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Original Article PEDIATRICS

How do the threshold values used in the decision on red blood cell and platelet transfusions comply with the guidelines?

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ABSTRACT

OBJECTIVE: Blood transfusion is life-saving medical practice with significant risks. National and international guidelines have been established for indications related to blood use and threshold values for transfusions. In this study, we aimed to determine the erythrocyte and thrombocyte transfusion rates in surgical, internal, and emergency clinics in our hospital and to compare the threshold values before erythrocyte and platelet (PLT) transfusion among the clinics.

METHODS: Red blood cell (RBC) and PLT transfusions in our hospital between January 2019 and June 2019 were retrospectively analyzed. Clinics were divided into three groups: surgical clinics, internal clinics, and emergency clinic. Demographic characteristics, pre-transfusion hemoglobin (Hb), and PLT values of patients were recorded. Data were analyzed statistically.

RESULTS: During the 6-month study period, 5179 patients were transfused in 24,924 patients and the transfusion rate was 21%. In this period, a total of 14,518 units of blood products including 8369 units RBC suspension and 1390 units PLT suspension were transfused. The mean age of the patient was 50.32±28.88 years and the female/male ratio was 1.11. The most RBC transfusions were performed in the general internal medicine service in internal clinics and gynecology in surgical clinics. The most PLT transfusions were performed in the general medicine service in internal clinics and pediatric cardiovascular surgery in surgical clinics. ES transfusions were performed in the emergency medicine clinic with the lowest mean Hb value (Hb: 8.07±1.84 g/dl) and in the surgical clinics with the highest mean Hb value (Hb: 9.29±1.46 g/dl). TS transfusions were performed in internal clinics with the lowest mean PLT value (PLT: 44030±44075/mm^3), while the highest mean PLT value (PLT: 97140±75782/mm^3) was performed in surgical clinics.

CONCLUSION: It was observed that threshold values in particular for PLT transfusions in our hospital were above the guideline recommendations. Our results suggest that the knowledge level of physicians about transfusion limits and practices should be increased.

Keywords: Platelet; red blood cell; transfusion.

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Blood transfusion is an important medical practice that is used frequently despite all the risks. It is known that blood transfusions have serious complications, some of which are life-threatening, which can be seen in short and long term [1]. While complications such as hemolytic reaction, febrile reaction, circulatory overload, transfusion-related lung injury, citrate toxicity, hyperkalemia, and post-transfusion purpura can be seen in the early period, viral, bacterial and parasitic infections, graft versus host disease, iron accumulation, and immunomodulation may develop in the long term [2].

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Red blood cell (RBC) transfusions are often performed to correct anemia and to increase preoperative oxygen transport capacity. RBC transfusion is life-saving in critically ill patients [3]. In transfusion practice, it is ensured that both unnecessary transfusions and possible complications are prevented with the correct indication. There are many national and international blood transfusion guidelines for using in daily practice [4, 5]. In our country, there is a guideline for appropriate clinical use of blood prepared by the Ministry of Health updated in 2020.

In this study, we aimed to determine the erythrocyte and thrombocyte transfusion rates in surgical, internal, and emergency clinics in our hospital and to compare threshold values before erythrocyte and platelet (PLT) transfusion among the mentioned clinics. It is planned to contribute to the blood transfusion strategy of our hospital by evaluating the compliance of our results with the guidelines.

Highlight key points

- RBC transfusions were mostly performed in the general internal medicine service within internal clinics and gynecology and obstetrics within surgical clinics in our study.
- The threshold values used for PLT transfusion were found to be higher than the guideline recommendations.
- There was a tendency to keep the PLT limit above 100.000/mm^3 in surgical clinics.

