




Management of blood and blood components at the Cardinal Stefan Wyszyński National Institute of Cardiology

Jarosław Kowal¹, Anna Lutyńska¹, Elżbieta Lachert²

¹Department of Medical Biology, Medical Diagnostic Laboratory, Transfusion Medicine Serological, Laboratory with Blood Bank, National Institute of Cardiology, Warsaw, Poland

²Quality Assurance Laboratory, Department of Transfusion Medicine, Institute of Hematology and Transfusion Medicine, Warsaw, Poland

Summary

Background: *The clinical activity of the Institute of Cardiology is focused on diagnosis and therapy of coronary artery disease, arterial hypertension, cardiomyopathy, heart failure, acquired and congenital heart defects. On the other hand, interventional cardiology, concentrates on the treatment of acute coronary syndromes, percutaneous aortic valve implantation, transcatheter aortic valve implantation, transcatheter pulmonary valve implantation, percutaneous mitral commissurotomy, percutaneous closure of intra- and extra-cardiac defects as well as carotid, renal and peripheral angioplasty.*

Material and methods: *The study aim was to analyze data and estimate the number of blood/blood component transfusions in the departments of the Institute of Cardiology over a two-year period (1st July 2018–30th June 2020). The data was supplied by the Transfusion Committee (TC) which cooperates with the Blood Bank and the Immunohematology Laboratory.*

Results: *At the Institute of Cardiology, blood and blood components were most often transfused in the 1st Department of Anaesthesiology and Intensive Therapy and in the operating room of the Department of Cardiac Surgery and Transplantology (over 87% of all blood components). Cryoprecipitate was transfused only in the operating room and in the 1st Department of Anaesthesiology and Intensive Therapy. Before and after transplantation, patients were transfused with irradiated leukoreduced packed RBCs, inactivated FFP and pathogen inactivated leukoreduced apheresis PCs. Similar volumes of leukoreduced PCs (47.72%) and leukoreduced apheresis PCs (48.64%) were transfused. Patients allergic to plasma proteins were administered washed blood components (0.15% of all blood components transfused).*

Conclusions: *Rational management of blood and blood components at the National Institute of Cardiology is ensured by following procedures, regular training of personnel and close cooperation between the Regional Blood Transfusion Center in Warsaw, members of the Transfusion Committee, the employees of the Blood Bank and staff of the clinics.*

Key words: transfusion committee, blood/blood components, blood management

J. Transf. Med. 2022; 15: 15–25

Correspondence address: dr hab. n. med. Elżbieta Lachert, Quality Assurance Laboratory, Department of Transfusion Medicine, Institute of Hematology and Transfusion Medicine, ul. Gandhi Street 14, 02–776 Warsaw, phone: 22 349 63 82, faks: 22 349 63 76, e-mail: elachert@ihit.waw.pl

Translation: mgr Krystyna Dudziak

This article is available in open access under Creative Common Attribution-Non-Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0) license, allowing to download articles and share them with others as long as they credit the authors and the publisher, but without permission to change them in any way or use them commercially.

The National Institute of Cardiology

The Institute of Cardiology was founded by the order of the Prime Minister of 21st March 1979 [1]. From January 1, 2020, pursuant to the regulation of the Council of Ministers of October 17, 2019, the Institute was granted the status of a National Research Institute and the name was changed to Cardinal Stefan Wyszyński National Institute of Cardiology — State Research Institute [2].

The National Institute of Cardiology is the main center for cardiology and cardiac surgery in Poland, a dynamic research and development center as well as an important center for postgraduate training and education.

Depending on the basic disease entity and indications for hospitalization at the Institute, patients are referred to one of 14 clinics/wards.

The clinical activity of the Institute is focused on diagnosis and therapy of coronary artery disease, arterial hypertension, cardiomyopathy, heart failure, acquired and congenital heart defects. On the other hand, interventional cardiology, concentrates on the treatment of acute coronary syndromes, percutaneous aortic valve implantation (Transcatheter Aortic Valve Implantation; TAVI), transcatheter pulmonary valve implantation; TPVI), percutaneous mitral commissurotomy (PMC), percutaneous closure of intra- and extra-cardiac defects as well as carotid, renal and peripheral angioplasty.

In the field of myocardial electrophysiology, the Institute is most often involved in: diagnostics and therapy of cardiac conduction disorders, invasive electrophysiological heart examination, intravenous electrode removal and hybrid therapies: ablations, pharmacotherapies, cardiac resynchronization therapy (CRT), implanted cardioverter-defibrillator (implantable cardioverter defibrillator; ICD).

As concerns cardiac surgery, the most frequently performed procedures include:

- coronary artery bypass grafting (CABG),
- mitral valve surgery,
- aortic valve surgery,
- surgical repair of ascending aortic and arch aneurysms,
- surgery for congenital and structural heart defects usually covers:
 - atrial septal defect (ASD),
 - ventricular septal defect (VSD)
 - transposition of great arteries (TGA),
 - tetralogy of Fallot (TOF),
 - coarctation of aorta (CoA),
 - hypertrophic cardiomyopathy (HCM)

- mechanical circulatory support with the POL-CAS system (extracorporeal pneumatic system of temporary heart support):
 - left ventricular assist device (LVAD)
 - right ventricular assist device (RVAD)
 - cardiac tumor resection,
- surgical treatment of atrial fibrillation.

Therapy is supported by cardiac rehabilitation directed at all the patients treated at the National Institute of Cardiology.

Organization of blood management at the National Institute of Cardiology

Pursuant to §8.1 of the order of the Minister of Health regarding blood and blood component therapy in medical entities performing stationary and 24/7 healthcare service which states that a Transfusion Committee should be established in any medical facility of more than four clinics/wards involved in transfusion of blood and blood components, the Institute has established such Committee. Members of the Transfusion Committee (TC) include: the chairman, i.e. the doctor responsible for blood management, heads/or deputy heads of 4 departments (1st Department of Anesthesiology/Aesthesia and Intensive Therapy/Care, 2nd Department of Anesthesiology/Aesthesia and Intensive Therapy/Care, Department of Cardiac Surgery and Transplantology, Department of Cardiac Surgery and Transplantology-OR), nurse-representatives from these clinics/wards, head of the Immunohematology Laboratory with Blood Bank and the nurse-coordinator of the Blood Bank [3].

The TC is in cooperation with the Blood Bank and the Immunohematology Laboratory to:

- solve problems related to blood and blood component therapy,
- solve problems related to the management of blood and blood components,
- supervise the blood and blood component therapy.

