥10 units RBCs within 24 hours of admission. None of the patients received tranexamic acid.

Statistical Analysis

Data were statistically analyzed using SPSS-22 software (Statistical Package for the Social Sciences, IBM Inc., USA). Continuous data were presented as Mean (±SD) unless otherwise stated. Group differences between the dichotomous and continuous variables were analyzed using independent samples t-test. Categorical variables were analyzed using the chi-squared test and Fischer's exact test as appropriate. Statistical significance was set at <0.05.

RESULTS

In this study, all patients were male, and the mean age was 28.7±7.8 years old. Five hundred and seventy-nine injured patients were admitted to the UTH within the specified date range. The early mortality rate (first 24 hours) was 54.2% (32/59) in the first 24 hours. Forty-three (73%) casualties were wounded with the gunshot and 16 (27%) with explo-

Table 1. Casualty demographics, injury mechanisms, anatomic sites of injury, and distribution of vascular injuries

Age (mean±SD), years	28.7±7.8
Early mlortality rate (first 24 hours)	54.2% (32/59)
Injury Severity Score, (mean±SD)	20.8±13.1
Mechanism of injury	
Gunshot wounds	43 (73%)
Explosives	16 (27%)

SD: Standard deviation.

sives (Table 1). Anatomical sites of injury and distribution of vascular injuries are in Figure 1. Torso (abdomen ± thorax) injuries comprised 36 of 59 (61%) patients.

Distribution of casualty blood groups is presented in Figure 2. A+ and B+ were the most common (50.8%, and 22%, respectively) blood types among the transfused casualties.

The distribution of transfused blood/blood products types is presented in Table 2. MT rates of the overall and transfused patients were 2.4% (14/579) and 23% (14/59), respectively. Overall, 552 units of blood/blood product transfusion were administered to 59/579 (10%) patients. The mean transfused blood units were 7.76±8.45 (min: 1, max: 53). The mean hemoglobin value of the patients who were transfused was 11.4±3.2 g/dL (min: 4.3, max: 16.1) at first admission. In patients with MT, and without MT, the mean (±SD) hemoglobin levels were 9.8±2.5 mg/dL, and 11.8±3.2 mg/dL (p=0.03), respectively. (Table 3) Additionally, torso injuries constituted 93.3% (13/14, p=0.006) of patients that required MT. The rate of MT in thoracic, thoraco-abdominal and abdominal injuries was 35.7%, 35.7% and 21.4%, respectively.

The mean ISS was 20.8±13.0 (min: 1, max: 50) and scores >15 indicate a major or severe injury. ISS scores of 42 (71%) patients were >15 and 14 (33.3%) of those severe injuries had MT. The association between the MT and ISS scores was statistically significant (p=0.006). A significant but not surprising finding was that ISS >15 patients received significantly more blood/blood product than ISS ≤15 patients (9.3±9.4 vs. 3.7±2.6, p=0.021) (Table 4). No transfusion-related complications were observed.

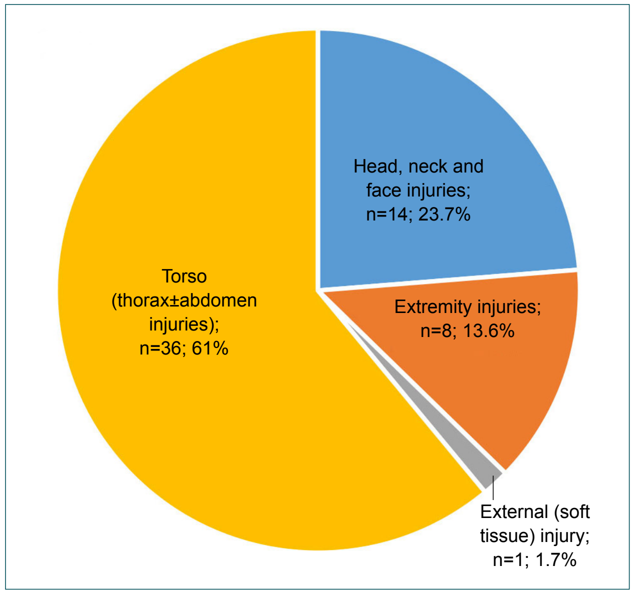

Figure 1. Anatomical site(s) of injury.

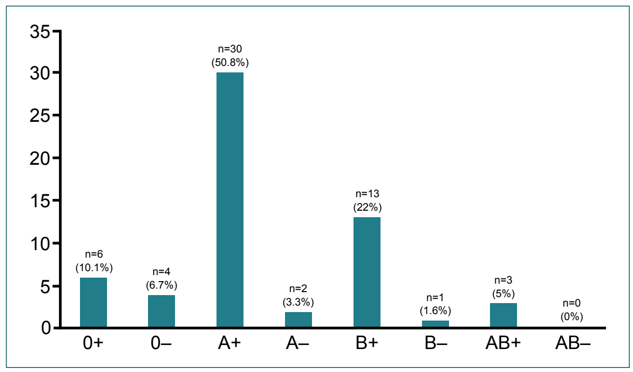

Figure 2. Blood groups of the patients in this study.