MATERIALS AND METHODS

Our hospital is one of the biggest research and training hospital in Istanbul, has 836 bed capacity, and provides treatment of complicated diseases with advanced healthcare services such as pediatric cardiology and pediatric cardiovascular surgery, pediatric and adult hematology-oncology clinics, solid organ transplantation units, pediatric bone marrow transplantation unit, two neonatal intensive care units, pediatric intensive care unit, and seven intensive care units for adult patients. All RBC and PLT transfusions within the 6-month period between January 2019 and June 2019 in our hospital were retrospectively analyzed. Plasma transfusions were excluded from the study. In this study, the data were created that combining the blood bank records with data from electronic health records for pre-transfusion laboratory results of the patients. The clinics where transfusions were administered to the patients were determined and these clinics were divided into three groups: emergency medicine, surgical clinics, and internal clinics. The demographic characteristics, hemoglobin (Hb), and PLT values of the patients before RBC and PLT transfusions were recorded. We compared pre-transfusion mean Hb for ES transfusion and pre-transfusion mean PLT values for TS transfusion among the mentioned clinics according to the threshold values in the transfusion guidelines. The recommendations of our national guideline for ES transfusion are: (1) if Hb 8-10g/dl and symptoms of tachycardia, hypotension, ischemia finding on ECG, lactic acidosis, and hypoxia, (2) if Hb <7–8 g/dl in chronic disease anemia, (3) if Hb <7–8 g/dl and acute leukemia, lymphoma, and stem cell transplant patients receiving chemotherapy, (4) Hb <6 g/dl patients without risk factors such as coronary artery disease, heart failure, and cerebrovascular disease, and (5) transfusion is not recommended if Hb >10 g/dl in people without additional disease. The recommendations of our national guideline for TS transfusion are as follows: (1) if PLT <10.000/mm^3 in patients with leukemia, solid tumor, and stem cell transplantation, (2) if PLT <20.000/mm^3 in patients with leukemia, solid tumor, and stem cell transplantation have additional risk factors such as fever, infection, and bleeding, (3) if PLT <20.000/mm^3 in patients with acute liver failure, (4) if PLT <100.000/mm^3 in patients with life-threating bleeding, (5) if PLT <50.000/mm^3 before lumbar puncture, (6) if PLT <50.000/mm^3 before percutaneous liver biopsy and transbronchial biopsy, (7) if PLT <20.000/mm^3 before non-invasive procedures such as endoscopy and bronchoscopy, (8) if PLT <100.000/mm^3 before eye or brain surgery, (9) if PLT <50.000/mm^3 before other major surgical operations, (10) if PLT <50.000/mm^3 before minor surgical and invasive procedures, (11) if PLT <20.000/mm^3 before catheterization, (12) if PLT <50.000/mm^3 before spinal anesthesia, and (13) if PLT <80.000/mm^3 in patients before epidural anesthesia. Our study complied with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. This study approved by Umraniye Training and Research Hospital's ethics committee.

Statistical Analysis

Statistical evaluation was performed using the Statistical Package for the Social Sciences (SPSS) for Windows 20 (IBM SPSS Inc., Chicago, IL). Categorical variables were expressed as numbers and percentages. Continuous variables were expressed as means with standard deviations as appropriate. Numbers and frequencies were calculated both overall and by subgroup.

Table 1. Number of patients and blood products with pre-transfusion mean Hb and PLT values

	Surgical clinics	Internal clinics	Emergency clinic	Total
Patients				5179
n	2274	1922	983	
%	43.9	37.1	19	
Total number of transfusions				14518
N	4390	8050	2128	
%	29.9	55.4	14.7	
RBC transfusions				
Patients n (%)	1042 (35.5)	1226 (41.8)	661 (22.5)	2929
Unit N (%)	2812 (33.6)	3695 (44.2)	1852 (22.1)	8359
*Mean Hb (g/dl)	9.29±1.46	8.45±1.46	8.07±1.84	
PLT transfusions				
Patient n (%)	62 (17.6)	265 (75.5)	24 (6.8)	351
Unit N (%)	175 (12.6)	1158 (83.3)	57 (4.1)	1390
**Mean PLT (/mm^3)	97140±75782	44030±44075	49570±34110	

Hb: Hemoglobin; PLT: Platelet; n: Number of patients; N: Number of blood products; *: Before RBC transfusions; **: Before PLT transfusions.

Table 2. Transfusion product types and their numbers by age group

	Number of patients		Number of transfusion		RBC transfusions		PLT transfusion	
	n	%	n	%	n	%	n	%
Newborn (0–1 month)	61	1.9	187	1.9	150	1.7	37	2.6
Children (0–18 years)	428	13	1395	14.3	973	11.6	422	30.3
Adult (>18 years)	2791	85	8167	83.7	7236	86.5	931	67
Total	3280	100	9749	100	8359	100	1390	100

RBC: Red blood cell; PLT: Platelet.

One-Way ANOVA and Tukey test were performed to test, whether there was a difference between the mean values. In statistical analysis, $p<0.05$ was considered significant.

RESULTS

During the 6 months of the study performed in our hospital, 24,924 inpatients were treated. Five thousand one hundred and seventy-nine patients had received at least one blood product. The rate of blood transfusion in our hospital was found to be 21%. In our study, a total of 14,518 units of blood products transfused during this period were examined including 8369 (57.6%) units of RBC, 1390 units (9.6%) of PLT suspensions, and 4759 (%32.8) units of plasma (Table 1). The mean age of patients receiving blood products was 50.32±28.88 years and the female/male ratio was 1.11. The oldest patient transfused was 100 years old. Of all patients who received ES and TS transfusion, 85% were adults, 13% were children, and 1.9% were newborns. The distribution of numbers of erythrocyte and PLT transfusions by age group is summarized in Table 2.

All clinics were divided into three main groups. Table 1 shows the total number of RBC and PLT transfusions used in surgical, internal, and emergency services. The mean Hb and the mean PLT values of the patients according to the clinics are given in Table 3.

