ORIGINAL ARTICLE

The Rate of Increase in the Delivery of Blood Components to Medical Organizations in Kazakhstan for 8 Years

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Abstract

Background and Objectives: To study the rate of increase and volume of blood components delivered to medical organizations in Kazakhstan for the years 2008–2015. **Materials and Methods:** The work used statistical sources for monitoring the activity of the blood service of Kazakhstan. The methods used for processing the obtained data were dynamics activity indexes, indicators of intensity of dynamics, and direct ranging. **Results:** The period from 2008 to 2015 saw an increase in the volume of blood components passed to medical organizations per 1000 persons: The growth rate of platelet concentrate in 2015 was +21.5, erythrocyte-containing media was +0.7, and plasma was −2.3. In the 2008–2015 period, the specific weight of leukoreduced blood components at the output to medical organizations increased the growth rate of platelet concentrate in 2015 was +1.1, erythrocyte-containing media +4, and plasma +11.8. In 2015, the specific weight of leukoreduced blood components was platelet concentrate - 95.0%, erythrocytes - 68.0%, and plasma - 28.4%. In 2015, the production of erythrocytes in Kazakhstan per 1000 persons was 10.0, platelets - 2.05 and plasma 8.9. **Conclusions:** Over the period of 2008–2015, the volume of blood components issued to medical organizations per 1000 persons increased, with an increase in platelet concentrate of 1.4 times. In 2015, the growth rate, compared to the previous year, was −2.3; the rate of increase in platelet concentrate was 21.5, erythrocyte-containing media increased 5.9 times with a rate of increase of 0.7 and plasma increased 3.6 times. The period of 2008–2015, the specific gravity of the leukoreduced blood components issued to medical organizations increased the platelet concentrate by 67.9 times. In 2015, the rate of platelet concentrate increase was 1.1, the erythrocyte-containing media increased 7.5 times with a rate of increase of 4.4, and plasma increased 3.8 times with a rate of growth of 11.8. Managerial decisions are necessary; it is necessary to make managerial decisions to increase the specific gravity of plasma leukoreduction. In Kazakhstan, the production of erythrocytes per 1000 persons in 2015 was 10.0, platelets - 2.05 and plasma - 8.9.

Key words: Delivery of erythrocyte-containing media, growth rate, leukoreduction, plasma, platelet concentrate

INTRODUCTION

In determining the erythrocyte stock volume, the American Association of Blood Banks recommends following prearranged supply numbers received from the surgical department or emergency department on the minimum blood supply.[1]

In 2007, the platelet share issued to medical organizations, for adults, per 1000 persons, was 0.3 in Russia, 4.1 in Austria, 5.3 in Belgium, 4.7 in Spain, 2.3 in Italy, 3.2 in France, and 6.2 in Finland. The blood service should, accordingly, increase the production of platelet concentrates and improve their quality and stock management.[2]

In many European countries, a relatively large proportion of plasma goes for leukoreduction: Belgium and France 100%, Greece 48%, and Italy 30%.[3,4] In many countries, plasma leukoreduction technology is being monitored on a permanent basis. In Russia, since 2011, and from 2009 to 2011, the volume of leukoreduced plasma increased 2 times.[5] In Kazakhstan,

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the monitoring of plasma leukoreduction technology has been carried out since 2008, and over the period of 2008–2015, the volume of leukoreduced plasma increased 3.8 times.

