

The path to the first heart transplant and current transplantology in Poland

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ABSTRACT

For centuries, knowledge about the heart, one of the most important organs in the human body, was limited to assumptions and theories. These ideas often served as a basis for understanding the functioning of the circulatory system, but they lacked scientific confirmation. It was not until the 17th century that scientists began to conduct more detailed, although often risky, experiments that shed light on the functioning of the heart. These experiments marked the beginning of reliable insights into the functioning of the circulatory system. As medical knowledge developed, the focus shifted to the treatment of circulatory system diseases. Initially, treatment consisted of minor procedures, but advances in science and technology paved the way for groundbreaking achievements. A historic milestone occurred on December 7, 1967, when the world's first successful heart transplant was performed. This achievement revolutionized medicine, giving new hope to patients with serious heart diseases. Today, a heart transplant is often considered a treatment of last resort, saving lives when other treatments have failed and significantly reducing mortality from cardiovascular disease (Circulatory System Disease). Despite advances in medical science, cardiovascular disease remains a global health challenge, affecting about 40% of the world's population. In Poland alone, about 12 million people suffer from conditions such as hypertension, myocardial infarction, stroke or atherosclerosis. These diseases have become a major public health problem, underlining the importance of prevention, early detection and advanced treatment options to combat their prevalence and impact.

KEY WORDS: heart transplant, transplantology, circulatory system, transplantation, transplant procedure

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INTRODUCTION

Over the last few years, with the dynamic development of medicine, the definition of human death has also changed- there has been a departure from the concept of human death as a whole. It has been assumed that the determinant of human death- as a whole- is brain death. In most Western countries, brain death is considered the definitive moment of a person's death. The introduction of this definition facilitated the development of transplantation. Legal systems are based on medical criteria confirmed by medical specialists.

These societies are more pragmatic in their approach to brain death, although there are still religious or philosophical groups (e.g. traditional Catholics or conservative Jewish groups) that question this concept. In Japan and South Korea, brain death is more controversial. Culturally and religiously (influenced by Buddhism

and Confucianism), life is seen as a whole, and as long as the heart is beating, some people do not consider the person dead.

In Japan, for years, restrictive regulations regarding transplantation were in force, and society had limited confidence in the definition of brain death. An additional controversy is "presumed consent". In Poland and France, there is a system of presumed consent. In these countries, the lack of formal objection means that a person can become an organ donor after brain death. The mechanism works on the principle of efficiency- more organs available for transplantation, shorter waiting lists. This is the Act of 1 July 2005 on the collection, storage and transplantation of cells, tissues and organs- the so-called "Transplantation Act". Art. 5 of the Act reads: "The collection of cells, tissues or organs from a deceased person may be carried out if they did not express an objection during their lifetime."

In the USA, Japan, and Germany, on the other hand, there is a system of expressed consent. Only people who have clearly declared their willingness to be donors can donate their organs after death. Main regulation: Law on the Donation, Removal, and Transfer of Organs and Tissues-“Transplantation Act-TPG”, of November 5, 1997, effective December 1, 1997. “Anyone who makes a declaration regarding organ and tissue donation may consent to organ and tissue removal in accordance with Section 3, object to it, or delegate the decision to a named person of their trust”.

It requires broad public education and encouraging people to register as donors. The effectiveness is lower, which leads to longer queues of people waiting for a transplant. Complex problems, disputes and dilemmas around the term of brain death and presumed consent to the removal of organs from a deceased donor have become the subject of numerous acts of international law. In 1978, the Committee of Ministers of the Council of Europe issued a resolution to unify the legislation of member states on the removal and transplantation of organs and tissues from living and deceased donors [1, 2].

The Catholic Church has also taken a position on transplants, thus supporting the treatment of patients with end-stage organ failure. Pope John Paul II and bishops have repeatedly expressed this in their teaching and in collegial speeches, emphasizing that “the body of the deceased deserves respect, and the removal of an organ after death does not violate its dignity or any rights of a human person” [3]. In 2000, John Paul II, at a meeting with participants of the 18th International Transplantology Congress in Rome, said: “Transplantation is a great step forward in the service of science to mankind and currently many people owe their lives to a transplanted organ” [3].

AIM

The aim of the paper is to present the path to the first heart transplant in Poland. The paper, by explaining the basic terminology in the field of transplantology, will go through a historical outline, including several important dates that have a great significance for the further course of the performed operations. Then we will focus on the first transplant attempt in Poland and the subsequent procedures performed. We will focus on the statistics related to transplants in Poland in the last 10 years and explain the process of qualifying the patient and donor for the heart transplant procedure.

MATERIAL AND METHODS

This publication is based on studies published in PubMed and Google Scholar. A thorough literature

search was conducted, covering publications from the years 1985-2024 to provide a comprehensive and up-to-date review of relevant findings. The search strategy included the use of specific keywords “first transplantation in Poland”, “history of transplantology” and “transplant qualification process”. The initial search yielded approximately 30 articles. After a detailed review, 18 articles related to the topic of the article were selected. The selection process gave priority and a primary theme to articles that provided direct information on the history and present of transplantology in Poland and worldwide.