In accordance with “§5.1 of the Decree of the Minister of Health regarding blood and blood component therapy in hospitals/medical entities providing medical activities such as inpatient and round-the-clock health services”, the director of the Institute of Cardiology is obliged to appoint a specialist in clinical transfusion medicine as the person responsible for blood management. The Institute does not employ a specialist in clinical transfusion medicine, therefore the duties of the doctor responsible for

blood management are performed by a cardiac surgeon who has been employed at the hospital for many years [3].

The main tasks of the TC include:

- forecasting/planning the demand for blood/blood components,
- reporting activities related to blood therapy,
- supervision of blood therapy in clinics/wards,
- analysis and assessment of any transfusion-related adverse reaction and event,
- analysis of blood/blood component consumption,
- analysis of reports regarding transfusion-related adverse events and reactions,
- development of training programs for physicians and nurses and supervision of their implementation,
- supervision over proper document-keeping [3–5].

The TC established at the Institute of Cardiology organizes meetings at least twice a year, which are attended by committee members and hospital staff. Reports and periodic briefings on the committee's activities are submitted to the director of the Institute and at least once a year to the Regional Blood Transfusion Center in Warsaw. This Regional Center supplies blood components to the Institute of Cardiology and performs substantial supervision over blood/blood component therapy performed there. In accordance with the Decree of the Minister of Health regarding “blood and blood component therapy in hospitals/medical entities providing medical activities such as inpatient and round-the-clock health services”, the Regional Center organizes external inspections at the Institute at least once in two years [3, 5].

Blood components in cardiac surgery

The therapeutic procedures performed at the Institute are highly specific; blood/blood components are transfused mostly in the 1st Department of Anesthesiology/Aesthesia and Intensive Therapy/Care, 2nd Department of Anesthesiology/Aesthesia and Intensive Therapy/Care, Department of Cardiac Surgery and Transplantology-OR, Department of Cardiac Surgery and Transplantology. The common procedures that require blood/blood components are: extracorporeal circulation, Extracorporeal Membrane Oxygenation (ECMO), CABG, aortic aneurysms, mitral and aortic valve surgery, LVAD and heart transplantation.

Extracorporeal circulation (cardiopulmonary bypass; CPB)

Extracorporeal circulation is a complex medical procedure burdened with high risk of complications related to changes in blood parameters, i.e. coagulation disorders or activation of coagulation process, functional disorders of blood elements (erythrocytes, leukocytes and thrombocytes), pH change, and systemic complications such as: bleeding, anemia, infections, heart, lung or kidney damage/ impairment and also death [6–8]

However, the high risk of complications can be significantly reduced if the patient is well prepared for the procedure and a sufficient amount of appropriate blood components (red blood cell concentrate (RBCC), platelet concentrate (PC), fresh frozen plasma (FFP) and cryoprecipitate) is provided [7, 8].

Extracorporeal Membrane Oxygenation (ECMO)

Like in the case of CPB, blood/blood components are indispensable before, during and after the procedure of ECMO [9, 10].

Depending on the patient's medical condition, the following blood components are in use for the ECMO procedure performed at the Institute of Cardiology: leukoreduced packed red blood cells, irradiated leukoreduced packed red blood cells as well as pathogen inactivated FFP and PC. Irradiation of packed red blood cells is a safeguard against Transfusion Associated Graft versus Host Disease (TA-GvHD) as it inhibits the proliferative capacity of lymphocytes in blood components. Routine pathogen inactivation in PCs with the Mirasol system (riboflavin) and the Intercept (amotosalen hydrochloride) was also found effective for inactivation of T lymphocytes responsible for TA-GvHD. Pathogen inactivation using one of the above-mentioned systems precludes/eliminates the need for irradiation [4, 11].

Blood and blood components in cardiac surgery

The procedure of extracorporeal circulation is inseparably related to the use of anti-coagulants (medication that prolongs blood clotting). An excellent example is heparin which dissolves fibrinogen and prevents the formation of a stable fibrin clot by inhibiting the activation of the fibrin stabilizing factor. Heparin does not have fibrinolytic activity; therefore, it will not lyse existing clots.

Despite its widespread use in cardiac surgery, the impact of heparin on the patient's system during the procedure of extracorporeal circulation

and later is not fully determined. However, administration of antifibrinolytic drugs prior to surgery minimizes the risk of postoperative bleeding.

Cardiac surgery is always associated with transfusion of ‘large’ amounts of whole blood and blood components. The scheme of treatment is based on administration of: colloids, crystalloids, FFP, PC, packed RBC, cryoprecipitate and recombinant coagulation factor VIIa (rFVIIa). The choice of appropriate component and the number of units to be transfused or prepared as support depends on the patient’s medical condition. The correct proportion between components used in the treatment of bleeding following cardiac surgery is of utmost importance. Administration of only crystalloids or colloids will correct the circulating blood volume on the one hand, and on the other, will contribute to “dilution” of erythrocytes, thrombocytes and coagulation factors [12].

In situations of emergency which put the patient’s health or life in jeopardy, the blood/blood component therapy begins with correction of the circulating blood volume. For this purpose, crystalloids, colloids and RBCs are transfused first. The next step is to transfuse 1 unit of FFP per 4–6 units of packed RBC. During FFP transfusion, it is important to control the prothrombin time (PT) and INR values because the administration of one FFP unit increases the level of coagulation factors by about 5%. The transfusion of PC comes next and should be started when the platelet count drops below $50 \times 10^9/l$ [12].

In cardiac surgery, cryoprecipitate is transfused after fibrinogen concentration is determined. It is recommended to transfuse 1–3 units/10 kg bw. Indication for transfusion is severe bleeding following major surgery at fibrinogen deficiency (less than 1 g/l) or hypofibrinogenemia (less than 2 g/l) [12–15].

Postoperative bleeding assessment is based on evaluation of the surgical drainage of the surgical field, which should be less than 100 ml/h. Depending on the procedure performed, two or three surgical drains are applied [15].

Intensive postoperative drainage (500 ml/h in the first hour, 400 ml/h for 2 hours, 300 ml/h for 3 hours or 200 ml/h for 4 hours) or any sudden increase in drainage intensity requires individual assessment, and if necessary, reoperation [15].

Blood and blood component therapy for organ recipients

The National Institute of Cardiology is one of six centers in Poland where heart transplants are performed. The heart transplantation program was initiated by Professor Zbigniew Religa in 2001. In 2017, simultaneous heart kidney transplants were performed for the first time, and in 2018, for the first time in Poland, a simultaneous heart liver transplant took place. The National Institute of Cardiology joined the group of world’s leading transplantation centers (Fig. 1, Fig. 2).

