

History of Perfusion and Cardiac Surgery in the Czech Republic

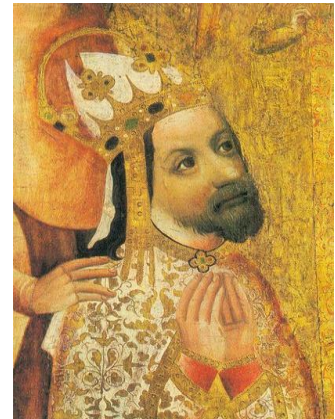
Vladimír Kučera, MD, PhD

It is indeed a great honor to have been invited by the American Academy of Cardiovascular Perfusion to present a lecture in the memory of Charles Reed during the Annual meeting of this respected institution. I greatly appreciate it.

Charles Reed significantly contributed to the development of Cardiovascular perfusion in the US. He was a key person in the founding of: AMSECT, American Board and American Academy of Cardiovascular Perfusion. He was always ready to help foreign perfusion societies with their educational programs. I personally met Charles Reed during an international CECEC meeting in Paris. His depth knowledge on the subject of cardiovascular perfusion as well as his kind personality impressed me a lot. His textbook was an important source of knowledge for us in the early beginnings of C-P bypass and for that we thank Charles Reed.

Before beginning my talk on the topic of perfusion and cardiac surgery in the Czech Republic, I would first like to share with you a condensed version of the history of my home country which today is known as the Czech Republic. The traditional English name for the country has been Bohemia, but over the centuries it has been known by many different names.

The name Bohemia was derived from Latin “Boiohaemum”, which means the home of Boii, a Keltic tribe who inhabited the region up to the 1st century before Christ. Czech tribes later came to this region. The Bohemian or Czech state emerged in the 9th century as a Duchy of Bohemia. It was elevated to the Kingdom of Bohemia in the 13th century. It was a significant regional power during the Middle Ages.



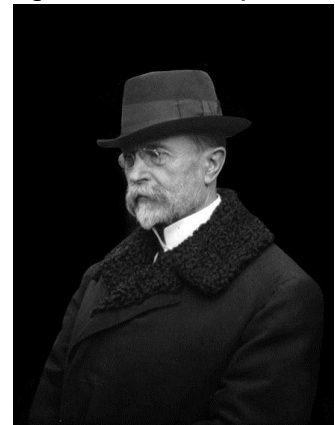
The reign of Charles the IV during the 14th century was considered the Golden Age of Czech history. When Charles the IV was elected as the Holy Roman Emperor, Prague became the seat of the Empire. Under his reign Bohemia became an important cultural center in Europe. In 1348 he founded Charles’ University in Prague, which is the oldest university in Middle Europe, north of the Alps. At that time the university attracted students from many European countries.

In the 16th century the Habsburgs were elected rulers of Bohemia and the kingdom increasingly came under their control. Thereafter, there was a continual conflict between the German speaking administration of the Habsburg monarchy which was strongly connected with the Roman Catholic Church and the Czech population which were 90



percent Protestant. The Czech revolt against the Habsburgs at the beginning of the 17th century marked the start of the Thirty Years War which quickly spread throughout Europe. The Czech Protestants were defeated and the Czech Kingdom was incorporated into the Habsburg Empire. Those that survived the war and the subsequent repressions were given a choice, either to convert to Catholicism or to leave the country. Many people emigrated, especially nobility and the Protestant intelligentsia. Some of their descendents are known as Moravian brothers and they are still around in the North America and in the other parts of the world as missionaries.

The Habsburgs ruled the country for 400 years. At the end of the 1st World War in 1918 the Austrian/ Hungarian Empire collapsed. During the war Czech and Slovak volunteers formed Czechoslovak legions and were fighting against central powers and later against Bolshevik troops in Russia. After the war the map of the Europe was redrawn. An independent Czechoslovakia was proclaimed after complicated diplomatic negotiations which were led by Thomas Masaryk. He wrote "The Declaration of the Independence" in Washington DC in 1918 and it was presented to President Wilson who supported the Declaration. Tomáš Masaryk was later elected the 1st president of Czechoslovakia. The Czech people have always been very grateful for the American support which was crucial for the recognition of a free Czechoslovakia.



Between the 1st and 2nd World Wars Czechoslovakia was economically strong and it was an island of true democracy in Middle Europe. Unfortunately, due to the Munich treaty and the subsequent invasion of Hitler's troops we lost our independence once again. Many Czech and Slovak people fought against the Nazis in local resistance movements and abroad in the armies of the allies.

In 1945 we regained our independence but unfortunately due to a multitude of post-war political and territorial circumstances we fell into the sphere of the Soviet interest. This was partially due to the fact that the Soviet Red Army liberated vast territories of Czechoslovakia at the conclusion of World War II. Rich uranium deposits also contributed to a strategic interest in our country by the Soviet Union. Thus we fell on the eastern side of the Iron Curtain and remained there for next 40 years.

