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POLISH THREAD IN THE HISTORY OF CIRCULATORY PHYSIOLOGY

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A review of the most outstanding achievements in physiology of circulation done by scientists and physicians from Poland and evaluation of their contribution to the world knowledge in this matter is presented in the paper. The authors associate the beginnings of the Polish history of studying heart and its diseases with the brilliant physician from the XIVth century - **Thomas of Wrocław**, and then in the XVIth century, with the most eminent physician of Polish Renaissance, the expert on pulse, **Joseph Struś**. The attempts to address the issues related to the circulatory system over historical period of early ages, through baroque and the blooming period in medicine of the XIXth, up to our times, were presented. The memories of the exceptional and the more or less known in the world cardiologic ancestors, associated with Poland, were recalled, such as: **Adam.Ch. Thebesius**, **Robert Remak**, **Edward Korczyński**, **Oscar Widmann**, **Napoleon Cybulski**, **Joseph Pawiński**, **Andrew Klisiecki**, **Adolph Beck**, **Leon Popielski**, **Wiesław Hołobut** and many others. The analysis of Polish achievements in the field of diagnosing and treatment of the ischaemic heart disease, starting from beginnings of the XIXth century, was performed. The authors also tried to recapitulate the achievements of the last 50 years in cardiological diagnostics, modern interventional cardiology, cardiac surgery along with transplantology and the scientific programmes concerning these issues. The examples of the greatest scientific achievements related to the circulatory system and to myocardial physiology and pathology over the period of recent decade were described.

Key words: *History of medicine, cardiovascular research, circulation, physiology of circulation*

One should realize, that in those times when the elaborations on the heart and on circulatory organs first appeared in Poland, the traditional, rational medicine lived its own life, acknowledging the importance of blood circulation for the maintenance of life. It existed far from and in spite of the metaphysical, ritual practices, affected strongly by the powerful Catholic Church. These first, timid elaborations mentioned above, appeared in Poland as early as in the Middle Ages to boldly catch up with the pace of world medicine in the Renaissance and Baroque and then, in the XIXth century, to gain international recognition for original ideas.

The knowledge of human physiology based on the great achievements of the ancients such as Aristotle, Hippocrates, Praksogoras, Alkmeon, Erasistratos, Herofilos, Celsus and Galen on the top of the list, did not have a chance to develop in the times of either Polish or European Middle Ages. What is known to us about the physiology in the early Middle Ages before Christianization, and so before writing was introduced? Indeed, just nothing. At that time in Europe there was no corresponding period of transition to that created by such medieval Arabian physicians, such as Avicenna, Rhases, Avenzoar or Ibn-an-Nafis.

The schools of medicine did not exist - only Salerno and Montpellier, with the most eminent minds of the Middle Ages can be considered significant. Christianisation of the country gradually introduced the Western ways of life, and with it appeared the scientific method. However, the teaching was based on the works of ancient doctors, and the most prominent teachers were foreigners, so the scope of the knowledge of physiology was contained. It was spiced with a pinch of mysticism, which was completely dominated by the church dogma created in the ancient times. This blend of scientific and theological dogma swerved far from the standards of rational thinking.

The achievements of **Thomas of Wrocław** (1297-1378), a titular bishop of Sarepta, operating the region of Lower Silesia, were the exception to the ocean of medieval dogmatism (1). He was thoroughly educated in Western Europe, in Montpellier, Salerno, Padua and Bologna. Once recognized as a scientist, he was repeatedly invited as a lecturer to the universities of Paris, Montpellier and Oxford. He treated pope John XXIInd, prince Henry VIth of Wrocław, and the Czech kings - John Luxemburger and Charles IVth, the Holy Roman Emperor. In 1360-1363 he published the work "Mihi Competit", which was a form of medical encyclopaedia, known as "**Kanon Biskupa Tomasza**" ("**The Bishop Thomas' Cannon**") or "**Śląski Kanon Avicenny**" ("***Silesian Cannon of Avicenna***") and "Practica Medicinalis", a collection of edicts referring to the art of medicine and pharmacy. The achievements of Bishop Thomas are linked to the history of cardiology by his work entitled "De syncopi et debilitate cordis", a text on the palpitations and syncope. This was probably the first work dealing with the heart to point to the relationship between slowing of the heart rate and syncope to

appear in Polish lands, and one of the first in the world. Thomas claimed that the palpitations (i.e. "trembling") would reflect imperfection of the heart, and it may very often result in syncope. In his opinion, syncope is serious and may lead to death. Can we notice here the beginning of the Polish way of thinking on physiology of circulation? Maybe yes, we can, as it seems that the basis of that kind of ideas could be the considerations referring to the regular versus irregular heart rate, and the resulting syncope. It is not out of place to mention that the observation on the irregularities in the heart rate (changes in the heart rate including slowing down) could be the first observation related to the loss of consciousness as a result of serious decrease of the heart rate, remaining well ahead of the other such reports (on so called Morgagni-Adams-Stokes' syndrome) by more than three centuries. M. Gerbezius made such a statement in 1691, before Morgagni's description in 1760. The author claims that the reason for these disturbances could be the damage to the "whiff within the heart", or its excessive excretion and he writes about the imbalance between the cold and the hot matter. Maybe in the Thomas' works we could detect some absence of balance in the proper perfusion of the cardiac muscle (deficiency in influx of nutritional substances). Thomas' recommendations concerning the application of ligatures on extremities were very intriguing, indeed, as if the author was foreseeing the role of redistribution of blood in the circulation (2).

The Akademia Krakowska (Cracovian Academy) that was open in 1364, and then reformed in 1400, had the Medical Faculty, but it was not showing progress in the quality of the scientific and educational activities in the XIVth and the XVth century. Not till the Renaissance this faculty showed some interest in the practical medicine. Young students of the Academy, eager to learn, showed more and more ambitions to catch up with the outstanding European leaders in medicine. That is why, after completing their studies in Kraków, they frequently travelled to the best-known scientific centres - most often choosing Italy. There they studied those subjects, which were not available at their *alma mater*. In the XVIIIth century the level of medical sciences in Kraków was still rather low. The physiological interpretation of Hippocrates, Galen and Avicenna was still respected. The second university centre, opened in Zamość, did not pursue medical sciences. The situation in the Western regions of the country was somewhat different. However, despite the fact that there was no university there, the doctors from that region were in constant and lively contact with Western European scientists in the field of biology and medicine. Nevertheless, we can start discussing the beginnings of Polish contribution to the disciplines of anatomy and physiology. Numerous works dealing with the relations of the heart and blood vessels written by Polish authors started appearing during this period. One should mention the work of **Peter Cziachowski** (XVIIIth century) in obstetrics, with a chapter: "O biciu serca y omdlewaniu brzemiennych" ("On the heartbeat and syncope of the pregnant women"). A rather clumsy explanation of

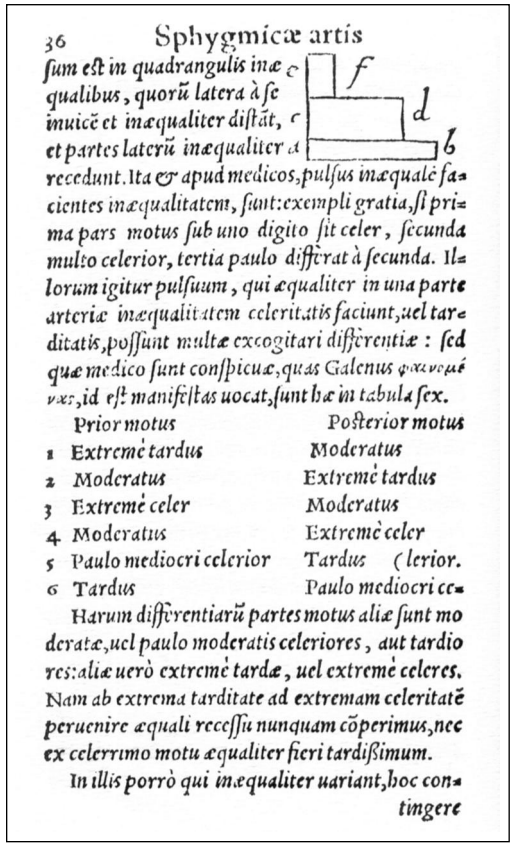
the reasons for the physical weakness and syncope appears in this chapter, ascribed by the author to the disturbances of the performance of the heart.

Adalbert (Wojciech) Nowopolski (1505-1559), the author of the first Polish manual on anatomy "Fabricatio hominis", quotes a variety of works, with the one by Andreas Vesalius among them. Nowopolski's work contains numerous fragments on the heart and blood vessels and presents ideas on the physiology of circulation (2, 3).

The only Polish physician of that era to became famous abroad in his lifetime and still remembered by historians of medicine, was **Joseph Struś** (1510-1568), the outstanding physician of the Renaissance. He became famous for his publication of the brilliant work "*Sphigmicae artis mille ducentos annos perditae et desideratae libri V*" (4). We can proudly claim that work to be the first Polish genuinely scientific dissertation on the physiology of circulation. Struś, born in Poznań, after completing his studies in Cracovian Academy went to Padova (Padua) to continue his education. At the age of 26 (1536) he became a professor of University of Padova. To honour his outstanding pedagogical skills and extraordinary knowledge the University community granted him a position of a prorector of the University. In 1537 he decided to go back to Poland. Struś started lecturing in Kraków on the 29th of October 1537. Unfortunately, he decided to stop lecturing next year. He took the position of a mansion physician of Starosta of Wielkopolska. Very soon he was offered a position of a court physician of queen Isabella - daughter of king Sigismund the Old, and a wife of John Zapoly (king of Hungary), to get yet another proposition of a post of a court physician of the king Sigismund August. He was also treating the Spanish king Philip II and Turkish sultan Suleiman II (the Magnificent) (2, 3).

Now let us get back to the great work of **Struś**, "*Sphigmicae artis...*" Soon after being completed, the book was published in Basel almost on the spot (1555), in approximately 1000 copies and doctors and medical students, greedy for knowledge, literally fought to get it. According to the records, 300 copies of the book were sold on the first day of its appearance in Padova! (5). The work of Struś, although based on the ideas of Galen, was genuine on nature. It took under consideration the most current achievements of the medical art. He suspected the existence of vasomotor nerves; he would agree that body temperature could affect the pulse. He classified pulse into five different types: high, frequent, accelerated, strong and soft, and many subordinate subtypes. He compared the pulse to the rhythm of music. It well could be that he was the first to depict the pulse graphically, so he can easily being considered the inventor, (pioneer) of sphygmography (*Fig.1*). He indicated that the changes of pulse could reflect the emotions, including sexual reactions and love (2, 4).

