Original Article

Investigation into Changes in Blood Transfusion Indicators and Returning Blood Products along with the Cause of Returning and Cost Calculation

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Abstract

Background and Objectives: Blood is a valuable source, and the wastage of blood products could impose severe impacts on healthcare. This study investigates the changes in blood transfusion indices and blood product transfusion from 2018 to 2019 in public hospitals affiliated to Kashan University of Medical Sciences. **Materials and Methods:** This descriptive cross-sectional study was carried out using a researcher-made checklist across five public hospitals in Kashan, Iran. The amount of cross-match/transfusion, transfusion index (TI), and T% (transfusion probability) indices were calculated and analyzed. **Results:** In 2018, we ordered a total of 19741 blood product units, among which 18,723 units (94.8%) were transfused. In addition, we ordered a total of 15,323 units of blood products in 2019, and 14,223 units (92.8%) were transfused. The CT ratio was 1.04 in 2018 and 1.06 in 2019, with a 2% increase. The transfused probability (T %) percentage in the studied public hospitals in 2018 was 38.04%, whereas the rate was 36.7% in 2019, with a 3.5% decline. In 2018, the TI in the studied hospitals was 0.96 and decreased to 0.85 (11%) in 2019. Moreover, the TI was higher than 0.5 in hospitals, except for Shahid Rajaei Hospital. Based on the results, the cost of blood products was 74459499405 Rials ($ 690526) in 2018 and 79073079143 Rials ($ 612115) in 2019, with a 6% increase. **Conclusions:** Blood order and transfusion enjoyed good conditions in public hospitals affiliated to Kashan University of Medical Sciences, though the blood order pattern was unfavorable in Shahid Rajaei Hospital.

Keywords: Blood products, blood transfusion index, hospital

Introduction

Since the early 20th century, blood transfusion has been widely used in medical practice to treat hemorrhage and anemia in traumatic and nontraumatic patients. It has also been used in medical practice to treat hemorrhage and anemia. Despite limited blood availability, high costs, and serious risks associated with transfusion, blood transfusion is still excessively used.[1] Excessive blood ordering often causes serious problems for blood bankers, especially in resource-limited settings. Maximal ordering of blood products by physicians has been reported in several developing countries.[2] Type and cross-match are routine protocols in Asian countries, especially in Iran. However, screen protocols and electronic types are more common in western countries.[3] Routine protocols in Iran may cause blood product unavailability for other individuals through increased costs of blood supply, inaccessibility for an emergency, inappropriate

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distribution of blood units, and increased workload for blood bank staff.[4,5]

Moreover, studies showed that many factors lead to the wastage of blood components, such as broken seals, broken bags returned after 30 min, expired units, clotted blood, or miscellaneous reasons, which are primarily due to a lack of proper knowledge and awareness.[6] One of the main causes of wastage of blood components in Iran is returning blood products after 30 min, through which the component warms up, and the risk of bacterial proliferation increases over time.[7,8] Furthermore, blood transfusion causes variable costs according to different reasons in treatment expenditures.[9] These costs include testing and preparing suitable components for transfusion, delivering blood components to hospitals, applying to the recipient, monitoring patient for adverse outcomes, treating transfusion-induced reactions, disposing of blood components as medical waste, and filing all mandatory information.[10]

Therefore, considering the importance of blood transfusion and the lack of enough studies in this domain, especially in Iran, we investigate changes in blood transfusion indices and blood products which were transfused and returned. To this end, we can take a step further to reduce the costs associated with transfusions and blood loss and return. In severe trauma cases, there may be certain problems with blood products. Thus, the bank should have adequate supply to respond to requests. Orders should be established according to needs and regulations. This problem is fundamental in massive transfusions in emergencies and trauma.

Materials and Methods

Target group

This retrospective study was conducted in Kashan Hospitals (Shahid Beheshti, Matini, Naghavi, Kargarnejad, Seyed Al-Shohada, and Shahid Rajaei) from November 2018 to May 2020. We searched through filed documents of blood banks in all hospitals to collect data. In this study, we recorded blood transfusion indices, blood product consumption and returning, and the reasons for returning blood products. Inclusion criteria consisted of all application forms and returning blood products from the blood bank of public hospitals affiliated to Kashan University of Medical Sciences. We excluded incomplete or distorted forms of request, injection, returning blood products, and the cases in which the reasons for returning blood products were not mentioned. Such faulty data were not trustable and were thus excluded.

