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Original Article

The effect of aging on the epidemiology of blood transfusions in North Khorasan province, Iran

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Abstract: Purpose: Additional knowledge on the epidemiology and recipients of blood transfusions will help healthcare managers to estimate the future needs. The study was performed to define the blood transfusion rate based on gender, sex, and clinical features of patients receiving blood products in all hospitals of the North Khorasan province of Iran. Methods: Data on blood transfusion implementation were extracted from blood bank documents. The data for all patients who received at least one blood product were collected from March 2018 to March 2019. Results: Among blood transfused patients, the highest transfusion rate was for packed red blood cells (PRBC) (47.7%). The two other most frequently used products were fresh frizzed plasma (FFP) (27.2%) and platelets (PLT) (21.9%). The patients in the age group of 51-80 years received the majority of PRBCs and FFPs. Patients aged 21-40 and 61-70 yrs had the highest transfusion rates for PLT. Elderly female patients (57.4%) received more blood products than their male counterparts. The highest blood transfusion rates were among patients with neoplasms, anemia, gastrointestinal bleeding, and gastric diseases. Conclusion: The primary Iranian blood recipients were elderly patients. Population aging is associated with an increase in the number of blood recipients and simultaneously declines the blood donors pool. It highlights the need for optimizing the use of blood in hospitals and having better strategies for overcoming the shortage of blood.

Keywords: Blood transfusion, aging, blood products, Iran

Introduction

Population ageing, an important demographic phenomenon, is an increasing median age in a population because of declining fertility rates and rising life expectancy. Globally increasing longevity is, at a currently unmatched level in human history, causes changes in population structure, needs and capacities and has significant implications for social and economic aspects [1]. Elderly people put a higher demand on modern health services. Blood transfusion is a critically important part of modern medical treatments. Managing for example trauma cases, chemotherapy for cancer patients and surgical procedures without blood transfusion is impossible [2, 3]. In an aging population, requests for transfusing blood products will increase and the number of people in age-matched donor groups will be reduced. A study in Germany highlighted this estimation when predicted a 60% reduction in donor age population till 2030 and was expected to reduce 4 million units of donated blood [4]. On the other hand, the blood component preparation process is becoming too costly for the average health care system. Blood transfusion puts the recipient patient at risk of infectious and non-infectious complications and should only be used when there is no other way to manage the situation [2, 5]. Many studies highlighted the importance of continuous monitoring, quality and efficiency assessment, and interventions in blood transfusion procedures to decrease

inappropriate blood transfusions [6-9]. Data collection for quality assessment of hospital transfusion practices is critical to blood transfusion performance. Interpreting and understanding detailed data regarding blood transfusion rates will help healthcare system managers to estimate the needs and to better manage the process [9, 10].

The Iranian Blood Transfusion Organization (IBTO) is the only nationally certified organization that manages blood transfusion protocols and procedures in Iran. These procedures span donor recruitment up and until the delivery and shipment of different blood products for blood banks. IBTO is among the best blood-supplying organizations around the globe with 100% free and voluntary blood donations, while correctly documenting all practices and implementing good manufacturing practices (GMP) [11, 12].

There is limited data on the actual use and epidemiology of blood transfusion in developing countries [13, 14]. Studies in Iran were limited by the number of hospitals and sample numbers included [15]. In the current study, we investigated the pattern of blood use and clinical features of patients who receive blood products in all hospitals with certified blood banks from IBTO in the North Khorasan province in North-East Iran.

Materials and methods

Subjects of study

During the study period March 2018 to March 2019, data collection was performed in 12 hospitals located in six different cities comprising ten hospitals under the management of North Khorasan University of Medical Sciences (NKUMS), a regional military hospital, and a private hospital managed by an insurance company. The data for all patients who received at least one blood product was included.

Inclusion and exclusion criteria: Patients included in the study when were subjected to blood or blood products transfusion for any medical reason in the 12 recognized hospitals by IBTO. Iranian blood transfusion rules restricted the transfusion practice to hospitals only. All blood practices data during the study period included with no exception. The patients' data excluded from study when complete data were not collectable using data sources listed below section. The data for eight patients were excluded from the study subject group because of unclear recorded data.

