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Evaluation of Changes in Blood Products Transfusion Indices Following Three Years of Implementation of Iranian Blood Transfusion Organization Standards

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ABSTRACT

Background: Increasing demand for blood and blood products mostly due to increased individual access to health care services rises the concerns over lack of adequate amounts of blood products. It also can impose additional costs to blood transfusion centers and may increase transfusion-related complications. We aimed to investigate the impact of the Iranian Blood Transfusion Organization (IBTO) standards after three years of blood-bank committee activities on optimizing the consumption of the blood products.

Methods: All request forms of blood and blood products of Mofid Children's Hospital were reviewed according to the department and type of the product in 2013 and indexes of "cross-matched to transfusion ratio" (C/T ratio), "transfusion index" (TI) and "transfusion probability" (%T) were calculated. Following 3 years of training by the Blood Bank Committee of the hospital and holding different meetings and workshops using IBTO standards, the same parameters were reassessed in 2017.

Results: In 2013, 13653 units of blood and blood products were ordered of which 10472 units (77%) were transfused and 3181 units (23%) were returned. C/T Ratio was equal to 1.43. After about 3 years of intervention, 17946 units of blood and blood products had been cross-matched of which 14775 units (83%) were transfused and 3171 units (17%) were returned. C/T Ratio after 3 years of intervention was equal to 1.33 (P<0.0001). T% was 69% in 2017 compared to 62% in 2013. Also, TI was 0.97 in 2017 compared to 0.83 in 2013. The blood bank committee's activities in surgical departments improved C/T ratio of 2.83 to 2.13.

Conclusion: This study showed that holding scientific sessions and blood bank academic activities during more than 3 years was successful to optimize the use of blood and blood products in our hospital, particularly in surgical departments.

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Introduction

Increasing demand for blood and blood products due to increased access to health care services rises the concerns over lack of adequate amounts of blood products as well as the need for better implementation of blood management strategies, especially during invasive medical procedures. Increased blood product utilization also imposes additional costs to blood transfusion centers, increases complications of blood transfusion, reduces blood bank reserves and interferes with proper distribution of blood and blood products in various medical centers, all of which eventually may reduce the quality of blood units (1-4).

This has been confirmed by several reports assessing blood demand and its utilization (5-7).

However, recently there has been a decline in blood transfusion consumption among different centers because of public health organizations emphasis on the potential risks of blood transfusion and blood products (8). Various studies have implicated that excessive demand for blood and blood products potentially cause a major shortage of hospital blood supply and can delay some advanced surgical procedures (9, 10). Moreover, ignoring the principles of blood ordering strategies, as what occurs in invasive interventions, leads to increased consumption of blood products, decreased quality and excessive increase in laboratory costs. On the other hand, the unnecessary transfusion of blood products may bring along the possibility of occurrence of adverse reactions as well as transmission of different kinds of infections (11). Reports from various surgical departments indicate that 40% and 22% of the ordered blood was transfused for general surgery and neurosurgical procedures, respectively(12, 13).

The cross-matched to transfusion ratio (C/T ratio) is an important indicator of the amount of consumed blood. A ratio of 2.5 is considered as significant blood usage in blood transfusion standards (14). In other words, any number higher than 2.5 indicates that 40% of the blood requests have been transfused. Another indicator for assessing optimal blood usage is "probability of transfusion" (%T) calculated by the number of patients transfused divided by the number of patients cross-matched. A value of 30 was considered indicative of significant blood utilization. Another important indicator is the "transfusion index" (TI), which is the ratio of number of the blood units transfused to number of the patients cross-matched. Accordingly, the value of 0.5 denotes significant blood consumption (14).

Although it is difficult to ensure how much blood is transfused annually for children, one study estimated that 3-6% of all transfused RBCs are allocated to children (15). Severe anemia in children is one of the major conditions requiring blood transfusion. Iron deficiency anemia is the most common cause of anemia. It is estimated that about 50 percent of the children in the developing countries suffer from anemia (4). Prevention and timely treatment of anemia is essential for reducing the need for blood transfusion in pediatric practices.

Among different conditions that should be taken into account to decide whether a child should be transfused or not, hemoglobin concentration and clinical conditions of the patients are the most important determinants (16, 17). Patients with a critical condition should be considered according to their age, hemoglobin level, preoperative platelet count, any antithrombotic or antiplatelet medications and type of any surgical procedure which are going to be undertaken (18).

We aimed to investigate the impact of the implementation of the Iranian Blood Transfusion Organization (IBTO) standards after three years of intervention including training sessions and instructions and holding blood bank committees in Mofid Children's Hospital in terms of improvement in blood transfusion utilization indices.