Study design

The study received ethics approval from the Ethics Committee of Kashan University of Medical Sciences (IR.KAUMS.MEDNT.REC.1399.086).

We obtained written permission from the research deputy of the medical school and referred to hospitals affiliated to Kashan University of Medical Sciences. After receiving confirmation to attend the blood bank and medical records unit of these hospitals, we reviewed the medical files. The recipients' data included age, sex, nationality, and the service department that ordered the cross-match. The number of requested and consumed units, ABO/Rh grouping of the transfused blood product and patient, and the type of requested blood product (packed red blood cells, fresh-frozen plasma [FFP], platelets) were considered.

We separately reviewed blood transfusion indices, blood product consumption and return, and the reasons for returning blood products in case of product types and the respective hospital. Then, the ratio of cross-match to blood injection, percentage of injection probability, and injection index were calculated and compared based on the following formulas.[11]

In the next step, the costs of injected blood products and patients' cross-match were recorded through hospital admissions and finance units. The cost was calculated and compared using the following formula in terms of price (Rials and Dollars) and percentage:

Cost of blood transfusion and blood products in the IBTO Kashan Center + cost of blood transfusion and blood products and returning blood products in all hospitals - total costs of technical and professional fees in all hospitals = total cost of blood transfusion and blood products.

Sample size

The data were collected from the blood banks of hospitals in 2018 and 2019. In 2018, the total number of 19,741 units of blood products fulfilled the inclusion criteria. In 2019, a total of 15,323 units of blood products were ordered.

Data collection

The data were collected using a checklist that was developed based on a thorough review of the literature from different sources and included relevant information. The checklist contained sections on blood transfusion-related information and associated factors. The questions and statements were grouped and arranged according to our particular objectives. Using a structured pretested checklist, we collected the records on the ward for transfusion, the unit of requested blood, the type of requested blood component, the unit of blood cross-matched, and units of used blood after cross-match by reviewing the recipients' cards and laboratory blood bank logbooks. The details, including a hematological profile of the patient, the number of expired units (outdated) before utilization, the number of transfused blood components, and the department issuing the request, were noted.

Data analysis

The data were analyzed and reported only for patients with completed information. Deformed or defected documents were excluded due to reliability concerns. All indices were calculated (transfusion index [TI], transfusion probability, and cross-match/transfusion [C/T]) by means of the data. Statistical analysis was done using SPSS version 22 software (SPSS Inc., Chicago, IL, USA). A Kolmogorov–Smirnov test was

used to evaluate the normal distribution of quantitative parameters. A Paired *t*-test was used for variables with normal distribution. On the other hand, Wilcoxon tests were used for variables without normal distribution. The categorical data were presented in terms of frequencies and percentages. The C/T, T%, and TI were calculated as follows:

Results

In public hospitals affiliated to Kashan University of Medical Sciences in 2018, a total of 19741 units of blood products were ordered, among which 18723 units (94.8%) were transfused. In 2019, 14,223 units (92.8%) were transfused out of 15323 units of ordered blood products. The findings also show that the demand and consumption of blood products from 2018 to 2019 decreased by 22 and 24%, respectively [Table 1].

Moreover, in 2018, 96.4% of the ordered PC were transfused, which was 94.4% in 2019. In addition, in terms of FFP, PLT, and CP products, 95.9%, 92.5%, and 97.2% were used in 2018, respectively. These rates were respectively 95.1%, 89.4%, and 95.5% in 2019 [Table 1].

The highest consumption of blood products in 2018 and 2019 in Beheshti Hospital was found in 3 medical wards (2692 units) and emergency and trauma departments (1564 units), respectively. In Naghavi hospital, the highest consumption was noted in the operating room wards (20 units) and ICU (17 units). The thalassemia ward in Matini Hospital and the emergency and trauma departments in Seyed Al-Shohada Hospital had the highest consumption of blood products [Table 2].