Data collection and data sources

A trained person visited all hospitals to collect the data in a uniform manner. The blood product request forms, blood bank registration books, and Hospital Information Systems (HIS) were the data sources. In the case of missing data, attending physicians were interviewed. The data collected for each patient were the patient's HIS identification number, age, sex, ward of hospitalization, type of blood administered product, number of transfused blood products, and diagnosed disease.

Ethics

The study was conducted under the rules and regulations approved by the ethics committee of NKUMS, Bojnurd, Iran (ethical approval Number: IR.NKUMS.REC.1397.083).

Statistical analysis

All descriptive statistical analyses like frequencies, percentages, ranges and Fischer's exact test for evaluating possible significant differences were performed by using SPSS version 21. *P*-values < 0.05 were considered significant.

Results

Demographic data

During the year of study, 4170 hospitalized patients who had at least one blood product transfusion and passed the inclusion and exclusion criteria were enrolled. Most blood product consumers were males (n=2206, 52.9%), while 47.1% were female (n=1964). Patients < 60 yrs old (31.8 ± 18.2) received the majority of transfusions (2045/4170, 57.7%) while 1765 (42.3%) elderly patients (≥ 60 yrs) (73.3 ± 8.8) received different blood products during the study period (**Table 1**). The majority of transfusion cases were in Imam Ali Hospital (n=1007, 24.1%), Imam Hassan Hospital (918, 22%) located in Bojnurd (the capital city of the province), and Hashmi Rafsanjani Hospital in Shirvan city (408, 9.8%), respectively (**Table 1**).

Table 1. Distribution of blood products recipients among different hospitals based on two age groups

Name of Hospitals	≥ 60 yrs (73.3 ± 8.8)	< 60 yrs (31.8 ± 18.2)	Sum (%)
Imam Ali	407	600	1007 (24.2)
Imam Hassan	568	350	918 (22)
Hashmi Rafsanjani	255	152	407 (9.8)
Imam Khomeini (Esfrayen)	183	177	360 (8.6)
Samen	130	228	358 (8.6)
Imam Reza	32	153	185 (4.4)
Porsina	68	108	176 (4.2)
Imam Khomeini (Shirvan)	29	108	137 (3.3)
Javdol aema	54	75	129 (3.1)
Army	20	19	38 (0.9)
Shohada	19	18	37 (0.88)
Bentolhoda	0	418	418 (10)
Sum	1765 (42.4)	2405 (57.6)	4170 (100)

Number in bracket: percent, yrs: years.

The amount of blood transfusions for the elderly was zero in Bentolhoda Hospitals as it is medically specialized as a birth center.

Blood product administration among age groups

Among 17019 units of blood products used by 4170 patients, the highest transfused product was packed red blood cells (PRBC) (8129 units, 47.7%) with an average unit per transfusion of 1.95 ± 1.75. The two other most used products were fresh frizzed plasma (FFP) (4626, 27.2%) and Platelets (PLT) (3737, 21.9%), with an average unit per transfusion of 1.1 ± 4.2 and 0.9 ± 4.91 (**Table 2**). The higher transfusion was among < 60 yrs old patients (9281 units, 54.4%) in comparison to elderly patients (7738, 45.5%). The majority of PRBC (4559, 56.1%) and PLT (2288, 61.2%) transfusions were in < 60 yrs old patients, but the elderly patients got the majority of FFP transfusions (2485, 53.7%). FFP transfusions unit among elderly patients was almost two times more than for the < 60 yrs old (1.41 ± 5.06 in comparison to 0.89 ± 3.42) (**Table 2**).

