



Anemia Development and Retrospective Evaluation of Blood Transfusions in Patients in Anesthesia Intensive Care Unit

Anestezi Yoğun Bakım Ünitesinde Yatan Hastalarda Anemi Gelişimi ve Kan Transfüzyonlarının Retrospektif Değerlendirilmesi

İ Oğuz Kağan Bulut¹, İ Azize Beştaş², İ Serpil Bayındır¹, İ Eşef Bolat², İ Ramazan Akel³, İ İsmail Demirel²

¹Elazığ Fethi Sekin City Hospital, Clinic of Anesthesiology and Reanimation, Elazığ, Türkiye

²Fırat University Faculty of Medicine, Department of Anaesthesiology and Reanimation, Elazığ, Türkiye

³Biga State Hospital, Clinic of Anesthesiology and Reanimation, Çanakkale, Türkiye

ABSTRACT

Objective: Anemia is a common problem of critically ill patients in intensive care units (ICU). This retrospective single-center study. We aimed to investigate the incidence of anemia and transfusions, transfusion-related risks, and clinical outcomes. We also investigated the contribution of the amount of blood taken for diagnosis and follow-up purposes to anemia.

Materials and Methods: In this retrospective single-center study (01.01.2015-31.12.2015), patients aged 18 years and older who were hospitalized for more than 24 hours were divided into two groups male (Group E) and female (Group K) and compared. The first 30-day hemoglobin (Hb) values, Hb values before and after transfusion, daily blood losses, and fluid balance, indications for transfusion, and related complications, and the number of erythrocyte suspensions used were recorded.

Results: Anemia was present in 60.7% and 83.9% of the patients on day 1 and day 3. Anaemia developed on the 3rd day in 55.6% of non-anemic patients. The mean Hb before transfusion was 7.5 ± 1.3 g/dL and the mean Hb after transfusion was 6.9 ± 1.1 g/dL. We found that the acute physiology and chronic health evaluation II score was higher in patients who received transfusion, and mortality was higher in female patients. On the 1st day of hospitalization, a mean of 37.0 ± 15.7 mL/person blood sample was taken; due to repeated blood samples (mean 147.2 ± 117.1 mL), we found that Hb values decreased significantly to require blood transfusion.

Conclusion: It was found that the majority of the patients admitted to the ICU were anaemic. Hb values continued to decrease over time. Repeated blood sampling contributed to the development of anaemia. Febrile reaction was the most common transfusion-related complication. It was concluded that practices in accordance with the current universal transfusion guidelines were performed.

Keywords: Anemia, blood transfusion, intensive care unit

ÖZ

Amaç: Yoğun bakım hastalarında anemi gelişimi sık karşılaşılan bir problemdir. Yoğun bakım kritik hastalarında anemi ve transfüzyon insidansını, transfüzyon ilişkili riskleri ve klinik sonuçları, tanı ve takip amaçlı alınan kan miktarının anemiye gelişimine katkısını retrospektif olarak araştırmayı amaçladık.

Gereç ve Yöntem: Retrospektif tek merkezli çalışmaya (01.01.2015-31.12.2015) 24 saatten uzun süreli yatan, 18 yaş ve üstü hastalar erkek (Grup E) ve kadın (Grup K) olarak iki gruba ayrılarak karşılaştırıldı. Transfüzyon yapılan ve yapılmayan hastaların ilk 30 günlük hemoglobin (Hb) değerleri, transfüzyon öncesi ve sonrası Hb değerleri, günlük kan kayıpları ve sıvı dengesi, transfüzyon endikasyonları ve ilişkili komplikasyonlar, kullanılan eritrosit süspansiyonu sayıları kaydedildi.

Bulgular: Hastaların yatışın 1. günü %60,7, 3. gününde %83,9'u anemikti. Anemik olmayanların %55,6'sında 3. günde anemi geliştiği saptandı. Hastaların transfüzyon öncesi Hb ortalaması $7,5 \pm 1,3$ g/dL, transfüzyon sonrası Hb ortalaması $6,9 \pm 1,1$ g/dL idi. Transfüzyon yapılanlarda akut fizyoloji ve kronik sağlık değerlendirmesi II skorunun daha yüksek olduğu ve bunlardan kadın hastaların mortalitelerinin daha yüksek olduğunu tespit ettik. Yatışın 1. günü ortalama $37,0 \pm 15,7$ mL/kişi kan örneğinin alındığını; tekrarlayan kan örnekler (ortalama $147,2 \pm 117,1$ mL) nedeniyle, Hb değerlerinin kan transfüzyonu gerektirecek şekilde anlamlı derecede düştüğünü tespit ettik.

