

## Blood transfusion service in Poland in 2018

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### Summary

**Background:** Assessment of the basic aspects of the activity of the Polish Regional Blood Transfusion Centers (hereinafter referred to as Centers) in 2018.

**Materials and methods:** Retrospective analysis of the 2018-data supplied by the Centers.

**Results:** In 2018, blood and blood components were collected in 21 Centers and 132 local collection sites as well as during 13 189 mobile collections. The overall number of blood donors was estimated at 590 470; the majority were non-remunerated donors (589 897 — including 37 824 responders to donation appeals), 73 remunerated donors and 500 autologous donors. Most frequent were whole blood collections (1 184 311), least frequent — granulocyte concentrate collections (116) and red blood cell (RBC) collection by apheresis (31 donations). Whole blood was collected mostly in local collection sites (44.85%), less frequently in Centers (28.47%) and at mobile collection sites (26.67%). Most frequently prepared blood components were RBC — 1 161 600 units) and fresh frozen plasma (FFP — 1 298 216 units; 20.93% dedicated for clinical use). Platelet concentrates (PCs) collected by apheresis amounted to 50 255 units and 83 598 were whole blood-derived.

Additional processing methods such as leukocyte depletion and irradiation were more frequently applied to PCs (32.56% leukocyte depleted, 1.37% irradiated, 58.07% both leukocyte depleted and irradiated) than to RBCs (17.29% leukocyte depleted, 0.31% irradiated, 8.94% both leukocyte depleted and irradiated). Pathogen reduction technologies were applied to 11.74% of PCs and 10.23% units of FFP issued for transfusion.

In 2018 — for various reasons — 14 067 units of whole blood, 30 521 units of RBC, 49 979 units of FFP, 1376 units of cryoprecipitate, 5186 units of pooled PCs and 1625 of apheresis PCs were wasted.

**Conclusions:** The study data may contribute to evaluation of the tendencies observed in Centers and may serve practical-benchmarking which in turn may prove beneficial to the transfusion community as a whole.

**Key words:** blood donors, blood donation, blood components

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### Introduction

This is the eleventh presentation of the selected issues related to the annual activity of public blood transfusion service (BTS) in Poland. Of

particular interest were 2018 — data referring to the following issues: number of donors, donations, collection sites for whole blood and blood components, including RBC, fresh frozen plasma (FFP), platelet cell concentrate (PC) and granulocyte con-

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centrate (GC). Discussed were also issues related to administration of additional preparation methods as well as inactivation of biological pathogens in labile blood components. The most common causes of blood component wastage as well as the scale of the phenomenon were also explored.

The activity of Polish BTS is regulated by the Public Blood Transfusion Service Act voted by the Polish Parliament in 1997 [1]. Pursuant to this Act, blood is collected in public Centers exclusively, no private collection Centers are permitted. There are 21 Centers as well as the Military Blood Transfusion Center (supervised by the Ministry of Defense) and the Blood Transfusion Center of the Ministry of Internal Affairs and Administration. The activity of BTS in Poland is supervised by the Polish Ministry of Health and the Institute of Hematology and Transfusion Medicine (IHTM) exercises supervision over the activity of all Centers.

## Materials and methods

As in the previous years, this study relies on data provided by 21 Centers in form of annual reports. With the aim of standardization of the forwarded data, IHTM together with the National Blood Centre (NCK) created a template of definitions.

**First-time donor** — donates blood during the reporting period but has never before donated blood for medical purposes.

**Multiple (regular) donor** — systematically donates blood (at least twice during the last 24 months).

**Multiple repeat donor** — donates blood again more than 2 years after the last donation.

**Non remunerated donor** — receives no financial compensation for donated blood/blood component at least once during the reporting period.

**Remunerated donor** — receives financial compensation for every donation during the reporting period.

**Responder to donation appeal** — donates blood /blood component following emergency appeal for donation at least once during the reporting period (the term also applies to former „family donors”).

**Directed donor** — donates blood for a specific patient at least once during the reporting period.

**Autologous donor** — donates blood/blood component for himself at least once during the reporting period.

**Donation** — whole blood or blood component collected by apheresis, including blood for clinical and scientific purposes collected from immunized and family donors etc.

**Unit (u.)** — volume of anticoagulated whole blood obtained from 450 ml of blood collected from the

donor or volume of blood component obtained from one unit of anticoagulated whole blood.

**Unit of plasma** — volume of plasma obtained from whole blood or by automated plasmapheresis. One automated plasmapheresis procedure provides 3 units of plasma (600 ml).

**Unit of PC from apheresis** — platelets obtained from a single donor with cell separator (1 donation regardless of platelet count).

**Therapeutic dose of PC** — PCs (either pooled or from apheresis) dedicated for an adult; according to current guidelines it contains  $\geq 3 \times 10^{11}$  platelets.

## Results

### Regional Blood Transfusion Centers (Centers)

In 2018 there were 21 Centers and 132 local collection sites operating in Poland, which is one local collection site less than in 2017. As in the previous year, 13 189 mobile collections were performed. In 2018 all Centers organized mobile collection sites and — just as in 2017 — the largest number of mobile collections was organized by the Center in Katowice (1949). More than 1000 mobile collections were organized in Łódź (1197), Wałbrzych (1269) and Warsaw (1243). As compared to the previous year, the number of mobile collections increased in 12 Centers and the upward trend was most evident for Szczecin (a 7.59% increase) (Table 1).

### Donors

In 2018, a total of 693 772 persons came to donate blood (in 2017 — 692 181). Only 590 470 of them were qualified (in 2017 — 588 184). It follows that — as in the previous years — approximately 85% of people who were willing to donate blood were qualified for donation of blood or blood components for clinical use. The difference was mostly due to donor deferral. In 2018, a total of 9147 permanent deferrals were applied as well as 226 542 temporary deferrals of 187 747 persons; as in previous years, the most frequent cause for deferral (75 099) was low hemoglobin level.