Among the three mostly used blood products, the majority of PRBCs consumed by more than 50 yrs old patients (4607 units, 56.6%), and age groups of 61-70, 71-80, and 51-60 yrs showed the highest transfusions (1437, 1154, and 1037 units) (**Table 3**; **Figure 1**). The situation was the same for FFP when the majority were used in patients being older than 50 (3188 units, 68.9%) among the age group of 61-70, 71-80, and 51-60 yrs (1056, 789 and 703 units) (**Table 3**; **Figure 2**). The PLT consumption pattern was different, and the higher PLT consumers were among patients younger than 60. Patients in the age group of 31-40 yrs (679 units, 18.2%), 61-70 yrs (654 units, 17.5%), and 21-30 yrs (537 units, 14.4%) had a higher transfusion of PLT (**Table 3**; **Figure 2**).

During the study period, the rate of blood transfusion among male patients (52.9%) was higher than among females (47.1%), but women over 60 yrs (57.4%) received a higher number of blood product in comparison to old male patients (42.6%). Higher PRBCs transfusion was in recipients ≥ 60 yrs old in both genders (**Figure 1**). Still, there is high consumption of PRBCs among female patients in delivery ages (20 to 50) (**Figure 1**). The use pattern for FFP and PLT among males and females was almost the same. Nevertheless, women of delivery ages had higher administration of both products (**Figures 2** and **3**). There is a considerably reduced transfusion of blood products among hospitalized patients with more than 90 yrs in both genders (**Figures 1**-**3**).

Blood product administration and diseases

The highest transfusion of blood products was among hospitalized patients with neoplasms (4221 units/421 patients) (**Table 4**). The other highest transfusion rate was for anemia (2850 units/597 patients), gastrointestinal bleeding (1601 units/208 patients), and other gastric diseases (1588 units/283 patients).

The transfusion pattern for different blood products was similar. Most PRBCs, FFPs, and PLTs were used in patients with anemia, neoplastic diseases, gastric and gastrointestinal bleeding (**Table 4**). Neoplastic patients with per-person transfusion of 10 units of blood products had the highest transfusion rate

Table 2. Details of used blood products by different age groups of patients

Blood Product	Total unit of product used		Age groups			
			≥ 60		< 60	
	No. (%)	Unit per transfusion	No. (%)	Unit per transfusion	No. (%)	Unit per transfusion
PRBC	8129 (47.7)	1.95 ± 1.75	3570 (43.9)	2.02 ± 1.79	4559 (56.1)	1.9 ± 1.72
FFP	4626 (27.2)	1.11 ± 4.2	2485 (53.7)	1.41 ± 5.06	2141 (46.3)	0.89 ± 3.42
PLT	3737 (21.95)	0.9 ± 4.91	1449 (38.8)	0.82 ± 3.95	2288 (61.2)	0.95 ± 0.06
CRYO	377 (2.2)	0.83 ± 0.09	203 (53.8)	0.12 ± 0.95	174 (46.1)	0.07 ± 0.72
Whole blood	6 (0.15)	0.001 ± 0.05	0	0	6 (100)	0.001 ± 0.05
Other product	144 (0.8)	0.03 ± 0.28	31 (21.5)	0.02 ± 0.25	113 (78.5)	0.05 ± 029
Sum of products	17019 (100)	7.77 ± 4.08	7738 (45.5)	4.38 ± 7.89	9281 (54.5)	3.86 ± 7.67

PRBC: packed red blood cells, FFP: fresh frizzed plasma, PLT: Platelet, CRYO: Cryo poor plasma.