Sonuç: Yoğun bakıma kabul edilen hastaların çoğunluğunun anemik olduğu, zaman içinde Hb değerlerinde düşüş devam ettiği; tekrarlayan kan örneklerinin anemi gelişimine katkısı olduğu; transfüzyon ilişkili komplikasyon olarak en sık febril reaksiyon görüldüğü tespit edildi ve mevcut evrensel transfüzyon rehberlerine uygun uygulamalar yapıldığı görüşüne varıldı.

Anahtar Kelimeler: Anemi, kan transfüzyonu, yoğun bakım ünitesi

Address for Correspondence/Yazışma Adresi: Serpil Bayındır MD, Elazığ Fethi Sekin City Hospital, Clinic of Anesthesiology and Reanimation, Elazığ, Türkiye

E-mail: serpilbayindir@gmail.com ORCID ID: orcid.org/0000-0001-7250-7060

Received/Geliş Tarihi: 08.12.2023 Accepted/Kabul Tarihi: 12.07.2024 Epub: 04.09.2024 Publication Date/Yayın Tarihi: 26.02.2025

Cite this article as: Bulut OK, Beştaş A, Bayındır S, Bolat E, Akel R, Demirel İ. Anemia development and retrospective evaluation of blood transfusions in patients in anesthesia intensive care unit. Türk J Intensive Care. 2025;23:30-37



Copyright© 2025 The Author. Published by Galenos Publishing House on behalf of Turkish Society of Intensive Care. This is an open access article under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License.

Introduction

Anemia, which is one of the most common hematological problems in society, can be defined as a decrease in the erythrocyte mass, which causes insufficient oxygen delivery to the tissues.

The development of anemia in critically ill patients during intensive care unit (ICU) follow-up and treatment is a common problem (1). Surgical procedures, coagulopathies, gastrointestinal system loss, intravascular hemolysis, nutritional deficiencies, and recurrent blood loss are among the most common causes of anemia in the ICU (2). Taking blood from ICU patients for diagnosis and follow-up, diagnostic blood loss (DBL) (coronary artery calcium) and phlebotomy are among the most important causes of anemia that are mostly neglected (3). In studies, because of the multiple causes of anemia, approximately one-third of ICU patients underwent transfusion without clinical indication, and the mortality rate in emergency department patients increased due to this high rate of transfusion (1,4,5). Transfusion of blood and blood products can be beneficial only when morbidity or mortality cannot be prevented by all other treatment methods. However, blood transfusion can reduce morbidity and mortality when used correctly despite the risks (6,7).

This study aimed to define the incidence of anemia and transfusion in patients undergoing follow-up and treatment, to determine the threshold hemoglobin (Hb) value used for transfusion, to identify the risks associated with transfusion, to evaluate the relationship between transfusion and clinical outcomes, and to investigate retrospectively the contribution of the amount of blood taken for diagnostic and follow-up to anemia. This investigation was conducted in the ICU of the Department of Anesthesiology and Reanimation Firat University Hospital.

Materials and Methods

In our study, after obtaining approval from the Firat University Hospital administration for reviewing patient records and the approval of the Firat University Non-Interventional Research Ethics Committee, (decision no: 18, date: 05.10.2016) the hospital files of all patients who were followed up and treated in Firat University Hospital Anesthesia ICU between 01.01.2015-12.31.2015 and the data recorded in Enlil Hospital Information Management System of Firat University Hospital were analyzed retrospectively.

Patients with a hospitalization time of less than 24 hours, patients younger than 18 years, patients with a history of

bleeding diathesis and/or hematologic disease, patients with acute renal failure (0.5 mg/dL/day increase in serum creatinine (Cr) basal value and/or 24-hour urine volume <400 mL) or chronic renal failure (Cr >1.3 mg/dL in women, Cr >1.5 mg/dL in men) and patients with sepsis having extreme values were excluded from the evaluation. Patients were divided into two groups, male (Group E) and female (Group K), and their data were compared.