The remaining 12 articles were excluded due to irrelevance or lack of focus on important aspects in the history of transplantology and current patient qualification processes in Poland. The selection of 18 key articles forms the basis of this review, ensuring that the conclusions drawn are both justified and consistent with current scientific knowledge.

REVIEW

HISTORICAL OUTLINE

The term transplantation– organ transplantation, means the transplantation of an organ in whole or in part, tissue or cells from one body to another (or within one body). The name comes from the Latin *transplantare* – “to graft”, *plantare* – “to plant” [4]. Cells (bone marrow, pancreas, brain or epidermis), parts of organs (heart valves, skin flaps, blood vessels) or entire organs can be transplanted: most often kidneys, heart, liver and pancreas. This has become possible thanks to the progress of immunology and new immunosuppressive drugs that prevent rejection of the transplanted organ [5]. Modern transplantology is considered a relatively young field of medicine, because its intensive development occurred in the first years of the 20th century. It is widely considered to be the greatest achievement of modern medicine. However, unsuccessful attempts at organ transplantation, as reported in records and various legends, date back to the Middle Ages. Man has long wanted to replace lost or diseased organs with healthy ones. The first mentions of a successful transplant date back to the 13th century. A legend from the life of Saints Cosmas and Damian (4th century) about the transplantation of a leg to a sick person has survived to this day. This successful procedure has been recorded in numerous paintings kept in the Louvre in Paris [6]. Initially, the source of transplanted tissues and organs were animals. These are so-called xenogenic transplants. Only with the gaining of experience and the conducting of numerous studies in the field of

genetics and immunology did transplants of tissues and organs taken from humans begin to be performed more frequently [7]. The first tissue transplanted to a human was sheep blood, which took place in the years 1635–1704 thanks to the work of J.B. Denis and P.E. Emmeretz. However, due to numerous fatal complications, this procedure was banned. The breakthrough came in 1901, when K. Landsteiner discovered blood groups A, B and O, and a year later A. von Castello and A. Sturli added group AB, which significantly contributed to the development of transplantology [7]. In 1902, Ullmann in Vienna performed the first autotransplantation of a kidney in a dog, and in 1905 Alexis Carrel repeated the experiment, although the transplanted kidneys did not function. Both surgeons, however, developed a technique for suturing vessels, including the so-called Carrel suture, which earned him the Nobel Prize in 1912 [8]. Another important discovery was the identification of the Rh factor by K. Landsteiner and A.S. Winer in 1940, which enabled the widespread use of blood transfusions. The Polish scientist L. Hirsfeld also distinguished himself in the study of serological conflicts [7]. During World War II, it was noticed that many seriously injured patients died of acute renal failure, which focused attention on the development of transplants. The first human kidney transplant was performed in 1933 by the Russian surgeon J. J. Voronoi. In the years 1947–1952, attempts were continued in Canada and France, although without major success [9]. The first successful kidney transplant between twins was performed by Murray and Merrill in Boston in 1954. Progress in this field required overcoming problems related to complications after transplants. An important step was the discovery of immunological causes of transplant rejection, which was studied by, among others, Medawar and Dausset, who in 1958 described the histocompatibility antigen HLA [8]. In 1980, Benacerraf, Dausset and Snell demonstrated genetic dependencies in protein structures on the cell surface [7]. The second half of the 20th century brought successes thanks to the development of immunosuppression methods, i.e. treatment that inhibits the body's immune reactions. Initially, body irradiation was used, but the breakthrough came with the introduction of drugs such as 6-mercaptopurine (6-MP) and cyclosporine, as well as the use of antilymphocyte serums and globulins [7]. In ophthalmology, corneal transplantation has been used since 1906, initially developed by E. K. Zirm and improved by Moner in the 1940s. In reconstructive surgery, skin and artificial skin grafts are used, and since 1957, urology has used the small intestine for bladder plastic surgery. In 1963, J.D. Hardy performed a successful lung transplant, in 1966 W. Kelly and R. Lillehei transplanted a pancreas, and in