In the trauma and emergency wards of Shahid Beheshti hospital in 2018, 24.5% PC, 16.8% FFP, and 4.3% PLT were consumed. However, 23.6% PC, 24.7% FFP, and 10.6% PLT were injected in 2019 [Table 1].

Totally, the CT ratio in public hospitals affiliated to Kashan University of Medical Sciences was 1.04 in 2018 and 1.06

Table 1: Frequency distribution of blood products requested, transfused (injected), and returned in public hospitals affiliated to Kashan University of Medical Sciences

Hospital	Blood product	Ordered		Transfused				Returned			
		IBTO Kashan center report		IBTO Kashan center report		Hospital blood bank report		IBTO Kashan center report		Hospital blood bank report	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Beheshti	PC	7023	5997	6934 (98.7)	5762 (96.1)	5474	4745	89 (1.3)	235 (3.9)	69	120
	FFP	2643	2281	2536 (95.9)	2178 (95.5)	1519	1009	107 (4.1)	103 (4.5)	121	100
	PLT	7530	5224	6957 (92.4)	4664 (89.3)	3982	1553	573 (7.6)	560 (10.7)	591	447
	CP	529	158	514 (97.1)	151 (95.5)	282	104	15 (2.9)	7 (4.5)	7	10
	Total	17725	13,660	16,941 (95.6)	12,755 (93.4)	11,257	7411	784 (4.4)	905 (6.6)	788	677
Naghavi	PC	162	170	140 (86.4)	124 (72.9)	124	95	22 (13.6)	46 (27.1)	26	72
	FFP	14	12	10 (71.4)	12 (100)	12	4	4 (28.6)	0	2	0
	PLT	26	16	26 (100)	16 (100)	23	14	0	0	11	0
	CP	5	0	5 (100)	0	5	0	0	0	0	0
	Total	207	198	181 (87.4)	152 (76.7)	164	113	26 (12.6)	46 (23.3)	39	72
Matini	PC	886	814	883 (99.6)	814 (100)	584	672	3 (0.4)	0	0	0
	FFP	8	2	8 (100)	2 (100)	-	-	-	-	-	-
	PLT	0	0	0	0	-	-	-	-	-	-
	CP	0	0	0	0	-	-	-	-	-	-
	Total	894	816	891 (99.6)	816 (100)	584	672	3 (0.4)	0	0	0
Rajaei	PC	234	169	75 (32)	65 (38.4)	65	50	159 (68)	104 (61.6)	125	92
	FFP	50	0	50 (100)	-	-	-	-	-	-	-
	PLT	-	-	-	-	-	-	-	-	-	-
	CP	-	-	-	-	-	-	-	-	-	-
	Total	284	169	125 (44)	65 (38.4)	65	50	159 (56)	104 (61.6)	125	92
Seyed Al-Shohada	PC	420	372	378 (90)	338 (90.8)	365	267	42 (10)	34 (9.2)	16	47
	FFP	70	31	66 (94.3)	21 (67.7)	35	21	4 (5.7)	10 (32.3)	6	0
	PLT	141	77	141 (100)	76 (98.7)	117	80	-	1 (1.3)	0	0
	CP	-	-	-	-	-	-	-	-	-	-
	Total	631	480	585 (92.7)	435 (90.6)	517	368	46 (7.3)	45 (9.4)	22	47
Total	PC	8725	7522	8410 (96.4)	7103 (94.4)	6612	5829	315 (3.6)	419 (5.6)	236	331
	FFP	2785	2326	2670 (95.9)	2213 (95.1)	1566	1034	115 (4.1)	113 (4.9)	129	100
	PLT	7697	5317	7124 (92.5)	4756 (89.4)	4122	1647	573 (7.5)	561 (10.6)	602	447
	CP	534	158	519 (97.2)	151 (95.5)	287	104	15 (2.8)	7 (4.5)	7	10
	Total	19,741	15,323	18723 (94.8)	14,223 (92.8)	12,587	8614	1018 (5.2)	1100 (7.2)	974	888