Age, Glasgow coma scale (GCS) values, hospitalization diagnoses, and additional diagnoses during admission, presence of co-morbidities, acute physiology and chronic health evaluation II (APACHE II) scores calculated in the first 24 hours, and Hb values measured at admission to anesthesia ICU (AICU) were recorded. Daily Hb values, daily DBL, and daily fluid balance (FB) in the first 30 days of hospitalization, Hb values before and after transfusion, indications for transfusion, number of erythrocyte suspension (ES) units used, complications associated with transfusion, and length of stay in the ICU were recorded. Daily FB was calculated using the difference between the total amount of enterally and parenterally administered fluids and the total urine volume within 24 hours. TKC was calculated separately for each patient based on blood tests such as hemogram, biochemical analysis, arterial blood gas (ABG), etc., for each day in the ICU. The amount of blood taken was recorded as 2 mL for ABG, 5 mL for hemogram, 1 mL for erythrocyte sedimentation rate, 5 mL for biochemical analysis, 3 mL for coagulation tests, 30 mL for blood culture, 6 mL for human immunodeficiency virus and hepatitis testing, 5 mL for drug levels, and 2 mL for standard excretion.

Statistical Analysis

Statistical analysis of the data was performed using the SPSS version 22.0. Data obtained from the census were evaluated by the chi-square test and Fisher's exact test if the expected value was less than 5; the Wilcoxon rank sum test, t-test, and Mann-Whitney U test were used for the data obtained by measurement. $P < 0.05$ was considered significant.

Results

A total of 413 patients were admitted to the AICU during the year between 01.01.2015 and 12.31.2015. Each admission of the patients who were admitted to the ICU more than once at different times in the same year, 3 patients in Group E, and 10 patients in Group K, was included in the evaluation separately. Data from 184 patients were excluded. The data of 229 patients-119 males and 110 females-, were evaluated.

Since 90% of these patients had less than 30 days of stay in the ICU, the data on the first 30 days of hospitalization were evaluated, because the data on hospitalization after 30 days could adversely affect the arithmetic mean as extreme values.

In general, the mean length of stay in the ICU was 12.2 ± 16.6 days (min: 2 days, max: 87 days). The duration of stay in the AICU of 90% of the patients included in the study was less than 30 days. Of these, 69.4% (n=159) had less than 10 days of stay in the AICU.

The reasons for admission to the ICU were 31.4% postoperative follow-up, 10% trauma, and 58.6% medical diseases including respiratory system problems such as chronic obstructive pulmonary disease, and pneumonia; neurological problems such as cerebrovascular disease, intracranial mass; cardiovascular system problems such as ischemic heart disease, myocardial infarction, etc., Table 1.

The median of GCS values was found to be 9 (Table 1). There was no statistically significant difference between the two groups in terms of the reasons for admission to ICU, GCS values, length of stay in ICU, and exit from ICU ($p > 0.05$, Table 1).

The mean APACHE II scores were found to be 21.20 ± 6.9 (min: 6, max: 37), 20.93 ± 6.68 in Group E and 21.50 ± 7.33 in Group K. Patients who underwent blood transfusion, 22.00 ± 4.51 in Group E, 23.90 ± 6.21 in Group K, had significantly higher APACHE II scores than those who did not undergo blood transfusion, 20.59 ± 7.72 in Group E, 20.64 ± 7.54 in Group K. However, no statistically significant difference was detected between the groups (Table 2).

It was found that 60.7% of the patients, 62.2% in Group E and 59.1% in Group K, were anemic on the day of admission to the ICU. It was observed that this rate increased to 83.9%, 81.9% in Group E and 86.2% in Group K on the 3rd day of hospitalization, and decreases in mean Hb values continued over the following days. Anemia developed on the 3rd day of hospitalization in 55.6%, 50% in Group E, and 63.2% in Group K, of patients who were not anemic on the day of admission to the ICU. In terms of changes in Hb values, although women had lower Hb values in all periods, there was no statistically significant difference between the two groups except for the 3rd and 20th days of hospitalization ($p < 0.05$).

An equal number of 58 (25.3%) patients from both groups were transfused with ES for indications such as anemia (41.4%), acute bleeding (24.1%), surgical intervention (12.1%) or hemodynamic instability (22.4%), (Table 3). Pre-transfusion Hb values were below 7 g/dL in 24 patients, between 7-10g/dL in 31 patients, and above 10 g/dL in 3 patients, who underwent transfusion due to acute hemorrhage.

In our study, the mean pre-transfusion Hb value was 7.5 ± 1.3 g/dL (min: 4.7 g/dL, max: 10.5 g/dL); for transfusions with anemia indication, the mean pre-transfusion Hb values were 6.9 ± 1.1 g/dL (min: 4.7 g/dL, max: 9.2 g/dL). There was no statistically significant difference between the groups in terms of the reasons for transfusion patients' admission to the ICU (Table 4).