Table 3. Blood products usage among ages groups

Year age group	Patients No. (%)	Transfused units						Total products used
		PRBC No. (%)	FFP No. (%)	PLT No. (%)	CRYO No. (%)	WB No. (%)	OTHER No. (%)	
Infants	206 (4.9)	191 (2.3)	356 (7.7)	90 (2.4)	15 (4)	1 (16.7)	28 (19.4)	681 (4)
1 m-10	174 (4.2)	193 (2.4)	51 (1.1)	37 (1)	3 (0.8)	0	14 (9.7)	298 (1.75)
11-20	221 (5.3)	433 (5.3)	98 (2.1)	329 (7.8)	5 (1.3)	0	21 (14.6)	886 (5.2)
21-30	423 (10.1)	910 (11.2)	356 (7.7)	537 (14.4)	48 (12.7)	4 (66.7)	12 (8.3)	1867 (11)
31-40	418 (10)	901 (11.1)	307 (6.6)	679 (18.2)	36 (9.6)	1 (16.7)	6 (4.2)	1930 (11.3)
41-50	445 (10.7)	894 (11)	270 (5.8)	344 (9.2)	30 (7.9)	0	10 (6.9)	1548 (9)
51-60	518 (12.4)	1037 (12.7)	703 (15.2)	308 (8.2)	37 (9.8)	0	17 (11.8)	2102 (12.3)
61-70	693 (16.6)	1437 (17.7)	1056 (22.8)	654 (17.5)	100 (26.5)	0	10 (6.9)	3257 (19.1)
71-80	588 (14.1)	1154 (14.2)	789 (17.1)	437 (11.7)	46 (12.2)	0	17 (11.8)	2443 (14.3)
81-90	425 (10.2)	871 (10.7)	608 (13.1)	332 (8.9)	53 (14.1)	0	0	1864 (11)
> 90	59 (1.4)	108 (1.3)	32 (0.04)	25 (0.7)	4 (1.1)	0	0	169 (1)
Sum	4170	8129	4626	3737	377	6	144	17019

Infants: less than 30 days old, m: month, No.: Number, Number in bracket: percent. PRBC: packed red blood cells, FFP: fresh frizzed plasma, PLT: Platelet, WB: Whole blood, CRYO: Cryo poor plasma.

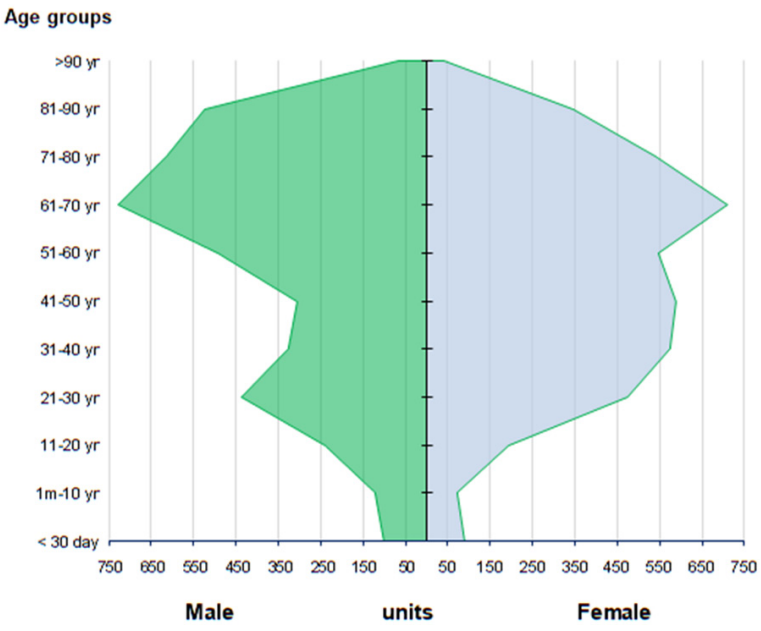

Figure 1. The age distribution among different gender for Packed Red Blood cell recipients.

among all diseases. Patients with orthopedic diseases (9.6 units) and non-traumatic head injuries (9.5 units) had the second and third high per-person transfusion rates, individually (**Table 4**).

Blood donor information

Based on data from the IBTO headquarter in the North Khorasan province, it was a decline in blood donation during the four years (2016-2019) (**Figure 4**). Volunteers in the