1967 C. Barnard performed the first heart transplant.

THE FIRST HEART TRANSPLANT IN THE WORLD

Christiaan Barnard was born on November 8, 1922 in Beaufort West, a small town in South Africa. The heart surgeon was 5 years old when his brother, who was 2 years younger, died of tetralogy of Fallot, which is a rare congenital heart defect. It was the death of his brother and the thought [...] "what would it feel like to have another person's heart beating in my chest" that caused his fascination with the circulatory system and especially the heart. He trained by conducting heart transplants on dogs. Together with his team (including his second younger brother Dr. Marius Barnard), on December 7, 1967, he attempted the first heart transplant at the Groote Schuur Hospital in Cape Town. The patient was 53-year-old Louis Washkansky. The patient suffered from heart failure and had also suffered 3 heart attacks during his life. The heart to be transplanted belonged to a victim of a road accident-25-year-old Denise Darvall. Before the procedure, Dr. Barnard assured the man's family that the chance of success was very high and amounted to 80% [10]. The heart transplant operation on the grocery store owner lasted 5 hours and was attended by 30 people. After the procedure, the patient woke up and was in very good condition- he talked to doctors, gave interviews, posed for photos. However, he died after 18 days, from causes that were not directly related to the procedure. The cause of death was pneumonia, which developed after the administration of anti-rejection drugs and at the same time weakened the body's resistance to various infections. After his death, Christiaan Barnard was criticized by most ethicists for misleading the family and the patient himself regarding the very high percentage points of the chance for a successful procedure and prognosis. Barnard later justified his decision with a vivid metaphor: "If a lion chases you onto the bank of a river infested with crocodiles...". This analogy, while emotionally compelling, has been critiqued in bioethics for oversimplifying patient consent and minimizing the uncertainty of experimental procedures. Public reactions to Barnard's operation ranged from severe criticism to enthusiastic admiration, reflecting the ethical and societal tensions of the time [11, 12].

THE FIRST HEART TRANSPLANT IN EUROPE

On April 27, 1968, in Paris, a team of cardiac surgeons led by Professor Christian Emile Albert Cabroli undertook a heart transplant. The patient was a 66-year-old man

suffering from advanced heart failure, which threatened his life. His health condition was so serious that a heart transplant was the only chance for survival. Due to the lack of effective pharmacological treatments, the operation was classified as experimental. The donor heart was a patient who had died as a result of a brain injury. In 1968, the criteria for declaring brain death were not yet well established, which was one of the controversial aspects of the operation. The donor heart was taken shortly after the death was announced to ensure its best condition. The procedure was considered successful despite the patient's death after 51 hours due to the fact that the heart was accepted by the recipient and began to beat in the patient's body. The patient's immune system attacked the new heart, a common problem at the time, when the effectiveness of immunosuppressive drugs was limited. Cabrol was a very well-known person in France. In addition to the field of cardiac surgery and transplantology, which he dealt with mainly, he was also a local government official, politician, and MEP of the 4th term. The history of Christian Cabrol places him in the first row of great scientists who achieved great achievements in the field of transplantology, because this event became the first milestone in European cardiac surgery [12].

THE FIRST ATTEMPT AT A HEART TRANSPLANT IN POLAND

In December 1968, a patient with an advanced heart defect was admitted to the hospital. Professor Jan Moll, together with professors Antoni Dziatkowiak and Kazimierz Rybiński, undertook the first attempt at a heart transplant in Poland on January 4, 1969. Jan Moll led the team operating on the recipient, while Kazimierz Rybiński led the team at the donor's table. The donor was a 27-year-old boy with irreversible brain damage. When the doctors decided to disconnect the equipment and pronounced brain death, they asked the deceased's mother about saving the heart for transplantation into another organism. During the operation, it turned out that the organ recipient could not be disconnected from extracorporeal circulation due to the fact that the heart had swollen and distended, which resulted in the loss of contractile strength. Despite further attempts to stimulate and support the heart, the patient could not be saved. He died on the operating table. The first unsuccessful transplant attempt resulted in the deceased's family filing a crime report with the prosecutor's office. Although the case was dismissed, Prof. Moll did not attempt any more transplants. Rybiński changed his specialization to endocrinology and became the founder of Polish endocrine surgery [13].

At that time, Poland lacked modern heart-lung machines, which were already standard in countries such as the US and France. The equipment used was outdated, which made it difficult to control circulatory and oxygenation parameters during surgery. At that time, Poland did not have access to modern immunosuppressive drugs, such as azathioprine or corticosteroids, which were already used in Western countries. This significantly increased the risk of transplant rejection. In Poland, there were no clear regulations governing the issue of organ harvesting for transplantation, including the definition of brain death.

The death of the donor was determined mainly on the basis of cardiac arrest, which caused delays in organ harvesting and reduced their chances for successful transplantation.

The lack of legal regulations led to ethical controversies—both in the medical community and in society. Heart transplantation was an innovative procedure that aroused mixed reactions in Poland, especially among more conservative circles. Some religious and social groups considered heart transplantation to be unnatural or inconsistent with the teachings of the Church. The first transplant attempt was a milestone in the world of cardiac surgery. The experience from this operation allowed for the gradual construction of modern transplantology in Poland, and in the following decades the country became one of the leaders in this field in Central and Eastern Europe [11, 13].