In some countries (France, Belgium), pathogens are inactivated in 100% of plasma; still, in other countries, it is a significantly rare procedure; 10% in Greece and 1% in Germany.[5]

In Belarus, the erythrocyte production per 1000 persons in 2008 was 15.7, platelets - 6.8 and plasma - 9.0.[3] Table 1 summarizes the plasma, erythrocyte and platelet ratios for selected countries.[3,6]

One of the priorities of the blood service in market conditions is the economic effectiveness of production transfusiology; accordingly, it is important to study blood component consumption and its safety in medical organizations.[3,7] In European countries, consumption is evaluated using the consumption rate per 1000 persons.[3,7]

Specifically, in Germany, the fresh frozen plasma (FFP) to erythrocytes ratio is 1:0.25, in France it is 1:0.16, and in Italy, it is 1:0.17.[7] For trauma and acute blood loss, the transfusion therapy standards advise to transfuse plasma and erythrocytes in the ratio of 1:2 or 1:1. A study by Hardin *et al.*[8] showed that plasma and erythrocyte transfusion in a ratio exceeding 1:1.5 had a lower case fatality rate in a group with combat injuries, as opposed to a group of the wounded, where similar components were administered in a ratio of 1:1.5 and lower. It should be noted that for the 5-year period, the ratio of "FFP/erythrocytes" in the structure of the blood components issued to medical facilities in the North-West FD (0.97 ± 0.04) and Ural FD (0.80 ± 0.05) was significantly lower ($P < 0.05$), and in the Central FD (1.34 ± 0.03) and Far Eastern FD (1.34 ± 0.03) was significantly higher ($P < 0.05$) than average in the Russian Federation.

It has been shown that FFP is the most frequent component of blood that causes post-transfusion complications, including acute hypervolemia, allergic and anaphylactic reactions, and transfusion-related acute lung damage.[3]

The volume of transfusion therapy and the ratio of transfused blood components is a subject of modern top research.[9]

Aim of the research

This study aims to study the rate of increase and volume of blood components delivered to medical organizations of Kazakhstan over the period of 2008–2015.

MATERIALS AND METHODS

The work used statistical sources for monitoring the activity of the blood service of Kazakhstan. The methods of processing the obtained data were dynamics activity indexes, indicators of intensity of dynamics, and direct ranging. The statistical processing was carried out in MS Excel.

RESULTS AND DISCUSSION

For the years 2008–2015, the blood centers of Kazakhstan registered an increase in the volume of blood components issued to medical organizations: Erythrocyte-containing media by 5.9 times, plasma by 3.6 times, and platelet concentrates by 1.4 times [Tables 1-3].

Analyzing [Table 1] the intensive dynamics of the indexes of the volume of banked and issued erythrocytes, we see a stable growth in Kazakhstan over the 8-year period from 2008 to 2015 ($P \leq 0.001$). In 2015, the index of the volume of banked and issued erythrocytes was 10.0 per 1000 persons; a 0.7 rate of growth compared with the previous year.

Analyzing [Figure 1] the average value dynamics of the volume of erythrocyte-containing media issued doses in regional blood centers; we see that the median is almost close to the average. In dynamics, over the 8-year period, this indicator increased 5.9 times ($P \geq 0.001$).

Analyzing [Table 2] the intensive indicators of the volume dynamics of prepared plasma-dose delivery, we see a stable growth over the 8-year period in Kazakhstan ($P \leq 0.001$). For 2015, this volume indicator of the banked plasma output was 8.9 per 1000 persons, with a rate of growth compared to the previous year of −2.3.

Analyzing [Figure 2] the dynamics of the volume average value of plasma doses issued by regional blood centers, we see that more than half of Kazakhstan's regional blood centers reduced their delivery to medical organizations.

Analyzing [Table 3] the intensive indexes of the volume dynamics of platelets banked concentrate issued, we can see a stable growth of 1.4 times over the 8-year period in Kazakhstan ($P \leq 0.05$). In 2015, this volume index of produced banked platelet concentrate was 2.05 per 1000