In 1628 appeared the fundamental work "*Exercitatio anatomica de motu cordis et sangunis in animalibus*" of **Sir William Harvey** (6). The same year **Gabriel Ochocki** (1673) was promoted to Baccalaureate at the Cracovian Academy, on the grounds of his thesis entitled "*Questio de motu cordis*". The question whether the


36 Sphygmicæ artis

ſum eſt in quadrangulis inæ
qualibus, quorũ latera à ſe
inuicẽ et inæqualiter diſtãt,
et partes laterũ inæqualiter
recedunt. Ita & apud medicos, pulſus inæqualẽ fa-
cientes inæqualitatem, ſunt: exempli gratia, ſi pri-
ma pars motus ſub uno digito ſit celer, ſecunda
multo celerior, tertia paulo differat à ſecunda. Il-
lorum igitur pulſuum, qui æqualiter in una parte
arteriæ inæqualitatem celeritatis faciunt, uel tar-
ditatis, poſſunt multæ excogitari differentiæ: ſed
quæ medico ſunt conſpicuæ, quas Galenus φανερά
νας, id eſt manifeſtas uocat, ſunt hæ in tabula ſex.

Prior motus	Posterior motus
1 Extremè tardus	Moderatus
2 Moderatus	Extremè tardus
3 Extremè celer	Moderatus
4 Moderatus	Extremè celer
5 Paulo mediocri celerior	Tardus (lerior.
6 Tardus	Paulo mediocri ce-

Harum differentiarũ partes motus aliæ ſunt mo
deratæ, uel paulo moderatis celeriores, aut tardio
res: aliæ uerò extremè tardæ, uel extremè celeres.
Nam ab extrema tarditate ad extremam celeritatẽ
peruenire æquali receſſu nunquam cõperimus, nec
ex celerrimo motu æqualiter fieri tardißimum.
In illis porrò qui inæqualiter uariant, hoc con-
tingere

Fig. 1. The first attempting of the diagrammatic record of the human pulse - J. Struś - 1555 r.

sensational discovery of William Harvey arrived that quickly to Kraków, remains unanswered. Was it an echo of the lectures attended (or the word passed by the third party?), or the Ochocki's work is coincidentally convergent with Sir William's work? It seems that Ochocki's short elaboration containing four conclusions was a result of his own speculations and, simply, of common sense - but it lacked the sharp wit and modern expressions one could find in Sir William Harvey's work. Moreover, there was no background of the original experimental verification for the theory in animal material performed by the great discoverer, Sir William. Nevertheless, it appeared original, as Ochocki at the time immediately before completing his writing was unlikely to have travelled abroad. All four "Ochocki's conclusions" were presented briefly and concisely as the evidence of his understanding of the blood flow in a human body. On the top of that he attempted to solve the dilemma of whether the heart moves "in a natural way". The expressions and notions applied still held the deep medieval appearance and they bore the scholasticism of his times, remote from the brilliance of Sir William

Fig. 2. Adam Christian Thebesius (1686-1732)

Harvey. But still, the description of blood flow and the directions of that flow were reported properly, all of it contradictory to the ideas of Galen (2, 3).

The Polish physicians studying and perfecting their skills in the Italian universities of the XVIIth century must have known the work of the brilliant English scientist. Unfortunately, the Harvey's work did not receive the adequate appreciation for a long time. It should be stressed then, that apart from Ochocki, another young physician, **John Toński**, was in the group of medics of the Cracovian Academy, who presented the original dissertation "*De motu sanguinis*" (1647) in order to get incorporated into the Medical Faculty after he completed his studies in the foreign universities (in Padova, among the others). Unfortunately, his dissertation was in a form of manuscript, as during those times publishing in print could compromise author's professional and scientific career of the highly unpopular Harvey's theses. Toński could differentiate the adult circulation from the foetal one; he described the role of *foramen ovalae* and *ductus arteriosus*. Despite few mistakes resulting mainly from the incomplete knowledge or wrong interpretation of the Harvey's work, his elaboration was the

first Polish open promotion of the new theory on the circulation of blood. Moreover, Toński was probably the first Polish author aware of the distinct physiology of foetal circulation (2).

The studies of **Adam Christian Thebesius** (1686-1732), a physician from Lower Silesia had the inestimable value for the understanding of circulatory physiology (*Fig.2*). He was one of the most famous scientists studying the anatomy of the heart, and the pioneer in studies on the coronary circulation (2, 7). He was not a Pole, he did not speak Polish, he spent almost all his life in Silesia - his native country - and he worked there, but we refer to that man with a satisfaction, recalling his links with our country. In 1708 he published the work "*Disputatio medica inauguralis de circulo sanquinis in corde*" in Leiden. After his return to Silesia for 20 years he performed the important function of a city "physicist" in Jelenia Góra. He was a consultant to the Habsburg court and a fellow of the Leopoldian-Carolian Academy of Nature Researchers in Wrocław (7). He was the first to describe in details the physiology of coronary circulation: venae cardiacae minimae, the coronary sinus valve, and some congenital anomalies of coronary arteries. The first out of these descriptions refers to the small veins collecting venous blood directly into the ventricles, being the element that complements the coronary venous return. Thebesius' veins gain the importance in pathology, e.g. in the congenital defects with total deficit of coronary sinus. Thebesius' valve is a small endocardial fold closing the outlet of the coronary sinus in a right atrium of the heart; sometimes it is only a residual film. It is a relic (similarly to the Eustachian valve) of a foetal valve of the right venous sinus. Moreover, as one of the first, Thebesius described the "ossification" of coronary arteries. However, it was his mistake to claim that the leaflets of aortic valve were closing the outlets of coronary arteries during the outflow of blood from the left ventricle.

In the XVIIIth century brilliant elaborations on the circulation and physiology of the heart were scarce in our country. Those who wanted to get educated in the medical arts had to study in Western Europe because of stagnation in the Cracovian Academy. Foreigners took positions of medical doctors, and even they did not represent any interesting personalities. The only exceptions in this situation were few elaborations that could serve as some sort of briefing on matters concerning the anatomy or physiology of circulation. Also some descriptions of the peripheral organ perfusion and the role of particular blood and lymphatic vessels appeared. The elaborations mentioned below were obviously based, to great extent, on the works of foreign masters, but they were prepared thoroughly, and since the eventual appearance of medical bibliography in Polish, the stage of creating a Polish medical nomenclature in the literature started. An altogether good elaboration of **John Adamus Kulmus**, a physician from Wrocław, appears in 1718. He was probably born and educated in this city. After completing his medical education and achieving the rank of a physician in the West (he was H. Boerheve's

student) he came to Gdańsk where he wrote two very interesting works: "*De sanguine ejusque circulatione*" (1718) and "*De circulatione sanquinis medicina universali*" (1744). The works mentioned were based on Harvey's theory of blood circulation, so they were not his genuine invention, but he earned recognition after publishing them in the Eastern Europe. That was the first scientific, carefully elaborated presentation based on a profound understanding of physiology in this part of the continent, a presentation of a theory that at that time was not very popular. In 1722 he published "*Tabulae anatomicae*" - a large atlas of anatomy, translated into seven languages, including Japanese. And so Kulmus gained international recognition (2).

In 1786 a small booklet entitled "Stan człowieka zdrowego naturalny" ("A natural condition of a healthy man") of **Felix Xavier Ryszkowski** was published in Polish (*Fig. 3*). The book was published in Kraków in 1786 (8). It was possibly written for laymen curious about the medical arts. The descriptions of blood circulation contained in the book, which, by the way, are quite often cited in historical elaborations, are light and easy and they are written in a beautiful old-fashioned Polish. The author presented the theory of blood flow through the

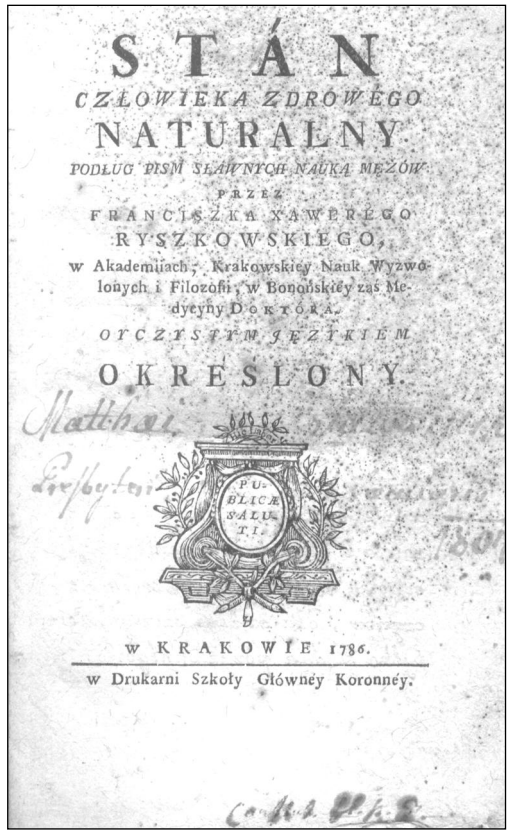
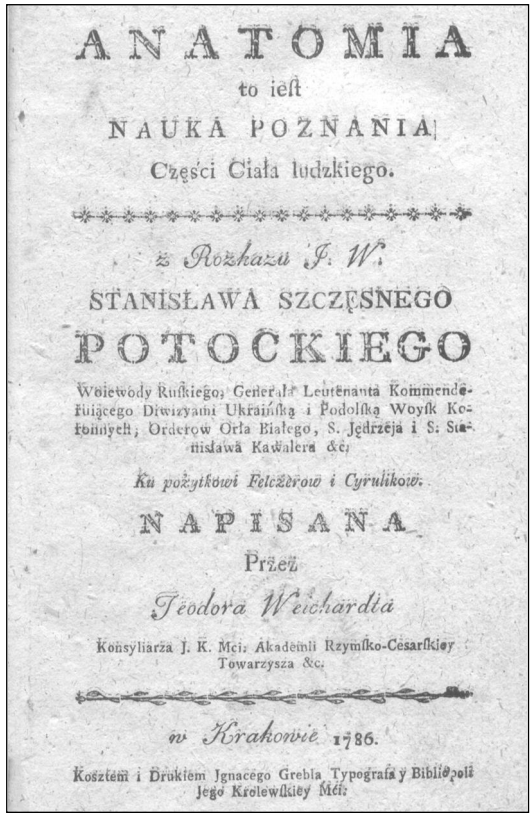

STÁN
CZŁOWIEKA ZDROWEGO
NATURALNY
PODŁUG PISM SŁAWNYCH NAUKA MĘŻÓW
PRZEZ
FRANCISZKA XAWEREGO
RYSZKOWSKIEGO,
w Akademiiach, Krakowskiey Nauk Wyzwolonych i Filozofii, w Bonońskiey zaś Medycyny DOKTÓRA.
OYCZYSTYM JĘZYKIEM
OKREŚLONY.
PUBLICÆ SALUTI.
W KRAKOWIE 1786.
w Drukarni Szkoły Główney Koronney.