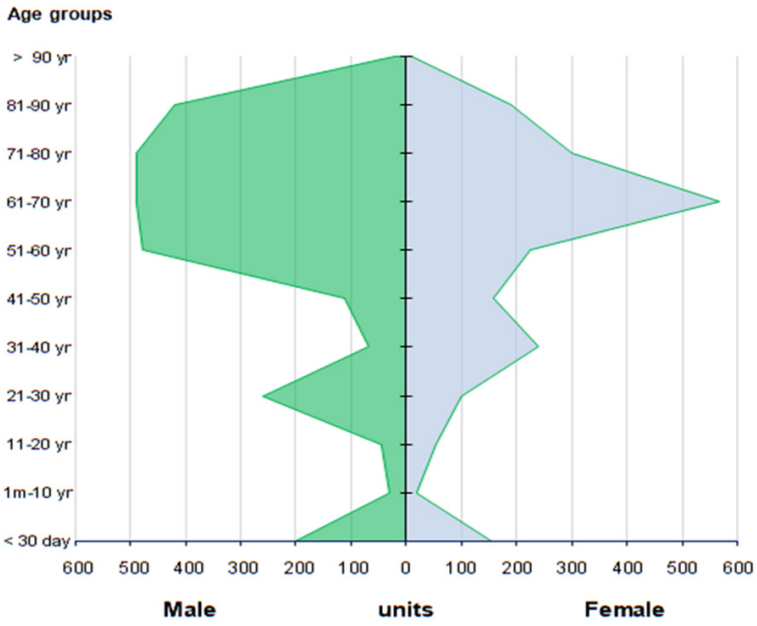

Figure 2. The age distribution among different gender for Fresh Frizzed Plasma recipients.

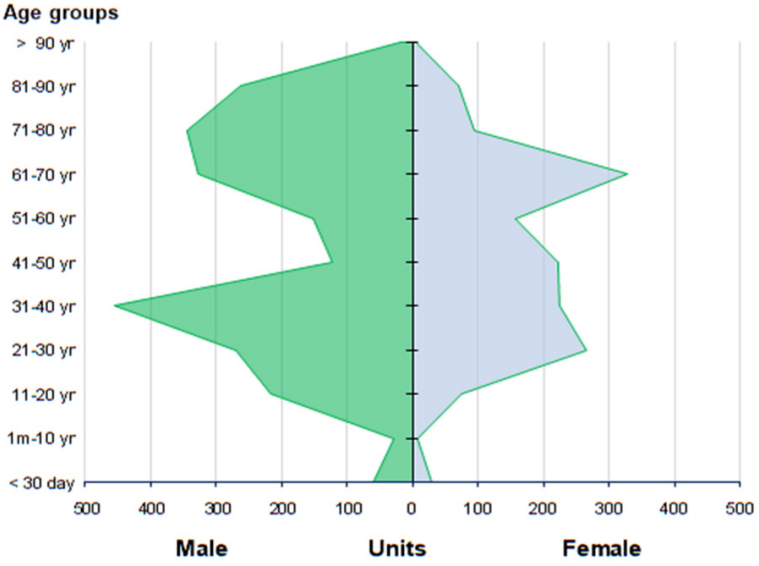

Figure 3. The age distribution among different gender for Platelet recipients.

age group of 31-35, 36-40, and 26-30 yrs formed the majority of blood donors (**Figure 4**). The people older than 60 had the lowest blood donations during the four-year study period.

Discussion

In the current study, elderly patients had the highest rates of transfusion of blood and blood products when they had the smallest role in the donation of blood. This result raises the critical alarm for an increased demand for blood products and associated shortage of supplies as the population ages. Heath and care systems in Iran need to optimize blood and blood product consumption to better manage the undeniable future imbalance in the donation and usage of blood products in the Iranian community of elderly.

The highest usage of blood products by < 60 yrs old patients, here is in concordance with results reported in the Netherlands [14], Nigeria [16], and a study in three hospitals in the center of Iran [15], while studies in France [17] and Denmark [18] illustrated the highest transfusions among ≥ 65 yrs old patients (57% and 73.5%). Patients aged 60-69 and 70-79 yrs had the highest reported transfusion rates in England [18].

Almost similar results were seen in Denmark and Australia, while patients in 70-79 and 75-80 yrs old groups had the most transfusions [18]. These differences may result from the higher percentage of senior citizens in those countries.