On account of the presence of A and B antigens in tissues, the organs selected for transplantation must be donor-recipient identical or compatible in the ABO system. This is of crucial importance for the “survival” of the transplanted organ and impacts on complications related to hemolytic anemia in the recipient [4, 17–19] (Table 1).

In over 50% of cases the transplanted organs are compatible in the ABO system. Transplantation of an organ from a 0-donor, to a A, B, or AB — recipient may reveal a cluster of “passenger lymphocytes” transferred with the organ. This may result in destruction of the recipient’s red blood cells by antibodies of the ABO system or other specificity, produced by proliferating donor lymphocytes/

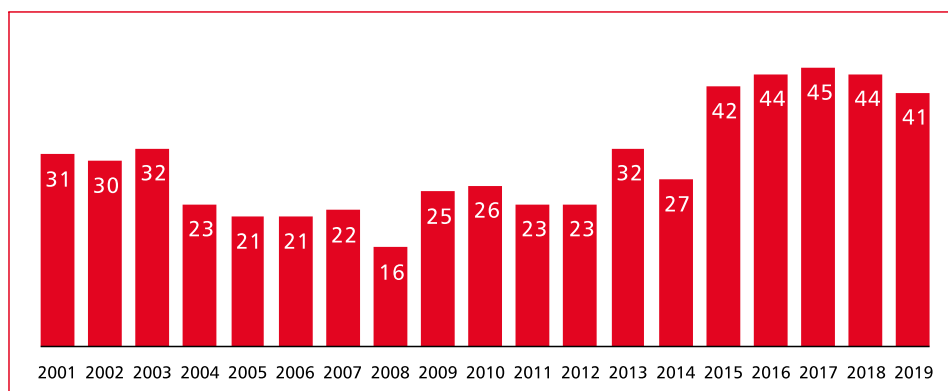


Figure 1. Heart transplants performed at the Cardinal Stefan Wyszyński National Institute of Cardiology — National Research Institute in 2001–2019 [16]

/plasmocytes. Depending on the antibody titer and activity of the recipient’s complementary system, this may cause hemolysis which manifests with or without clinical symptoms. Antibodies on blood cells are reported and haemolysis is observed in about 70% of heart transplant patients [4, 17, 19].

Transfer of “passenger lymphocytes” with the transplanted organ, may lead to haematological complications which correspond to “minor incompatibility” complications. It is therefore of utmost importance to determine the cause of haemolytic anemia as soon as possible in the first

days after transplantation. It is equally important to select appropriate blood and blood components for transfusions [4, 19] (Table 2).

Successful management of organ recipients depends on adequate use of blood and blood components in both the pre- and post-transplant period. The choice of blood components depends on the treatment scheme and the patient’s medical condition. There are currently no uniform standards for the transfusion of blood and blood components in organ transplantation [10]. The National Institute of Cardiology has therefore developed its own,



Figure 2. The percentage of the heart transplantations in Poland performed at the National Institute of Cardiology [16]

Table 1. Type of ABO compatibility of organ recipient and organ donor

Recipient’s blood group	Donor’s ABO status	
	Identical	Compatible
O	O	O
A	A	O
B	B	O
AB	AB	A, B, O

internal standards. Patients in the period before transplantation (e.g. ECMO, LVADO, RVADO and TAH) as well as afterwards (after organ transplantation) are administered irradiated leukoreduced red blood cells, pathogen inactivated FFP pathogen inactivated apheresis PC and cryoprecipitate. The aim is to protect organ recipients against transmission of pathogens that are not routinely determined as well as the Transfusion Associated Graft versus Host Disease (TA-GvHD).

Table 2. The safest choice of blood components in the event of haemolytic complications (corresponding to “minor incompatibility”) following transfer of “passenger lymphocytes”

Recipient	Donor	RBCs	PC	Plasma
A	O	Washed* O	Washed* O	A
B	O	Washed* O	Washed* O	B
AB	O	Washed* O	Washed* O	AB
AB	A	Washed* A	Washed* A	AB
AB	B	Washed* B	Washed* B	AB
RhD+ (positive)	RhD– (negative) with anti-D antibodies	RhD– (negative)	RhD– (negative)	Recipient —compatible

*Washed red blood cells and/or platelets may be suspended in: AB plasma, in 5% albumin solution, 0.9% NaCl solution, in additive solution [5, 6, 19]

At the Institute of Cardiology, the heart transplant patient — depending on his clinical condition — is safeguarded by 6–8 units of irradiated leukoreduced red blood cells, 4–6 units of pathogen inactivated FFP, and 1–2 units of inactivated apheresis PC. Cryoprecipitate is administered only in severe coagulation disorders occurring during surgery or in the postoperative period. The number of units of individual components is consequently higher in the case of multi-organ (eg. heart/kidney) transplantations.

Aim of the study

The aim was to present the number of blood and blood component transfusions in individual hospital wards over the two-year period (01/07/2018 — 30/06/2020).

Results

At the Institute of Cardiology the cardiac surgery and cardiology departments are on round-the-clock duty, so the Blood Bank must be ever ready to supply blood components for any urgent surgical procedure, from acute coronary syndrome to aortic aneurysm surgery and heart transplantation. The Blood Bank is obliged to have sufficient stock of blood components of all blood types in the AB0 and RhD systems. In the period from 1st July 2018 to 30th June 2020, the following amounts of blood components were transfused at the National Institute of Cardiology:

- 12 892 units of packed RBCs,
- 11 144 units of FFP,
- 2169 units of PC (all subjected to pathogen inactivation),
- 1891 units of Cryoprecipitate (Figs. 3–8).

In the period under analysis, over 32% of all blood components were transfused at the Department of Cardiac Surgery and Transplantology, Operating Room (Fig. 3), 54% of which were PCs. The statistics is the outcome of the cardiac surgery procedures in extracorporeal circulation performed at the Institute. After the completion of such procedures, patients are given PC transfusions.

All patients after cardiac surgery are referred to the 1st Department of Anaesthesiology and Intensive Care, so more than 55% of all blood components are transfused there (Fig. 3). In the period of time under analysis apart from the operating room (OR), it was the only department where cryoprecipitate was transfused (Figs. 9–14).

Summary

Worldwide, the life span of men and women is on the increase. This results in a higher incidence rate for civilization diseases (diabetes, atherosclerosis and arterial hypertension) which may lead to acute coronary syndrome, cardiomyopathy and left ventricular failure, and then — to symptomatic heart failure. Heart failure is considered one of the “civilization epidemics” of the 21st century. In the advanced stages the prognosis may be worse than for most cancers.