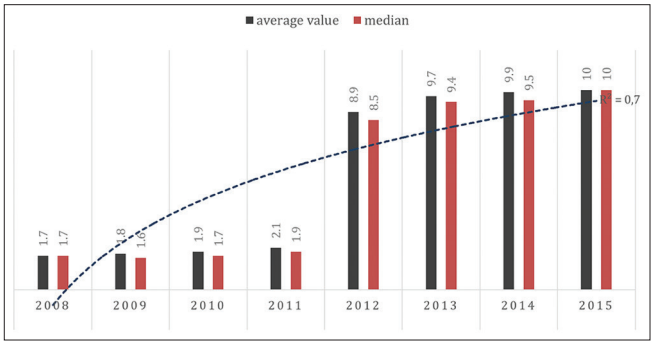

Figure 1: Comparative dynamics of mean value and median volume of erythrocyte-containing media issued doses in regional blood centers (n = 16) in Kazakhstan, per 1000 persons

persons. The rate of increase for 2015 was 21.5 and positive compared with the previous year.

Analyzing [Figure 3] the average value dynamics of platelet concentrate issued dose volume in regional blood centers, we can see that more than half of the regional blood centers in Kazakhstan, by the average median indicator, reduced their issuance to medical organizations over the 8-year period by 1.2 times.

Our next step was the analysis of the variation in the frequency of blood component delivery in Kazakhstan. The analysis unveiled a significant scatter in the data and indicated significant variability of this index in different blood centers across the country. The frequency variation coefficient of issued doses of erythrocytes, platelets, and plasma exceeds the allowed values [Table 4].

A graphic representation of the increase in the rate of blood component delivery to medical organizations [Figure 4] demonstrates a noticeable rate of growth in 2015 of platelet concentrate and erythrocyte-containing agents, and a negative rate of increase in plasma.

Table 1: Volume dynamics of doses issued of erythrocyte-containing media by region (*n*=16) in Kazakhstan, per 1000 population

Year	Frequency of issue	Me	m	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	1.7±1.0	1.7	0.25	-	-	-	-	100
2009	1.7±1.0	1.6	0.25	0.02	101.2	1.15	0.02	101.2
2010	1.9±0.9	1.7	0.23	0.12	106.9	6.4	0.02	108.0
2011	2.1±1.0	1.9	0.25	0.26	113.9	5.6	0.05	123.1
2012	8.9±5.1	8.5	1.28	6.8	419.2	76.1	0.09	516.2
2013	9.7±5.3	9.4	1.33	0.8	109.0	8.2	0.10	562.4
2014	9.9±5.4	9.5	1.35	0.2	102.0	2.0	0.10	574.0
2015	10.0±4.9	10.0	1.13	0.07	100.7	0.7	0.10	578.0

Table 2: Quantitative dynamics of issued plasma doses (*n*=16) in Kazakhstan, by region, per 1000 persons

Year	Frequency of issue per 1000	Me	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	2.5±1.7	2.3	-	-	-	-	100
2009	2.4±1.5	2.1	−0.1	−10	−4.2	0.02	96
2010	2.5±1.71	2.0	0.1	10	4.0	0.03	100
2011	2.2±1.7	2.0	−0.2	−30	−9.1	0.02	88
2012	9.1±8.5	8.0	6.9	413.6	75.8	0.09	364
2013	9.9±8.8	8.0	0.8	108.7	8.1	0.1	396
2014	9.1±7.0	8.0	−0.8	−80	−8.8	0.09	364
2015	8.9±6.0	7.0	−0.2	−20	−2.3	0.09	356

Table 3: Quantitative dynamics of platelet doses issued in Kazakhstan, by region (*n*=16), per 1000 persons

Year	Frequency of issue per 1000	Me	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	1.50±2.3	1.1	-	-	-	-	100
2009	2.54±3.38	1.6	1.04	169.3	40.90	0.025	169.3
2010	1.76±2.35	1.0	−0.78	69.3	−44.3	0.017	117.3
2011	1.72±1.95	1.4	−0.04	97.7	−2.3	0.017	114.7
2012	1.32±1.93	1.0	−0.4	76.7	−30.3	0.013	88.0
2013	1.66±2.84	0.9	0.34	125.8	20.5	0.016	110.7
2014	1.61±3.15	0.6	−0.03	97.0	−3.1	0.009	107.3
2015	2.05±3.98	0.9	0.44	127.3	21.5	0.020	136.7

Next, we studied the dynamics of leukoreduced platelet doses in Kazakhstan for the same period of 2008–2015 [Table 5].