Donors were mostly non-remunerated (589 897 — 37 824 responders to appeal and 64 directed donors). In 2018, blood and blood components were also donated by 73 remunerated donors and 500 autologous donors.

In 11 Centers blood was donated only by non-remunerated donors. The highest number of remunerated donors (27) was reported by Center in Poznań.

**Table 1.** Mobile collections organized in Polish Regional Blood Transfusion Centers (2017–2018)

Centers	Mobile collections		
	2017	2018	Increase/ /decrease as compared to 2017
Białystok	730	729	↓
Bydgoszcz	806	816	↑
Gdańsk	523	432	↓
Kalisz	395	416	↑
Katowice	1959	1949	↓
Kielce	292	285	↓
Kraków	796	833	↑
Lublin	321	337	↑
Łódź	1273	1197	↓
Olsztyn	510	507	↓
Opole	315	271	↓
Poznań	816	851	↑
Racibórz	235	250	↑
Radom	342	325	↓
Rzeszów	228	240	↑
Słupsk	161	164	↑
Szczecin	369	397	↑
Wałbrzych	1299	1269	↓
Warszawa	1168	1243	↑
Wrocław	369	383	↑
Zielona Góra	282	295	↑
<b>Total</b>	<b>13 189</b>	<b>13 189</b>	<b>No change</b>

↓ — decrease as compared to 2017

↑ — increase as compared to 2017

In 2018 there were 140 813 first-time donors (23.85%), 368 748 (62.45%) multiple regular donors and 80 909 (13.70%) multiple repeat donors.

10 Centers reported a decrease in the number of donors while 11 noted an increase. As compared to 2017, the highest increase was observed in Centers in Lublin (by 10.67%) and Warsaw (by 6.44%). Table 2 presents the number of donors in each Center in 2018.

As in the previous years, the largest group of donors were aged 18–44 (514 093; 147 218 women and 366 875 men).

## Donations

In 2018, whole blood was collected most frequently (1 184 311 donations), while the least frequent were collections of granulocytic concentrate (116 donations in 6 Centers) and RBC

from apheresis (31 donations in 2 Centers). As in previous years, the largest number of whole blood donations was reported by Center in Katowice (113 983) and in Warsaw (108 658). Apheresis was mainly used for preparation of PC (24 587 donations) and plasma (36 655 donations). The largest number of apheresis plasma donations was reported by Center in Kalisz (8116) and Center in Warsaw performed the largest number of apheresis PC donations (8031).

Automated donations of a combination of blood components were also performed usually PC and plasma (19 143), less often PC and RBC (60).

Table 3 presents the number of complete donations of blood and blood components in 2018.

Blood was collected primarily in local collection sites (44.85% of whole blood donations), less often in Center (28.47%) as well as during mobile collections (26.67%). As in the previous years, most of the whole blood (59.72%) was collected during mobile collections organized by Center in Wałbrzych. Table 4 provides a list of whole blood donation sites in 2018.

## Blood components

### Red Blood cells (RBCs)

Donated blood was processed into blood components, mostly RBC (1 161 600 units), which represented a slight increase country-wide as compared to the previous year (1 154 239 units). As in previous years, the majority of RBC were obtained in Centers in Katowice and Warsaw (112 735 and 108 332 units respectively) (Table 5). The largest increase in the number of RBC was recorded in Lublin (by 10.83%) and in Warsaw (by 5.34%). A decrease was reported by 10 Centers and an increase by 11.

Some RBC were subjected to additional preparation — mostly leukocyte reduction and irradiation.

In 2018, a total of 200 792 units of leukocyte depleted RBC was obtained (17.29% of all RBC), 3 579 units of irradiated RBC — 0.31%. In many cases leukocyte reduction and irradiation were used in combination to obtain 103 886 units of both leukoreduced and irradiated RBC — 8.94% of all red cell units.

Country-wide, 26.23% of all RBC (20.70% in 2017) were subjected to leukocyte reduction and 9.25% to irradiation (8.46% — in 2017). Table 6 presents the number of irradiated RBC units and leukocyte depleted RBC obtained by each Center in 2018.

**Table 2.** Blood donors in Polish Regional Blood Transfusion Centers (2018)

Centers	Donors			Total	Increase/decrease as compared to 2017
	First-time	Multiple regular	Multiple repeat		
Białystok	5193	20 871	3455	29 519	↓
Bydgoszcz	8361	22 332	4375	35 068	↑
Gdańsk	6375	18 324	3722	28 421	↓
Kalisz	4440	13 680	2493	20 613	↑
Katowice	10 389	34 076	6108	50 573	↓
Kielce	5475	10 191	2709	18 375	↑
Kraków	10 656	28 495	5629	44 780	↑
Lublin	7496	16 355	3988	27 839	↑
Łódź	10 253	18 726	5957	34 936	↓
Olsztyn	4962	10 728	5170	20 860	↑
Opole	3043	8638	1861	13 542	↓
Poznań	10 423	31 236	6499	48 158	↓
Racibórz	2293	10 153	1745	14 191	↓
Radom	3312	6566	1814	11 692	↑
Rzeszów	5745	20 295	3199	29 239	↑
Słupsk	3160	6662	1212	11 034	↓
Szczecin	6164	15 603	3030	24 797	↓
Wałbrzych	2621	8013	1243	11 877	↓
Warszawa	17 344	34 258	9342	60 944	↑
Wrocław	9571	23 696	5451	38 718	↑
Zielona Góra	3537	9850	1907	15 294	↓
<b>Total</b>	<b>140 813</b>	<b>368 748</b>	<b>80 909</b>	<b>590 470</b>	↑

↓ — decrease as compared to 2017

↑ — increase as compared to 2017

### Platelet concentrate

Platelet concentrate (PC) was the second most frequently prepared blood component, just like in the years before. Two basic methods were used for PC preparation:

- centrifugation of whole blood from traditional donations, and — if necessary — pooling of several units of the PC to obtain pooled PC. In some Centers automated methods were used;
- apheresis with cell separators (some of the PC units obtained with this method were divided into smaller therapeutic doses).