Over the past two decades tremendous advancement has been made in strengthening the safety of blood and blood components, with significant contribution to the effectivity of interventional therapy, cardiac surgery and transplantation. The success was achieved through hemovigilance and optimal use of blood and blood components tailored to the individual needs of the patient and his clinical condition (according to the internal guidelines for blood and blood component therapy at the National Institute of Cardiology).

Blood and blood components are most often transfused in the 1st Department of Anaesthesiology and Intensive Therapy and in the operating room of the Department of Cardiac Surgery and Transplantology (over 87% of blood components transfused at the Institute of Cardiology). The statistics is closely related to the scope of the procedures performed in this specific hospital.

In the period under analysis, cryoprecipitate was transfused only in the operating room and in the 1st Department of Anaesthesiology and Intensive Therapy where all patients are transferred after surgery. This is closely related to the use of extracorporeal circulation and anticoagulant therapy during cardiac surgery.

For patients before transplantation and after the procedure, the Regional Blood Transfusion Center in Warsaw prepared irradiated leukoreduced red blood cells, pathogen inactivated FFP and pathogen inactivated leukoreduced apheresis PC. At first, the Mirasol system (with riboflavin) was used for pathogen inactivation in FFP and PCs. Since 2020, the Regional Blood Transfusion Center in Warsaw subjected FFP and PCs to pathogen inactivation procedure with the Intercept system (with amotosalen hydrochloride).

The volume of pooled leukoreduced PCs and leukoreduced PCs from apheresis transfused at the Institute of Cardiology is comparable (47.72% and 48.64% respectively). The exception are reconstituted and thawed blood components.

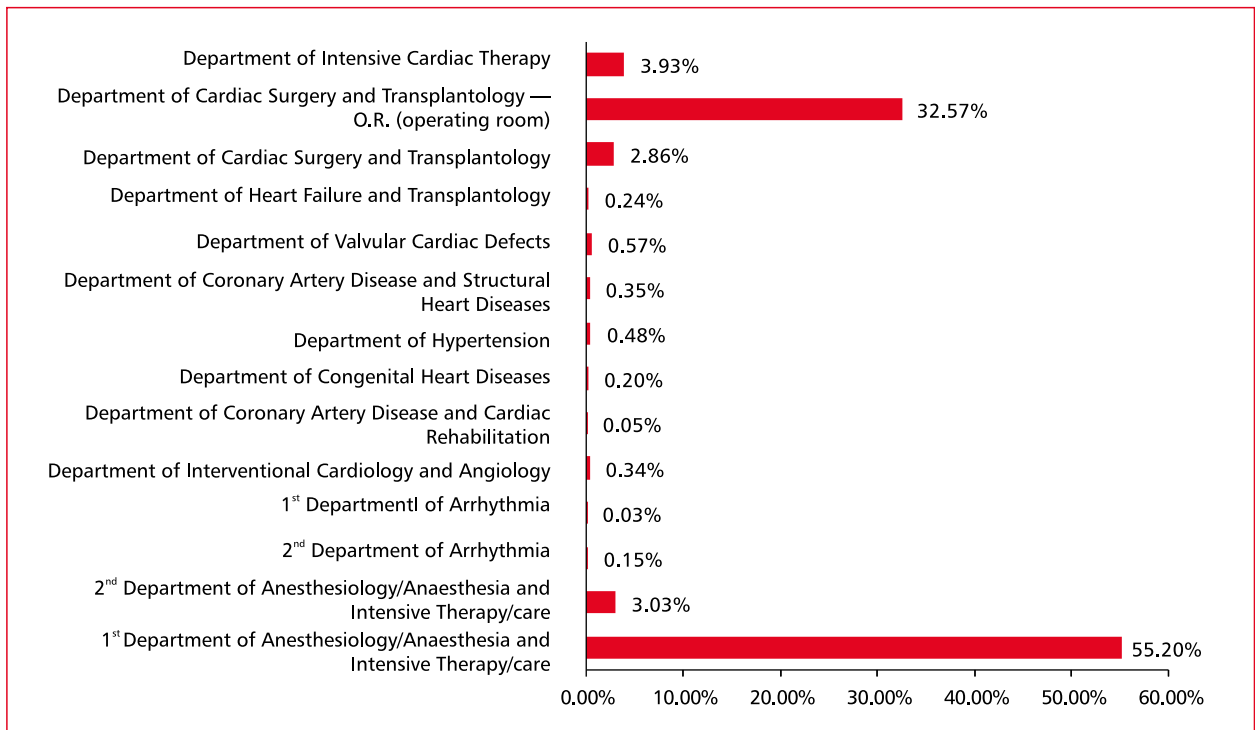


Figure 3. Usage of all types of blood components in respective clinics/departments