18.9% of the transfused patients underwent transfusion within the first 24 hours of their stay in the ICU, and approximately half (46.5%) were transfused within the first three days (Figure 1).

Complications developed in 17.2% (n=10) of the transfused patients and were thought to be associated with transfusion (Table 5). The most common complication was febrile reaction (90%). An allergic reaction developed in one patient.

When we look at the exit status of patients from the ICU, 17.5% of the discharged patients and 38.4% of the patients who died were transfused. Among transfused patients, the number of patients who died was higher in Group K, and this difference was statistically significant ($p < 0.05$, Table 6).

Although the amount of DBL per ICU day was higher in transfused patients than in non-transfused patients, it was significantly higher in patients who underwent transfusion per ICU day ($p < 0.05$). There was no statistically significant difference between the groups in terms of total DBL and FB amounts, and mean values per intensive care day ($p > 0.05$, Table 7).

Discussion

Anemia is either present or may develop in the early period in the majority of patients who are monitored in the ICU. Anemia was reported in 95% of the patients 3 days after admission to the ICU (3,8). In our study, although the female patients had lower Hb values, similar changes were observed in the Hb values of both male and female patients undergoing intensive care in our AICU. According to the definition of World Health Organization (WHO); Hb values $Hb < 13$ g/dL [Haematocrit (Htc) $< 39\%$] in adult men and $Hb < 12$ g / dL (Hct $< 36\%$) in non-pregnant women are accepted as anemia (9). According to this definition, it was observed that 60.7% of the patients were anemic on the day they were admitted to the ICU. This rate was 83.9% on the 3rd day of their hospitalization, and the decrease in mean Hb values continued over time. Anemia developed on the third day of hospitalization in 55.6% of the patients who were not anemic at the time of their admission to the ICU. These changes in Hb

Table 1. Characteristics of patients

	Group E n (%)	Group K n (%)	Total n (%)	
Age groups (year)				
<50	41 (34.5)	37 (33.6)	78 (34.1)	X ² =0.40 p=0.980
51-69	33 (27.7)	30 (27.3)	63 (27.5)	
> 70	45 (37.8)	43 (39.1)	88 (38.4)	
Surgical intervention				
Yes (postoperative acceptance)	43 (36.1)	49 (44.5)	92 (40.2)	X ² =1.734 p=0.420
During their stay	15(12.6)	13(11.8)	28 (12.2)	
No	61 (51.3)	48 (43.6)	109 (47.6)	
Admittance diagnosis				
Postoperative follow-up	35 (29.4)	37 (33.6)	72 (31.4)	X ² =7.514 p=0.185
Respiratory system problems	31 (26.1)	31 (28.2)	62 (27.1)	
Neurological problems	21 (17.6)	20 18.2)	41 (17.9)	
CVS system problems	5 (4.2)	5 (4.5)	10 (4.4)	
Trauma	18 (15.1)	5 (4.5)	23(10.0)	
Other	9 (7.6)	12(10.9)	21 (9.2)	
Associated disease				
Single system disease	47 (39.5)	43 (39.1)	90 (39.3)	X ² =8.510 p=0.037
Two system disease	24 (20.2)	32(29.1)	56 (24.5)	
More than two system disease	7 (5.9)	13(11.8)	20 (8.7)	
No	41 (34.5)*	22 (20.0)	63 (27.5)	
GKS				
Coma (3)	11 (9.2)	12(10.9)	23(10.0)	X ² =3.975 p=0.409
Precoma (4-7)	29 (24.4)	37 (33.6)	66 (28.8)	
Stupor (8-12)	55 (46.2)	38 (34.5)	93 (40.6)	
Confusion (13-14)	19(16.0)	17(15.5)	36 (15.7)	
Oriented (15)	5 (4.2)	6 (5.5)	11 (4.8)	
Admittance Hb (g/dL)				
S7	0 (0.0)	3 (2.7)	3(1.3)	X ² =3.851 p=0.146
7-10	33 (27.7)	25 (22.7)	58 (25.3)	
S10	86 (72.3)	82 (84.5)	168 (73.4)	
Transfusion status				
Yes	29 (24.4)	29 (26.4)	58 (25.3)	X ² =0.120 p=0.729
No	90 (75.6)	81 (73.6)	171 (74.7)	
Exit status from ICU				
Discharged	75 (63.0)	68 (61.8)	143 (62.4)	X ² =0.036 p=0.851
Death	44 (37.0)	42 (38.2)	86 (37.6)	

*: p<0.05, in Group E according to Group K, Hb: hemoglobin, ICU: intensive care unit, GCS: Glasgow coma scale, CVS: cardiovascular system

*: $p<0.05$, in Group E according to Group K, Hb: hemoglobin, ICU: intensive care unit, GCS: Glasgow coma scale, CVS: cardiovascular system

levels compared to the values at the time of admission were statistically significant.