Table 2. The distribution of transfused blood/blood products types

Blood product(s)	Casualty number (%)	Overall number of transfused blood products (unit)
ES	15 (25)	31 ES
FFP	0	0
WFWB	8 (14)	102 WFWB
ES + FFP	1 (1)	7 ES + 5 FFP
WFWB + FFP	14 (24)	130 FWB + 60 FFP
ES + WFWB	14 (24)	48 ES + 82 WFWB
ES + FFP + WFWB	7 (12)	25 ES + 29 FFP + 33 WFWB
Total	59 (100)	552

ES: Erythrocyte suspension; FFP: Fresh frozen plasma; WFWB: Warm fresh whole blood.

Table 3. Distribution of the number of transfusions, and admission hemoglobin level

	Number of transfused patients (n)	Transfusion rate in all patients (n)	Number of transfused blood units (Mean±SD)	Admission hemoglobin level (mg/dL, Mean±SD)
Non-MT patients (<10 units)	45/59 (77%)	45/579 (7.7%)	5.3±2.7	11.8±3.2
MT patients (≥10 units)	14/59 (23%)	14/579 (2.4%)	18.8±11.2	9.8±2.5
Total	59 (100%)	59/579 (100%)	7.76±8.5	11.4±3.2

MT: Massive transfusion; SD: Standard deviation.

Table 4. Distribution of Injury Severity Score (severe injury).

	ISS >15	ISS ≤15	p
Number of transfused patients	42/59 (71%)	17/59 (29%)	–
Number of MT	14/42 (33%)	0/17 (0%)	0.006
Number of transfused blood product units (mean±SD)	9.3±9.4	3.7±2.6	0.021

MT: Massive transfusion; SD: Standard deviation; ISS: Injury Severity Score.

DISCUSSION

The primary finding of this study was that the need for MT and the mortality rate was higher as a result of increased blood loss due to difficult bleeding control in thoracic injuries. ISS can provide a reliable prediction of the severity of the injury and the need for MT. Medics performing initial intervention and triage on the battlefield can make a positive contribution to MT and mortality by rapidly assessing the presence of thorax injury and ISS.

The data reported in this study may not be easily discussed as comparable (urban combat injury and transfusion) studies are few in the literature. However, combat trauma literature has firmly established the foundations of certain facts on which the authors of this study shall build their arguments. The first and the most notorious fact to emphasize is the early mortality, delayed evacuation and delays in surgical care. Combat support hospitals report conventional battle mortality of 2–4%, although the prehospital mortality was five or 10 times more due to the above delays.[10] Decreasing the transport time from the point of injury to definitive care has been shown to decrease the mortality of noncompressible torso hemorrhage (NCTH- one or more of the thoracic cavity, grade 4 liver, kidney or spleen injury, named torso vessel and pelvic ring fracture) combined with an amputation injury.[11] The mortality rate of NCTH is >85% and 90% of these die in the pre-hospital period.[12] Our UTH was approximately one km from the city center during the urban operations in Şırnak. Casualty transport time was <10 minutes. Thus, it was the authors' observation that more exsanguinating casualties arrived alive at the UTH. Unsurprisingly, 61% of casualties that reached definitive care at our UTH had NCTH and their mortality rate was 58%. Our overall mortality rate was 54.2%. Combat injuries differ from civilian trauma using explosives and high-velocity missiles designed for maximum damage.[11] This fact is also relevant for urban operations, as reflected by the current study. Explosives were the dominant injury mechanism during military conflicts.[4,13] However, during urban operations, our data show that 73% of casualties were wounded by GSWs. Champion et al.[14] presented the only urban combat-related mortality data. Israeli Defence Forces' (IDF) most common urban conflict wounding mechanism was also GSWs, their evacuation time averaged 53 minutes, their chest injury rate was 67% and 73% of chest injuries had died. As a result, their exsanguination related mortality rate increased from 41% to 56%, which was a common finding in our study.

The mean Hb value of transfused patients may not appear to be too low. However, the Hb values measured in these patients are higher than they actually are due to hemoconcentration in acute blood loss. After acute and severe bleeding, it is generally assumed that Hb and hematocrit do not reflect the estimated blood loss since the passage of fluids through the interstitial space into the vessels is relatively slow.[15] Thus, we performed transfusion according to the injury site and severity of injury regardless of the measured Hb value.

Although not sufficient alone, ISS is a scoring method developed to predict mortality. Most trauma studies showed ISS scores correlated with prehospital hypotension or the need for urgent RBC transfusion upon hospital arrival.[16] Our study showed that ISS scores >15 were also associated with MT and a higher amount of RBC transfusion. Severe injuries that require transfusion have an increased mortality rate (range 10–20%).[17] Besides, a retrospective study from US military campaigns in Iraq suggested a significant decrease in mortality when ES, FFP and platelets were initially transfused at a 1:1:1 ratio.[18] Holcomb et al.[19] performed a prospective randomized study in civilian trauma patients and showed that a 1:1:1 transfusion ratio resulted in better hemostasis and decreased 24-hour mortality; however, the differences in 24-hour and 30-day survival was not statistically significant. In our cases, our data show that only 25% of erythrocytes were used (at a ratio of 1:0.8) for trauma patients; WFWB was preferred in the majority of cases. No platelet suspensions were available during the operations, which may have affected the type of blood/blood product use.