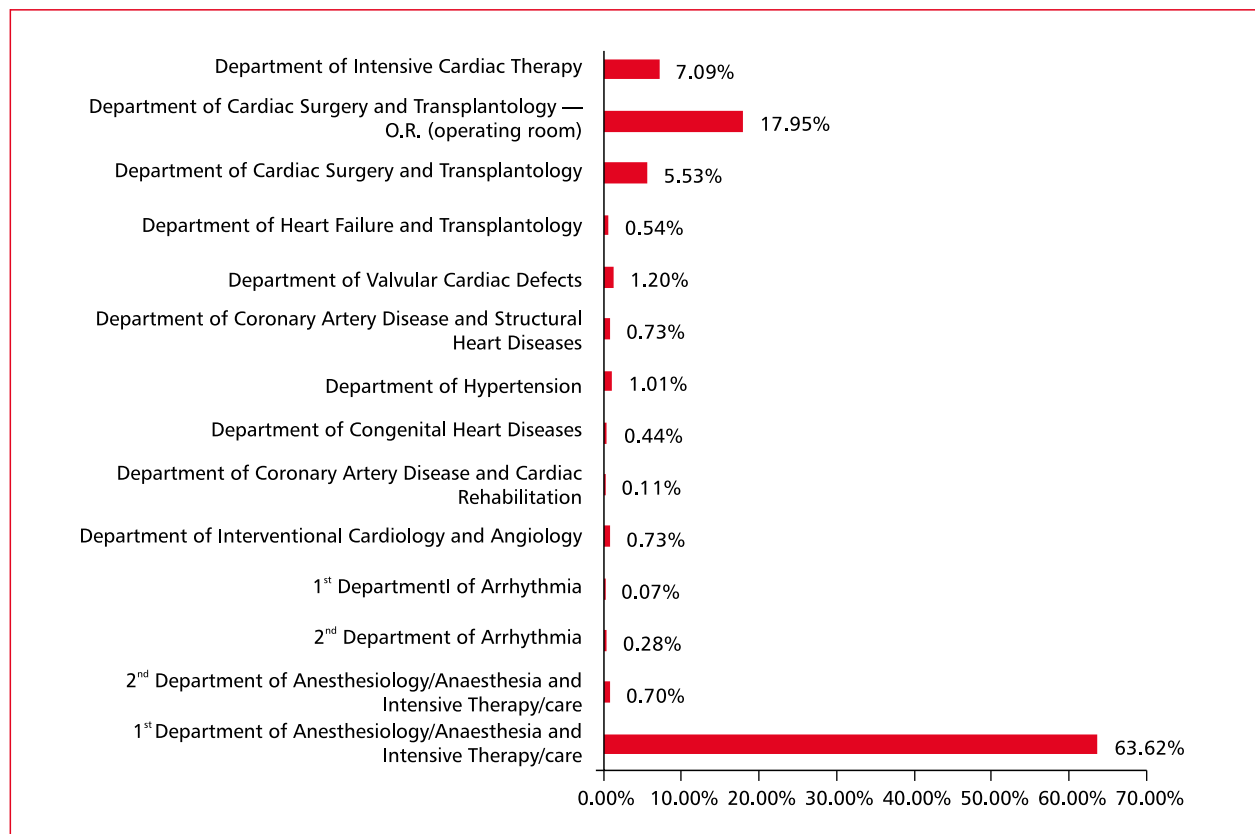


Figure 4. Usage of packed RBC in respective clinics/departments

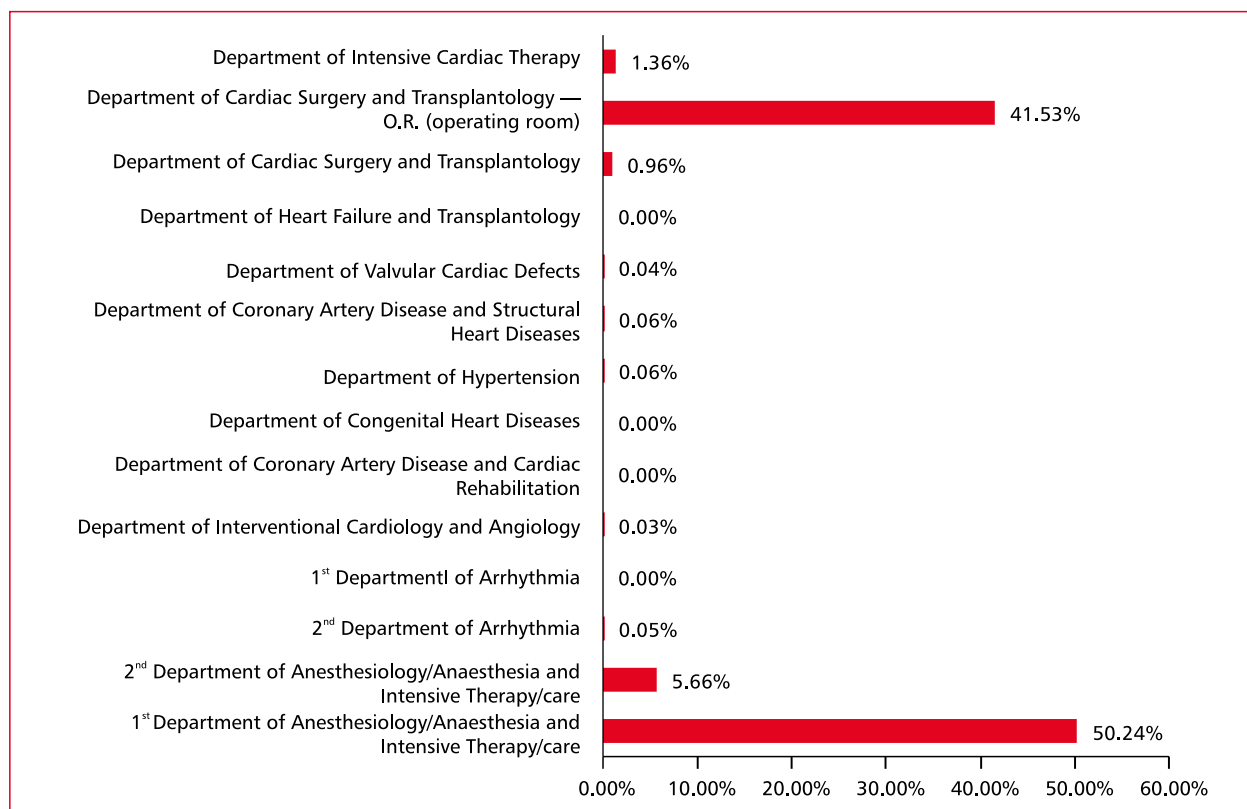


Figure 5. Usage of FFP in respective clinics/departments

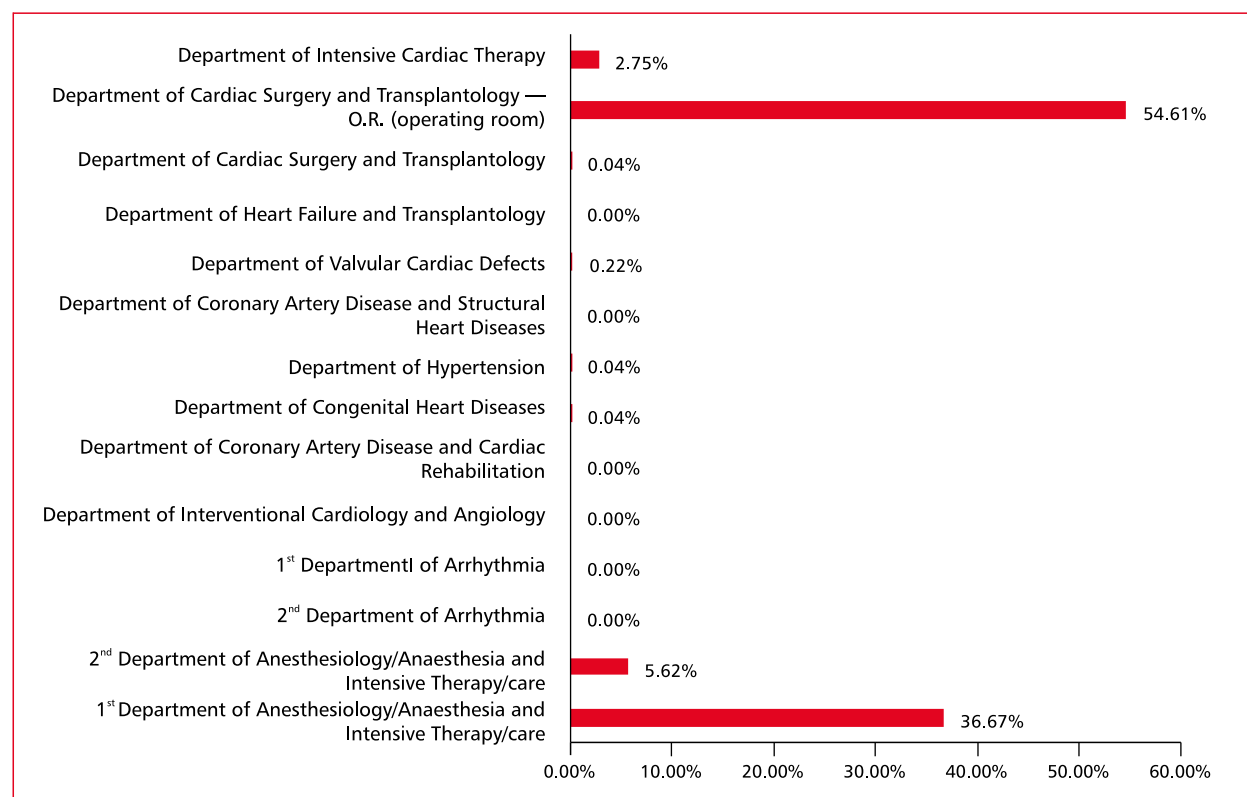


Figure 6. Usage of PC in respective clinics/departments