PC: Platelet concentrate, FFP: Fresh frozen plasma, PLT: Platelets, CP: Convalescent plasma

Table 2: Frequency distribution of transfused blood products by different departments across public hospitals affiliated to Kashan University of Medical Sciences (hospital blood bank report)

Hospital	Department	PC		FFP		PLT		CP	
		2018	2019	2018	2019	2018	2019	2018	2019
Beheshti	Emergency trauma								
	Emergency	1343 (24.5)	1123 (23.6)	255 (16.8)	249 (24.7)	171 (4.3)	164 (10.6)	79 (28)	28 (26.9)
	Internal general	215 (3.9)	214 (4.5)	75 (4.9)	51 (5.1)	159 (4)	70 (4.6)	35 (12.4)	23 (22.2)
	Internal medicine								
	Medical 1	164 (3)	153 (3.2)	55 (3.6)	32 (3.2)	28 (0.7)	22 (1.5)	10 (3.5)	9 (8.7)
	Medical 2	77 (1.4)	58 (1.3)	28 (1.8)	24 (2.4)	27 (0.7)	21 (1.4)	0	0
	Medical 3	636 (11.6)	338 (7.1)	228 (15)	64 (6.3)	1725 (43.3)	139 (8.9)	103 (36.5)	5 (4.9)
	Medical 4	83 (1.5)	58 (1.3)	23 (1.5)	10 (1)	15 (0.4)	6 (0.4)	0	0
	Surgery								
	Men's surgery 1	92 (1.7)	116 (2.4)	14 (0.9)	26 (2.6)	14 (0.3)	51 (3.4)	0	6 (5.7)
	Men's surgery 2	159 (2.9)	195 (4.1)	0	2 (0.2)	50 (1.2)	6 (0.4)	0	0
	Men's surgery 3	234 (4.3)	212 (4.4)	22 (1.4)	27 (2.7)	52 (1.3)	22 (1.4)	0	1 (0.9)
	Gynecological surgery	196 (3.6)	193 (4.1)	14 (0.9)	13 (1.3)	33 (0.8)	4 (0.2)	0	0
	Obstetrics and gynecology								
	Gynecology	105 (1.9)	109 (2.3)	33 (2.2)	5 (0.5)	15 (0.4)	5 (0.3)	0	2 (1.9)
	Obstetrics	79 (1.4)	44 (0.9)	6 (0.5)	1 (0.1)	7 (0.2)	1 (0.1)	0	0
	Pediatrics								
	Pediatrics	78 (1.4)	35 (0.7)	0	2 (0.2)	118 (2.9)	32 (2)	0	0
	Neonatal ward	30 (0.6)	42 (0.9)	5 (0.4)	17 (1.7)	0	1 (0.1)	0	0
	NICU	72 (1.3)	102 (2.1)	45 (2.9)	21 (2.1)	23 (0.6)	36 (2.3)	0	0
	PICU	187 (3.4)	33 (0.8)	64 (4.2)	12 (1.2)	19 (0.5)	18 (1.1)	7 (2.6)	0
	Intensive care								
	CCU								
	CCU-1	20 (0.4)	30 (0.7)	24 (1.6)	15 (1.5)	20 (0.5)	0	10 (3.5)	0
	CCU-2	38 (0.8)	33 (0.8)	10 (0.7)	12 (1.2)	0	10 (0.6)	1 (0.4)	0
	Postcath	18 (0.4)	20 (0.4)	3 (0.3)	17 (1.7)	0	7 (0.4)	0	0
	ICU								
	ICU-1	231 (4.3)	249 (5.2)	220 (14.5)	115 (11.5)	91 (2.4)	141 (9.1)	5 (1.8)	5 (1.9)
	ICU-2	159 (2.9)	198 (4.2)	56 (3.7)	57 (5.7)	36 (0.9)	80 (5.1)	10 (3.5)	6 (5.7)
	ICU-3	113 (2)	110 (2.3)	68 (4.5)	106 (10.6)	120 (3)	82 (5.3)	14 (4.9)	0
	ICUOH	183 (3.3)	126 (2.6)	186 (12.2)	94 (9.4)	220 (5.5)	207 (13.3)	2 (0.7)	19 (18.3)
	Operating room								
	Central	138 (2.5)	229 (4.8)	19 (1.2)	31 (3.1)	0	14 (0.9)	0	0
	Cardiac	77 (1.4)	0	48 (3.1)	0	53 (1.3)	0	6 (2.2)	0
	Infectious	84 (1.5)	57 (1.2)	3 (0.3)	6 (0.6)	58 (1.5)	3 (0.2)	0	0
	Chemotherapy	663 (12.1)	668 (14.1)	15 (0.9)	0	928 (23.3)	411 (26.4)	0	0
Naghavi	Internal medicine	1 (0.9)	-	2 (16.7)	-	0	-	0	-
	Surgery	8 (6.4)	4 (4.3)	0	0	5 (21.7)	0	0	0
	ICU	5 (4)	10 (10.5)	2 (16.7)	1 (25)	0	6 (42.8)	5 (100)	0
	Operating room	20 (16.1)	12 (12.6)	0	2 (50)	0	0	0	0
	Trauma	90 (72.6)	69 (72.6)	8 (66.6)	1 (25)	18 (78.3)	8 (57.2)	0	0
Matini	Surgery	3 (0.5)	2 (0.3)	-	-	-	-	-	-
	Thalassemia	581 (99.5)	670 (99.7)	-	-	-	-	-	-
Rajaei	Obstetrics	65 (100)	50 (100)	-	-	-	-	-	-
Seyed	Emergency and trauma	242 (66.4)	142 (53.3)	8 (22.8)	2 (9.5)	95 (81.2)	7 (8.7)	-	-
Al-Shohada	Internal medicine	37 (10.1)	38 (14.3)	0	8 (38.2)	3 (2.5)	29 (36.2)	-	-
	Pediatrics	8 (2.2)	13 (4.8)	0	0	5 (4.3)	0	-	-
	Intensive care								
	CCU	7 (1.9)	6 (2.2)	9 (25.7)	0	0	0	-	-
	Post-CCU	-	2 (0.7)	-	0	-	0	-	-
	ICU	49 (13.4)	42 (15.7)	18 (51.5)	9 (42.8)	14 (12)	44 (55.1)	-	-
	Operating room	8 (2.2)	5 (1.9)	0	2 (9.5)	0	0	-	-
	Dialysis	14 (3.8)	19 (7.1)	0	0	0	0	-	-