Fig. 3. Stan człowieka zdrowego naturalny..., by Feliks Ksawery Ryszkowski, Kraków, 1786


ANATOMIA
to ieſt
NAUKA POZNANIA
Części Ciała ludzkiego.

z Rozkazu J. W.
STANISŁAWA SZCZĘSNEGO
POTOCKIEGO
Woiewody Ruſkiego, Generała Leutenanta Kommendeiącego Diwizyami Ukraińską i Podolską Woyſk Koronnych, Orderow Orła Białego, S. Jędrzeja i S. Stanisława Kawalera &c.

Ku pożytkowi Felczerow i Cyrulikow.

NAPISANA
Przez
Teodora Weichardta
Konsyliarza J. K. Mci. Akademii Rzymſko-Cesarſkiey Towarzysza &c.

w Krakowie 1786.

Kosztem i Drukiem Ignacego Grebla Typografa y Bibliopolii Jego Krolewſkiey Mci.

Fig. 4. Anatomia... by Theodore Weichardt, 1786

pulmonary capillaries and explained the idea of gas diffusion through the alveolar-capillary membrane, quoting M. Malpighi's discoveries.

The same year (1786) an army physician, **Theodore Weichardt** presented similar but slightly more professional description of physiology of blood circulation and of heart and blood vessel anatomy (*Fig. 4*). He published a very thoroughly elaborated small work, "Anatomy", in Polish (9). A fragment referring to a foetal circulation reflects the perfect knowledge of the topic and excellent theoretical background of the author. If not for the old-fashioned language, some of the Weinhardt's descriptions could easily be incorporated into the contemporary manuals for the students.

POLISH CONTRIBUTION TO THE UNDERSTANDING OF THE CIRCULATION OF BLOOD IN THE XIXth CENTURY

The turn of the XVIIIth and XIXth century coincided with the loss of independence as a result of partitions of Poland. Polish lands were annexed to

Russia, Prussia and Austria. Socially underdeveloped, pushed to the level of uncivilised and economically neglected province, submitted to the process of denationalization, the country sank into anarchy. All that would strongly affect the fate of the development of science in Poland. Two Polish regions were granted a sort of a semiautonomy. One was the Polish Kingdom, remaining within the Russian occupational zone and the other was Kraków with a small piece of the adjacent land, which became a miniature "Republic" under the control of all three occupants. In those regions some residual freedoms allowed for promotion of development of science and the reform of the national education. The great progress in medical sciences that took place at the same time (the beginning of the XIXth century) in Western Europe had a substantial impact on Polish medicine. The experience and new discoveries flowing from the West very soon led to initiation of an interest in the circulatory system, its structure and pathology. The beginnings of the Polish involvement in this matter are mainly linked to the medical colleges and to the newly set medical associations. The scientific analyses of the etiology of diseases of the circulatory system and the application of increasingly more rational treatment began. It is obvious that the foundation is physiology, in which the physicians of the XIXth century naturally had to develop a more profound interest. It opens up the road to a better understanding of all irregularities of the human system, which needed to be treated more effectively. Physiology as a separate branch of science first appears in the first half of the XIXth century and blooms by the end of it. A department of physiology, the first in the world, was founded in Wrocław, initiated by **John Evangelist Purkinyě** (1787-1869), a great Czech scientist who was one of the founders of experimental physiology. His discovery of fibres of the conductive system in the heart (later called "Purkinye's fibres") (6) was one of his many major achievements in physiology. Obviously, we do not attempt to include the great scientist in the Areopagus of Polish fathers of medicine. Purkinyě worked in Wrocław, which presently is a Polish city; he made all his exquisite discoveries in Wrocław, and we recall this outstanding researcher and his substantial contribution to the studies on the heart only for the clarity (3, 6).

One of the centres of Polish science was the ***Vilnius Academy***, in which there appeared a chance for a progress in the studies on circulatory system. It was founded in 1579 as the Jesuit Academy, but it did not undertake teaching of medical sciences until the end of the XVIIIth century. The Medical Faculty was finally founded on April 4th 1803. The Vilnius University was transformed into the **Szkoła Medyko-Chirurgiczna** (***Medico-Surgical Academy***) in 1832, but unfortunately, 10 years later it was closed and moved to Kijów (10). Vilnius Academy was the leading Polish centre of development of medicine including cardiology in the first half of the XIXth century. This centre was also recognized as a part of European scientific community thanks to such scientists as **Joseph Frank**, **Jędrzej (Andrew) Śniadecki**, **Vincent Herberski** or **Felix Rymkiewicz** (3, 10). Polish medical terminology in theoretical sciences was also created in this

Academy, including cardiological terms. In 1804 **Joseph Frank** (1771-1842) from Vienna became a chair of the Department of Pathology. He chaired the Department of Detailed Therapy and Medical Department since 1806. He was an outstanding practitioner and a shrewd observer of the human physiology. As an author of voluminous medical work he presented the most current achievements in medicine in a monograph on the heart and circulation. The school created by Frank had profound influence on the development of Polish cardiology, and his students (with W. Herberski, J. Oczapowski or F. Rymkiewicz among them) became renowned leaders of the modern cardiologic diagnostics far beyond their country (10). Jędrzej Śniadecki (1768-1838) is considered to be a co-creator of modern resuscitation (11). He recommended the application of mouth-to-mouth method of artificial ventilation (in 1805). In selected cases he suggested tracheotomy. Among his very innovative methods was the application of electric current to the chest in order to initiate breathing during resuscitation.

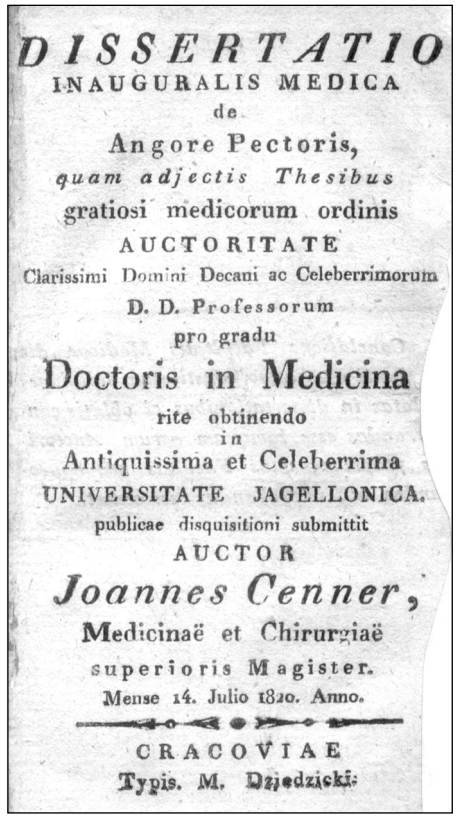
Jakub (James) Szymkiewicz (1775-1818), the author of the first Polish case report on a cyanotic heart defect (1806), very accurately describes the physiological state of systemic cyanosis pointing to the disturbances in saturation of blood with oxygen, either caused by anatomical conditions (such as narrowing of pulmonary arteries), pulmonary embolism, or decrease in the area of oxygen exchange due to the tuberculous lesions in the lungs (10).

The first manual of physiology in Polish by Hyacinth **J. Dziarkowski: "Fizjologia czyli fizyka ciała ludzkiego dla lekarzów i przyjaciół antropologii"** ("*Physiology*, i.e. *the physics of a human body for physicians and friends of anthropology*") appeared in 1809. This manual was based on the work of G.W.Ch. Consbruch containing the information on blood and lymph circulation. Another book published in Warszawa in 1816 by Franciszek (Francis) Brandt, "Angiology" on the blood and lymphatic vessels, was based on the work of G.F. Hildebrandt. Very good descriptions of the pulmonic and systemic blood circulation could be found there (10).

The reform of Cracovian Academy at the turn of XIXth and XXth century was a major breakthrough for Polish medicine and cardiology as well. There appeared numerous publications of Cracovian physicians (Joseph Lewicki, Alexander Kremer, John Cenner, John A. Klecki, Onuphrius Dzianott, John B. Bobrzyński) referring to the circulatory system (5, 12, 13). The work of **Klecki** (1833) on oedemas appearing in the course of circulatory failure is worth mentioning. The author explained that the misbalance between the fluid escape through the capillaries and its reabsorption was the reason for the oedema. **Alexander Kremer** (*Fig. 5*) in his manual on the percussion and auscultation (1841) presented his opinions pertaining to the physical basis of generation of tones and murmurs in the heart (10). In his doctorate in 1820 ("*De angore pectoris*") John Cenner summarized the contemporary state of art in angina pectoris (*Fig. 6*). Along with the information on the essence of disease (some of it based on wrong assumptions) the author gave quite precise recommendations as to the conditions

Fig. 5. Alexander Kremer (1813-1880)

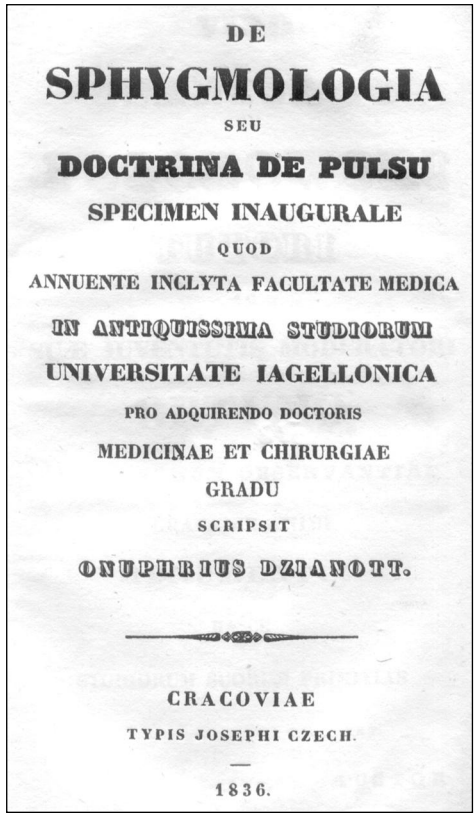
favouring the occurrence of the disease and the methods of prevention. He presented the hygienic and nutritional instructions pointing to the proper diet versus improper one, and he drew our attention to the need for proper care as far as the balance in the delivery of fluids was concerned ("large volumes of liquids,



DISSERTATIO
INAUGURALIS MEDICA
de
Angore Pectoris,
quam adjectis Thesibus
gratiosi medicorum ordinis
AUCTORITATE
Clarissimi Domini Decani ac Celeberrimorum
D. D. Professorum
pro gradu
Doctoris in Medicina
rite obtinendo
in
Antiquissima et Celeberrima
UNIVERSITATE JAGELLONICA.
publicae disquisitioni submittit
AUCTOR
Joannes Cenner,
Medicinaë et Chirurgiaë
superioris Magister.
Mense 14. Julio 1820. Anno.