The release of leukoreduced doses of platelet concentrate showed a positive growth rate of 1.1 in 2015 compared to the previous year [Table 6].

Table 4: Frequency variation coefficient

The variation coefficient	Year, %							
	2008	2009	2010	2011	2012	2013	2014	2015
Erythrocyte	58.8	58.8	47.3	47.6	57.3	54.6	54.5	49.0
Plasma	68.0	62.5	71.3	77.3	93.4	88.9	76.9	67.4
Thrombocyte	153.3	133.1	133.5	113.3	146.2	171.1	195.6	194.1

Table 5: Quantitative dynamics of leukoreduced doses of platelets issued in Kazakhstan, by region (*n*=16), per 1000 persons

Year	Frequency of issue per 1000	Me	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	1.4±2.4	1.1	-	-	-	-	100
2009	49.9±38.7	44.8	48.5	3564.2	97.2	0.50	3564.2
2010	54.8±29.7	50.0	16.1	109.8	29.4	0.55	3914.3
2011	82.5±36.6	45.6	27.7	150.5	55.3	0.50	5892.8
2012	78.0±36.4	78.0	–4.5	94.5	–5.8	0.78	5571.4
2013	69.9±38.3	92.0	–8.1	89.6	–11.5	0.70	4992.9
2014	94.0±20.5	94.0	24.1	134.5	25.6	0.94	6714.3
2015	95.0±22.3	94.0	1.0	101.1	1.1	0.90	6785.7

Table 6: Quantitative dynamics of leukoreduced plasma doses issued in Kazakhstan, by region (*n*=16), per 1000 persons

Year	Frequency of issue per 1000	Me	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	7.4±12.8	1.8	-	-	-	-	100
2009	23.8±30.9	8.0	16.4	31.1	221.6	0.074	321.6
2010	14.8±20.6	6.8	–9	160.8	–60.8	0.148	200.0
2011	16.5±18.1	8.2	1.7	89.7	11.4	0.149	222.9
2012	38.4±27.0	29.0	21.9	42.9	132.7	0.165	518.9
2013	26.9±24.2	21.0	–11.5	142.8	–42.7	0.269	363.5
2014	25.4±17.3	19.0	–1.5	105.9	–5.58	0.268	343.2
2015	28.4±22.4	23.0	3.0	89.4	11.81	0.254	383.8

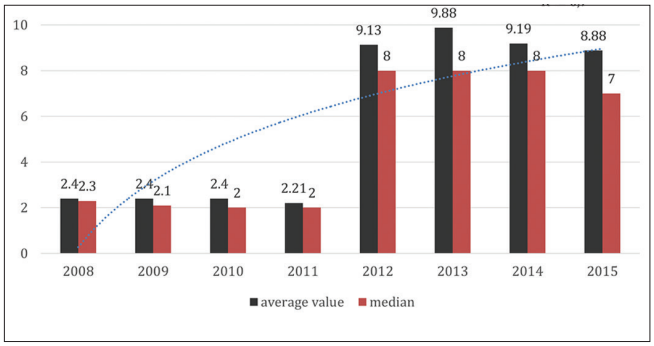

Figure 2: Comparative dynamics of mean value and median volume of plasma doses issued in regional blood centers (*n* = 16) in Kazakhstan, per 1000 persons