Materials and Methods

In this descriptive study, at baseline all requests for blood and blood products from different departments in blood bank of Mofid Children's Hospital's in 2013 were reviewed. Three key indexes in transfusion medicine were analyzed. C/T ratio: cross-matched to transfused ratio, transfusion probability (%T): Number of patient transfused ×100/ number of patients cross-matched, and transfusion index (TI): Number of units transfused/number of patients cross matched were calculated for the existing requests.

After three years of intervention, the analysis was repeated similar to the baseline. The transfusions and the requests were reviewed in terms of both type of the product and the relevant department.

Statistical analysis was performed using SPSS software, version 21. Frequency and percentage analysis was used for qualitative variables. C/T ratio, %T and TI were calculated and compared for the results before and after intervention. Fisher's exact test was used to analyze the changes in utilization of blood and blood products before and after intervention. $P<0.05$ was considered as the statistical significant level.

Results

Analysis of the blood transfusion request forms in blood bank of Mofid Children's Hospital in year 2013 showed that there were a total of 13653 ordered units of blood and blood products out of which 10472 were consumed. Similarly, when the study was repeated in January 2017, 17946 units of blood and blood products were requested, out of which 14775 units were consumed. The findings indicated that although the request for blood and blood products increased by 31%, their use was increased by 41% in a 3-year period.

Results of the frequency of packed-cell requests by each department are shown as a frequency distribution in figure 1. It indicated that packed-cell request rate increased after 3 years by all departments except for the neonatology and pediatric hematology/oncology departments (table 1).

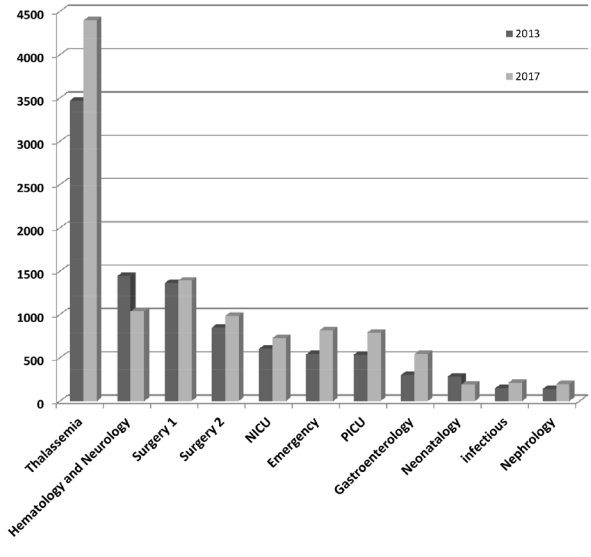

Figure 1: Frequency distribution of "packed-cell" request according to each department in Mofid Children's Hospital in years 2013 and 2017 (before and after intervention)

Table 1: The cross-matched, transfusions and cancellations of packed cell units in Mofid Children's Hospital in years 2013 and 2017

Year	2013						2017					
Department	**Blood Requests**	**Consumption**	**Cancellation**	**C/T ratio**	**T (%)**	**TI**	**Blood Requests**	**Consumption**	**Cancellation**	**C/T ratio**	**T (%)**	**TI**
Thalassemia	3471	3286	185	1/06	95	0.95	4396	4122	274	1/07	94	0.94
Hematology and Neurology	1443	1026	417	1/41	71	0.71	1035	888	147	1/17	86	0.86
Surgery 1	1361	481	880	2/83	35	0.35	1389	609	780	2/28	44	0.44
Surgery 2	848	300	548	2/83	35	0.35	984	501	483	1/96	51	0.51
NICU	604	455	149	1/33	75	0.75	727	521	206	1/40	72	0.72
Emergency	540	360	180	1/50	67	0.67	818	546	272	1/50	67	0.67
Neonatology	285	161	124	1/77	56	0.56	192	145	47	1/32	76	0.76
PICU	534	404	130	1/32	76	0.76	788	610	178	1/29	77	0.77
Gastroenterology	299	141	158	2/12	47	0.47	542	286	256	1/90	53	0.53
Infectious	149	95	54	1/57	64	0.64	214	135	79	1/59	63	0/63
Nephrology	137	64	73	2/14	47	0.47	195	107	88	1/82	55	0.55
Total	9671	6773	2898	1/43	70	0.70	11280	8470	2810	1/33	75	0.75