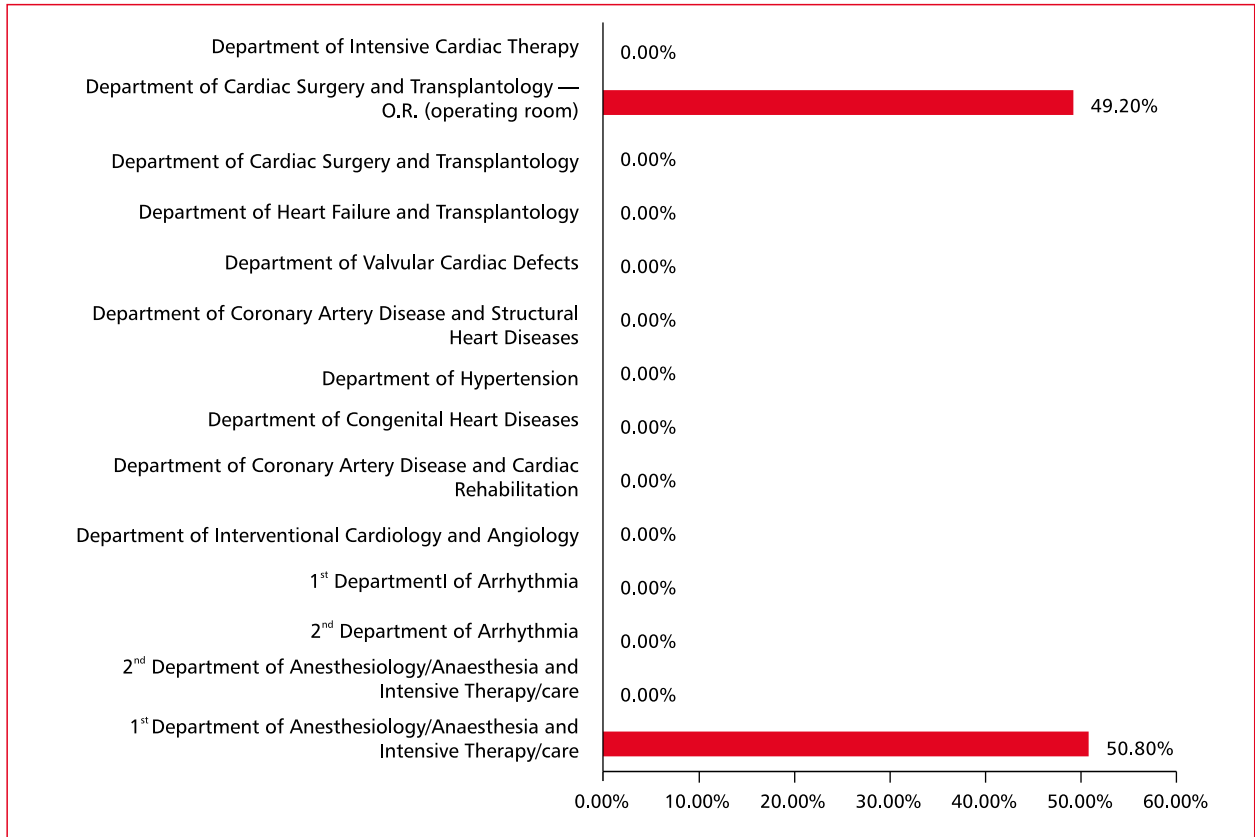


Figure 7. Usage of cryoprecipitate in respective clinics/departments

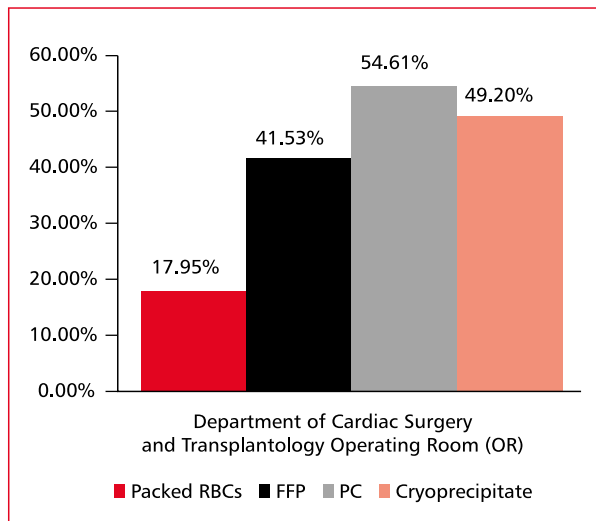


Figure 8. The percentage of blood components transfused in the Department of Cardiac Surgery and Transplantology Operating Room (OR) against transfusions in the hospital as a whole