Corwin et al. (4) showed that 50% of intensive care patients underwent blood transfusion during hospitalization, and this

rate increased to 85% in patients with hospitalization longer than one week. Vincent et al. (3) reported, similar to Corwin et al. (4), that the majority of transfusions were performed in the first week of admission to ICUs and that 73% of the patients in

the ICU for more than one week were transfused. In the same study, they reported that 41% of patients underwent transfusion within 28 days. In our study, we observed that 25.3% of the patients underwent transfusion within 30 days, 39.8% of the patients hospitalized for more than one week underwent transfusion, and a statistically significant relationship was observed between the duration of ICU stay and transfusion rates. There was no statistically significant difference between the groups in terms of length of stay in the ICU.

Table 2. Evaluation of APACHE II scores of patients

	Number of patients	Mean $\pm$ SD	p-value
Male	119	20.93 $\pm$ 6.67	0.541
Female	110	21,50 $\pm$ 7.33	
Underwent T ransfusion	58	22.95 $\pm$ 5.47*	0.028
No Transfusion	171	20.61 $\pm$ 7.35	
Underwent Transfusion			
Male	29	22.00 $\pm$ 4.51	0.189
Female	29	23.90 $\pm$ 6.21	

*: p<0.05, people underwent transfusion compared to who did not, SD: standard deviation, APACHE: acute physiology and chronic health evaluation

Table 3. Distribution of transfusion indications by groups

First transfusion reason	Group E n (%)	Group K n (%)	Total n(%)
Anemia	11 (37.9)	13 (44.8)	24 (41.4)
Acute hemorrhage	8 (27.7)	6 (20.7)	14 (24.1)
Surgery during follow-up	3 (10.3)	4 (13.8)	7 (12.1)
Hemodynamic instability	7 (24.1)	6 (20.7)	13(22.4)
Total	29 (100)	29 (100)	58 (100)

$\chi^2=0.672$, p=0.880

Table 4. Distribution of transfusion patients' reasons for admission to intensive care unit

Reasons for admission to intensive care	Group E n (%)	Group K n (%)	Total n (%)
Postoperative follow-up	8 (27.6)	8 (27.6)	16 (27.6)
Respiratory system problems	6 (20.7)	10 (34.5)	16 (27.6)
Neurological problems	4(13.8)	6 (20.7)	10 (17.3)
Cardiovascular system problems	0 (0.0)	2 (6.9)	2 (3.4)
Trauma	11 (37.9)	2 (6.9)	13 (22.4)
Other	0 (0.0)	1 (3.4)	1 (1-7)

$\chi^2=10.631$, p=0.059

In blood transfusion practice, there may be different implementations depending on the hospital. Hébert et al. (10) observed many institutional changes in their study, including patients with similar age, arrival APACHE II scores, and similar conditions in four main categories; cardiovascular diseases, respiratory failure, major surgeries, and trauma. Vincent et al. (3) found significant differences in the transfusion rates of ICUs, with the highest rate (44.2%) observed in academic hospitals. The researchers attributed this difference between hospitals to the patient populations examined. Our hospital is a university hospital and tertiary health center that also serves the surrounding provinces. Therefore, patients with serious diseases can be treated in our hospital. Therefore, APACHE II scores of transfused patients are expected to be higher than those of non-transfused patients. More invasive procedures are applied to patients with serious disease, different laboratory tests are required, and therefore the blood volume taken is higher, and as a result, these patients are more prone to anemia (11). Similarly, the high APACHE II score in our AICU was associated with a higher number of blood samples for diagnostic purposes.