PATIENT FROM KRZEPICE FOR TRANSPLANT

Professor Marian Zembala, found out that the father of a friend from his hometown was staying in the Cardiology Clinic. According to Professor Marian Zembala, the patient was breathing with great difficulty and could barely speak. During the conversation with the patient, he mentioned that his heart would not withstand such an operation and suggested a heart transplant in cooperation with Professor Religa. He reassured him and explained that people with a new heart can continue to live. He told him about a case in France, about a man who had had a new heart for eighteen years. The patient from Krzepice agreed without a second thought because he knew he did not have much time left to live, while Zbigniew Religa did not make such a decision right away. He saw that he was not an ideal patient for a transplant. The patient was exhausted by a long-term severe heart disease. A conversation with the patient, a discussion with Professor Pasyk and members of the team decided that having a donor for a transplant with the ORh (+) group, they would try to take a risk. The patient was transferred in October to

the Provincial Cardiology Center (WOK), in Zabrze. The doctors were skeptical about making the attempt, because the patient was receiving a continuous infusion of dopamine and any attempt to disconnect it resulted in shortness of breath. His heart contracted only as a result of the administration of stimulants. The plan to undertake the transplant was still in the doctors' heads and the confirmation was the fact that the National Duty Physician reported the need for a heart donor. On Monday, November 4, 1985, the patient looked weaker and weaker, but the ward was revived, as it turned out that a donor for a new heart had been found. Around 2 a.m. after reaching the WOK, Zbigniew Religa informed the patient that the heart was on its way to Zabrze [11].

ORGAN DONOR

The organ donor turned out to be 29-year-old Włodzimierz Z, who had been in the Wolski Hospital in Warsaw for neurosurgery since November 1 with a damaged skull and brain. The donor was found on a bench in a park in the capital of Poland. He was bleeding badly, he had probably been hit with a non-sharp object. Despite immediate surgery, doctors were unable to cope with the injuries that were too severe. The drop in body temperature, the lack of eyeball response to stimuli and the lack of independent breathing caused them to disconnect the artificial respiration apparatus on November 4 and issue a death certificate. Doctors contacted Religa, knowing about his idea. The proposal to save another person's life using the organs of a deceased person was met with no objections from the potential donor's family. Tissue compatibility tests were performed by taking samples from the inguinal lymph nodes and blood. The results had to wait until late at night that same day. The results were communicated to the WOK by phone, and after midnight Doctor Grzegorz Gallert (anaesthesiologist) and Cichoń, together with the donor, got into the transport ambulance. The people travelling in the ambulance were constantly supplementing the donor's body with the necessary drugs to maintain the organs' ability to be transplanted. The results were correct and the organ was suitable for transplantation. In this way, the heart reached Zabrze and the recipient was ready to receive the organ, which started the procedure for the donor and the recipient [10, 11].

AFTER THE OPERATION

The patient woke up at around 2 p.m. Doctors recommended that the patient stay in bed and do breathing exercises. On November 7, the patient's condition

deteriorated significantly. He was urinating less and less and blood was still flowing from the drains, which doctors concluded that he had problems with clotting. At around 4 p.m., his chest was reopened, and there were a lot of clots in it. Doctors tried to transfuse blood, but kidney failure, a ruptured stomach ulcer, and the aforementioned lack of clotting caused the patient's death. The patient died on November 11, 1985 at 8:02 a.m. An autopsy was performed, which found no traces of the transplant rejection process. The cause of death was most likely multiple organ failure resulting from postoperative complications. At that time, immunosuppressive drugs, which prevent rejection of transplanted organs, were not yet available in Poland in sufficient quantities, which made it difficult to control the heart rejection process [12]. The first heart transplant performed in the Zabrze clinic, despite its dramatic course, did not discourage the team of cardiac surgeons led by Professor Zbigniew Religa from continuing such operations. A week later, on November 12, 1985, the second transplant was performed. The patient was a 25-year-old man suffering from stage IV heart failure according to the NYHA classification, caused by post-inflammatory cardiomyopathy. The patient's condition was constantly deteriorating, and conservative treatment proved ineffective. The ejection fraction of his left ventricle was 35%, and the pulmonary pressure reached 45 mmHg. The donor was a 30-year-old man in a state of brain death after a skull injury. Initially, there were no complications after the surgery, and biopsies did not show any rejection of the transplant. However, after several weeks, the patient struggled with infections, including fungal pneumonia and generalized sepsis, which led to his death 39 days after the procedure. The transplanted heart functioned properly, which indicates the success of the transplant— if not for the complications related to the necessary immunosuppression, the patient would have had a chance for a long-term improvement in health [10]. The third heart transplant in the Zabrze clinic took place on April 25, 1986. The patient was a 34-year-old man with advanced heart failure, which was a consequence of previous heart attacks and bypass surgeries. His ejection fraction was only 10%, and pulmonary pressure— 75 mmHg. The donor was a 35-year-old man who had been diagnosed with brain death after a skull injury. The surgery was initially without complications, but from the second day onwards, progressive right ventricular failure appeared, associated with persistent pulmonary hypertension. Despite intensive therapy, the patient died on the seventh day after the transplant. This case confirmed that persistent pulmonary hypertension is a key contraindication to heart transplantation. The next, fourth

transplantation took place on May 11, 1986 and was successful. The recipient was a 35-year-old patient with a history of two heart attacks and increasing dyspnea and circulatory failure of NYHA class IV. The donor was a 35-year-old woman who died of acute respiratory failure. The operation was successful and the patient regained full circulatory capacity [12, 13]. After four weeks he left the clinic in good condition and his health remained at a satisfactory level for many years. It was the first fully successful heart transplant performed in Poland, proof of the determination and skills of Polish cardiac surgeons.