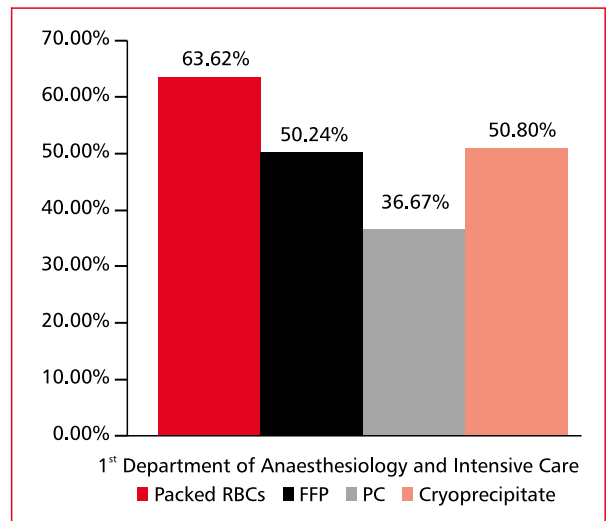


Figure 9. The percentage of blood components transfused in the 1st Department of Anaesthesiology and Intensive Care against all transfusions performed in the hospital

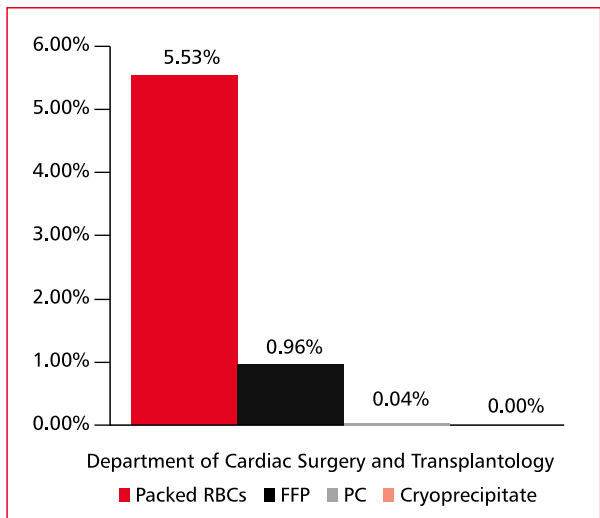


Figure 10. Percentage of blood components transfused at the Department of Cardiac Surgery and Transplantology

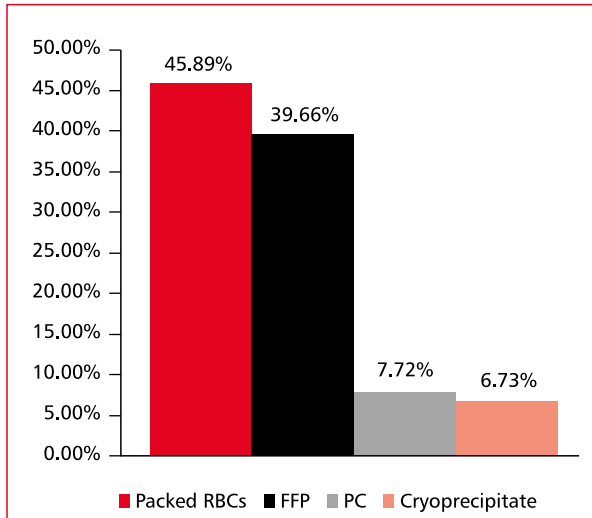


Figure 11. Percentage of each type of transfused blood component

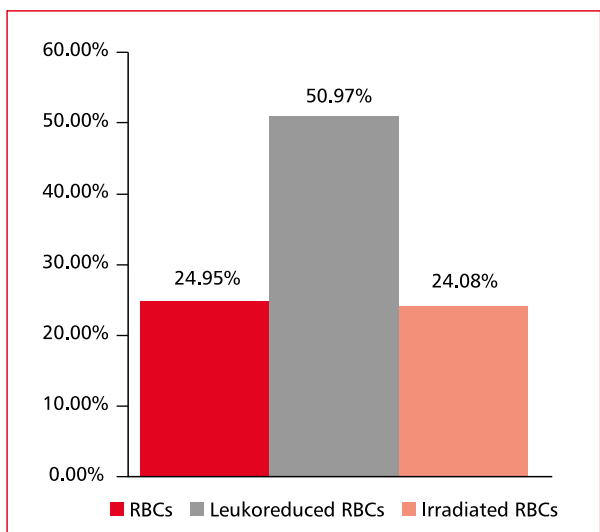


Figure 12. Percentage of the type of transfused packed red blood cells

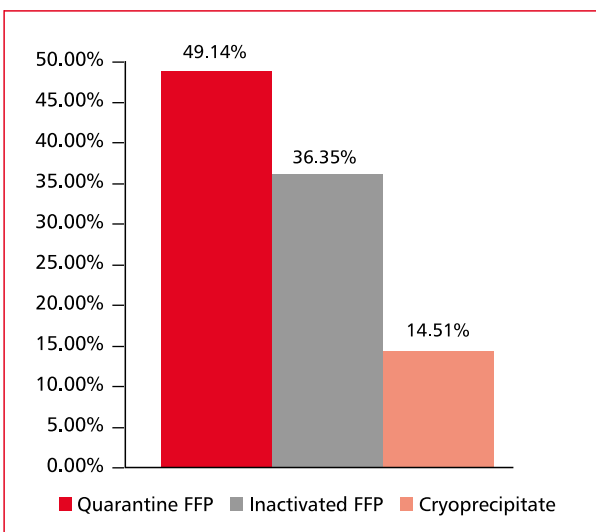


Figure 13. Percentage of types of transfused FFP and cryoprecipitate

If identical match blood components are unavailable, reconstituted PC is used. For patients allergic to plasma proteins, washed blood components are prepared; in the period under analysis they accounted for 0.15% of all transfused blood components.

To assess the usage of FFP, the volume of transfused FFP should be presented in relation to transfused RBCs to determine the FFP/RBC ratio. In the period under analysis, the FFP/RBC ratio was 0.86 which is high and indicates abnormal or unjustified plasma consumption. However, the Institute of Cardiology is a specific hospital and FFP

is used primarily in the management of coagulation disorders in patients with many plasma coagulation factor deficiencies. It should also be remembered that the high FFP/RBC ratio is not only due to the excessive use of FFP but also to lower consumption of RBC during cardiac surgery. The FFP/RBC ratio is therefore primarily related to the advancement of cardiac surgery and the tendency to limit the use of RBCC at the National Institute of Cardiology.