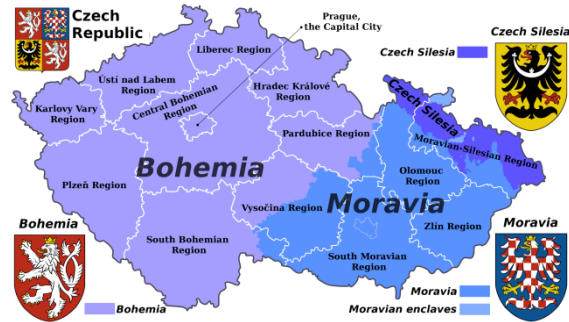
The Czech and Slovak people tried to establish a more democratic society in 1968 but this effort was crushed with the invasion of the Warsaw pact troops.



The collapse of Soviet Union and the velvet revolution in Czechoslovakia in 1989 brought about the change from a totalitarian regime to a parliamentary democracy under leadership of Vaclav Havel, who was eventually elected as the president of CzechoSlovak federation. In 1992 the country peacefully divided after a democratic vote in the Slovak parliament into two independent republics, namely the Czech and Slovak Republics.

Today the Czech Republic has a geographical area of 79,000 square kilometers and a population of close to 11

million. It is composed of 3 lands – Bohemia, Moravia and Czech Silesia. The Czech Republic is a mid-sized country in the European Union with a land mass comparable to Austria or Ireland.



I would now like to conclude the brief history lesson on my home country and to proceed with my talk on the history of perfusion and cardiac surgery in the Czech Republic.

The beginnings of cardiac surgeries in the world was closely connected with surgeries for congenital heart defects.. The first ligation of patent duct in Czechoslovakia was performed by Polak in Prague in 1946. The Blalock shunt and resection of the coarctation of the aorta was first performed by Rapant in Olomouc and later by Kafka in Prague.

Further progresses in cardiac surgery led to the method of open-heart surgery in surface hypothermia with temporary circulatory arrest, in inflow occlusion. It was first successfully introduced by Floyd John Lewis in Minnesota in 1952. The closing of ASD had to be done within 8 min. while maintaining a rectal temperature of 28° C. The brain could tolerate this period of circulatory arrest. This method was first used by Navrátil in Brno, Czechoslovakia in 1956. He operated on 44 patients using this method. In Prague, Kafka closed ASDs using this method starting in 1958.

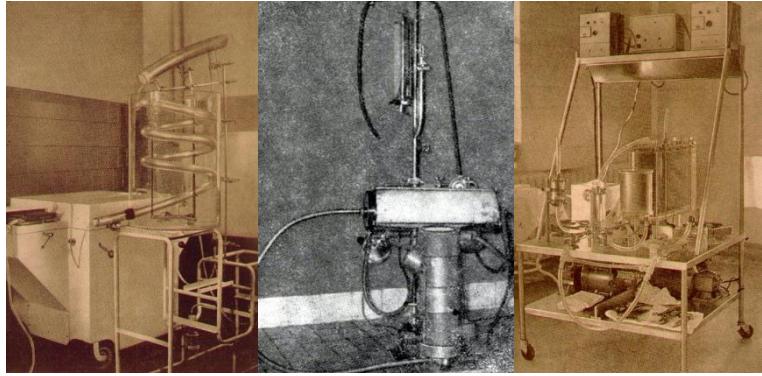
An important world event for cardiac surgery was the construction of the heart lung machine by John H. Gibbon, Jr.. He first used it clinically in Philadelphia in 1953. This important discovery happened in the dark communistic period of Czechoslovakia when the country was isolated from scientific information and from having personal contacts with people from western countries. The purchase and delivery of a heart lung machine was inaccessible for a long period of time and the American embargo of export of new technologies to eastern block countries, also contributed to unattainability of such equipment.

Czech surgeons in cooperation with scientists and engineers had to help themselves. There traditionally was a high standard of mechanical engineering and industry in Czechoslovakia. Together these professionals designed and constructed their own heart lung machine and open-heart surgery in our country then began.

The first open-heart operation using cardiopulmonary bypass in Czechoslovakia was performed by Navrátil in Brno in 1958. He repaired an incomplete A-V canal in a 7 year old patient.

In the same year Procházka in Hradec Králové closed an ASD and in 1960 Kafka did so in Prague.

In this picture you can see two of the first HLM's which were manufactured in Czechoslovakia. On the left side is Navrátil's HLM which he used on 7 patients. He used a modified De Wall Lillehei bubble oxygenator. His team of co-workers made it from polyvinylchloride and the arterial outlet was



connected with a peristaltic linear pump. The oxygenator was immersed in a warm water bath. Priming of the device required 3 litres of fresh blood. Later Navrátil used the first American commercially made heart lung machine, the Mark III (right side of the picture) with the static mesh oxygenator. This device required priming with 2 and half litres of blood. The blood flow through this type of oxygenator could not be interrupted. He used this device during operations on 270 pts, with a mortality rate of 16%.