At that time, the availability of modern immunosuppressive drugs in Poland was limited. The introduction of cyclosporine in the early 1980s revolutionized transplantology, but its use in Poland was difficult due to high costs and limited access. These drugs were crucial for preventing rejection of transplanted hearts, but they had numerous side effects, such as kidney damage, increased risk of infection and cancer. In the 1980s, methods of monitoring rejection were less advanced than they are today. Endomyocardial biopsies were difficult to perform, and immunological tests were less precise. Thanks to state support and the involvement of Professor Religa's team, cyclosporine was introduced into postoperative therapy. Intensive cooperation with foreign centers helped to obtain modern drugs and knowledge about their use [11, 12].

THE ROLE OF TACROLIMUS IN MODERN IMMUNOSUPPRESSIVE REGIMENS: A COMPARATIVE CLINICAL PERSPECTIVE

Immunosuppressive therapy remains the cornerstone of successful solid organ transplantation, aiming to prevent graft rejection while minimizing adverse effects and maintaining long-term patient and graft survival. Among the various classes of immunosuppressants, calcineurin inhibitors (CNIs) – primarily cyclosporine and tacrolimus – have been the mainstay of maintenance immunosuppression since the late 20th century. Over the past two decades, extensive clinical research, randomized controlled trials, and systematic reviews have focused on comparing the efficacy and safety of these two agents in different transplant settings, including heart, kidney, and liver transplantation.

Tacrolimus, first approved for clinical use in the 1990s, is generally considered more potent than cyclosporine and has been associated with improved outcomes in various transplant populations. A systematic review and meta-analysis by Webster et al. (2005), which included 30 randomized controlled trials involving kidney transplant recipients, demonstrated that tacrolimus signifi-

cantly reduced the risk of acute rejection compared to cyclosporine (RR = 0.56, 95% CI: 0.43–0.73) without increasing overall mortality [1]. Similar findings were observed in heart transplant recipients. A meta-analysis conducted by Penninga et al. (2010) evaluated seven randomized trials with 885 patients and concluded that tacrolimus was associated with a lower incidence of severe acute rejection at both 6 and 12 months (RR ~0.61–0.69), while also showing a trend toward reduced treatment discontinuation [2]. Although tacrolimus was linked to a higher incidence of new-onset diabetes after transplantation (NODAT), its superior efficacy in reducing immunological complications often made it the preferred first-line agent.

In Poland, observational cohort studies have corroborated these global trends. A multicenter study conducted on 734 kidney transplant recipients across several Polish centers revealed that tacrolimus-based regimens were associated with significantly fewer episodes of biopsy-proven acute rejection and tended toward improved one- and five-year graft survival compared to cyclosporine-based therapy. These benefits were especially notable in patients with high immunologic risk or delayed graft function, highlighting the drug's applicability in challenging clinical scenarios.

In liver transplantation, tacrolimus has similarly outperformed cyclosporine in several domains. According to a Cochrane review by Haddad et al. (2006), tacrolimus improved patient and graft survival at one year and resulted in better control of blood pressure and lipid profiles. However, this came at the cost of higher incidence of metabolic side effects, particularly post-transplant diabetes mellitus. Despite this, due to its ability to more effectively suppress T-cell mediated rejection, tacrolimus became the preferred CNI in many liver transplant protocols worldwide, especially in the early post-transplant period [14].

An important aspect of this therapeutic comparison lies in long-term follow-up. While short-term benefits of tacrolimus are well documented, long-term exposure to calcineurin inhibitors, regardless of type, is associated with nephrotoxicity, neurotoxicity, hypertension, and metabolic syndrome. Thus, many transplant centers are moving toward minimization strategies, such as lowering tacrolimus trough levels, introducing adjunctive agents (e.g., mTOR inhibitors or mycophenolate mofetil), or switching to CNI-free regimens in select patients. Yet, most comparative studies still suggest that tacrolimus offers a more favorable risk-benefit profile, particularly when metabolic side effects are carefully monitored and managed [15].

In conclusion, both tacrolimus and cyclosporine remain foundational drugs in transplant immunology,

but the evidence from large- scale meta- analyses and clinical trials consistently favors tacrolimus in terms of reducing acute rejection, improving graft survival, and achieving superior overall outcomes across organ types. Nonetheless, patient- specific factors, comorbidities, and risk of metabolic complications must guide therapeutic decisions. Ongoing research is also exploring pharmacogenetic predictors of CNl response, aiming to tailor immunosuppression more precisely and safely in the future.

ORGAN PROCUREMENT PROCEDURE AND ORGANIZATION

In Poland, there is Act No. 169 item 1411 of 2005, which allows for the removal of organs from a deceased person only if they did not express their objection to such a procedure during their lifetime. People who do not want their organs to be used after death are required to file their objection in the Central Register of Objections. For those who have not registered such an objection, the organ harvested from the deceased can be used for transplantation. However, this process involves many procedures to ensure that the organ goes to the most suitable recipient. A key aspect that determines the success of the transplant is the precise matching of donors and recipients, which involves a number of detailed medical and immunological tests.