CRACOVIAE
Typis. M. Dziedzicki.

Fig. 6. Dissertatio inauguralis medica de angore pectoris, by Jan Cenner, Kraków, 1820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SPHYGMOLOGIA

SEU

DOCTRINA DE PULSU

SPECIMEN INAUGURALE

QUOD

ANNUENTE INCLYTA FACULTATE MEDICA

IN ANTIQUISSIMA STUDIORUM

UNIVERSITATE IAGELLONICA

PRO ADQUIRENDO DOCTORIS

MEDICINAE ET CHIRURGIAE

GRADU

SCRIPSIT

ONUPHRIUS DZIANOTT.

CRACOVIAE

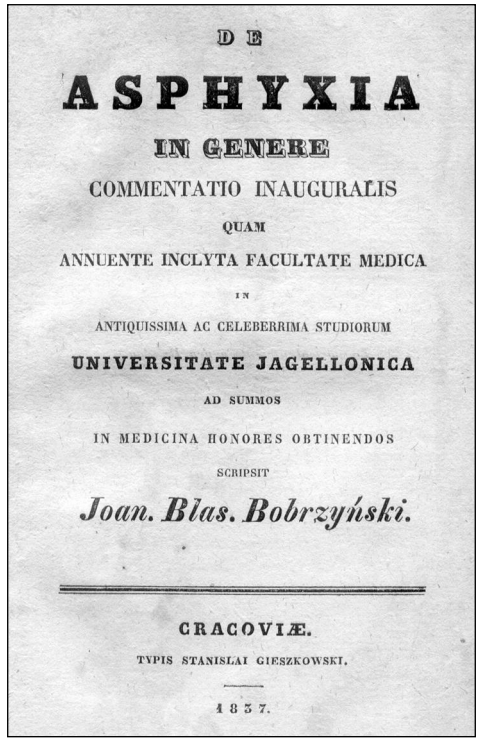
TYPIS JOSEPHI CZECH.

1836.

Fig. 7. Sphygmologia seu doctrina de pulsu…, by Onufry Dzianott, Kraków, 1836

tea or coffee are contraindicated...") and recommended refraining from alcoholic beverages or other stimulants (12).

A dozen or so years later, in his doctoral dissertation (*Fig. 7*) in 1836, **Onuphrius Dzianott** came back to sphygmology, the knowledge of pulse, which for ages has been of interest for physicians (5). We know that physicians of those times did not know how to examine the pulse, nor could they make anything out of it, as did the physicians earlier. They assumed that palpation lacked precision required to make it useful and led to mistakes. However, the new methods and means of percussion and auscultation came into use at that time, and application of these methods made evaluation of the conditions of the circulatory system incomparably simpler. The old ways were not abandoned quickly, but after a period of backwardness in the Cracovian medicine, which also included simply neglecting the thorough clinical examination of a patient, the examination of pulse was restored. The above mentioned work did not contain any brilliant discoveries nor was it the first Polish work on human pulse as almost three centuries earlier our great countryman, already mentioned Joseph Struś, wrote his magnificent work on this matter. Nevertheless, it was a thorough "review" of the



DE

ASPHYXIA

IN GENERE

COMMENTATIO INAUGURALIS

QUAM

ANNUENTE INCLYTA FACULTATE MEDICA

IN

ANTIQUISSIMA AC CELEBERRIMA STUDIORUM

UNIVERSITATE JAGELLONICA

AD SUMMOS

IN MEDICINA HONORES OBTINENDOS

SCRIPSIT

Joan. Blas. Bobrzyński.

CRACOVIÆ.

TYPIS STANISLAI GIESZKOWSKI.

1837.

Fig. 8. De asphyxia in genere commentatio inauguralis, by Jan B. Bobrzyński, Kraków, 1837

earlier achievements and of the ways the thinking of medicine was shaping as far as the interpretation of pulse was concerned (5). Next, in 1837, there appeared the doctoral dissertation "*De asphyxia in genere*" (*Fig. 8*) of **John B. Bobrzyński**, dealing with the conditions of circulatory system. The author attempted the description of causes of dyspnea in different types of diseases and tried to find the relationship between these conditions and the congenital anomalies of the heart and compromised pulmonary circulation or the corrupted function of the left ventricle. He also pointed out to the necessity of restoration of circulatory system function in the course of resuscitation (13).

The Varsovian physician, **Ferdinand Dworzaczek** was an excellent observer of physiological events in cardiovascular system. In the 1840's he was occupied with the problem of fetal circulation, the causes of cyanosis in congenital defects of the heart and intracardiac shunts. He was a promoter of the modern physical examination in clinical medicine and associated the physical symptoms with the physiology of circulation (10).

Bogusław Palicki (1813-1868) from Poznań was professionally active at the same time. He completed his studies and defended his dissertation "*De muscularu cordis structura*" (1839) in Wrocław. He wrote his thesis under the supervision of Purkinyě who advised him as to "*the entire clarification of the complex structure*

of the heart" (10). The author performed the detailed review of the literature on the macroscopic image of the cardiac muscle and of the studies performed thus far. He used animal hearts for his experiments. It never was an investigation of the physiology of this organ, but rather so called functional morphology. As far as the character of the description was concerned, it was the synthesis of all the contemporary scientific approaches and one of the broadest works on the subject on international scale (6). **Robert Remak** was another scientist of Polish origin from Poznań, but very often is mistaken for a German. He performed studies on the neurogenic theory of cardiac automatism. This great scientist spoke Polish and kept confirming his relations with Poland. Later, after living for years in Germany, he published his papers only in German. He made numerous discoveries in histology, and his leading achievements pertained to the neuron. He described the neurons without the myelin sheath. Remak was the first to observe the neural ganglia in the heart. These localised in the neural plexuses in the area of the junction of main veins and subendocardially in the interventricular septum and in papillary muscles (2, 6). Some outstanding clinical doctors, who ran their own departments, such as **Joseph Dietl** (1804-1878), **Edward Sas-Korczyński** (1844-1905) from Kraków, **Oscar Widmann** (1830-1900) from Lwów, **Henry Łuczkiewicz** (1826-1891), **Ignatius Baranowski** (1833-1919), **Theodore Dunin** (1854-1909) from Warszawa, were equally interested in physiology of circulation. Joseph Dietl, the chair of the Medical Department in Krakow,

Fig. 9. Edward Sas Korczyński (1844-1905)

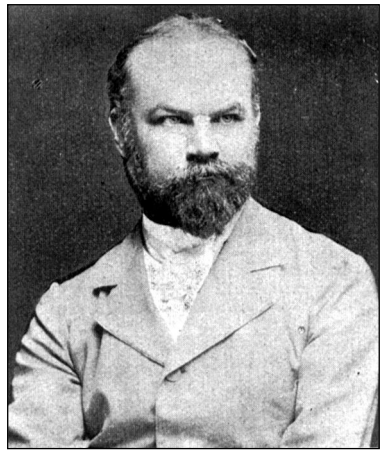


Fig. 10. Theodore Dunin (1854-1909)

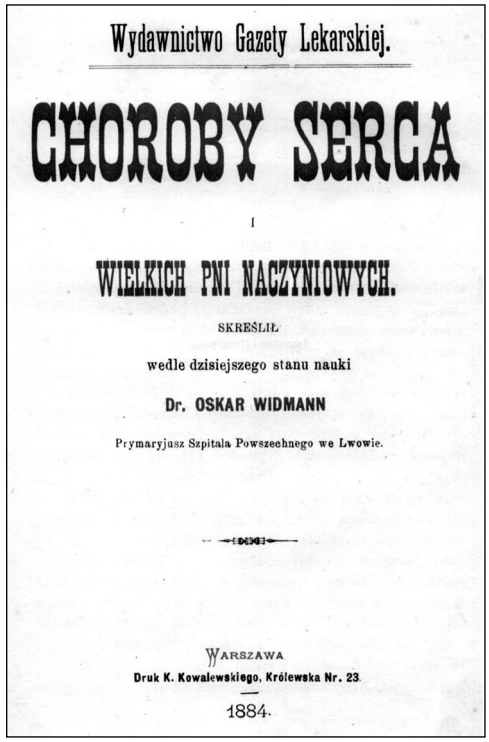
attempted to introduce the scientific principles in diagnostics and treatment of heart diseases, based on a profound analysis of physical and physiological phenomena. That kind of analysis was also promoted in Warszawa by **Łuczkiewicz** and **Baranowski** (10). E. Korczyński (*Fig. 9*) was familiar with the physiological issues related to the heart and blood vessels. He performed advanced clinical studies pertaining to the vasomotor reactions and the influence of nitroglycerine on the circulatory and nervous system. Among phenomena reported were the feeling of warmth in the head, the feeling of fullness, and problems with concentration. Korczyński is believed to be the second in the world to recognize myocardial infarction in a live patient in 1887 (6, 10).

T. Dunin (*Fig. 10*) was an experienced investigator. He made attempts to elucidate the mechanism of initiation of hypertension in the course of atherosclerosis. Basing on about one thousand experiments performed he concluded that the increased blood pressure was related to disturbances in lipid metabolism. He also performed studies on so-called functional hypertension. In 1893 he analysed the causes of degenerative lesions of the heart, called "ungluing" of the myocardiocytes.

The papers of **O. Widmann** from Lwów contained a vast knowledge of pathophysiology of congenital anomalies of the heart. His manuals concerning the diseases of the heart and the blood vessels (1879 and 1884) were the first publications on those topics in Poland (*Fig. 11*) (10).