In 2018, a total of 83 598 pooled PC units were prepared (in 2017 — 77 671), including 53 369 from buffy coat with manual method and 30 228 with automated methods. A total of 50 255 PCs (37.54%) were obtained by apheresis (in 2017 — 39.86%).

As in previous years, the largest volume of whole blood PCs was obtained in Poznań (11 547 pooled PC units), and of apheresis PCs in Warsaw (13 311).

The percentage of PCs from apheresis differed significantly between Centers and ranged from 0.95% in Zielona Góra to 77.72% in Warsaw and 70.73% in Wrocław (Table 7).

Some part of the PC units were subjected to leukocyte depletion and/or irradiation. PCs collected by apheresis with modern cell separators are usually leukocyte depleted and require no additional leukocyte depletion.

In 2018, a total of 43 589 therapeutic doses of leukocyte-reduced PCs were obtained, which was 32.56 % of the total PCs obtained and 1 834 therapeutic doses of irradiated PCs (1.37%). Leukocyte reduction and irradiation were often used in combination to obtain 77 734 therapeutic doses of both leukocyte depleted and irradiated PCs (58.07%).

Country-wide, a total of 90.64% of all PC therapeutic doses were leukocyte depleted and 59.44% were irradiated (in 2017 — 92.07% and 57.60% respectively).

**Table 3.** Whole blood and apheresis donations in 2018

Centers	Wholeblood	Apheresis						Total
		Plasma	RBC	PC	GC	PC+plasma	PC+RBC	
Białystok	60 817	5514	0	153	44	1244	0	67 772
Bydgoszcz	69 619	3823	0	927	27	0	0	74 396
Gdańsk	60 078	1274	0	531	0	0	0	61 883
Kalisz	40 793	8116	0	377	0	415	0	49 701
Katowice	113 983	53	0	5259	0	4578	0	123 873
Kielce	33 213	663	0	640	0	0	0	34 516
Kraków	91 429	32	0	2065	27	0	0	93 553
Lublin	55 141	3194	0	1381	0	0	0	59 716
Łódź	60 772	106	0	672	0	0	0	61 550
Olsztyn	42 885	1031	0	7	0	560	0	44 483
Opole	28 808	46	0	401	0	0	0	29 255
Poznań	94 843	2471	0	1043	0	660	0	99 017
Racibórz	32 245	1601	0	0	0	372	0	34 218
Radom	22 176	1084	0	52	0	583	0	23 895
Rzeszów	63 621	2083	0	1159	0	0	0	66 863
Słupsk	23 058	175	0	225	0	142	14	23 614
Szczecin	50 969	610	0	30	3	2485	0	54 097
Wałbrzych	26 078	0	25	89	0	0	25	26 217
Warszawa	108 658	83	0	8031	5	3245	0	120 022
Wrocław	72 602	4670	6	1520	10	4834	21	83 663
Zielona Góra	32 523	26	0	25	0	25	0	32 599
<b>Total</b>	<b>1 184 311</b>	<b>36 655</b>	<b>31</b>	<b>24 587</b>	<b>116</b>	<b>19 143</b>	<b>60</b>	<b>1 264 903</b>

\*Complete donations only

Table 8. presents the numbers of leukocyte depleted and irradiated PCs obtained by each Center in 2018.

In 2018 a total of 126 786 therapeutic doses of PC were issued for clinical use (in 2015 — 113 984, in 2016 — 118 153 and in 2017 — 123 443), the upward trend is therefore evident.

Some PCs were stored frozen.

In 2018, 3.7% of all PCs were subjected to freezing (including 3.8% pooled PCs, 3.6% PCs from apheresis). For the last several years the percentage of frozen PCs is observed to decrease; as compared to 2017 by 0.9%. However, in consecutive years the percentage of frozen PCs in individual Centers is on the same level despite recommendations for the number to be reduced. The percentage differs between Centers and ranges from 0% in Kalisz and Poznań to 18.7% in Słupsk (increase by 0.6% as compared to 2017), 24.3% in Opole (decrease by 2.0%), 32.2% in Radom (in-

crease by 0.4%), 43.7% in Wałbrzych (decrease by 6.5%), and as much as 60.0% in Raciborz (increase by 0.8%). As in 2017, Raciborz reported the largest percentage of frozen pooled PCs (75.2%).

In 2018, thawed PCs were 3.7% of all PC therapeutic units issued for clinical use, i.e. 0.4% less than in 2017. The largest number of thawed PC units was issued by Racibórz (79.0% of all PC units issued for clinical use), Wałbrzych (41.0%), Radom (35.7%), Opole (24.0%) and Słupsk (18.9%). The Centers in Racibórz and Słupsk reported a marked decrease as compared to 2017 (by 9.6% and 11.3% respectively).