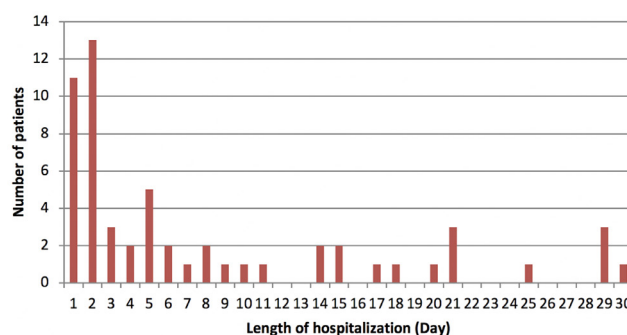


Figure 1. Distribution of transfused patients according to days in which transfusion implemented

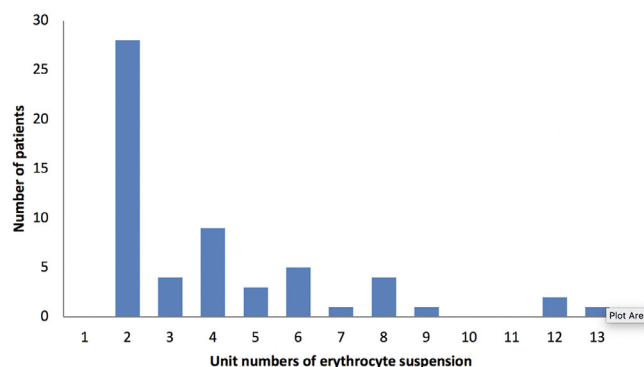


Figure 2. Unit numbers of transfused erythrocyte suspension

Threshold Hb level is one of the main determinants of transfusion decisions (12). The threshold Hb value for blood transfusion varies between hospitals from 7-12 g/dL (10,12-14). As a result of the multicenter ABC study involving 3534 patients, the transfusion threshold Hb value was found to be 8.4 g/dL (3). A similar threshold Hb value (8.6 g/dL) was found in the CRIT study (14). In the same study, many patients were able to tolerate Hb values of 7 g/dL and below. According to the Cochrane group (15), the threshold for transfusion should be 7-9 g/dL in patients without severe cardiac disease. In our study, the mean pre-transfusion Hb value was generally 7.5 ± 1.3 g/dL (min: 4.7 g/dL, max: 10.5 g/dL), and in transfusions with anemia indication, it was 6.9 ± 1.1 g/dL (min:

4.7 g/dL, max: 9.2 g/dL). Three patients with Hb values of 10 g/dL and over before transfusion were transfused for acute hemorrhage.

In a study by King et al. (16), a non-hemolytic febrile reaction was observed in 6.8% of patients who received ES transfusions without leukocyte reduction. Allergic reactions are common after transfusion of blood products, and the severity of these reactions varies clinically (17). During our study, complications developed after transfusion in 17.2% of the patients who underwent transfusion, with 9 febrile cases and 1 allergic reaction case.

In a meta-analysis (18), the daily blood intake for laboratory tests was 377 mL/day in the cardiothoracic ICU and 240 mL/day in the general surgery ICU. Corwin et al. (4) reported that approximately 60-70 mL of blood samples were obtained from 49% of the patients undergoing blood transfusion and there was no reason requiring transfusion in 29%, and that blood draw was one of the most common causes of transfusion in patients who were followed up in the ICU for a long time. Chant et al. (12) suggested that blood transfusion was correlated with the amount of blood transfused to critically ill patients

Table 5. Complications after transfusion

Complication after transfusion	Group E n (%)	Group K n (%)	Total n (%)
Febrile reaction	6 (10.3)	3 (5.2)	9 (15.5)
Allergic reaction	1 (1-7)	0 (0.0)	1 (1-7)
None	22 (37.9)	26 (44.8)	48 (82.7)
$\chi^2=2.333$, $p=0.331$			

Table 6. Exit status from intensive care unit by groups

Exit Status from ICU		Group E n (%)	Group K n (%)	Total n (%)
Discharged	Underwent	17 (%68.0)	8 (%32.0)	25 (%100)
Transfusion	No transfusion	58 (%49.2)	60 (%50.8)	118 (%100)
Death	Underwent	12 (%36.4)	21 (%63.6)	33 (%100)
Transfusion	No transfusion	32 (%60.4)	21 (%39.6)	53 (%100)
ICU: intensive care unit				

Table 7. Distribution of mean of diagnostic blood loss and fluid balance by groups