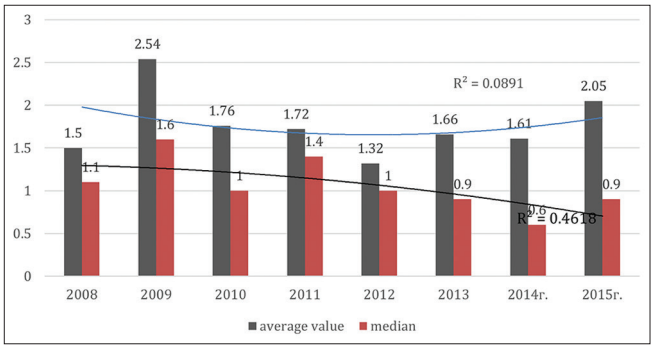

Figure 3: Comparative dynamics of mean and median volume of doses of platelet concentrate issued in regional blood centers (*n* = 16) in Kazakhstan, per 1000 persons

The release of leukoreduced plasma doses had a positive growth rate of 11.81 in 2015 compared with the previous year.

The release of leukoreduced erythrocyte-containing doses had a positive growth rate of 4.4 in 2015 compared with the previous year.

A clear picture of the rate of increase in the rate of delivery of leukoreduced blood components to medical organizations [Figure 5] shows a positive rate of increase in the leukoreduction of blood components in 2015 compared with previous years.

Analyzing [Figure 6] the volume of the specific weight of the blood components with leukoreduction in Kazakhstan for the period of 2008–2015, we see a significant and stable increase in plasma leukoreduction of 3.8 times ($P \leq 0.05$), 28.4%, an increase of erythrocytes of 7.5 times ($P \leq 0.01$), - 68.0%, and thrombocytes of 68 times ($P \leq 0.01$), - 95.0% by 2015 [Table 7].

Analyzing [Table 8] the leukoreduction variation coefficient of blood components in Kazakhstan, we see a significant variation of this indicator in different blood centers across Kazakhstan in the period from 2008 to 2015. In 2014, this variation became allowable in erythrocyte-containing media and platelet concentrate.

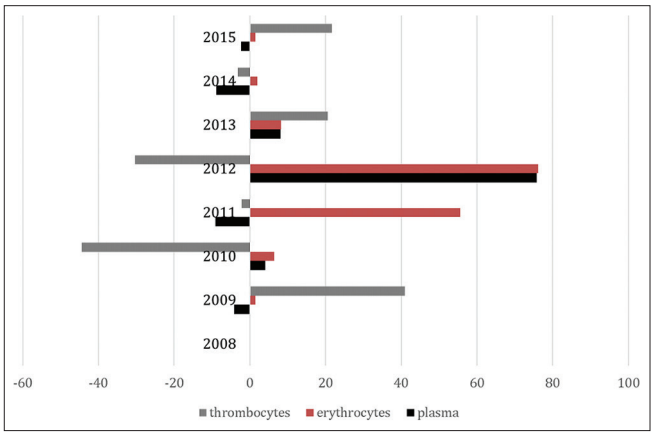

Figure 4: Rate of increase in the volume of issued doses of platelet concentrate, erythrocytes, and plasma in Kazakhstan

CONCLUSIONS

1. Over the 2008–2015 period, the volume of blood components issued to medical organizations per 1000 persons increased; platelet concentrate increased 1.4 times. In 2015, the rate of increase for platelet concentrate was 21.5, for erythrocyte-containing media was 5.9 times with a rate of increase of 0.7 and plasma 3.6 times; additionally, in 2015, the growth rate was negative and was 2.3 compared to the previous year.
2. The period of 2008–2015, the specific gravity of the leukoreduced blood components issued to medical organizations increased; the platelet concentrate increased 67.9 times. In 2015, the rate of growth was 1.1, the erythrocyte-containing media increased 7.5 times with a rate of increase of 4.4, and plasma increased 3.8 times, with a rate of growth of 11.8.