### **Fresh frozen plasma**

In 2018, a total of 1 298 216 units of FFP were prepared (in 2017 — 1 287 001 units). As in the previous years, FFP was mainly obtained by manual method, i.e. plasma obtained from anticoagulated whole blood. With this method, 1 154 958 FFP

Table 4. Sites of whole blood collection in 2018\*

Centers	Whole blood collected (units and percentage)						
	Center site		Local collection site		Mobile collection site		Total
	U.	%	U.	%	U.	%	U.
Białystok	24 660	40.25	17 460	28.50	19 140	31.24	61 260
Bydgoszcz	17 168	24.47	26 458	37.71	26 538	37.82	70 164
Gdańsk	18 838	31.14	31 465	52.02	10 185	16.84	60 488
Kalisz	7923	19.34	17 208	42.00	15 841	38.66	40 972
Katowice	13 794	11.95	63 085	54.66	38 529	33.39	115 408
Kielce	15 009	44.91	10 376	31.04	8038	24.05	33 423
Kraków	22 784	24.77	48 123	52.32	21 072	22.91	91 979
Lublin	15 868	28.49	31 703	56.92	8126	14.59	55 697
Łódź	16 026	26.02	22 102	35.89	23 455	38.09	61 583
Olsztyn	12 023	27.66	19 158	44.07	12 289	28.27	43 470
Opole	6353	21.97	16 634	57.53	5929	20.50	28 916
Poznań	26 146	27.14	43 963	45.64	26 213	27.21	96 322
Racibórz	4132	12.72	21 552	66.35	6797	20.93	32 481
Radom	11 188	50.24	3511	15.77	7568	33.99	22 267
Rzeszów	15 980	24.92	42 202	65.82	5933	9.25	64 115
Słupsk	9892	44.56	8529	38.42	3777	17.02	22 198
Szczecin	22 332	43.60	18 796	36.70	10 090	19.70	51 218
Wałbrzych	10 611	40.28	0	0.00	15 731	59.72	26 342
Warszawa	26 382	23.94	50 461	45.80	33 338	30.26	110 181
Wrocław	34 830	47.36	26 693	36.30	12 018	16.34	73 541
Ziel. Góra	8287	25.25	16 425	50.04	8113	24.72	32 825
<b>Total</b>	<b>340 226</b>	<b>28.47</b>	<b>535 904</b>	<b>44.85</b>	<b>318 720</b>	<b>26.67</b>	<b>1 194 850</b>

\*Incomplete donations included

units were obtained in 2018. With the less frequent method of apheresis 143 258 units were obtained (11.04% of all FFP units) as compared to 2017 — 140 309 units — 10.90% . The percentage of FFP obtained by apheresis varied between Centers and ranged from 0% in Wałbrzych to 38.31% in Kalisz.

Table 9. presents the number of FFP units obtained by manual method and by apheresis in individual Centers in 2018.

A total of 271 702 FFP units were issued for clinical purposes (20.93% of all plasma collected), i.e. slightly less than in 2017 (291 989 FFP units, i.e. 22.69%). In individual Centers, the percentage of FFP issued for clinical purposes ranged from 6.82% in Center in Kalisz to 40.48% in Warsaw (Table 10).

### Granulocyte concentrate

As in previous years, granulocyte concentrate (GC) was sporadically obtained (116 donations),

however an increase was reported as compared to 2017 (50 donations). The number of Centers in which GC was collected also increased (in 2018 — 6, in 2017 — 4). The largest numbers of GC donations were reported for Białystok (44) and Krakow (27).

### Quarantine and inactivation of biological pathogens in labile blood components

In Poland, for strengthening the safety of transfused blood components we rely solely on quarantine<sup>1</sup> or pathogen inactivated FFP and cryoprecipitate. In vitro studies as well as multicenter clinical trials have also proved that some methods of pathogen inactivation (Mirasol PRT with ribofla-

<sup>1</sup>Quarantine of FFP and cryoprecipitate consists in storage for at least 16 weeks of donation date followed by testing the donor for infectious disease markers (to eliminate the diagnostic window period).

**Table 5.** Units of RBCs prepared in Polish Regional Blood Transfusion Centers in 2018

Centers	RBCs	Increase/decrease as compared to 2017
Białystok	59 416	↓
Bydgoszcz	69 569	↑
Gdańsk	59 683	↓
Kalisz	39 318	↓
Katowice	112 735	↑
Kielce	33 131	↑
Kraków	91 226	↓
Lublin	55 039	↑↑
Łódź	60 633	↓
Olsztyn	42 796	↑
Opole	28 782	↑
Poznań	91 450	↑
Racibórz	31 606	↓
Radom	21 889	↑
Rzeszów	60 768	↑
Słupsk	21 979	↓
Szczecin	50 955	↓
Wałbrzych	26 078	↓
Warszawa	108 332	↑↑
Wrocław	63 774	↑
Zielona Góra	32 441	↓
<b>Total</b>	<b>1 161 600</b>	↑

↓ — decrease as compared to 2017

↑ — increase by 0.1-5.0% as compared to 2017

↑↑ — increase by &gt;5.0% as compared to 2017

**Table 6.** Leukocyte-depleted and irradiated RBCs produced in Polish Regional Blood Centers (2018)

Centers	Units of leukocyte-depleted RBCs	Units of irradiated RBCs	Units of both irradiated and leukocyte-depleted RBCs
Białystok	1961	0	5543
Bydgoszcz	3229	0	9584
Gdańsk	1440	1	14 080
Kalisz	10 563	0	0
Katowice	28 729	1839	6721
Kielce	5804	0	2722
Kraków	6307	620	7342
Lublin	0	516	8852
Łódź	13 215	40	9885
Olsztyn	4618	7	4078
Opole	3927	0	464
Poznań	14 021	7	7999
Racibórz	3622	0	20
Radom	1723	0	178
Rzeszów	135	65	7836
Słupsk	968	0	1544
Szczecin	954	465	917
Wałbrzych	309	0	0
Warszawa	87 754	0	7150
Wrocław	5266	19	6766
Zielona Góra	6247	0	2205
<b>Total</b>	<b>200 792</b>	<b>3579</b>	<b>103 886</b>

vin, Intercept with amotosalen hydrochloride) do not only reduce the risk of pathogen transmission but may be an alternative to irradiation applied for prevention against Transfusion-Associated Graft Versus Host Disease, TA-GvHD)] [2–4].