The first step in this process is the compatibility of blood groups between the donor and the recipient, which is the basis for the initial selection. Then it is necessary to look for the greatest possible genetic compatibility between the donor and the recipient in terms of histocompatibility antigens (MHC – Major Histocompatibility Complex). The complex MHC plays a key role in recognizing histocompatibility antigens, especially HLA (Human Leukocyte Antigens) class I and II proteins, which are present in all human cells [16, 17]. Obtaining organs for transplantation is the most important problem in transplantology. Advances in medicine and the development of modern transplantology have caused an imbalance between the number of people waiting for transplants and the number of organs obtained. The problem is growing not only in Poland, but also all over the world. This is related to the paradox occurring in transplant medicine – a living organ is needed for organ transplantation. It can be obtained from a deceased donor, then we talk about *ex mortus* transplants, but for it to be successful, it depends to a large extent on the quality of the organ obtained. In addition to many factors (e.g. donor age, health condition, course of brain death, conditions of organ storage), the quality of the organ obtained is also influenced by organizational

activities in the process of organ collection. Organs can also be obtained from a living donor – then these are *ex vivo* transplants. The procedure for obtaining organs is then slightly different and less complicated [18].

In the initial period, organs from donors were collected in designated hospitals that ran transplant centers. This involved sending corpses to these centers, which often caused conflicts with the families of the deceased. In the 1990s, attempts were made to improve the system of collecting organs for transplantation. In 1996, the Organizational and Coordination Center for Transplantation *Poltransplant* was established. It is a budget unit subordinate to the Ministry of Health and Social Welfare, established under the Transplantation Act of 1996. The *Poltransplant* office is located in the Infant Jesus Hospital in Warsaw [18]. The process of collecting organs for transplantation requires extensive knowledge, responsibility, planning, and efficient flow of information at many levels. It is also difficult because in this process (especially when it concerns *ex mortus* transplants) one should not skip the conversation with the family, providing them with sufficient information, care and support [19].

Transplant coordinators play an important role in this process. A transplant coordinator is a person responsible for the organization, supervision and coordination of the entire process of organ procurement. Usually, this is a specialist with medical education, e.g. a doctor or nurse, who deals with a wide range of activities, from the identification and qualification of donors, through the organization of the procurement process, to the care of transplant recipients. Coordinators also deal with documentation and education, organizing workshops and information campaigns. In order to effectively perform their duties, coordinators must have knowledge in the field of clinical transplantology, immunology, intensive care, but also in clinical psychology, law, and organization and management. In countries with a well-developed network of transplant coordinators, such as Spain, the Netherlands or the United States, the number of donors who are identified and qualified for transplants is much higher, and the system functions more efficiently. In Poland, however, there is a shortage of coordinators, and their tasks are usually limited to transplantation centers or regional coordinators. Finding the right specialists in hospitals where potential donors are identified is difficult, and the system still requires improvement. A special role is played by local coordinators, who work in hospitals where it is possible to identify potential deceased donors, and therefore where organs can be collected for transplantation. In Poland, the transplant system has undergone significant changes in recent years. According to data from the

Supreme Audit Office (NIK) from the first half of 2021, there were 388 hospitals in the country with the potential for organ donation, of which 255 facilities (66%) employed a total of 314 transplant coordinators [20].

The process of organ collection begins with the identification of the donor and reporting to the regional coordinator. In order to streamline the activities, a so-called 6-step strategy was developed (Table 1). After the collection of organs, the team involved in donor identification receives written and oral information from the coordinator about the results of the transplanted organs. The donor's family also receives information and support, but the recipient remains anonymous. Even if the diagnosis of brain death is clear, families often experience emotional resistance to this decision, especially in the case of young people who have suffered serious injuries or accidents. In such situations, a key role is played by anaesthesiologists who ensure appropriate communication with the family, providing support and explaining difficult issues related to the diagnosis and the possibility of organ collection. Poltransplant organizes training for anaesthesiologists, which aims to prepare them to conduct difficult conversations with the families of the deceased. In Poland, the family of the deceased formally has no right to object to organ donation, because the principle of presumed consent applies. The decision to donate organs depends solely on whether the deceased person objected during life in the manner provided for by law. If no objection was raised, it is assumed that the deceased agreed to be a donor. Despite the legal basis of organ donation based on "presumed consent", each interaction with the family should be full of respect, sensitivity and care. Failure in this respect can lead to social resistance to transplantation, which is why proper communication and emotional support are so important and should accompany the entire process [18, 21].

NUMBERS IN POLAND AND THE WORLD – HEART TRANSPLANTATION

From 1985 to 2023, 3,272 heart transplants were performed in Poland. Out of 38,288 total transplants, this is 8.55%. The table shows the last 10 years of the annual summary by the Polish Society of Transplantology. According to the WHO global reports, in 2021 (this is a report from December 2022), hearts were transplanted 8,409 times, which was 5.82% of all 144,302 transplants in the world. Although the result is reduced by 0.42% of all transplants compared to the previous year, 308 more transplants were performed than in 2020. Bar chart showing the distribution of heart transplants performed on individual continents in 2020.