The studies of the Cracovian scientist, **Napoleon Cybulski** (1854-1919) (*Fig. 12*) made significant contribution to the development of Polish physiology and cardiology. He set up a centre of physiological studies, which became well known throughout Europe, and a major part of his research contributed substantially to the development of sciences related to the circulatory system in the world. One of his most significant achievements was his discovery (together with **Władysław Szymonowicz**) (1895) of a substance contained in the adrenal glands that strongly constricted blood vessels and increased blood pressure. That discovery had a great

impact on the understanding of hypertension and it further affected the progress in clinical studies. The scientist named this substance "nadnerczyna", which was then translated into "adrenaline". Then Cybulski's invention of photohaemotachometre (1885) (i.e., a device for measurement of blood flow in vessels) also had a great influence on the progress in research on hemodynamics (3, 10, 14). Cybulski, being fascinated by the discoveries of W. Einthoven, was the first in Poland to obtain the records of electric activity of the heart. Therefore, he was a pioneer of electrocardiography in our country. Cybulski's numerous students and followers, such as physiologists **Adolph Beck** (1863-1942), **Andrew Klisiecki** (1895-1975), and **Francis Czubalski** (1884-1965), and histologists Stanisław Maziarski (1873-1956) and Władysław Szymonowicz (1869-1939) further continued his studies. For instance, **Adolph Beck's** (1894) dissertation entitled: "On the changes of blood pressure in veins" qualifying him for an associate professor referred to the physiology of the circulatory system (10, 14, 16). The experimental scientist, John Prus (1859-1926), the chair of the Department of General and Experimental Pathology in Lwów, performed the studies on the resuscitation of people in clinical death. He was the first in the world (January 19th 1900) to perform a direct massage of the heart after surgical opening of a chest (suicidal hanging), with simultaneous artificial ventilation through a tracheostomy tube. Two hours after death he


Wydawnictwo Gazety Lekarskiej.

CHOROBY SERCA

I

WIELKICH PNI NACZYNIOWYCH.

SKREŚLIŁ

wedle dzisiejszego stanu nauki

Dr. OSKAR WIDMANN

Prymaryjusz Szpitala Powszechnego we Lwowie.

WARSZAWA

Druk K. Kowalewskiego, Królewska Nr. 23.

1884.

Fig. 11. Choroby serca i wielkich pni naczyniowych, by Oskar Widmann, Warszawa, 1884

Fig. 12. Adolph Beck (1863-1942) with Napoleon Cybulski (1854-1919), from left to right (Museum of History of Medicine, Kraków)

restored the action of the heart within 15 minutes. Thus Prus became one of the pioneers of reanimation. He tried to prove in his works that it was possible to restore activity of the heart after sudden cardiac arrest, using mechanical stimuli. He analysed the bibliography of the other authors in different countries (1901-1910), who also applied his method of reanimation. He found 11 case reports of successfully performed reanimation in patients with cardiac arrest during surgical procedures (3, 14).

We may also mention the book, which was published in 1899 by **Wilhelm Pisek**, a physician from the Public Hospital in Lwów (an ex-assistant to Korczyński). That book entitled "*The therapy of diseases of heart and blood vessels*" had quite different character, which swerved from the trends of rapid progress in medical science concerning studies on circulation and the heart. However, it was connected with cardiology, as the author tried to "complement the principles of treatment of valve dysfunction and degeneration of the cardiac muscle" in his own way. In fact, in order to treat these diseases he recommended, among the others, massage and Swedish gymnastics and physiotherapy and climatic therapy. But that was not all. He attempted to define acceptable limits for the physical exertion and the capability of procreation of patients with heart diseases (15).

The second half of the XIXth century brings the development of theoretical specialisations in medicine, including physiology. In particular, the great progress

was made in the physiology of circulation. **Henry Hoyer** (1834-1907), an embryologist from Warszawa and the author of the first Polish manual on histology, left behind numerous papers of great importance referring to these matters. He discovered native arterio-venous anastomoses. Felix Nawrocki, a professor of physiology, worked at the same time in Warszawa. He was a student of both Rudolph Heidenhein at the acclaimed Institute of Physiology in Wrocław and of Claude Bernard in Paris. Nawrocki made several interesting observations on the relationship between the blood pressure and heart function (3, 10).

THE END OF THE XIXth CENTURY AND THE FIRST HALF OF THE XXth CENTURY

Physiology had already crystallised into a separate branch of science, but still valuable contributions from the borderline between theory and practice were made by a group of clinicians - practitioners, interested in the essence of events in cardiovascular system. An outstanding scientist, **Edmund Faustyn Biernacki** (1866-1911), published a series of articles referring to the physiology and pathology of the heart. **Joseph Pawiński** (1851-1925), who became famous as a genuine creator of cardiology in Poland (*Fig. 13*), noticed that heart disease led to disturbances in physiology of the entire organism of the patient (10, 16). His numerous papers referred to heart failure in the course of organic anomalies; he also studied cardiac dysrhythmias and introduced the term of so-called incomplete contraction. He wrote about the influence of disturbances in the nervous system on the cardiovascular diseases, about the impact of emotions and mental overburden, nicotine and some cardiac drugs. Working with Anthony Hołowiński, he performed creative experiments that allowed for graphic recording of circulatory system function and obtaining tracings of heart sounds,

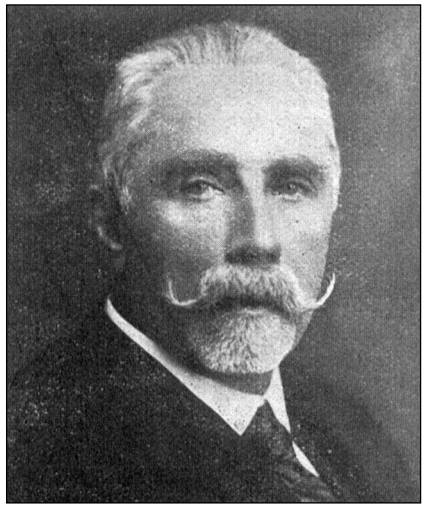


Fig. 13. Joseph Pawiński (1851-1925)

Fig. 14. Casimir Rzętkowski (1870-1924)

thus becoming a pioneer in the field of phonocardiography. In 1883 Pawiński, independently from Graham Steele, reported and proved the existence of diastolic murmur in a case of mitral stenosis, resulting from the partial insufficiency of the pulmonary artery valve. Physiology of circulation was also the major field of interest for the other outstanding clinician from Warszawa **Kazimierz (Casimir) Rzętkowski** (1870-1924) (*Fig. 14*). He studied the physiology of cardiac function in different heart diseases, heart failure and chemical changes in the cardiac muscle. Some 10 years before H. Eppinger he reported the chemical changes as the cause of disturbances in cardiac function (16). He found the decrease in protein content, the increase in sodium chloride concentration and claimed that ionic imbalance was responsible for the loss of ability of cardiac muscle to use the energy resources for contraction. In 1904 Rzętkowski performed the experiments on rabbits treating them with intravenous injections of adrenaline, which raised their blood pressure and, subsequently, led to the development of atherosclerosis of aorta. He addressed the issue whether adrenaline damaged the vessel wall by the increase of blood pressure or whether adrenaline could trigger atherosclerosis through its direct detrimental action on the vessel wall. **Edwin Mięsowicz** (1875-1914) and **Zenon Orłowski** (1871-1948) continued Rzętkowski's investigations in 1906, and W. Nowicki with Joseph S. Hornowski did so in 1907 (3, 16). The authors concluded that chronic arterial hypertension dependent on adrenaline was the trigger for atherosclerosis and similar condition could occur in humans through the stimulation of nervous system. They tried to elucidate the mechanism of hypertension and concluded that the increase of vascular tone and the vasoconstrictor reactions played an important role. They associated hypertension and atherosclerosis with improper diet, especially with high content of meat and animal fat (16). Another investigator who had contributed much to the development of clinical medicine in Poland, **Władysław Biegański** (1856-1917), worked in Częstochowa. In 1881, basing his conclusions on clinical studies, he found that atherosclerosis was a process secondary to chronic hypertension.

The studies performed by a group led by **L. Popielski** (1866-1920) made a significant contribution to the progress in physiology of circulation. In 1909 Popielski's team discovered a compound that could be found in every tissue, which could lower blood pressure in physiological conditions; it was histamine. Popielski produced in the stomach is most powerful stimulant of gastric acid secretion. He found also a compound coming from disrupted erythrocytes, which was capable to efficiently lower blood pressure; he named it "**wazodylatyna**" ("*vasodilatine*"). He also showed that intravenous atropine and morphine lowered blood pressure because they hemolysed erythrocytes, which, in turn, released vasodilatine. Unfortunately, Popielski never tried to use his observations in the treatment of hypertension (10, 16).

During the interwar period, Polish investigators working in the field of physiology of the cardiovascular system published important new clinical findings. One of those clinicians is **Tadeusz Tempka** (1885-1974) showed in 1923 in Kraków the powerful influence of calcium ions on the cardiac muscle and pointed to the necessity of monitoring of these ions in the course of treatment with digitalis (17). An internist, **Alexander Oszacki**, working in diabetology and endocrinology in Kraków, performed interesting studies in clinical physiology. Eventually, he published a paper in 1920 entitled "**Energetyczne wskaźniki sprawności krążenia**" ("*Energy indicators of efficiency of circulation*"). That paper presented the principles of evaluation of the general state of circulation and pointed to the relation between the size of the heart during systole and diastole and its anatomical and physiological condition. Strong research centres appeared in Lwów. **Marian Franke** (1877-1944) created an excellent experimental centre in the Department of General and Experimental Pathology of the University of Lwów, which he chaired. Next, the Department of Experimental Pharmacology, chaired by **Włodzimierz Koskowski**, became famous for its studies on the action of vasoactive drugs and on histamine-induced hypotension, in particular. In his paper of 1920 Koskowski reported that histamine-induced hypotension resulted from the inhibitory action of this amine on the sympathetic nerve endings or on a hypothetical neuromuscular mediator, which mediated the action of catecholamines. He also made an assumption that "the site of action of α-imidazolylethanolamine was the same as that for adrenaline" (16). This way he explained the interaction of these two amines in their action on blood vessels. In the USA, half a century later, W.G. Richards and C.R. Gannelin obtained the same results (18). In 1920 Koskowski also showed that nicotine affected the heart through the ganglia but not through the vagal nerve endings (19). The Koskowski's studies on plant extracts allowed for introduction of a new hypotensive drug, "Myostratol", into the clinic. The scientists from the Koskowski's group (J. Dadlez, P. Kubikowski and J. Teuchmann), who worked on the activity of biogenic amines, obtained surprisingly interesting results and their papers were highly valued among their peers, pharmacologists of cardiovascular system (16).