In 2018, 12 Centers subjected to pathogen reduction technology (PRT) from 0.09% (Lublin) to 22.52% (Poznań) of plasma from whole blood or collected by automated plasmapheresis. The highest percentage of pathogen inactivated plasma was reported in Poznań (22.52% — Theraflex MB Plasma system), in Warsaw (10.18%; 9.94% inactivated with Mirasol system, 0.24% with Intercept system) and in Katowice (10.00% with Mirasol system). In the remaining Centers the percentage of pathogen inactivated plasma did not exceed 6% and ranged from 0.09% in Lublin to 5.15 in Kraków.

In 2018, 89.71% of quarantine FFP and 81.48% of cryoprecipitate units were issued for clinical use, as well as 10.23% of pathogen inactivated FFP and 18.52% of cryoprecipitate (cryoprecipitate only in Poznań and Łódź).

In 5 Centers the system of pathogen inactivation for PCs was implemented. The highest percentage of PCs subjected to pathogen inactivation was reported for Warsaw (99.34% of pooled leukocyte depleted PCs and 47.85% of leukocyte depleted PCs from apheresis). Center in Łódź pathogen inactivated (with Mirasol system) only 0.37% of leukocyte depleted PCs from apheresis (12.8% — in 2017). In 2018, no pathogen inactivation was applied to PCs in the Center in Kielce although in the same Center in 2017 13.6% of leukocyte depleted apheresis PCs were subjected to pathogen inactivation. In

**Table 7.** PCs (from apheresis and whole blood) prepared in Polish Regional Blood Transfusion Centers (2018)

Centers	PCs (therapeutic doses)			
	Pooled from whole blood	Apheresis	Total	% apheresis PCs
Białystok	1349	2784	4133	67.36
Bydgoszcz	7916	1147	9063	12.66
Gdańsk	5387	815	6202	13.14
Kalisz	1773	522	2295	22.75
Katowice	9733	7395	17 128	43.17
Kielce	3415	701	4116	17.03
Kraków	6621	2570	9191	27.96
Lublin	4055	1666	5721	29.12
Łódź	4616	804	5420	14.83
Olsztyn	3795	695	4490	15.48
Opole	1169	401	1570	25.54
Poznań	11 547	3080	14 627	21.06
Racibórz	966	391	1357	28.81
Radom	821	678	1499	45.23
Rzeszów	5963	1240	7203	17.22
Słupsk	848	302	1150	26.26
Szczecin	2324	2678	5002	53.54
Wałbrzych	1085	119	1204	9.88
Warszawa	3816	13 311	17 126	77.72
Wrocław	3695	8930	12 625	70.73
Zielona Góra	2704	26	2730	0.95
<b>Total</b>	<b>83 598</b>	<b>50 255</b>	<b>133 853</b>	<b>37.54</b>

Centers in Lublin and Łódź the percentage of inactivated leukocyte depleted apheresis PCs did not exceed 1% (0.71% and 0.37% respectively). In Katowice only trace volumes were subjected to inactivation (0.01% of pooled leukocyte depleted PCs and 0.02% of leukocyte depleted apheresis PCs).

In 2018, country-wide statistics reported a total of 11.74% of inactivated PC therapeutic units (in 2017 — 11.41%).

Table 11 presents the 2018 — percentage of FFP units, and PC therapeutic units issued for clinical purposes following pathogen inactivation.

### Wastage of blood and blood components

In 2018, a total of 102 755 units of blood and the most common blood components were wasted, including 14 067 units of anticoagulated whole blood, 30 521 units of RBCs, 49 979 units of fresh

frozen plasma (FFP), 1625 therapeutic units of apheresis PC, 5 186 PCs from whole blood, and 1376 units of cryoprecipitate.

As in the previous year, the most common reasons for wastage of blood components were:

1. Date expiry.
2. Seropositivity for transfusion transmitted diseases, syphilis, implementation of look-back procedure.
3. Other causes, including:
  - Inadequate visual control,
  - Low quantity/volume,
  - Seropositive serological results,
  - other, including incorrect procedures, medical deferral, mechanical damage, donor self-deferral.

Table 12 presents the number of blood components wasted in individual Centers in 2018; causes of wastage are shown in Table 13.



**Table 8.** Leukocyte-depleted and irradiated PC therapeutic doses produced in Polish Regional Blood Transfusion Centers (2018)

Centers	PC therapeutic doses	Leukocyte-depleted PCs	Irradiated PCs	Both irradiated and leukocyte-depleted PCs
Białystok	4133	0	0	4121
Bydgoszcz	9063	71	0	8992
Gdańsk	6202	583	0	5496
Kalisz	2295	2295	0	0
Katowice	17 128	3806	0	5001
Kielce	4116	834	0	2084
Kraków	9191	4647	3	4541
Lublin	5721	206	0	5477
Łódź	5420	320	2	5098
Olsztyn	4490	462	0	3984
Opole	1570	1538	0	31
Poznań	14 627	813	1829	11 205
Racibórz	1357	1335	0	22
Radom	1499	1295	0	29
Rzeszów	7203	3425	0	3778
Słupsk	1150	503	0	647
Szczecin	5002	3004	0	1998
Wałbrzych	1204	1204	0	0
Warszawa	17 127	15 442	0	1685
Wrocław	12 625	269	0	12 352
ZielonaGóra	2730	1537	0	1193
Total	133 853	43 589	1834	77 734

## Discussion

Demand for blood and blood components is steadily growing and is associated with advancement in various fields of medicine as well as such factors as aging of societies. Despite recent attempts at promoting therapies that are alternatives to transfusion of blood and blood components (including patient blood management programs (PBM), the available blood supply still largely depends on the good will of volunteer, non-remunerated blood donors [5–9].