In the years 2013–2023, the number of heart transplants in Poland showed a clear upward trend, which is reflected in the data presented in the table. In 2013, only 87 heart transplants were performed, which constituted 5.40% of all organ transplants in the country. In the following years, this number systematically increased, reaching a maximum in 2021– 200 transplants, which constituted as much as 14.99% of all transplants, which may be the effect of increased activity after the period of pandemic restrictions in 2020. In 2023, 182 heart transplants were performed, which – despite a decrease compared to 2021 – still indicates a persistently high level of transplant activity [22].

The increase in the number of heart transplants can be associated with advances in diagnostics, patient qualification, the development of organ perfusion technology, as well as improvements in the organization of donation. It is interesting, however, that despite the growing number of transplants performed, the total number of transplants (of all organs) did not show a stable increase- for example, in 2014 and 2015, 1,619 and 1,508 transplants were performed, respectively, while in 2021 there were only 1,334. This means that the share of heart transplants in the total number of transplants in Poland increased not only due to the increase in the number of these operations, but also as a result of a decrease in the transplantation of other organs in some years. Such a phenomenon may indicate the need for further analysis of human resources and infrastructure in the transplant system. The years 2017 and 2018 are also particularly important, as there was a decrease in the number of heart transplants (97 and 145, respectively), which may suggest local organizational problems, a temporary limitation in the availability of donors, or the effects of legislative changes. In total, however, the data for the years 2013–2023 reflect a clear trend in the development of Polish heart transplantology, with the simultaneous need to continue supporting it through systemic and social activities, such as educating the public about organ donation, developing donation programs after cardiac arrest (DCD) or expanding donor qualification criteria (Table 2) [23–25].

The second graph illustrates the number of heart transplants in individual WHO regions and confirms the significant disproportion in access to transplantology between world regions. The Americas region (mainly the USA and Canada) leads with 4,419 transplants per year, while the European region – second in terms of the number of transplants – performs 2,513 operations per year. The Western Pacific region is next in line (949 transplants), and much lower values are observed in Southeast Asia (122), the Mediterranean region (98), while the African region does not record any heart transplants (Fig. 1).

Table.1. 6 Step Strategy

STEP I Identification of potential organ donors among the deceased (ICU patients – with symptoms of brain death)
STEP II Fulfillment of legal and clinical requirements necessary for organ collection (data from medical history, previous laboratory tests, bacteriological, viral, fungal, tumor tests, certifying brain death)
STEP III Assessment of organ use, fulfillment of legal and social requirements: organ collection in accordance with Polish legislation, proper conduct of conversation with family, relatives.
STEP IV Appropriate care for the potential donor (limitation of the negative impact of systemic disorders related to brain death on the biological quality of organs)
STEP V Correct collection of organs for transplantation (protection against ischemia and ensuring proper transport)
STEP VI Selection of the appropriate recipient based on established criteria

Source: [14]

Table 2. The last 10 years of the annual summary by the Polish Society of Transplantology

Year	Heart transplants	Total	Percent of heart transplants to all transplants [%]
2023	182	1898	9,59
2022	173	1495	11,57
2021	200	1334	14,99
2020	145	1236	11,73
2019	142	1541	9,21
2018	145	1447	10,02
2017	97	1608	6,03
2016	101	1545	6,54
2015	99	1508	6,56
2014	76	1619	4,69
2013	87	1610	5,40

Source: [20]