More frequent transfusion of blood products reported among male patients (52.9%) similar to China (52.8%) [19], the Netherlands (56.3%) [13], Denmark (56.3%) [18], and England (50.7%) [20], while a study in France demonstrated equality among male and female patients [17]. A South Korean study showed growth in the number of transfusions in female patients (up to 51.7%) in five years [21]. In the current study, the majority of transfused elderly patients were female (57.4%), which is almost

Table 4. Blood product transfusion in different disease and age groups

Rank	Disease	Cases			Total No. of products	per person transfusion	No. of products	Blood products/Number				
		Total patients No.	age group year	No. of patients in group				PRBC	FFP	PLT	CRYO	OTHER
1	Neoplasm	421	≥ 60	251	4221	10	2732	553	1522	640	5	12
			< 60	170			1489	388	167	911	-	23
2	Anemia	597	≥ 60	318	2850	4.7	1881	668	968	237	-	8
			< 60	279			969	538	25	388	8	10
3	Gastrointestinal bleeding	208	≥ 60	131	1601	7.7	1258	382	789	71	16	-
			< 60	77			343	178	134	16	14	1
4	Gastric disease	283	≥ 60	132	1588	5.6	957	247	600	100	10	-
			< 60	151			631	302	210	8	63	1
5	Respiratory disease	229	≥ 60	130	1430	6.2	1071	229	752	73	17	-
			< 60	89			359	167	126	49	16	1
6	Renal disease	245	≥ 60	149	1244	5.1	834	287	534	2	10	1
			< 60	96			410	184	135	43	43	5
7	Femur fracture	239	≥ 60	113	760	3.1	406	196	210	-	-	-
			< 60	126			354	125	300	36	17	1
8	Traumatic head injuries	141	≥ 60	48	577	4.1	238	99	139	-	-	-
			< 60	93			339	237	83	19	-	-
9	Non-traumatic head injuries	57	≥ 60	48	542	9.5	507	110	330	62	5	-
			< 60	9			35	19	16	-	-	-
10	Hematologic disorders	69	≥ 60	28	462	6.7	317	52	194	60	5	6
			< 60	41			145	50	14	72	-	9
11	Cesarean	123	≥ 60	-	426	3.4	-	-	-	-	-	-
			< 60	123			426	227	67	120	12	-
12	Orthopedic disease	44	≥ 60	10	424	9.6	76	23	41	12	-	-
			< 60	34			348	198	111	39	4	-
13	Premature infants	97	≥ 60	0	424	4.4	-	-	-	-	-	
			< 60	97			424	116	215	65	11	17
14	Neurologic disease	36	≥ 60	24	265	7.3	227	201	12	14	-	-
			< 60	12			38	20	18	-	-	-
15	Myocardial infarction and heart disease	83	≥ 60	47	265	3.2	184	57	120	5	-	2
			< 60	18			81	34	44	3	-	-
16	Poisoning	29	≥ 60	11	162	5.6	117	14	78	14	11	-
			< 60	18			45	18	25	2	-	-
17	Internal disease	24	≥ 60	14	124	5.1	62	20	42	-	-	-
			< 60	10			62	31	22	9	-	-
18	Emergency surgery	13	≥ 60	4	63	4.8	40	15	20	5	-	-
			< 60	9			23	16	7	-	-	-
19	Icterus	32	≥ 60	0	60	1.8	-	-	-	-	-	-
			< 60	32			60	32	28	-	-	-
20	Brain surgery	16	≥ 60	4	38	2.4	14	7	7	-	-	-
			< 60	12			24	24	-	-	-	-

PRBC: packed red blood cells, FFP: fresh frizzed plasma, PLT: Platelet, CRYO: Cryo poor plasma.