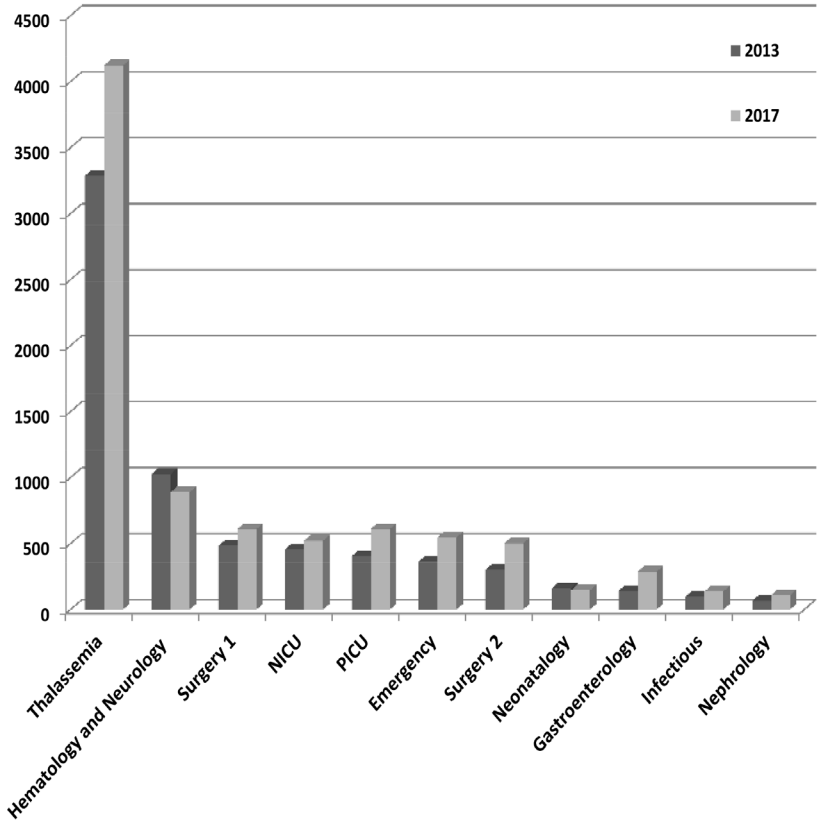

Figure 2: Frequency Distribution of packed cell consumption according to different departments in Mofid Children's Hospital in years 2013 and 2017.

The frequency of distribution of the packed cell consumption by each department in the studied years is shown in figure 2. The results indicated increased packed cell transfusion mainly in thalassemia department, except for the neonatology and hematology departments.

The analysis of requests for FFP showed an increase in requests from all departments except for the surgery department. Moreover, in both PICU and gastrointestinal departments, the increase in FFP requests was remarkably high. Transfusion of FFP also increased in almost all departments. Both requesting and transfusion had a highly significant increase in PICU, yet the cancellation rate in year 2017 was similar to data in year 2013 (table 2).

Platelet requests increased significantly from all departments except for thalassemia, surgery, nephrology and neonatology. Of note, this increase was more remarkable in PICU, emergency and hematology departments. Platelet transfusions increased in all departments, but the increase was significantly higher in PICU and hematology/oncology departments (table 3). Despite the increase in platelet request and its transfusion rate, its cancellation rate markedly decreased. Such a decrease was significant in the gastrointestinal and hematology/oncology departments. Increased cancellation of platelet orderings was also observed in surgical, emergency, NICU and PICU departments.

Table 2: The frequency of cross-matched, transfused and cancelled FFP units in Mofid Children's Hospital in years 2013 and 2017

Year	2013			2017		
Department	**Request**	**Consumption**	**Cancellation**	**Request**	**Consumption**	**Cancellation**
Thalassemia	7	7	0	7	7	0
Hematology	129	115	14	194	193	1
Surgery 1	21	19	2	54	50	4
Surgery 2	98	96	2	61	55	6
NICU	143	139	4	388	374	14
Emergency	25	22	3	60	58	2
Neonatology	27	26	1	51	48	3
PICU	279	255	24	914	890	24
Gastroenterology	33	31	2	331	321	10
Infectious	17	17	0	27	27	0
Nephrology	19	18	1	74	66	8
Total	798	745	53	2161	2089	72

Table 3: The cross-matched, transfusions and cancellations of platelet units in Mofid children hospital in 2013 and 2017

Year	2013			2017		
Department	**Cross-matched**	**Transfusion**	**Cancellation**	**Cross-matched**	**Transfusion**	**Cancellation**
Thalassemia	165	165	0	0	0	0
Hematology	1729	1630	99	1965	1922	43
Surgery 1	47	41	6	127	102	25
Surgery 2	93	87	6	52	38	14
NICU	90	87	3	151	118	33
Emergency	293	269	24	539	284	255
Neonatology	21	20	1	0	0	0
PICU	377	353	24	1061	1014	47
Gastroenterology	94	56	38	89	62	27
Infectious	24	22	2	84	81	3
Nephrology	31	31	0	0	0	0
Total	2964	2761	203	4068	3621	447