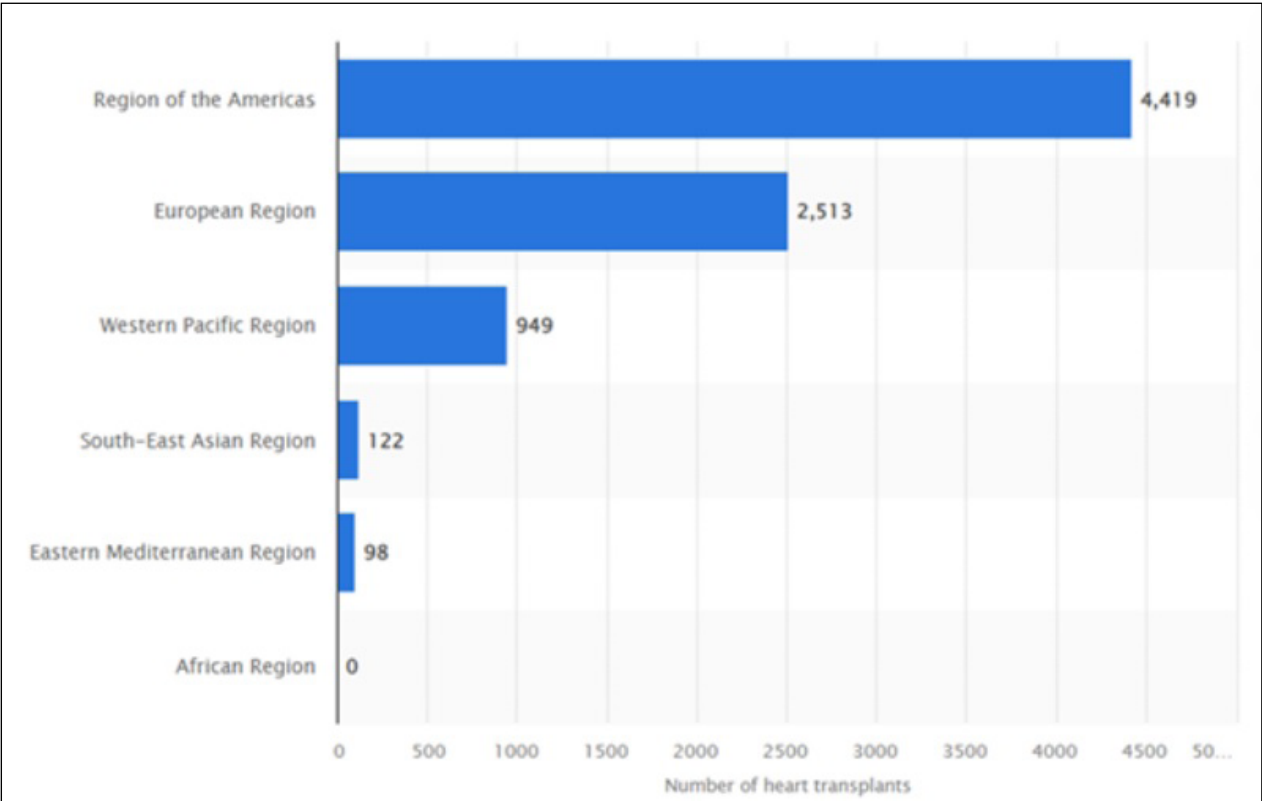


Fig. 1. Bar chart showing the distribution of heart transplants performed on each continent in 2020

Source: [21]

These data indicate inequalities resulting from the level of development of healthcare systems, infrastructure, availability of qualified personnel and cultural and legislative conditions in the field of organ donation [26].

In the context of heart transplantation, Poland still remains below the European average, but the gradual increase in the number of transplants indicates a positive direction of change. Despite systemic difficulties and organizational challenges, the years 2020–2023 have shown that the transplant system in Poland is resistant to crises such as the COVID-19 pandemic. The data indicate the need for further development of programs to increase the number of donors and intensification of educational activities in society.

CONCLUSIONS

Modern transplantology in Poland and around the world is developing dynamically, although with visible regional differences. In Poland, the activity coordinated by *Poltransplant* focuses on increasing the number of deceased donors and improving the organization of transplants, but the system still struggles with social barriers, a shortage of specialized personnel and limited infrastructure. These difficulties became particularly visible during the COVID-19 pandemic, when transplant activity was drastically reduced, despite the implementation of new safety procedures. At the same time, Spain is the world leader, achieving the highest donation rate (over 52 deceased donors per million inhabitants), thanks to an effective coordination system, modern technologies and wide social acceptance.

Globally, there is an increase in the number of transplants, the development of specialized teams for organ procurement and the increasing role of international organizations such as WHO, which develop strategies to ensure ethical and equitable access to transplantation. Common challenges include the development of donor registries, improving social education and the use of technologies such as ECMO and *ex vivo* perfusion.

The development of transplantology in Poland has resulted in the establishment of many specialist centres. However, the problem remains the low availability of organ donors for transplantation. The development of clinical transplantology will be possible thanks to the activity and actions promoting reliable knowledge about organ donation and transplantation. Social awareness plays a significant role- the knowledge that in order to save someone's life, an organ is needed. The hope for a better understanding of the relationship between transplantation and saving human life encourages us to get involved in the process of creating a culture of life in the modern world, where there are many ambiguities and negative stereotypes surrounding transplantology.

According to data from the Central Statistical Office, in 2019, deaths due to CVD amounted to 39% of all deaths. A year later, 72,095 citizens of the Republic of Poland died of CVD. Which, compared to the result of 181,984 of all deaths, gave 39.6% of the causes of all deaths in 2020. In 2021, the number of deaths due to diseases related to vessels and, of course, the heart increased by over 150% compared to the previous year and amounted to 180,662. 270,662 people died then, which constitutes 66.74% of all deaths in 2021. The conclusion from this is very simple- more and more people are dying from circulatory system diseases, so the event that was started in the world by Christiaan Barnard, continued by other colleagues, cardiac surgeons, including Professor Zbigniew Religa and Prof. Marian Zembala, and is continued by their sons, Professors Michał Zembala and Grzegorz Religa, was, is and will be a great step in saving human life. The future of transplant medicine depends to a decisive extent not only on the willingness and knowledge of doctors, existing legal solutions, but also on the level of social acceptance, the spread of attitudes ready to come to the aid of another person. Any opposition, even well-motivated from a moral and ethical point of view, is ineffective against therapy, effective, but above all the only possibility of saving life.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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