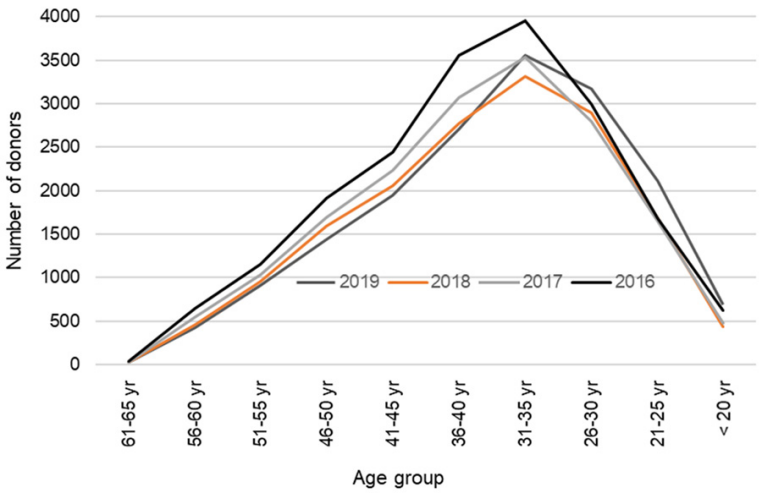

Figure 4. The age distribution of Blood donors.

the same as results of other studies in England (56%) [22], the United States (59.8%) [23], and Ireland (53%) [24]. This can possibly be explained by the higher life expectancy for women.

In the current study, the most commonly used blood product was PRBC (47.7%), and < 60 yrs old patients consumed the most of it (56.1%). These results are in contrast to the results of a study in three hospitals in Iran which reported 29.5% usage of PRBCs in elderly patients [15], and epidemiologic studies of blood product transfusion in other countries that revealed the highest PRBC transfusions among elderly patients [4, 17, 18, 21]. In concordance with results reported from Australia and three European countries, patients in the age group 60-69 yrs used the majority of FFPs [14, 18]. In this study, PLT was the lowest-consumed blood product. Patients of 30-39 and 60-69 yrs old had the highest transfusion frequency of PLT, as was reported in England as well [18]. The most frequent transfusion of PLTs was observed in the 50-60 yrs age groups in Australia and Denmark [18].

The majority of transfusion cases were patients who were hospitalized because of anemia and/or malignancies. These results align with a German study in 2010, which reported patients with hematological disorders and cancers as the most frequently transfused cases [14]. Patients who have cancer and gastrointestinal problems in France [17], South Korea [21], the United States, Denmark, Australia, and England were the most frequently transfused cases [18].

Among senior patients, those suffering from anemia, cancer, gastrointestinal problems, and kidney disorders were most often subjected to PRBC transfusion, which is almost the same in the Netherlands and Ireland [13, 21]. Here, the highest PLT transfusion among cancer patients with age ≥ 60 yrs is similar in England and Denmark [18].

Many studies have already reported an increase in the demand for blood product transfusion [4, 20, 22, 24-26]. Medical interventions needed for diseases are increased by aging, and in the current study, most transfusions happened in the ≥ 60 yrs age group. In four years, most blood donors were among the 26-35 yrs age group in the study's region. Population aging reduces the blood donor pool for the elderly while at the same time increasing blood component consumption [4]. When the population of older people increases in all societies, the situation for the young population is adverse, this means the blood production reservoir decreases and its consumers increases. The Iranian population had a fertility rate of 6% in past decades, but the current fertility rate is less than 2%. It will increase the portion of people in the age group of ≥ 60 yrs and decreases the demand for blood donation resulting from a lower population of < 60 yrs old individuals.

Conclusion

The results from the current study among a large group of hospitalized patients in North Khorasan province with a population of different Iranian ethnic groups can be considered a regional model of blood product transfusion in the country. The current study results revealed a higher transfusion rate for different blood products among elderly patients suffering from age-related diseases, which shows the request for these products, especially PRBCs, will be increased dramatically in the country by aging the population in the coming years. The results

of the current study emphasize the importance of optimal consumption management for the proper use of blood products in hospitals to overcome the shortfalls in the amount of donated blood. The weakness of the current study is the focus on the blood product practices in Iranian hospitals, not appropriate blood transfusion. The proper blood transfusion practice is a critical factor for overcoming future shortages in blood products. We recommend investigating on appropriate administration of blood products for patients in Iran, which is necessary to find a way to reduce the demand for blood product administration in Iranian hospitals.

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Disclosure of conflict of interest

None.

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