As shown above, in 2018 the number of blood donors in Centers was slightly higher than in 2017 (590 470 and 588 184 respectively) which might signal the end of the downward trend observed for the last several years.

One unfavorable phenomenon observed in the recent years is a steady decrease of population in the 18–65 age group — the potential “recruitment

source” of blood donors. The Demographic Yearbook reports for December 31, 2011 and December 2018 is — 26 464 477 and 25 264 348 respectively [10, 11]. During the last 7 years the population in this age group has therefore decreased by over a million people, with impact on the number of active blood donors.

In member states of the Council of Europe, the average number of blood donors per 1000 inhabitants decreased from 29.0 in 2008 to 25.0 in 2011 [12]. For Poland the numbers per 1000 inhabitants were 15.37 in 2018 and 15.30 in 2017.

Apart from demographic changes, the number of blood donors is adversely affected by factors such as:

- no opportunity to donate blood or economic reasons;
- periodic disease outbreaks;
- travel-associated risk of infections e.g. malaria or West Nile virus [13];

**Table 9.** FFP units (from whole blood and apheresis) prepared in Polish Regional Blood Transfusion Centers in 2018

Centers	Whole blood	Apheresis	Total	% FFP from apheresis
Białystok	59 052	23 299	82 351	28.29
Bydgoszcz	69 264	11 506	80 770	14.25
Gdańsk	59 531	3849	63 380	6.07
Kalisz	39 318	24 413	63 731	38.31
Katowice	112 737	4687	117 424	3.99
Kielce	33 039	1997	35 036	5.70
Kraków	91 238	98	91 336	0.11
Lublin	53 482	11 152	64 634	17.25
Łódź	60 633	321	60 954	0.53
Olsztyn	40 189	3835	44 024	8.71
Opole	28 782	137	28 919	0.48
Poznań	91 410	9290	100 700	9.22
Racibórz	31 606	5219	36 825	14.17
Radom	21 880	3890	25 770	15.10
Rzeszów	60 768	6252	67 020	9.33
Słupsk	21 965	660	22 625	2.92
Szczecin	50 508	5363	55 871	9.60
Wałbrzych	25 021	0	25 021	0.00
Warszawa	108 332	3386	111 718	3.03
Wrocław	63 762	23 802	87 564	27.18
Zielona Góra	32 441	103	32 544	0.32
<b>Total</b>	<b>1 154 958</b>	<b>143 258</b>	<b>1 298 216</b>	<b>11.04</b>

- emerging infectious diseases, e.g. the Zika virus epidemics [14–16];
- health condition of the population, including reduced hemoglobin levels (most common cause of deferral for the several last years) [17–20].

The number of autologous donors in 2018 was estimated at 500 which is lower than in 2016 (679) and 2017 (561). The smaller number of preoperative autologous donations is a phenomenon typical for many countries [21]. According to current trends, autologous donations are mostly relied on when they have significant advantage over allogeneic transfusions and when the indication for transfusion is strong [22].

In 2018, the total number of blood and blood component donations amounted to 1 264 903 including 1 184 311 whole blood donations; once more there is a slight increase as compared to the previous year (in 2017 — 1 249 655 donations with 1 171 302 whole blood donations).

One of the methods used for more effective collection of blood components is automated apheresis. In 2018, the number of apheresis PCs donations increased (from 22 552 in 2017 to 24 587), as was the case with PCs and plasma combined (from 16 626 to 19 143); on the other hand the number of only plasma donations decreased (from 39 084 to 36 655). Collection by apheresis of other blood components, i.e. RBC and granulocyte concentrate was sporadic.

It should be noted that in Poland automated methods (apheresis) are still used to a relatively small extent (in 2018 — only 6.37% of all donations).

Mobile collections are organized to make blood donation easier for donors. In 2018 the number of mobile collection sites organized by the Centers did not change as compared to 2017 (13 189). The percentage of whole blood donated during mobile collections has been steadily growing since 2016, and is now relatively stable (26–29%). In 2018, as in the previous years, blood

**Table 10.** FFP units issued for clinical use in Polish Regional Blood Transfusion Centers (2018)

Centers	Prepared	Issued for clinical use	% FFP issued for clinical use
Białystok	82 351	12 131	14.73
Bydgoszcz	80 770	17 082	21.15
Gdańsk	63 380	11 426	18.03
Kalisz	63 731	4346	6.82
Katowice	117 424	26 991	22.99
Kielce	35 036	6921	19.75
Kraków	91 336	23 141	25.34
Lublin	64 634	16 205	25.07
Łódź	60 954	18 090	29.68
Olsztyn	44 024	9055	20.57
Opole	28 919	4840	16.74
Poznań	100 700	17 692	17.57
Racibórz	36 825	2712	7.36
Radom	25 770	3173	12.31
Rzeszów	67 020	10 831	16.16
Słupsk	22 625	3018	13.34
Szczecin	55 871	15 846	28.36
Wałbrzych	25 021	5079	20.30
Warszawa	111 718	45 222	40.48
Wrocław	87 564	12 310	14.06
Zielona Góra	32 544	5593	17.19
<b>Total</b>	<b>1 298 216</b>	<b>271 702</b>	<b>20.93</b>

was mainly collected at local collection sites (44.85%) which may be explained by the fact that donors are more willing to donate in familiar places. However, the contemporary high standards for collection of blood dedicated for clinical use do not favor small collection sites; centralization of blood transfusion service is recommended.

The demand for blood components depends on numerous factors such as: profile of the clinical ward, current guidelines issued by scientific societies, recommendations of the physician and last but not least - economic factors.