Table 3. Features of transfusions according to the clinics in our hospital

Clinics	Number of total transfusions		Number of RBC transfusions		*Mean Hb (g/dl)	Number of PLT transfusions		**Mean PLT (/mm³)
	n	%	n	%		n	%	
Emergency	1886	19.3	1830	21.9	8.07±1.84	56	4	49570±34110
General internal medicine	1450	14.9	1074	12.8	8.42±1.26	376	27	29210±28886
Anesthesiology and reanimation	968	9.9	704	8.4	8.38±1.19	264	19	68010±60525
Gynecology and obstetrics	834	8.6	792	9.5	8.95±1.37	42	3	79690±33037
General surgery	637	6.5	616	7.4	9.05±1.44	21	1.5	71330±64029
Orthopedics	566	5.8	564	6.7	9.26±1.08	1	0.1	81000
PHO	488	5	313	3.7	7.88±1.42	175	12.6	32140±25773
PICU	424	4.3	293	3.5	8.86±1.42	131	9.4	52150±31932
Medical oncology	353	3.6	332	4	8.47±0.89	21	1.5	62200±72095
Urology	301	3.1	298	3.6	9.11±1.29	0	0	–
Pediatric CVS	232	2.4	160	1.9	11.19±2.0	72	5.2	113690±91488
Gastroenterology	216	2.2	177	2.1	8.22±1.14	39	2.8	25940±18747
ICU	184	1.9	121	1.4	8.71±1.61	63	4.5	41030±26842
NICU	178	1.8	141	1.7	9.89±2.94	37	2.7	82730±84292
Neurosurgery	160	1.6	156	1.9	9.29±1.19	1	0.1	15000
Nephrology	138	1.4	137	1.6	7.74±1.07	0	0.0	–
Pediatrics	132	1.4	106	1.3	8.75±2.12	26	1.9	69160±73625
Surgical ICU	129	1.3	115	1.4	9.21±1.36	14	1	89000±25940

*: Mean Hb (g/dl) before erythrocyte transfusion; **: Mean PLT (/mm³) before thrombocyte transfusion; PHO: Pediatric hematology oncology; PICU: Pediatric intensive care unit; CVS: Cardiovascular surgery; ICU: Intensive care unit; NICU: Neonatal intensive care unit.; PLT: Platelet..

In the entire hospital, mostly RBC and PLT transfusions were performed in internal clinics (Table 1). Among internal clinics, RBC transfusions were mostly performed in the general internal medicine service, anesthesiology and reanimation, pediatric hematology and oncology, medical oncology, and PICU, respectively. Among the internal clinics, PLT transfusions were most frequently performed in the general internal medicine service, anesthesiology and reanimation, pediatric hematology-oncology, and PICU, respectively. Among surgical clinics, RBC transfusions were most frequently performed in clinics of gynecology and obstetrics, general surgery, orthopedics, and urology, respectively. Among the surgical clinics, most frequently PLT transfusions were performed in clinics of pediatric CVS, obstetrics, and general surgery, respectively (Table 3).

Mean Hb values before RBC transfusions were 9.29±1.46 g/dl in surgical clinics, 8.45±1.46 g/dl in internal clinics, and 8.07±1.84 g/dl in emergency clinics (Table 1). A statistically significant difference was found between surgical clinics, internal clinics, and emergency clinics for mean Hb values before RBC transfusions ($p<0.05$). Mean PLT counts before PLT transfusions were 97140±75782/mm³ in surgical clinics, 44030±44075/mm³ in internal clinics, and 49570±34110/mm³ in the emergency department (Table 1). There was a significant difference between internal and surgical clinics and also between emergency units and surgical clinics for mean PLT values ($p<0.05$). It was observed that transfusions were performed with the highest mean PLT value in surgical clinics. There was no statistically significant difference between the internal and emergency clinics for pre-transfusion mean PLT counts.

DISCUSSION

Blood transfusion is a form of treatment with acute and chronic complications. It is important to be aware of transfusion rates of the hospitals to reduce unnec-

essary transfusions with appropriate measures. According to the results of the 2-year multicenter retrospective REDS-III study, the rate of blood transfusion in hospitalized patients (n=641751) was found to be 12.5% (n=80362).[6] In the study of Shehata et al. [7], 15.7% (n=38265) of 244,013 inpatients received blood transfusions. In our study, blood transfusion rate was 21% (n=5179) among 24,924 inpatients appeared to be higher. When we compare our study with Shehata et al.'s [7] that the rate of blood use according to clinics was found to be similar, while the rate of blood use was higher in our hospital which can be explained by the high number of complicated patients admitted to our hospital and the small number of study samples.