	Group E n [Mean+SS (mL)*]	Group K n [Mean±SS (mL)*]	p-value
DBL Total			
Underwent T ransfusion	29 (133.82±101.84)	29 (165.79±140.22)	$p=0.323$
No Transfusion	90 (134.80±124.06)	81 (137.86±127.32)	$p=0.874$
DBL, per ICU day			
Underwent Transfusion	29 (29.34±15.97)	29 (24.44±14.01)	$p=0.220$
No Transfusion	90 (21.84±8.86)	81 (22.85±11.28)	$p=0.515$
FB Total			
Underwent T ransfusion	29 (5019.31 ±7379.57)	29 (5286.38±7212.88)	$p=0.890$
No Transfusion	90 (5687.89±7281.94)	81 (5390.57±6583.11)	$p=0.781$
FB, per ICU day			
Underwent Transfusion	29 (531.96±472.92)	29 (694.82±991.64)	$p=0.428$
No Transfusion	90 (679.46±591.73)	81 (651.72±536.77)	$p=0.750$

* The mean values of the transfused patients until the day of transfusion, DBL: Diagnostic blood loss, FB: Fluid balance, ICU: Intensive care unit, SD: standard deviation

with a hospitalization duration of approximately 50 days. In the studies performed, it was reported that most blood samples were taken in the ICU in the first 24 hours and that the number of samples decreased gradually in the following days (19,20). In the ABC study (3), the mean DBL was 41.1 ± 39.7 mL/day in the ICU and there was a positive correlation between organ dysfunction and daily blood intake. A decrease in Hb concentration in ICU patients also contributes to increased blood loss and erythrocyte destruction during interventions such as central catheter placement, blood gas sampling, as well as DBL (21). In addition, erythrocyte production decreases due to the direct inhibitory effects of inflammatory cytokines on erythropoietin production in critical patients (22-24). In some studies, it was emphasized that in about one-third of transfusion events, no indication was identified; transfusions were usually performed due to daily DBL. It was concluded that blood transfusions should be conservative and transfusion guidelines should be followed (1,5,7). There are also studies reporting that factors, such as disease severity scores and mechanical ventilation therapy, have a positive correlation with high DBL (3,25). In our study, while the total DBL and per-intensive-care-day DBL patients who underwent transfusion (total DBL 149.76 mL; mean 26.89 mL/day) were found to be higher compared to non-transfused patients (total DBL 136.25 mL; mean 22.32 mL/day), a statistically significant difference was observed only in the per-ICU-day DBL for transfused patients. However, there was no statistically significant difference between the groups. The higher DBL means of transfused patients may be due to the higher APACHE II scores.

Conclusion

In conclusion, we found that most of the patients admitted to the ICU had Hb levels that could be accepted as anemic, according to the definition of the WHO. The decrease in mean Hb values continued over time in the following days. Of the patients who were not anemic at the time of admittance, 55.6% (50% in Group E, 63.2% in Group K) had developed anemia by the 3rd day of hospitalization. The mean Hb value before transfusion in our ICU was 7.5 ± 1.3 g/dL (min: 4.7 g/dL, max: 10.5 g/dL). In transfusions done with anemia indication, the mean pre-transfusion Hb values were 6.9 ± 1.1 g/dL (min: 4.7 g/dL, max: 9.2 g/dL). A mean of 37.0 ± 15.7 mL of blood sample per person was taken for diagnostic purposes on the first day of hospitalization. Due to repeated blood samples (mean 147.2 ± 117.1 mL) over time, Hb values decreased significantly, requiring blood transfusion. In patients undergoing transfusion, we determined that only a few cases

had febrile reactions and one patient had allergic reactions as transfusion-related complications. The mortality rate was higher in transfused patients than in non-transfused patients; however, transfused patients had higher APACHE II scores, and mortality rates were higher in female patients undergoing transfusion.

Ethics

Ethics Committee Approval: In our study, permission to examine patient records was obtained from the management of Firat University Hospital and approval was obtained from the Firat University Non-Interventional Research Ethics Committee (decision no: 18, date: 05.10.2016).

Informed Consent: the data recorded in Enlil Hospital Information Management System of Firat University Hospital were analyzed retrospectively.