PC: Platelet concentrate, FFP: Fresh frozen plasma, PLT: Platelets, CP: Convalescent plasma, ICU: Intensive care unit, NICU: Neonatal ICU, PICU: Pediatric ICU, CCU: Coronary care unit, ICUOH: Intensive care unit of Open heart surgery

in 2019, with a 2% increase. Furthermore, the CT ratio in Rajaei hospital was much higher compared to other hospitals. The percentage of transfused probability (T %) in public hospitals in 2018 was 38.04%, which was 36.7% in 2019, with a 3.5% decrease. In addition, transfusion probability in Beheshti and Rajaei hospitals was <50% and was higher than 50% (optimal limit) in the other three hospitals. The TI in the hospitals was 0.96 in 2018, whereas the rate decreed to 0.85 (11%) in 2019. Also, the TI was higher than 0.5 (optimal limit) in other hospitals, except in Rajaei hospital, which was <0.5 [Table 3].

The cost of blood products in Kashan University of Medical Sciences was 74459499405 Rials in 2018 ($ 690526) and 79073079143 Rials ($ 612115) in 2019, with a 6% increase [Table 4].

Discussion

The most important purpose of blood transfusion centers is to supply blood and its products, especially to traumatic patients. Handling blood supply is important as any disturbance in processing, such as lack of supply, can harm the traumatic patients. The reason is that returned blood products from other wards cannot be reused and should be put aside. On the other hand, anemia in hospitals is one of the major problems, which has often delayed or canceled many surgeries. In fact, the mismatch between blood ordering principles and the maximum blood required for a particular operation causes false deficiency, increases the age of stored blood in the blood bank in hospitals, reduces quality, imposes high laboratory costs, and increases waste due to expiration date. Therefore, blood bank specialists and hospital managers make efforts to create and implement a standard blood ordering system and correct consumption patterns.