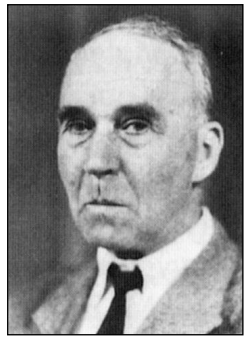


Fig. 15. Andrew Klisiecki (1895-1975)

In the 1920's, in the Veterinary Medical College in Lwów, a young scientist, **Andrzej Klisiecki** (1895-1975) performed his studies (*Fig. 15*) in continuation of the research run by his mentor, Napoleon Cybulski from Kraków. Having modified the device, he started studies on the speed of blood flow using the photohaemotachometer. Klisiecki worked out the equation for the speed of blood flow in a cannula: $V=\sqrt{R-g}$ (R - a difference in pressures, g - gravitation coefficient) (20). In his dissertation for getting qualified as an associate professor, he presented the evidence for the presence of systolic and dicrotic speed waves in the aorta, of breath waves, which thus far were known to occur only in the peripheral arteries, and the third order speed waves analogous to the so called Traube's and Hering's waves in the tracings of arterial blood pressure. He also analysed the dynamics of blood flow in arteries corrupted by calcifications resulting in a loss of elasticity (1929-1935). In the thirties, Klisiecki and his very talented student, **Wiesław Hołobut**, investigated the etiopathogenesis of histamine shock. The results were presented in a classical paper (1937) on the disturbances of function of the left

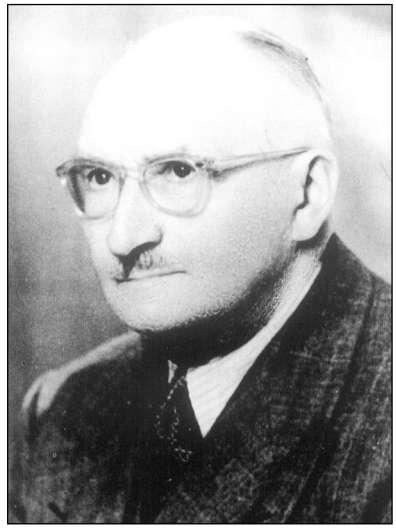


Fig. 16. George Kaulbersz (1891-1986) [reproduced with permission of J. Grochowski]

ventricle, resulting in a fall in arterial blood pressure in the course of histamine shock (21). After the war Klisiecki lived and continued his studies in Wrocław.

A very interesting body of research, done by **Jerzy (George) Kaulbersz** (1891-1986), an outstanding Cracovian physiologist (*Fig. 16*) and the head of the Department of Physiology, was started in the 1920's and referred, to some extent, to the cardiovascular system (22). These studies related to the high mountain medicine and the reaction of the human body to high altitude (the Alpes and Peruvian and Bolivian Andes) and received worldwide recognition. After World War II, one of his major interests was high mountain physiology extended to aviation and space medicine. He also investigated physiology of physical exercise, e.g. adaptation of the circulatory system to the prolonged physical effort in skiers during international ski competition in Zakopane. Part of these studies was done in collaboration with **Andrew Ogiński** and **Vincent Wcisło** (1913-1985) (*Fig. 17*). Research into the physiology of circulation made up the majority of Wcisło's professional activity, and his hard work and ingenuity assured his impact on the development of experimental techniques in the world of experimental cardiology (23). The first work that started his contribution to the world science was his doctor's dissertation (1945), entitled: "The influence of gas masks on the breathing and cardiac output per minute". During very hard times following World War II he (with Kaulbersz) studied the functional reserve of the heart in humans during rapid changes of the volume of flowing blood (during work or physical training). He also started experimenting with the circulatory systems of animals. He was the first to measure and record in a single living animal the following circulatory system parameters simultaneously: blood pressure in the aorta and the vena cava, the output of right and the left heart, the coronary and total systemic blood flow (22, 23).

Fig. 17. Vincent Wcisło (1913-1985) [reproduced with permission of J. Grochowski]

He measured cardiac output using Fick's and plethysmographic methods along with the determination of pulmonary artery blood flow. He measured the blood flows using Cybulski's photohaemotachometre, which he himself modified. For the measurement of the changes in volume of the organs he used a plethysmograph he had constructed. After he had perfected the experimental methodology he started his studies on the performance of the heart during an episode of acute circulatory failure. In his paper on the pathogenesis of histamine shock (1959) he described several interesting original hemodynamic tests, which he applied to prove that both cardiac and vascular factors contributed to the development of histamine shock. One of Wcisło's most brilliant contributions was the introduction of a **new method of evaluation of coronary blood flow** in dogs (along with the measurement of the outflow from the coronary sinus), without the necessity of opening of the animal's chest. He could make it by using a set of cannulas and external tubings in the femoral artery, carotid artery and coronary artery, as well as the coronary sinus. At the same time he continued his studies on the physiology of work and sports, investigating the metabolism of cardiac muscle. In 1967-68 he elaborated a new method of experimental provocation of an acute coronary failure by means of a small cannula introduced into the coronary artery. His methods were internationally recognised by physiologists [presentations at conferences in Washington (1968) and in Munich (1971)]. He was the creator of educational films on physiology and pathophysiology of the circulatory system. His films became famous worldwide after their presentation at festivals of educational films [Cannes (1958 and 1959), Padua (1963), Varna (1966), Venice (1977), and others] (23).

The issues pertaining to the physiology and pathophysiology of the circulatory system remained in the scope of interest of the Department of Physiology of Medical College in Kraków (at present Collegium Medicum of Jagiellonian University) for a long time. At the moment it is a very influential centre of modern physiological studies and it is difficult to cite all the spectacular achievements related to the circulatory system in works led by **Stanisław Konturek** and **Wiesław Pawlik**.

In Warszawa, **Bohdan Lewartowski** made remarkable achievements in the range of basic sciences related to the heart. His studies, which fundamentally clarified the problem of calcium ion flow in the intracellular compartments, are known worldwide. Polish cardiologists received and still do receive acknowledgement due to their studies, which are very often cited in the prestigious literature on cardiology, as for example, the paper of **L. Ceremużyński** and his collaborators in 1969, on the dysrhythmias in experimental ischemia of cardiac muscle (24). The last quarter of the XXth century brought several achievements in this matter in a number of scientific centres in Poland. In fact, there is no room for offering them here, so we finish presenting our "short historical outline" of Polish studies on physiology of circulation at end of the 1960's.

POLISH INTERESTS IN THE PATHOPHYSIOLOGY OF CORONARY ISCHEMIC DISEASE

Early in the Renaissance Polish scientists contributed to the elaboration of diagnosis of the diseases of the heart (coronary ischemic disease in particular) and their etiopathogenesis. The descriptions of the coronary ischemic disease were known in the ancient times. Lucius Seneca (the Younger) suffered from this disease, as we learned from his letters to his friend Licilius. He described in them the symptoms of his dramatic illness, which could not be anything else but angina pectoris. The "numbness" of coronary vessels drew the attention of Giovanni M. Lancisi (1654-1720), who attempted to find the reason for angina pectoris by investigating the details of heart anatomy. Both **A. Ch. Thebesius**, a physician from Lower Silesia, in 1708, and **J.B. Morgagni** (1628-1771), in 1760, followed suit. But it was only in 1768, when **W. Heberden** (1710-1801) presented a complete description of angina pectoris that was close to today's definition (6).

The first descriptions of angina pectoris from Polish sources appeared in the first half of the XIXth century. They were contained the works of J. Chrzczonowicz (1812), J. Cenner (1820), A. Janikowski (1844) and J. Rompalski (1850) (25-28).

Two eminent clinicians, Joseph Pawiński and Mściwój Semerau-Siemianowski, greatly advanced the understanding of ischemic heart disease in the first half of the XXth century by characterizing sign and symptom patterns with stages of advancement of coronary artery disease.

Pawiński pointed out the significance of factors such as atherosclerosis, smoking and emotional stress and their effects on the etiopathogenesis of angina pectoris. The majority of **Semerau-Siemianowski's** activities took place in the 1920's and concentrated on etiopathogenesis and diagnostics of angina pectoris (29).

The increasing incidence of angina pectoris just after the World War II resulted in a rapid progress in studies on etiopathogenesis of this illness. The new name for the disease was accepted, a literal expression from English, i.e. ischemic heart disease. It was firmly stated that atherosclerosis was the main culprit in the ischemic heart disease and myocardial infarction in particular. The disturbances in homeostasis of the organism, such as incorrect lipid metabolism, became the major targets of the studies, although the other less common causes of myocardial infarction, such as bacterial infection and resulting inflammation of the coronary vessels or influenza (30) were also investigated. Detailed studies of hormonal and immunological reactivity in the ischemic heart disease were performed in Poland during the 1970's. **L. Ceremużyński**, **W. Januszewicz** and **M. Sznajderman** found profound endocrine disturbances in the course of a fresh myocardial infarction (31-33). The authors emphasised a marked increase in catecholamine and a significant drop in glucocorticosteroid concentration in the plasma during the acute phase of myocardial infarction, in particular. Numerous studies performed later in other cardiology centres confirmed these observations. The understanding of these processes became a prerequisite for rational action in the therapy of myocardial infarction, based on the blockade of excessive reactivity of the adrenergic system.

The autoimmune reactions are another important issue in the cardiac muscle diseases. The first paper in the world on immunological problems in the heart diseases appeared in 1937; it was a paper of the Polish scientist, H. Brokman. It started the period of investigations on the contribution of immunological reactions to the etiopathogenesis of the heart diseases (34). **M. Gamski** (1954) was the first in Poland to study the immunological reactions in ischemic heart disease. J. Kuch and **T. Chorzelski** performed a comprehensive evaluation of the autoimmunological phenomenon in myocardial infarction using immunofluorescence IF test and immunofluorescence IF staining (35, 36). Screening a significant cohort of 60 patients with acute myocardial infarction they detected the presence of anti-cardiac antibodies (IgG) in blood serum in a quite high percentage of patients tested (19 patients). The increase in concentration of the antibodies could be detected for several weeks after the myocardial infarction. Moreover, using indirect - IF staining, the authors established the presence of antigen - antibody complexes (muscle cells - IgG) in the scrapes of muscles taken from the area of post myocardial scar from patients post mortem. Later **A. Żebrowski** obtained similar results, using the same method (37).