In 2018, approximately 30.38 units of RBC per 1000 inhabitants were issued for clinical purposes (in 2017 — 30.22 units, 2016 — 29.99, 2015 — 29.87) [11, 23–25]. The differences observed in the past several years are insignificant but the upward trend is observed. RBC consumption however is

**Table 11.** Pathogen inactivated FFP (%), cryoprecipitate (%) and PCs (%) issued for clinical use in 2018

Centers	% FFP (U.)	% cryoprecipitate (U.)	% PCs (therapeutic doses)
Białystok	12.13	0	0.10
Bydgoszcz	5.07	0	0.00
Gdańsk	1.91	0	0.00
Kalisz	0.00	0	0.00
Katowice	5.74	0	0.00
Kielce	0.00	0	0.00
Kraków	18.79	0	0.00
Lublin	2.87	100	2.09
Łódź	6.15	0	1.27
Olsztyn	0.00	0	0.00
Opole	0.00	0	0.00
Poznań	7.77	98.07	0.00
Racibórz	5.13	0	0.00
Radom	0.00	0	0.00
Rzeszów	7.65	0	0.00
Słupsk	0.00	0	0.00
Szczecin	0.00	0	0.00
Wałbrzych	0.00	0	0.00
Warszawa	27.19	0	97.11
Wrocław	25.37	0	1.84
Zielona Góra	0.00	0	0.00
<b>Total</b>	<b>10.23</b>	<b>18.52</b>	<b>11.74</b>

still markedly lower than in some other European countries; in 2011, the consumption of RBC in 32 member states of the Council of Europe was on average 37 units/1000 inhabitants [12].

In 2018 the number of FFP units issued for clinical purposes amounted to 271 702 and was again lower than in the preceding year (2017 — 291 989 units). In 2018, the ratio of RBC for clinical use to FFP was approximately 4.09 (in 2017 — 3.77, in 2016 — 3.56, in 2015 — 3.45). The consumption of FFP gradually decreases as compared to red blood cells. The RBC/FFP ratio is however still lower than in many other European countries [12]. This may be explained by lower consumption of RBC in Poland but in many cases also by the fact that FFP is used with no sufficient reason and sometimes against current indications [26, 27].

As already mentioned the last several years have witnessed an increase in the consumption of PC. In the period 2015–2018 the number of PC units issued for clinical use has increased by about 11%.

**Table 12.** Wastage of blood components in Polish Regional Blood Transfusion Centers (2018)

	Whole blood	RBCs	PCs (therapeutic doses)		FFP
			Pooled from whole blood	Apheresis	
Białystok	296	628	30	29	1171
Bydgoszcz	511	531	195	18	3364
Gdańsk	454	1381	402	12	1932
Kalisz	71	1758	139	11	1223
Katowice	1496	3127	534	173	2222
Kielcach	77	806	494	26	1389
Kraków	536	1510	168	33	8137
Lublin	664	1497	130	76	3048
Łódź	1008	2428	219	48	3527
Olsztyn	152	2127	225	52	1295
Opole	134	485	45	11	1211
Poznań	1530	2967	765	102	3009
Racibórz	147	281	66	32	758
Radom	286	744	185	36	889
Rzeszów	2895	1713	582	47	1441
Słupsk	220	313	0	4	334
Szczecin	151,3	1656	177	146	2974
Wałbrzych	283	789	32	6	277
Warszawa	1820	2930	238	592	8509
Wrocław	953	1859	163	169	2440
Zielona Góra	383	991	397	2	832
<b>Total</b>	<b>14 067</b>	<b>30 521</b>	<b>5186</b>	<b>1625</b>	<b>49 979</b>

Additional preparation methods (leukocyte depletion, irradiation) for prevention of transfusion associated adverse reactions were applied much more frequently to PCs (32.56% leukocyte depleted PCs, 1.37% irradiated PCs and 58.07% irradiated leukocyte depleted PCs) than to RBC (17.29% leukocyte depleted, 0.31% irradiated and 8.94% leukocyte depleted and irradiated). Leukocyte depleted RBC require additional preparation, while in the case of PCs from apheresis, leukodepletion may occur at collection. Some automated methods of PC preparation from buffy coat also allow leukodepletion but the cost is high as compared to manual methods. Automated methods do however guarantee high quality parameters due to standardization.

Currently, most Centers prepare almost exclusively leukocyte depleted PCs (Table 8). As mentioned above, leukocyte-depleted PCs account for about 90.64% of all PCs obtained country-wide. In

many countries regular/common leuko-depletion is currently used although its effectiveness in preventing transfusion-related adverse reactions is sometimes questioned [28].

As in the previous years, the number of frozen PCs in some Centers is too high. As mentioned earlier, in 2018 there was a decrease by 0,9% as compared to 2017. The percentage reported for the whole country is acceptable. It must be noted however, that routine freezing of large volumes of blood components — eg. pooled PCs in Racibórz (75,2%) — is not to be accepted. Thawed PCs may be used only in special circumstances, therefore it is not recommended to freeze more than 10%. This does not refer to freezing of apheresis PCs collected from patients with anti-HLA or anti-HPA antibodies.

It is worth noting that freezing and thawing adversely affects quality parameters of platelets and so their therapeutic efficacy. It follows from

**Table 13.** Reasons for blood component wastage in Polish Regional Blood Transfusion Centers (2018)

Reason	Whole blood	RBCs	PCs (therapeutic doses)		FFP
			Pooled from whole blood	Apheresis	
Date expiry	2	10 023	3155	712	561
Seropositivity for transfusion transmitted diseases, syphilis, implementation of look-back procedure	27	2513	183	53	3778
Other causes, including: — inadequate visual control, — low quantity/volume, — seropositive serological results, other, including incorrect procedures, medical deferral, mechanical damage, donor self-deferral	14 038	17 985	1848	860	45 640
<b>Total</b>	<b>14 067</b>	<b>30 521</b>	<b>5186</b>	<b>1625</b>	<b>49 979</b>

the 2018 data that the situation has improved, especially in Wałbrzych, where the amount of thawed PCs for clinical use has decreased by 11,3% as compared to 2017.