In this study, a total of 19741 and 15323 units of blood products were ordered in 2018 and 2019, respectively. Our findings show that the demand and transfusion of blood products decreased by 22 and 24% from 2018 to 2019, respectively, which contrasts with those of Chegini *et al*.,[12] Akhavan Sepahi *et al*.,[13] Belayneh *et al*.,[2] and Alaoddolei *et al*.[14] These differences might be due to the discrepancy in hospital types, ward types, and even the departments requesting blood and its products.

In this study, the CT ratio in public hospitals was 1.04 and 1.06 in 2018 and 2019, respectively. In general, the pattern of order and transfusion of blood and its products in hospitals was appropriate in our study. Reasons for the desirability of the request and transfusion of blood products in these hospitals include regular meetings of the hemovigilance committee in hospitals, hemovigilance training workshops for physicians and nurses, and continuous training of blood bank staff. These findings are in line with the studies of Chegini *et al*.,[12] Anani Sarab *et al*.,[15] Rafiei Mehr,[16] Akhavan Sepahi *et al*.,[13] Trisal *et al*.,[17] Yangdon *et al*.,[18] Belayneh *et al*.,[2] Vrotsos *et al*.,[19] Rezaie *et al*.,[20] and Gharehbaghian *et al*.[21] Blood transfusion is essential for surviving patients in need, without which thousands of surgeries are impossible.[22] By contrast, in this study, there were significant differences in the clinical pattern of demand and transfusion in Shahid Rajaei Hospital (C/T ratio was 3.12 and 3.6 in 2018 and 2019, respectively). This indicates the inadequacy of demand and transfusion patterns in this specialized hospital (obstetrics and gynecology).

Another indicator of blood transfusion is the probability of the blood transfusion in a treatment protocol (% T), which is obtained by calculating the ratio of the percentage of patients who received blood products to the number of patients who were cross-matched. Acceptable values for this index are 50% and above.[23] In our study, the probability of blood transfusion in Shahid Beheshti and Shahid Rajaei Hospitals was low, which is consistent with the studies of Zewdie *et al*.,[24] Ibrahim *et al*.,[25] and Belayneh *et al*.,[2] However, we observed an acceptable probability of blood transfusion in Matini and Seyed Al-Shohada hospitals, which agrees with the findings of Trisal *et al*.[17] and Yangdon *et al*.[18] In this study, except for Shahid Beheshti and Shahid Rajaei hospitals, this index was acceptable in other hospitals and was 38.04 and 36.7 in all public hospitals

Table 3: Blood transfusion indices of public hospitals affiliated to Kashan University of Medical Sciences

Hospital	YR	Number of cross-matched patients	Number of patients transfused	Number of cross-matched units	Number of transfused units	CT ratio	T (%)	TI
Beheshtti	18	7439	2188	7023	6934	1.01	29.4	0.93
	19	7082	1992	5997	5762	1.04	28.1	0.81
Naghavi	18	150	124	162	140	1.16	82.7	0.93
	19	167	95	170	124	1.37	56.9	0.74
Matini	18	584	584	886	883	1.003	100	1.51
	19	672	672	814	814	1	100	1.21
Rajaei	18	190	65	234	75	3.12	34.2	0.39
	19	142	50	169	65	2.6	35.2	0.46
Seyed Al-Shohada	18	381	365	420	378	1.11	95.8	0.99
	19	314	267	372	338	1.1	85.03	1.07
Total	18	8744	3326	8725	8410	1.04	38.04	0.96
	19	8377	3076	7522	7103	1.06	36.7	0.85

CT: Cross-match transfusion, TI: Transfusion index, T%: Transfusion probability, YR: year

Table 4: Blood product costs in public hospitals affiliated to Kashan University of Medical Sciences