The Progress in Non-invasive Diagnostics

In the past 10 years (1994-2004) we witnessed a great progress in cardiology. Even though from a historical perspective a decade is a rather short time, there happened a tremendous advances in diagnostics and treatment of cardiovascular diseases. Polish cardiology and cardiosurgery kept pace with the rest of the world.

Both in a non-invasive (tissue Doppler's echocardiography, three-dimensional echocardiography, magnetic resonance) as well as in invasive diagnostics (intravascular echocardiography, coronarography) many diagnostic centres in Poland meet the standards of the most experienced European centres.

Echocardiography as the Basic Diagnostic Method

Since 1954 echocardiography has been one of the basic diagnostic methods. First echocardiographic recording in Poland was performed in the Institute of Cardiology of Medical Academy in Warszawa in 1966. The work of **Christine Ilmużyńska** led to a broad acceptance of one-dimensional echocardiography in cardiology clinics throughout the country. Nevertheless, there was an obvious delay in introduction of the method as compared to the Western European centres.

The introduction of two-dimensional echocardiography into the clinics was a major breakthrough in the cardiologic diagnostics. It allowed for the imaging of the anatomical structures of the heart and the evaluation of the heart in motion, i.e. of its action in a real time. Introduction of other methods made possible the assessment of flow using Doppler's method and allowed new options for visualisation of the heart and the great vessels. In 1987 W. Rydlewska-Sadowska published the first broad and complex dissertation on the evaluation of flow by Doppler's technique (38). The

author presented the first discussion of colour visualisation of flow in a monograph "Clinical Echocardiography", published by the Institute of Cardiology in Warszawa. In 1988 **Wojciech (Adalbert) Braksator** and his team from the Department of Cardiology of the II Faculty of Medicine of Medical Academy in Warszawa performed the first echocardiographic intraesophageal examination in Poland (39). It was few years after publications of Hisnaga, Matsumoto and Hanrath, who introduced this method as a routine procedure into the clinical practice at the turn of seventies and eighties. This method turned out to be very useful in the evaluation of structure of the heart, especially of valvular insufficiency and isolated disturbances in contractility after myocardial infarction in those cases, which were difficult to diagnose by the transthoracic technique.

The end of the eighties and the beginning of the nineties of the XXth century meant the continuous and rapid progress in echocardiography; in a way, the progress was a step ahead of the possibilities of application of this method in practice. The intravascular echocardiography became the most sophisticated technique of echocardiographic examination. Due to the miniaturisation of the echocardiographic probe of the frequency of 20 MHz it was possible to evaluate the coronary blood vessels, to "look inside" these vessels. W. Rużyłło with his group presented the first paper on this topic in Poland at the Congress on Cardiology in Gdańsk in 1992. At present this technique is used for qualification of patients for surgery and monitoring of procedures during interventional cardiology: angioplasty, rotablation and implantation of intravascular stents. It should be mentioned, that it was a Polish physician, **Tomasz Cieszyński** from Medical Academy in Wrocław, who was the first in the world to introduce the echocardiographic probe into the heart in order to examine its structure. His original was patented in Poland on October 19th in 1956 (40).

During the mid 1990's two new echocardiographic techniques were introduced into clinical use. The first one, colour kinesis is based on the automatic detection of endocardium in consecutive images during contraction. The motion of the endocardium is encoded with different colours depending on the phase of contraction. It allows for an evaluation of the kinetics of motion with accuracy on the order of tens of milliseconds.

The second method, the tissue Doppler echocardiography consists of an analysis of motion of cardiac tissues. In this method the ultrasonographic signal reflected from the cardiac tissue undergoes Doppler analysis; the speed of the motion of the tissue is presented in the form of a colour map superimposed on a conventional black and white echocardiographic image. It becomes possible to differentiate the moving fragments of cardiac tissue, encoded with colour, from immobile, non-coloured pericardial tissue. In the echocardiographic diagnostics this method offers better visualisation of the borders of endocardium and enables the evaluation of the speed of the cardiac motion at any phase of cardiac cycle. **J. Drożdż** of the Cardiology Department of the Medical Academy in Łódź performed first studies on this new diagnostic imaging technique in Poland. He

started his work on the subject during his stay in Essen in 1993, in a group with R. Erbel and H. J. Nesser, and continued it in Poland. The results were presented at cardiologic congresses and published in scientific journals (41, 42). They were the basis for the first monograph on this subject. It was published in 1995 (R. Erbel, H. J. Nesser, J. Drożdż "Atlas of Tissue Doppler Echocardiography").

At present, three-dimensional echocardiography is considered the best among the non-invasive techniques for evaluation of the morphology of the heart. The studies of Wallschlager (and his team) and the resulting papers from the late 1980's provided the rationale for the introduction of this method into clinical diagnostics. **J. Kasprzak** from the Department of Cardiology at the Medical Academy in Łódź was the first in Poland to apply this technique. He learned it during his training abroad and investigated it in Thoraxcentre in Rotterdam. He published his results together with J.R.T. Roelandt (42, 43). He is a co-author of a series of experimental investigations, performed in an animal model. These pioneer studies related to the measurement of the area of ischemia by means of the three-dimensional echocardiography after application of contrast. The value of three-dimensional echocardiography in determining the mapping of the ischemia in cardiac muscle has been proven. The size and the mass of the region prone to necrosis resulting from the occlusion of coronary arteries in pigs were evaluated. If this technique is available it may become a useful and important method for the assessment of the pathological lesions in acute coronary episodes in humans in the future. Moreover, three-dimensional echocardiography is useful for the evaluation of heart structure, and, especially, of the thoracic aorta and its valve during three-dimensional reconstruction.

The Application of Magnetic Resonance in Coronary Angiography

An American physicist, **I.I. Rabi**, discovered the **phenomenon of magnetic resonance (MRI)** in 1939. He was awarded the Nobel Prize for his discovery. Then, P.C. Lanterbur from the New York University published his first images made by means of magnetic resonance, in Nature in 1963. Not until 20 years later, in 1982, the first equipment enabling the imaging of the entire body by MRI was presented.

Coronary angiography with the use of magnetic resonance offers the possibilities of the non-invasive imaging of epicardial coronary arteries in the majority of patients (44). **J. Walecki** and **T. Zaleska** and her group from the Central Railway Hospital in Warszawa presented first papers on the heart structure and function in the primary cardiomyopathy at the International Cardiologic Symposium in 1993 (45). Later, in 1998, the results of studies on the evaluation of the myocardial infarction size were presented at the Congress of International Magnetic Resonance Association (ISMRM). The group of T. Zaleska, J. Walecki and A.Torbicki presented very interesting studies on the evaluation of the chronic thrombosis in the main pulmonary arteries with the use of magnetic resonance.

The method proved to be very useful in diagnosing, determining the progress of the illness, and evaluating the effectiveness of treatment.

Out-patient ECG Monitoring

Out-patient ECG monitoring in Poland started when first records using radio waves (radioelectrocardiography) were registered in the Institute of Cardiology of Medical Academy in Warszawa in the 1960's. The first recorders were constructed in 1969 in the Clinical Laboratory of Medical Electronics, using magnetic tape for registration of the tracings of ECG in non-hospitalised patients. They were some of the first recorders in the world and anticipated what would become the Holter monitor.

The demonstrated success in the studies gained numerous followers and several clinical centres appeared. The Polish version of the recorder, Oxford-Medilog system, obviously promoted broad availability of the method and became standard equipment at many newly established centres. The establishment of the Holter Section in 1993 (the Section of Non-invasive Electrocardiography of the Polish Society of Cardiology at present) was a very important event as it led the way in research and education.

The well-received papers on the diagnostic value and clinical relevance of parameters evaluated by the Holter system were published in 2001 (46). The unique system of standard values for the parameters evaluated for both the adults and children were discussed. The Holter system was used for the first time in the world for complex analysis of the sinus node function with the simultaneous evaluation of the dynamics of the sino-atrial timing (World Report 1988).

The vivid activity of the Polish research centres on the international scene resulted in the significant role of Polish cardiologists in functioning of the International Society for Holter and Non-invasive Electrocardiology. W. Zaręba is the president-elect; R. Piotrowicz is a member of the Board and R. Baranowski is a member of the extended Board.

Invasive Cardiologic Diagnostics and Intervention Cardiology

Hemodynamic heart diagnostics is the system of investigation based on the analysis of data obtained directly from the heart chambers and great vessels. There are several methods that serve this purpose, and the most important one is the cannulation of the heart and angiography. The first method yields the information on the blood flow and the other one reflects the morphological structure of the heart.

The first cannulation of the right half of the heart was performed in Poland in 1948 (**I. Krzemińska-Ławkowicz**, Warszawa). In 1962, **T. Hryniewiecki** (Warszawa) performed the first cannulation of the left half of the heart using intra-arterial and interseptal technique (47).

In 1948, **A. Jakubowski** and **L. Zgliczyński** (Warszawa) constructed a simple seriograph to perform the first angiography. The method of direct examination of the coronary arteries by means of a selective coronarography was introduced in 1967. **W. Rużyłło** pioneered this work in 1967-68 (the Department of Cardiology, Warszawa). Coronarography became the method of special significance when the era of the coronary surgery started in the late sixties.

Soon after A. Gruentzig's announcement of first experiments using transcutaneous intravascular coronaroplasty (PTCA) in 1977, W. Rużyłło went through the training in his laboratory and in 1981 he performed the first procedures of widening the narrowed coronary arteries. During the late 1980's one might say that the Polish school of invasive cardiology was established. Since the introduction of percutaneous intravascular coronaroplasty, a dynamic progress of therapeutic techniques based on the cannulation of the heart could be observed. In the mid eighties the methods of non-surgical treatment of the congenital and acquired defects of the heart based on the balloon technique became more and more common. Those were the first procedures of pulmonary and aortic valvuloplasty, angioplasty of aortic coarctation and percutaneous mitral comisurotomy in our country (47).