Footnotes

Authorship Contributions

Concept: O.K.B., S.B., R.A., İ.D., Design: O.K.B., A.B., S.B., E.B., İ.D., Data Collection or Processing: O.K.B., S.B., E.B., R.A., Analysis or Interpretation: O.K.B., A.B., E.B., İ.D., Literature Search: O.K.B., S.B., R.A., Writing: O.K.B., A.B., S.B., İ.D.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Corwin HL, Surgenor SD, Gettinger A. Transfusion practice in the critically ill. *Crit Care Med*. 2003;31:668-71.
2. Lelubre C, Vincent JL. Red blood cell transfusion in the critically ill patient. *Ann Intensive Care*. 2011;1:43.
3. Vincent JL, Baron JF, Reinhart K, Gattinoni L, Thijs L, Webb A, et al. ABC (anemia and blood transfusion in critical care) investigators. Anemia and blood transfusion in critically ill patients. *JAMA*. 2002;288:1499-507.
4. Corwin HL, Parsonnet KC, Gettinger A. RBC transfusion in the ICU. Is there a reason? *Chest*. 1995;108:767-71.
5. Napolitano LM. Scope of the problem: epidemiology of anemia and use of blood transfusions in critical care. *Critical Care* 2004;8:18.
6. Carson JL, Hill S, Carless P, Hébert P, Henry D. Transfusion triggers: a systematic review of the literature. *Transfus Med Rev*. 2002;16:187-99.
7. Tinmouth AT, McIntyre LA, Fowler RA. Blood conservation strategies to reduce the need for red blood cell transfusion in critically ill patients. *CMAJ*. 2008;178:49-57.
8. Page C, Retter A, Wyncoll D. Blood conservation devices in critical care: a narrative review. *Ann Intensive Care*. 2013;3:14.

9. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva. Access link: <https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1>
10. Hébert PC, Wells G, Martin C, Tweeddale M, Marshall J, Blajchman M, et al. Variation in red cell transfusion practice in the intensive care unit: a multicentre cohort study. *Crit Care*. 1999;3:57-63.
11. Nguyen BV, Bota DP, Mélot C, Vincent JL. Time course of hemoglobin concentrations in nonbleeding intensive care unit patients. *Crit Care Med*. 2003;31:406-10.
12. Chant C, Wilson G, Friedrich JO. Anemia, transfusion, and phlebotomy practices in critically ill patients with prolonged ICU length of stay: a cohort study. *Crit Care*. 2006;10:140.
13. Rao MP, Boralessa H, Morgan C, Soni N, Goldhill DR, Brett SJ, et al. North thames blood interest group. blood component use in critically ill patients. *Anaesthesia*. 2002;57:530-4.
14. Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, et al. The CRIT study: anemia and blood transfusion in the critically ill--current clinical practice in the united states. *Crit Care Med*. 2004;32:39-52.
15. Carson JL, Carless PA, Hébert PC. Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion. *Cochrane Database Syst Rev*. 2016;10:CD002042.
16. King KE, Shirey RS, Thoman SK, Bensen-Kennedy D, Tanz WS, Ness PM. Universal leukoreduction decreases the incidence of febrile nonhemolytic transfusion reactions to RBCs. *Transfusion*. 2004;44:25-9.
17. Domen RE, Hoeltge GA. Allergic transfusion reactions: an evaluation of 273 consecutive reactions. *Arch Pathol Lab Med*. 2003;127:316-20.
18. Henry M, Garner W, Fabri P. Iatrogenic anemia. *American Journal of Surgery* 1986;151:362-63.
19. T. Saleh E. Anaemia during critical illness. *Br J Anaest*. 2006;97:278-91.
20. Hajjar LA, Auler Junior JO, Santos L, Galas F. Blood tranfusion in critically ill patients: state of the art. *Clinics (Sao Paulo)*. 2007;62:507-24.
21. Vincent JL, Sakr Y, Sprung C, Harboe S, Damas P. Sepsis occurrence in acutely ill patients (SOAP) investigators. Are blood transfusions associated with greater mortality rates? Results of the sepsis occurrence in acutely ill patients study. *Anesthesiology*. 2008;108:31-9.
22. Fuller BM, Gajera M, Schorr C, Gerber D, Dellinger RP, Parrillo J, et al. Transfusion of packed red blood cells is not associated with improved central venous oxygen saturation or organ function in patients with septic shock. *J Emerg Med*. 2012;43:593-8.
23. Shapiro MJ, Gettinger A, Corwin HL, Napolitano L, Levy M, Abraham E, et al. Anemia and blood transfusion in trauma patients admitted to the intensive care unit. *J Trauma*. 2003;55:269-73.
24. Leal-Noval SR, Muñoz-Gómez M, Jiménez-Sánchez M, Cayuela A, Leal-Romero M, Puppo-Moreno A, et al. Red blood cell transfusion in non-bleeding critically ill patients with moderate anemia: is there a benefit? *Intensive Care Med*. 2013;39:445-53.
25. Andrews T, Waterman H, Hillier V. Blood gas analysis: A study of blood loss in intensive care. *J Adv Nurs*. 1999;30:851-57.