Cost (million Rials)	IBTO Kashan center		Beheshti		Naghavi		Matini		Rajaei		Seyed Al-Shohada	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Water, electricity and gas	207.28	191.53	176.7	195.8	850.1	970	66	66	77.19	170.6	21.52	40.3
Transportation												
Petrol	-	-	600	720	75	90	-	-	80	96	160	192
Repair	-	-	250	300	250	300	-	-	250	300	250	300
Agency	-	-	-	-	-	-	38.4	48	-	-	-	-
Staff	-	-	1620	1800	1620	1800	1080	1200	1620	1800	1620	1800
Total	394.8	306.4	2470	2820	1945	2190	1118.4	1248	1950	2196	2030	2292
Personnel	11,449.78	10,419.64	2160	2400	1620	1800	1620	1800	1620	1800	1620	1800
Normal saline	-	-	409.106	374.53	8.26	8.06	52.097	52.91	4.425	4.225	22.302	21.97
Blood transfusion set	144	144	203.292	153.06	2.172	1.824	10.692	9.792	1.5	0.78	7.02	5.22
Blood bag	45,404.3	45,969	-	-	-	-	-	-	-	-	-	-
Cross-match	481.7	608.5	-	-	-	-	-	-	-	-	-	-
Lab												
HIV	3312	3312	-	-	-	-	-	-	-	-	-	-
HBSAg	3312	3312										
HCVAB	3312	3312										
VDRL	547.5	547.2										
BVRh	1200	1200										
Others*	54.75	54.75	16,393.29	16,036.86	175.14	191.1	862.19	1025.68	120.95	81.7	564.15	546.9
Returning	-	-	2326.7	3426.8	77.09	174.74	9.05	0	472.64	395.3	136.64	169.7
Total costs	69,819.6	69,377.1	24,139.14	25,407.09	4677.8	5335.73	3738.4	4202.6	4246.72	4648.7	4401.6	4876.2
Patients' payment												
Technical fee	-	-	29,166.65	26,202.9	441.8	506.79	2162.5	2291.6	575.3	475.7	1237.3	1180.3
Professional fee			14,282.4	10,852.8	182.7	177.4	843.7	774.9	224.1	160.8	536.07	428.3
The cost of returning on the IBTO Kashan center	2980.2	4117.08	-	-	-	-	-	-	-	-	-	-
Cost estimation**	66,839.5	65,260.03	−5027.5	−795.8	4235.9	4828.9	1575.8	1911.04	3671.3	4172.9	3164.2	3695.8

*Others: alcohol,betadine, gloves,...,**The costs in the IBTO Kashan center is obtained from the difference between the total costs and the cost of returning, and from the difference between the total costs and technical fees in hospitals. VDRL: Venereal disease research laboratory, BVRh: Blood variant Rhesus, HBSAg: Hepatitis B surface antigen, HCVAB: Hepatitis C virus antibody

affiliated to the university in 2018 and 2019, respectively. These values are not acceptable and indicate that most blood units for patients were not transfused, which necessitates investigating the reasons for requesting blood transfusion.

The next indicator is known as the blood TI, and values of 0.5 and above indicate the system's optimal use of the ordered blood. This index was acceptable in all hospitals, which is similar to what Anani Sarab *et al*.,[15] Rafiei Mehr,[16] Trisal *et al*.,[17] Yangdon *et al*.,[18] and Belayneh *et al*.[2] reported. Our findings in this respect contrast with Zewdie *et al*.' results.[24] This index was not acceptable in Shahid Rajaei Hospital, indicating that the volume of blood orders was higher than blood transfusions in this specialized center. In general, this index was acceptable in all public hospitals affiliated to the university. This index is important because over-ordering a blood product requires the cross-matched blood remain in the hospital blood bank for a long time, even until the patient is discharged. Consequently, this lengthy storage increases the amount of waste that can negatively affect blood supply, especially negative blood groups. In such cases, especially in Shahid Rajaei Hospital, it is better to use the antibody grouping and screening system rather than cross-match and blood storage. These methods increase the speed of blood preparation, especially in emergencies and trauma, in addition to economic efficiency and TI index improvement.[26]