Approaches for appropriate clinical use of blood are recommended in the guidelines [5, 8]. According to the results of observational studies, the risk of death and ischemic complications, delay in wound healing, and duration of hospital stay was found to be higher in patients who received RBC transfusions [9–11]. At present, two main types of strategies are used for blood transfusions. According to the restrictive strategy, Hb value is kept between 7 and 9 g/dL, while it is kept between 10 and 12 g/dL in the liberal strategies [12]. It is agreed by international guidelines of different countries that transfusion is beneficial when Hb <6–7 g/dl but not beneficial when Hb>10 g/dl [13–21]. In many studies, there are no difference between the clinical results of transfusions in patients having Hb values of 9–10 g/dl and Hb 7–8 g/dl [12, 22, 23]. In a meta-analysis by Rohde et al. [24], the risk of infection was found to be lower with the restrictive blood transfusion strategy compared to the liberal practices. On the other hand, it was found that mortality rates are higher in liberal strategy, and restrictive transfusion strategy is associated with safe and lesser blood use [12]. For these reasons, restrictive transfusion strategy is recommended in most guidelines. Although restrictive strategy is not applied in our hospital, the threshold Hb values before RBC transfusion were found close to the threshold values recommended by guidelines in clinics of emergency and internal clinics. RBC transfusions were performed in patients with the lowest Hb values in the emergency clinic in our hospital.

We reviewed the publications related to RBC transfusion practices. Shehata et al. [7] reported that most frequently performed RBC transfusions in the general internal medicine service (14%), hematology-oncology clinics (14%), orthopedics (13%), cardiac surgery (8.8%), and general surgery (8.5%). In our study, RBC transfusions were mostly performed in the general internal medicine service within internal clinics and gynecology and obstetrics within surgical clinics. RBC transfusions are most frequently in the general internal medicine clinic of our hospital, because most of adult hematology and oncology patients are transfused in this clinic.

According to the guidelines, PLT count is taken into account for the decision of PLT transfusion. PLT transfusion is performed in a thrombocytopenic patient in the presence of active bleeding or risks for bleeding (sepsis, invasive procedure, or surgical operation) [3]. The majority of prophylactic PLT transfusions are used in hematology and oncology clinics in thrombocytopenia due to chemotherapy or radiotherapy. According to the results of randomized controlled studies, the threshold PLT counts for transfusion were reported as 10.000/mm^3 and 20.000/mm^3, and no difference was found in terms of bleeding risk between these two different threshold values [25].

Different threshold values have been determined in the guidelines for PLT transfusions according to the invasive or surgical procedures planned. The threshold values for PLT counts have been also recommended: >100.000/mm^3 for major surgeries (performed on critical organs such as brain and eye); >50.000/mm^3 for other major and minor surgeries; and >20.000/mm^3 for invasive procedures such as catheterizations and endoscopy. In our study, the threshold values used for PLT transfusion were found to be higher than the guideline recommendations. Our results showed that there is a tendency to keep the PLT limit above 100.000/mm^3 in surgical clinics.

Potential risks should be considered in the decision of PLT transfusion. Non-hemolytic febrile reactions (2%) and mild allergic reactions (4%) are common with PLT transfusions; also, anaphylaxis can be rarely seen (1/20.000–50.000). TRALI occurs more frequently after PLT transfusions rather than RBC transfusions [2]. The risk of bacterial infection is also high (1/10.000) in PLT transfusion [3]. Considering the transfusion risks, it would be a more rational to use the threshold values according to the guideline recommendations for PLT transfusion.

PLT transfusions were mostly performed in hematology-oncology, CVS, cardiology, and stem cell transplantation units in Shehata et al.'s study [7]. In our

study, we found that PLT transfusions were mostly performed in general internal medicine service, anesthesiology-reanimation, pediatric hematology-oncology, and pediatric intensive care unit, respectively. Among the surgical clinics, the PLT transfusions have been mostly performed in pediatric CVS, obstetrics, and general surgery, respectively. The reason why PLT transfusions are mostly performed in the general internal medicine clinic in our hospital is that most of adult hematology and oncology patients are transfused in this clinic. Results of both studies were similar about frequency of PLT transfusions among clinics.

Our study revealed that PLT transfusion thresholds were above the guideline recommendations, especially in surgical clinics. In the survey study investigating the awareness of physicians working in surgical clinics at Medical Faculty of Ege University about blood transfusion, Gunusen et al. [26] observed that there are different approaches in blood transfusion practices among physicians. They concluded that training activities on this subject should be increased and these trainings should be renewed periodically. According to the results of the survey studies conducted by Kupesiz et al., increasing the knowledge of physicians about transfusion medicine and blood banking both during medical school and postgraduation training will bring blood transfusion practices to a better point [27, 28].

Conclusion

In our study, it was observed that threshold values for PLT transfusion were above the recommendations in guidelines. Our results suggest that the knowledge level of physicians about indications of transfusion should be increased.

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