MT is required in exsanguinating patients, which has been estimated to occur in 3% to 5% of civilians and 8% to 10% of military trauma patients. Mortality in MT patients is the most common cause of death within 1-hour of arrival.[9] The mortality rate of these trauma casualties range between 40% to 60%, and they are reported to consume >70% of total RBCs transfused. In our study, the overall MT rate was 2.4%, but they only used 57% of all transfused RBCs. This relatively lower proportion of overall RBCs used in MT may be because some patients expired very early upon arrival that MT protocol could not be initiated.

Ramsey reviewed 24 medical reports on mass casualty events after 1980 for transfused RBCs.[20] The mean RBCs and FFP use per admitted patient was 3 and 2.1 units, respectively. They suggested that the number of patients might be useful for estimating the blood/blood product needs, especially in terrorist bombings. Although our mean transfused RBCs were 7.7 units, which was not surprisingly high as military trauma creates more severe injuries, the authors of this study agree with Ramsey's RBC need estimation method.

Despite the paucity of trauma data-driven studies in Turkey, injury prevention, control of compressible blood losses using modern military tourniquets[21] expedited transport to military treatment facilities, early resuscitation of ongoing hemorrhage by blood and blood products,[17,22] and increasing the national transfusion capabilities by different blood/blood products[23,24] have become the primary focus of Turkish trauma system. These and other ongoing efforts to improve the Turkish trauma system need to be implemented to increase the preparedness levels for national security protection.

This study has inherent limitations. Our data lack blood pressure measurements, standard transfusion triggers, blood gas analyses, time to transport after injury, follow up after medical evacuation to a higher level center. Additionally, the number of cases in this retrospective descriptive study is small, as it includes cases limited to a two-year tenure. However, to our knowledge, this is the first study on transfused urban combat casualties in Turkey, and it will make a significant contribution to the literature.

Conclusion

Torso injuries that occurred in the combat field are associated with high MT and mortality rates. Although larger series are obviously needed to obtain a brighter picture of such injuries, we can roughly estimate the significance of the ISS score and the presence of torso injury. Thus, medical personnel will be alerted for immediate and accurate intervention to these injuries.

Ethics Committee Approval: Approved by the local ethics committee.

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Saha hastanesinde kan transfüzyonu uygulanan hastalarda yaralanma şiddeti ve anatomik lokalizasyonunun analizi

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AMAÇ: Travma olgularında en önemli mortalite nedeni kanamadır. Yaralıların hızlı değerlendirmesi ve uygun transfüzyonu hayat kurtarıcıdır. Bu çalışmanın amacı, mevcut verilere dayanarak, kan/kan ürünü transfüzyon deneyimlerini analiz etmek, transfüzyon gereksinimi ile yaralanma şiddeti skoru (injury severity score-ISS), ve yaralanma bölgesinin anatomik yerleşimi arasında ilişkiyi değerlendirmektir.
GEREÇ VE YÖNTEM: Çalışmaya 30 Temmuz 2014–30 Temmuz 2016 tarihleri arasında, saha hastanesine başvuran ve en az bir ünite kan/kan ürünü transfüzyonu yapılan yaralılar alındı. Hastane transfüzyon kayıt defterinden, hastaların yaşı, yaralanma mekanizması, yaralanmanın anatomik yerleşimi, hastaneye kabul hemoglobin (g/dL) değeri, ISS, transfüze edilmiş eritrosit süspansiyonu, sıcak taze tam kan, taze donmuş plazma gibi kan ürünleri miktarı ve masif transfüzyon (MT) oranı ile ilgili veriler elde edildi.
BULGULAR: Tüm hastalar erkekti, ortalama yaş 28.7±7.8 yıl idi. Toplamda 579 hastadan 59'una (%10) 458 ünite RBC (ES+WFWB) transfüzyonu yapıldı. Transfüzyon uygulanan yaralıların %61'inde gövde (toraks±karın) yaralanması vardı ve bu hastaların %93'üne masif transfüzyon uygulandı. Hastaların % 71'inde ISS >15 idi ve bu hastalarda istatistiksel olarak anlamlı yüksek kan/kan ürünleri kullanımı ve MT oranı vardı (p=0.021, p=0.006).
TARTIŞMA: Yaralanmaların ve ISS'nin anatomik yeri, MT'nin hızlı bir şekilde belirlenmesinde ve kazazedelerin hayatta kalma oranlarında değerlidir. Özellikle gövde yaralanmalarında kanama kontrolü zordur ve transfüzyon gereksinimi ve mortalite oranları yüksektir. Ayrıca bu makale bir saha hastanesindeki, kentsel arazi çatışmasıyla ilgili transfüzyon verilerini sunmaktadır.
Anahtar sözcükler: Kanama; taze tam kan; transfüzyon; travma.

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