Table 7: Quantitative dynamics of leukoreduced doses of erythrocytes issued in Kazakhstan, by region (*n*=16), per 1000 persons

Year	Frequency of issue per 1000	Me	Absolute growth	Growth rate	Rate of increase	Value of 1% increase	Visual expression since 2008, %
2008	9.08±17.0	7.5	-	-	-	-	100
2009	5.5±4.0	4.9	–3.58	60.5	–65.0	0.059	60.5
2010	42.0±30.5	31.6	36.5	763.6	86.9	0.420	462.6
2011	47.6±27.4	39.0	5.6	560.0	13.3	0.421	524.2
2012	55.0±26.5	46.0	7.4	115.4	13.5	0.548	605.7
2013	61.0±25.2	59.0	6.0	110.9	9.8	0.612	671.8
2014	65.0±21.3	57.0	4.0	106.6	6.2	0.645	715.9
2015	68.0±23.5	62.0	3.0	104.6	4.4	0.681	748.9

Table 8: Variation coefficient in the proportion of leukoreduction of blood components in regional blood centers (*n*=16)

The coefficient of variation	Year, %							
	2008	2009	2010	2011	2012	2013	2014	2015
Erythrocytes	187.2	72.7	72.6	57.5	48.1	41.3	32.7	34.5
Plasma	173.0	129.8	139.2	109.7	70.3	90.0	68.1	78.9
Thrombocytes	171.4	77.6	54.2	44.4	46.7	54.8	21.8	23.5

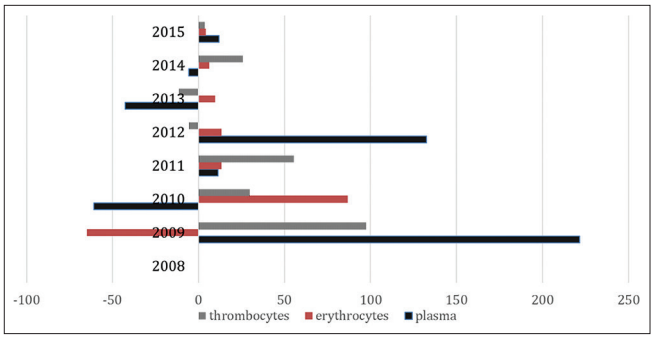

Figure 5: Rate of increase in the volume of issued doses of platelet concentrate, erythrocytes, and plasma in Kazakhstan

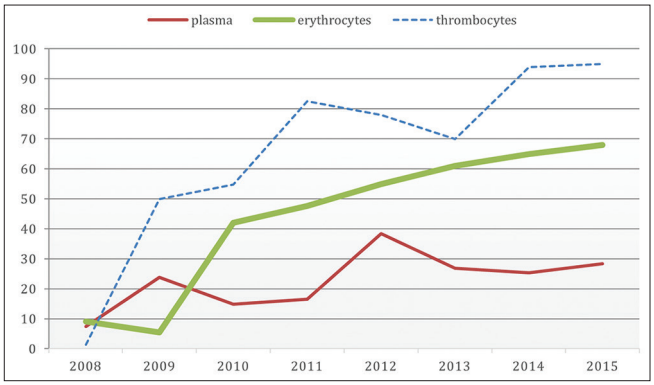

Figure 6: Specific gravity dynamics of leukoreduction of the given doses of platelet concentrate, erythrocytes, and plasma in Kazakhstan for the period of 2008–2015, by %

3. The variation coefficient in the volume of issued blood components per 1000 persons across all of the blood centers in the republic exceeds allowable differences.
4. The variation coefficient in the specific gravity of the leukoreduced blood components per 1000 persons across all the blood centers of the republic exceeds the allowable differences in the period from 2008 to 2013; and, only since 2014, has the platelet concentrate and erythrocyte-containing media been within normal range. This fact is confirmed across the country at the republic level.
5. It is necessary to make managerial decisions to increase the specific gravity of plasma leukoreduction.
6. In Kazakhstan, the production of erythrocytes per 1000 persons in 2015 was 10.0, platelets - 2.05 and plasma - 8.9.
7. It is necessary to study the low demand for platelet concentrate in Kazakhstan.

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