The first procedure of pulmonary valvuloplasty in Poland was performed in 1984, two years after the first world publication. A regression of the right ventricle outflow tract obstruction was observed after completion of balloon pulmonary valvuloplasty procedure (48). At the end of the eighties percutaneous mitral comisurotomy became an alternative to surgery in treatment of the stenotic mitral valve in some cardiology centers in the world. It was introduced in Poland in 1987 as the method of treatment of the mitral valve stenosis without the need for thoracotomy. In 1994 the new techniques of non-surgical closure of patent ductus arteriosus (Rużyłło *et al.*), Rashkind's double umbrella (1994), "detached coils" (1996) and Amplatz's cork (1997) were introduced in Poland. Detached coils and Amplatz's cork became the methods of choice in the treatment of patients with patent *ductus arteriosus*, both in the world and in Poland. In 1997 the procedures of non-surgical closure of atrial septal defects of II type were introduced in Poland simultaneously in three cardiology centers (W. Rużyłło, M. Demkow, Warszawa; J. Białkowski, Zabrze; G. Brzezińska-Rajszys, Warszawa). Those were the first clinical trials with a new type of an occluder, which were also performed in other cardiologic centres in the world at that time. It also became the method of choice in the treatment of large group of patients with the same type of defect (49). In December 1999, W. Rużyłło and M. Demkow performed for the first time in Poland, and perhaps in the world, a successful non-surgical procedure of closure, by stages, of the two postinfarction ventricular septal defects, using the Amplatz's occluder (50). The introduction of stent implantation in the narrowed sections of the coronary arteries during the 1980's was quite revolutionary. In 1989, **H. Bonnier** from Holland performed the first procedure of the coronary stent implantation during Workshops on Hemodynamics in the

Silesian Centre for Heart Diseases in Zabrze. A team of Polish physicians (M. Dąbrowski, A. Witkowski - Institute of Cardiology in Warszawa) implanted for the first time two Palmatz-Schatz stents into the right coronary artery in 1992. The Institute of Cardiology coordinated the first multicentre national programme "Angioplasty or stent?" which compared the results of stent implantation with balloon angioplasty in patients suffering from ischemic heart disease. A programme of primary angioplasty in the acute myocardial infarction with hemodynamic laboratory being on duty 24 hours a day was initiated in Poland in the **Silesian Centre for Heart Diseases** in the middle of 1987. The period of rapid increase in the availability of primary angioplasty lasted from 2000-2001, until now. In 2003, the number of patients treated with primary angioplasty in Poland reached the level of 20 thousand, and the number of centres with a hemodynamic laboratory on duty 24 hours a day increased up to 40. In April 2002 in two centres in Poland (the Institute of Cardiology in Warszawa and Collegium Medicum of Jagiellonian University in Kraków) gene therapy was used in the treatment of patients with ischemic heart disease who were disqualified from classical revascularisation procedures. The gene encoding the vascular endothelial growth factor (VEGF) was administered percutaneously directly into the myocardium of the left ventricle using NOGA system as a part of the international research programme EUROINJEST ONE. In 2003, for the first time in Poland, **I. Siminiak** (Medical Academy in Poznań) injected myoblasts through the cardiac veins into the myocardium of a patient with damaged left ventricle, while monitoring with intravascular ultrasonography (IVUS) (47).

POLISH CARDIAC SURGERY: THERAPY AND CARDIOVASCULAR PATHOPHYSIOLOGY RESEARCH PROGRAMMES

While briefly summarising the history of studies on the cardiovascular system in Poland, starting from the distant past up to the present, and placing it in the international context, one cannot forget about cardiac surgery. Very often it was surgery that was the inspiration for the pursuit of the knowledge and better understanding of biology of the myocardium and the blood vessels, the energy processes, the complex mechanisms of ischemia and possibilities of cardiac muscle protection, mediators, enzyme systems and all the other intriguing and mysterious issues related to the human body. Continuing progress in cardiac surgery is inevitably linked to contemporary research programmes in physiology of the circulatory system and contemporary cardiology. Polish cardiac surgery has its own tradition that has begun more than a century ago. In 1898 (hardly 2 years after a famous operation of suturing of the heart wound performed by Louis Rehn) Witold Horodyński and a few months later Wacław Maliszewski performed the operations of puncture wound repair of the heart; unfortunately without success. Jan Borzymowski in the Holy Spirit Hospital (Szpital św. Ducha) in Warszawa

performed a similar operation on April 23rd 1902, and then, in 1904, reported three such cases, out of which one (on February 28th 1903) turned out to be a full success (52). **Borzymowski's** patient was one the first such patients in the world saved that way. The beginnings of cardiac surgery of congenital heart defects in Poland had some delay; it was not until after World War II. Nevertheless, Polish surgeons tried hard to catch up with the progress in medicine, in spite of post-war problems and a huge gap in the possibilities of therapy between the West and our country, harassed first by the war and then the post-war communist anarchy. In the 1940's and 1950's Polish surgeons followed the progress of cardiac surgery in the West (especially in the USA). One only can to imagine how in the face of scarcity of diagnostic and technical means for surgery, yet presented with desperate need of the operation in patients with cardiac defects they bravely performed these difficult tasks. Poland may be proud of the group of great and talented surgeons, who became part of history of world medicine. Among them, **Leon Szoege-Manteuffel**, who earned the reputation of a pioneer in paediatric cardiac surgery when he performed the first mitral comisurotomy in Poland in 1953. He ligated the *ductus arteriosus* in 1948, 10 years after the first operation of that kind in the world performed in Boston by R. Gross in 1938. In 1950 Manteuffel made the Blalock-Taussig shunt for the first time in Poland, and in 1958, together with **Jan Kossakowski** he performed the first correction of aortic coarctation, not to mention the first Polish open heart operation (closure of the atrial septal defect in hypothermia) performed by Victor Bross in Wrocław in 1958 (hardly 6 years after the first operations of that kind, in the USA) (53). In the 1990's the results of Polish cardiac surgeons were equal to those, whose achievements were published by the leading centres in the West. Their numbers also approached the level of satisfying the needs for treatment of children with cardiac defects. Consequently our paediatric cardiac surgery has reached a stage similar to that of the most developed and richest European countries. Moreover, since in the present paper we attempt to evaluate the contribution of Polish physicians to the world science in the field of physiology of circulation, let us recall that in the last two decades of the XXth century there occurred a breakthrough in the approach that surgeons make to the physiology of circulation of a newborn with a severe defect. This breakthrough consists of a novel surgical procedure, which resulted in a spectacular improvement in the outcome. Polish cardiac surgeons substantially contributed to this progress, when they succeeded in the treatment of the transposition of the great arteries (**Jacek Moll, Łódź**) or the hypoplastic left heart syndrome (**Edward Malec, Kraków**) with results no worse than those obtained by the most renowned cardiologic centres in the world, if not better.

The routine introduction of the surgical procedure of cavo-pulmonary connection in cases of a heart with a single ventricle morphology (according to "Fontan's principles") made necessary certain revolutionary changes in postsurgical therapy, ones based on the special hemodynamics of a new pattern of pulmonary flow that is entirely different from the physiological one (56).

The centres such as Warszawa (**B. Maruszewski**), Kraków (**E. Malec**) and Zabrze (**J. Skalski**) are the most experienced in the treatment of this group of patients. In 1997 the programme of mini-invasive and cosmetic treatment of congenital heart defects was introduced (J. Skalski with his team, Zabrze). The experience of Polish paediatric cardiac surgeons is not without an impact on the development of science in this field of medicine. An immense progress in the adult cardiac surgery and surgical treatment of ischemic heart disease in particular occurred in Poland. The first by-pass operation for ischemic heart disease with use the saphenous vein (CABG) was performed in Poland by Jan Moll in 1970. Then in 1984 in Łódź, **Richard Jaszewski** used internal thoracic artery for the same purpose. The programme for surgical treatment of recent myocardial infarction, introduced into Zabrze in 1985 by Zbigniew Religa, brought positive results. It was further extended by Marian Zembala, in cooperation with invasive cardiologists, to a group of patients operated during myocardial infarction and cardiogenic shock and was presented at numerous international congresses (57). In 1985, 16 years after the first unsuccessful attempt of heart transplantation by J. Moll in 1969 in Łódź, **Zbigniew Religa**, as the first in Poland, performed the operation successfully (53).

M. Zembala and his team were the first to successfully perform the heart and lung transplantation in Poland, in Zabrze in 2001 (54, 55). In 1987 M. Zembala and P. Buszman introduced for the first time in our country, in Zabrze, a surgical treatment of ventricular paroxysmal tachycardia using the Harken's technique (endocardial peeling) with a concomitant intraoperative epi- and endocardial mapping. Kazimierz Suwalski further developed this treatment in Warszawa. The first procedure of epicardial ablation with the use of microwave technique on a beating heart without extracorporeal circulation was performed in Zabrze in 2001. For patients who were not qualified for by-pass surgery, transmyocardial laser revascularisation (TMLR) was performed for the first time in Poland by Marian Śliwiński in 1996. At the beginning of the 1990's some cardiac surgical centres in Poland (Katowice, Zabrze, Warszawa, Szczecin, Gdańsk) introduced operations on a beating heart without application of extracorporeal circulation. Stanisław Woś's team in Katowice successfully performed the first mini-invasive operation (MIDCAB) in 1996. One of the newest of the less invasive treatment methods for ischemic heart disease is hybrid revascularisation. It consists of a combination of percutaneous angioplasty, very often combined with arterial stenting, and by-passing of the coronary arteries through a small access on a working heart. In Poland the majority of such procedures were performed in Szczecin (K. Filipiak, R. Gil), in Katowice (R. Bachowski, M. Cisowski, P. Buszman) and in Zabrze (R. Przybylski, T. Hrapkowicz, J. Pacholewicz, M. Gąsior). In 1998 Andrzej Bochenek and Marek Cisowski introduced a videoscopic technique of harvesting the internal thoracic artery using the surgical robot (AESOP). Romuald Cichoń, a surgeon from Zabrze, working in Dresden,

was the first to perform the operation on the heart using an operational robot of the Da Vinci type without thoracotomy and circulatory arrest (57).

The progress in Polish cardiology and cardiac surgery in the recent times in performing research studies on the complex matters of myocardial physiology and pathology, with postinfarction cardiomyopathy in particular, cardiogenic shock, cardiac protection, remodelling, angiogenesis and, eventually, the transplantation of stem cells, is outstanding, indeed. The character of this article and its rather narrow range destined for presentation of the outcome of discussion on the history of physiological studies on the circulation in Poland do not allow for touching, even in a nutshell, of all the scientific trends of the recent times. Then we kindly request the forgiveness in case we did not give a rightful chance to some very important issues to get included in this paper. We also ask for your leniency if, without ill will, we contained in our work too much of the subjectivism which is probably always present in historical elaborations, anyway.

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