According to the case files, the reasons for not transfusing blood and its products and their return to these hospitals were the expiration date and patients' allergic reactions to blood transfusions and products. This finding is consistent with the study of Maramazi Ghafleh *et al*.,[27] whereby the most common cause of blood loss was the expiration date. This could be due to blood over-requests by physicians without adequate knowledge about properly requesting blood and its products and with fear of not accessing sufficient blood during surgery and trauma.[28] In this regard, Keramati suggested that management practices in determining the level of blood storage in hospital blood banks, managing how to request blood and applying methods, such as type and screen (antibody screening), and using guidelines for maximum blood demands in Maximum Surgical Blood Ordering Schedule surgeries are very effective in blood transfusion status.[29] The importance of excessive demand for blood and its products creates a false deficiency, prolongs blood storage in the blood bank, reduces quality, imposes high laboratory costs and wastes due to expiration date, increases the likelihood of contamination due to unnecessary transfusion, and leads to increased pressure on donor statistics. Such actions are especially important in the current situation (the COVID-19 pandemic and present restrictions for blood donors across the country) as it is necessary to maintain a reasonable distance between supply and demand.[21]

Documentation defects and reports were evident in the present study in all files. In the studies of Karami *et al*.,[28] Friedman and Ebrahim,[30] and Gharehbaghian *et al*.,[21] this documentation defect was also observed and reported. Therefore, training physicians, assistants, nurses, and blood bank staff is essential to improve accurate documentation of blood returning causes and manage blood product waste. This issue has been overlooked in blood bank systems so far. Furthermore, one of the findings of this study concerned the difference between the Iranian Blood Transfusion Organization (IBTO) Kashan center and the Blood Bank of Hospitals in document registration of consuming and returning blood and its products. Therefore, we must establish an accurate daily reporting system to record these cases. To improve this issue, the role of a blood bank or hemovigilance committee is important to monitor the status of statistical reports on requests and cases of blood transfusions and ultimate strategies to improve the quality of blood transfusion.

The cost of the IBTO Kashan center was 69819.83 and 69377.11 Rials in 2018 and 2019, respectively, and the cost of blood and its products was 74459499405 Rials (690526 $) in 2018 and 79073079143 Rials in 2019 (612115 $) with a 6% increase. An important finding in our study was the increase in the cost of blood and is products from 2018 to 2019. Moreover, the cost of returning blood and its products was 2980.28 Rials in 2018 and 4117.08 Rials in 2019. In the study of Kooshesh *et al*.,[31] the cost of preparing each unit of blood, from blood sampling to preparation and distribution among medical centers, was about 30–40 thousand Tomans in Iran. In one medical center in the US, a study found that the base price for PC preparation was 114 $.[32] The production cost of a pack cell unit was estimated at 70 $ in Italy and 80 $ in France.[33] The cost of producing each unit of blood was estimated as 40 $ by the World Health Organization.[21] In Iran, the real costs of blood supply have not been calculated, though the Blood Transfusion Organization has estimated the costs to be 600 thousand Rials. According to a study conducted in 2002, the average current cost of producing a blood unit was about 120 thousand Rials.[34] Yazd Blood Transfusion estimated the processing cost of each blood bag as 150,000 Tomans in 2015, which reached 5 million Tomans for rare blood groups. Other costs must be added to the above amount, including cross-match, transferring, maintenance, and screening tests.[34] Due to health policies in the country, the government is committed to providing free access to blood products, and thereby some hospitals may not put enough effort into the optimal use of blood products. Indeed, hospitals consider the cost of blood transfusions to the patient in their services (technical fee and professional fee).[35]

Conclusions

Blood order and transfusion were in good condition in public hospitals affiliated to Kashan University of Medical Sciences, though the pattern of blood order was unfavorable in Shahid Rajaei Obstetrics and Gynecology Hospital. However, efforts should be made to improve the quality of blood product orders and transfusions. The most crucial ward that such improvements can influence could be emergency trauma.

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Conflicts of interest

There are no conflicts of interest.

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