Table 4: Comparison of the cross-matched, transfusion and cancellations rate of the blood and blood products in Mofid Children's Hospital in years 2013 and 2017

Units of Blood and blood products	2013	2017	Value Change
Cross-matched (Rate)	13653	17946	+4293 (31%)
Transfusion (Rate)	10472	14775	+4303 (41%)
Cancellation (Rate)	3181 (23%)	3171 (17%)	-6%

Table 5: Comparison of the blood and blood products consumption in Mofid Children's Hospital in years 2013 and 2017

Variable	2013	2017
C/T ratio	1.43	1.33
%T	62%	69%
TI	0.83	0.97

A detailed review in the request, transfusion and cancellation rates of the all blood and blood products in 2013 and 2017 is presented separately in table 4. The findings showed a 31% increase in requests, 41% increase in transfusion (or consumption) rate and 6% decrease in cancellation of blood and blood products following 3 years of intervention. In other words, there was a statistically significant increase in the rate of requests and transfusions of blood and blood products after intervention ($P<0.0001$) and a statistically significant decrease in number of cancellations during this period ($P<0.0001$).

The cross-matched to transfusion ratio (C/T ratio), the probability of transfusion (%T) and the transfusion index (TI) in years 2013 and 2017 were calculated and presented in table 5.

Discussion

Packed cell transfusion guidelines in children and adults are based on a specific level of hemoglobin or hematocrit according to different clinical situations at the time of transfusion. However, still precise attention is needed regarding the fact that transfusion should be performed for correction of symptoms of anemia, not just for the

increment in the level of hemoglobin. Blood transfusion guidelines in children are stricter than in adults since normal hemoglobin levels are lower in healthy children than in adults and most children will better compensate the anemia.

Platelet transfusion guidelines in children and adolescents with quantitative and qualitative disorders of platelets, in which the risk of life-threatening hemorrhage following injury or spontaneously can be related to the severity of thrombocytopenia, are similar to adults. However, it is worth mentioning that in premature neonates, the level of plasma coagulation factors and anticoagulant proteins can be somewhat lower, so transfusion of plasma and plasma derived factors are determined by clinical conditions and risk of bleeding, not only by a simple increase in clotting time (19).

In the current study, all cross-match requests, blood ordering and transfusion practice records of blood bank of our hospital were assessed. The purpose of this study was to determine the changes in blood transfusion practice indices after 3 years of implementation of IBTO guidelines.

The overall results of our study indicated the efficacy of supervising strategies and guidelines of IBTO on blood transfusion practice. Similar studies have shown that despite an increase in blood and blood product requests in late 2016 (31%), all indicators were improved similar to several reports (3, 20, 21). The increase in number of requests and transfusions of blood products and decrease in number of cancellations in both year 2013 and 2017 were statistically significant. However, cancellation rate in our results was 23% less than the other studies (1, 18, 22-24) except for the study by Chegini et al. which reported a cancellation rate less than ours (25).

In addition to the requests for packed cell, the analysis of requests for FFP showed a decrease in the surgery department in contrast to the rest of the departments, which could be explained due to the modifications in the indications and more compliance with the relevant protocols. On the other side, the significant increase of FFP requests in both PICU and gastrointestinal departments could be due to an increase in gastrointestinal procedures or increase in hospitalized patients with liver failure and coagulopathy unveiling the necessity for a careful consideration.

In a retrospective study, analysis of improving blood transfusion practice by educational committees was performed. They showed a C/T ratio of 3.9 and %T of 27.7%. Again, the results of this study unveiled the need for continuous assessment of blood requests and how they are utilized in the hospitals (20).

Another retrospective study was performed on the use of blood in non-surgical management of solid organ blunt trauma of the children with the aim of determining the percentage of transfused to cross-matched blood and establishing hard principles for blood requirements. According to the results of that study, a total of 187 units were requested for 60 patients of which only 24.2% were transfused (21).

Conclusion

We found that the average C/T ratio is widely different across the various departments. The results of this study indicated that despite increase in both blood ordering and transfusions, the rate of cancellation in ordered packed cells decreased. The present study also showed a 31% increase in demand, 41% increase in transfusion and a 6% reduction in blood and blood products consumption after 3 years of intervention of IBTO guidelines.

Conflict of Interest: None declared.

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