Depletion of blood and blood component supplies is also associated with wastage which — though sometimes inevitable — occurs for a number of reasons. In 2018 (as in previous years) the most common causes of wastage were the so-called “other reasons”, in particular:

- inadequate visual control;
- incorrect/low volume;
- seropositive test results;
- incorrect procedures, medical deferral, mechanical damage, donor self-deferral, etc.

Most probably some waste could be avoided by better adherence to procedures [29].

Date expiry or positive results of viral tests were less frequently the reason for waste (Table 13).

Data related to quarantine and pathogen inactivated FFP and cryoprecipitate revealed that quarantine FFP is still most commonly used in clinical practice. As in the previous years, most Centers did not make adequate use of the illuminators installed on their premises (Mirasol PRT system — 28 illuminators, Theraflex MB Plasma system — 12 illuminators, Intercept system — 1 illuminator). The most likely reason is that physicians rarely order pathogen inactivated FFP, and PCs. One reason for limited use of pathogen inactivated plasma is the easy access to quarantine FFP. On the other hand, physicians who order components are not always fully aware that pathogen inactivated plasma is much safer than quarantine plasma; it protects against the

consequences of the “diagnostic window” (as is the case with quarantine plasma) but also prevents the transmission of a wide spectrum of pathogens.

Study results demonstrated that both the Mirasol and Intercept PRT systems reduce the number of viable T lymphocytes in PCs (> 6 log and > 5.4 log, respectively) [4]. Further research confirmed these systems to be an alternative to irradiation of cellular blood components so far used for prevention of TA-GvHD in high risk patients [2].

Physicians who are not always aware that pathogen inactivation is an alternative to irradiation of cellular blood components often order PCs subjected both to pathogen inactivation (in one of the above mentioned systems) and irradiated. The procedure is incorrect because the use of both gamma irradiation and inactivation may induce platelet activation, which contributes to faster removal of platelets from the recipient’s circulatory system [30].

This suggests that the number of training courses for physicians on pathogen inactivation and strengthening of blood safety is still not sufficient.

## Conclusions

The study is a brief presentation of selected issues related to the activity of Polish Regional Blood Transfusion Centers in 2018, as well as to some recently observed tendencies which may be a good starting point for analysis of issues related to the activity of healthcare units in Polish BTS, for comparison of experiences and development of optimal solutions for the future. Such data reviews

on blood and blood components are systematically performed in other countries.

### **Current problems of blood transfusion medicine**

In light of available data, the worldwide number of blood transfusions is still too high and excessively exploited despite intensive campaigns and appeals for rational blood therapy and spectacular successes of some countries which implemented the PBM programs [31].

In the United States in 2011, blood transfusion was the most common procedure performed during hospitalization (12% of surgeries), and since 1997 the number of hospitalizations with surgery has more than doubled [32]. In Poland the number of red blood cell units issued for clinical use has been stable for the last several years, while the number of PCs is steadily growing [33–35].

Higher demand for PCs is also observed in other countries. Great Britain is one such country [36]. The greatest PC consumers are:

- patients with hematologic malignancies (67%);
- cardio surgical patients (up to 10%);
- intensive therapy patients (8%).

Higher demand for PCs is determined by the following factors: overall population increase, aging of societies, higher incidence rate of hematologic malignancies and modifications in the therapy of myeloproliferative disorders. However, the only available data that can be directly compared between countries refers to overall population. There seems to be no evidence that the increase in PC transfusions in cardio surgical or intensive therapy patients is higher than that determined by overall population growth. Data on the issue are scarce [36].

In 2005 the patient blood management (PBM) program was developed which shifted the attention from transfusion of allogenic blood to that of the patient's. As already signaled in earlier publications, the program was supported by numerous organizations including WHO and European Commission as well as by research and expert societies [33–35]. Within the new approach to transfusion therapy the PBM principles are indisputable, the methods of their implementation at hospital level are however open to discussion. European institutions devote much time to analysis of PBM implementation and in March 2017 published a guide “*Supporting Patient Blood Management (PBM) in EU. A practical implementation guide for hospitals*” [37]. In this publication attention is focused on the following indicators of blood use:

- transfusion rate (TR) i.e. number of transfused patients in a defined cohort;
- transfusion index (TI) i.e. average number of RBC units transfused per patient in a defined cohort.

The values help to determine the degree of PBM implementation in a hospital; the higher the values, the lesser degree of PBM use. The next step (in PBM implementation) is collection of data on anemia frequency and methods of treatment. A still further step is collection of data on perioperative blood loss. The final step is the comparison of treatment outcome for patients transfused according to PBM and for those who were not.

An exceptionally interesting world-wide initiative for implementation of PBM are the Consensus Conferences. They are not only examples of a restrictive and transparent scientific process but also contribute a unique value of promoting international cooperation. The participants represent European, American, Canadian and Australian organizations which focus attention on principles of transfusion medicine and PBM promotion. During the last, 2018 Consensus Conference in Frankfurt, international experts addressed an interdisciplinary panel with a set of evidence-based recommendations for PBM and research rated according to GRADE (Grades of Recommendation, Assessment, Development and Evaluation) [38]. The issues discussed during the conference referred to:

- hemoglobin (Hb) threshold for RBC transfusion;
- preoperative anemia;
- education and training in the implementation of PBM principles.

The analysis presented during the Conference included the outcome of 63 random clinical trials (23 143 patients) and 82 observation studies (more than 4 million patients). The current data base for PBM evidence for scientific and practical purposes was defined and 10 clinical indications as well as 12 recommendations were suggested. One of the significant recommendations of the Conference referred to the management of preoperative anemia. Four (4) clinical and 3 research recommendations were developed including one explicit recommendation — namely, to identify and treat anemia in due time before surgery.

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