Rational management of blood and blood components at the National Institute of Cardiology is ensured by following the implemented procedures, regular training of personnel and close cooperation

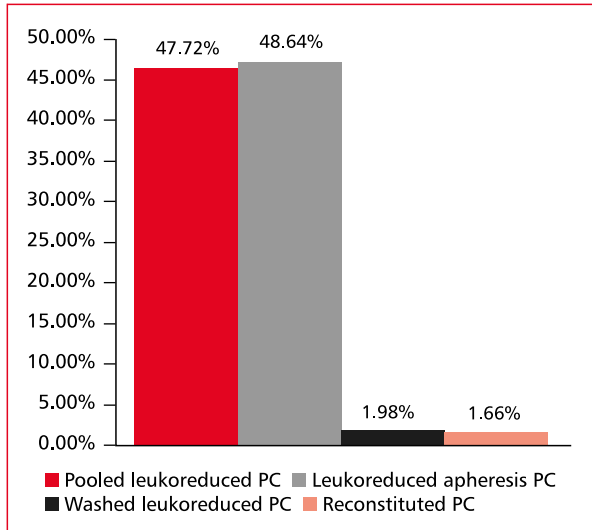


Figure 14. Percentage of the type of transfused PCs

between the Regional Blood Transfusion Center in Warsaw, members of the Transfusion Committee, the employees of the Blood Bank and staff of the clinics/wards.

Conflict of interest: none declared

References

- Zarządzenie nr 26 Prezesa Rady Ministrów z 21 marca 1979 r. w sprawie utworzenia Instytutu Kardiologii. (M.P. poz. 58).
- Rozporządzenie Rady Ministrów z dnia 17 października 2019 r. w sprawie reorganizacji Instytutu Kardiologii im. Prymasa Tysiąclecia Stefana Kardynała Wyszyńskiego oraz nadania Instytutowi statusu państwowego instytutu badawczego.
- Obwieszczenie Ministra Zdrowia z dnia 17 lutego 2021 r. w sprawie ogłoszenia jednolitego tekstu rozporządzenia Ministra Zdrowia w sprawie leczenia krwią i jej składnikami w podmiotach leczniczych wykonujących działalność leczniczą w rodzaju stacjonarne i całodobowe świadczenia zdrowotne.
- Antoniewicz-Papis J., Łąguna P., Poglód R. i wsp. Standard pracy Komitetu Transfuzjologicznego [Standard for activity of the Transfusion Committee], ed. Poglód R. and Antoniewicz-Papis J., 2020, ISBN 978-83-949959-1-1, <https://ihit.waw.pl/o-nas/dzialalnosc-instytutu/dzialalnosc-naukowa/dzialalnosc-wydawnicza/>
- standard-pracy-komitetu-transfuzjologicznego.
- Korsak J., Fabijańska-Mitek J., Jędrzejczak W. i wsp. Wytyczne w zakresie leczenia krwią i jej składnikami oraz produktami krwio pochodnymi w podmiotach leczniczych. Wyd. III. PZWL Wydawnictwo Lekarskie, Warszawa 2020.
- Obwieszczenie Ministra Zdrowia z dnia 30 marca 2021 r. w sprawie wymagań dobrej praktyki pobierania krwi i jej składników, badania, preparatyki, przechowywania, wydawania i transportu dla jednostek organizacyjnych publicznej służby krwi.
- Sarkar M, Prabhu V. Basics of cardiopulmonary bypass. *Indian J Anaesth.* 2017; 61(9): 760–767, doi: [10.4103/ija.IJA_379_17](https://doi.org/10.4103/ija.IJA_379_17), indexed in Pubmed: [28970635](https://pubmed.ncbi.nlm.nih.gov/28970635/).
- Ismail A, Semien G, Miskolczy SY. Cardiopulmonary bypass. StatPearls Publishing 2019, indexed in Pubmed: [29489210](https://pubmed.ncbi.nlm.nih.gov/29489210/).
- Makdisi G, Wang IW. Extra Corporeal Membrane Oxygenation (ECMO) review of a lifesaving technology. 2015; 7(7): E166–E176, doi: [10.3978/j.issn.2072-1439.2015.07.17](https://doi.org/10.3978/j.issn.2072-1439.2015.07.17), indexed in Pubmed: [26380745](https://pubmed.ncbi.nlm.nih.gov/26380745/).
- Baran DA. Extracorporeal Membrane Oxygenation (ECMO) and the Critical Cardiac Patient. *Curr Transplant Rep.* 2017; 4(3): 218–225, doi: [10.1007/s40472-017-0158-5](https://doi.org/10.1007/s40472-017-0158-5), indexed in Pubmed: [28932651](https://pubmed.ncbi.nlm.nih.gov/28932651/).
- Brojer E, Grabarczyk P. Czynniki zakaźne istotne w transfuzjologii. Wyd. I. Fundacja Pro Pharmacia Futura, Warszawa 2015.
- Franchini M, Lippi G. Fibrinogen replacement therapy: a critical review of the literature. *Blood Transfus.* 2012; 10(1): 23–27, doi: [10.2450/2011.0015-11](https://doi.org/10.2450/2011.0015-11), indexed in Pubmed: [22153684](https://pubmed.ncbi.nlm.nih.gov/22153684/).
- Holcomb JB, del Junco DJ, Fox EE, et al. PROMMTT Study Group. The prospective, observational, multicenter, major trauma transfusion (PROMMTT) study: comparative effectiveness of a time-varying treatment with competing risks. *JAMA Surg.* 2013; 148(2): 127–136, doi: [10.1001/2013.jamasurg.387](https://doi.org/10.1001/2013.jamasurg.387), indexed in Pubmed: [23560283](https://pubmed.ncbi.nlm.nih.gov/23560283/).
- Spahn DR, Bouillon B, Cerny V, et al. Management of bleeding and coagulopathy following major trauma: an updated European guideline. *Crit Care.* 2013; 17(2): R76, doi: [10.1186/cc12685](https://doi.org/10.1186/cc12685), indexed in Pubmed: [23601765](https://pubmed.ncbi.nlm.nih.gov/23601765/).
- Korsak J, Łętowska M. red.). *Transfuzjologia kliniczna.* Wyd. I. α-Medica Press, Bielsko-Biała; 2009.
- <https://www.poltransplant.org.pl/>.
- Nowak J, Fabijańska-Mitek J. red. *Podstawy immunogenetyki transplantacyjnej.* Fundacja ProPharmacia Futura, Warszawa; 2012: 145–174.
- Ramsey G, Mintz PD. *Transfusion practice in solid organ transplantation.* W: Mintz P.D. (red.). *Transfusion Therapy. Clinical Principles and Practice,* AABB Press, Bethesda 2011, edycja 3: 339–353.
- Nowak J, Fabijańska-Mitek J. *Podstawy immunogenetyki transplantacyjnej.* Fundacja ProPharmacia Futura, Warszawa 2012: 145–174.