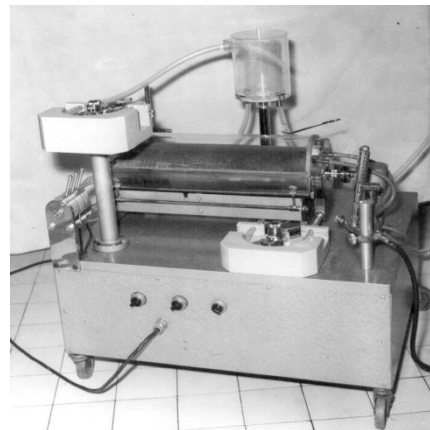
Three HLM Mark III's were imported into Czechoslovakia in the late nineteen fifties with the help of UNRRA organization (United Nations Relief and Rehabilitation Administration). One of the Mark III's was used by Navrátil, one by Kafka in the pediatric cardiac surgery programme and one was delivered to the Department of experimental surgery.

In Hradec Králové, Procházka used two heart lung machines constructed for him in 2 special machine factories. Here in the middle you can see a rather bad picture of his first device, the function of which I am not able to describe in detail. It was used in his clinical practice in 1958.

Later on another factory ADAST (right) made for him a better HLM, which was fitted with roller pumps, and they used an original Kay-Cross disc oxygenator. In 1969 they received an American Optical HLM (left). Behind the machine you can see the first Czech non-medical perfusionist, who received on-the-job training. His original education



was as a laboratory technician. Up until that time all perfusionists in Czechoslovakia were medical doctors.

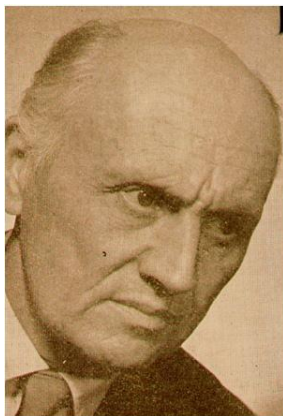


In Hradec Králové they even made innovations to the rotating disc oxygenator. They constructed a cylindrical rotation mesh oxygenator which was easier to set up and clean. The oxygenator became



patented in Great Britain, Austria and Sweden.

I would now like to tell you more about the work of prof. Navrátil (1952-67) in Brno. He was a gifted surgeon and self-made man, considering that in the fifties it was impossible for him to gain experience abroad. He was also a very good manager. He began performing surgeries on closed hearts in 1953; in 1956 he began to operate on open hearts in surface hypothermia; in 1958 he made his first open-heart operation using cardiopulmonary bypass and in 1965 he implanted a mechanical valve. He was also involved in an experimental programme: hypothermic perfusion of coronary vascular bed, orthotopic heart transplantation, design of knitted vascular prostheses and heart mechanical support. In 1967 he was officially invited to Vienna where he founded a school of cardiac surgery in Allgemeines Krankenhaus. He operated on patients both in Brno and Vienna where he was very successful. Due to ongoing harassment by the communist government in the seventies he decided to stay in Vienna, where he died in 1992.



This gentleman is prof. Kafka (1902-1991). He was a pioneer of pediatric heart surgery in Czechoslovakia. In 1954 he founded the Department of Pediatric Surgery in the Teaching Pediatric Hospital in Prague. There he established a Czech school of pediatric cardiac surgery. In 1958 he started open heart operations in hypothermia and circulatory arrest. Between 1959 and 1967, 110 operations in extracorporeal circulation were performed in his Department on older children, mainly ASDs, VSDs and TOF with 10% hospital mortality rate. In all operations the old HLM Mark III was used. The results were very good if you can imagine the problems with the old technology and high priming of the HLM. In 1967

he had to stop the programme of open-heart surgery mainly because he did not have access to modern HLM. In 1968 prof. Kafka retired but before he left he put young surgeons in charge of the development of an open-heart surgery programme for infants. These kinds of operations were never before performed in Czechoslovakia. Dr. Stark on the right side was the leader of this group and he invited me as a young surgeon to his team. The invasion of Czechoslovakia in August 1968 by Russian troops delayed plans to realize this programme. Dr Stark left for London and began to work in the Hospital for Sick Children where he later became a chief consultant in pediatric cardiac surgery. In the seventies he was one of the top pediatric cardiac surgeons in the world. Dr Hučín, the youngest,(on the left side), returned from London after practicing one year in The Hospital for Sick Children and he restarted the programme of Pediatric Cardiac Surgery in Prague. He began with palliative surgery on closed hearts. At that time there was no modern HLM available



in the Department and there were no perfusionists educated in newborn or infant perfusion. I was asked to study this method and to fulfill this role. I was lucky in that I received in 1974 a scholarship through the International Research and Exchange Board to study at the Children's Hospital Medical Center in Boston. I appreciated that I could observe for 4 months Dr. Aldo Castaneda, an excellent pediatric cardiac surgeon and at the same time I was able to learn the technique of deep hypothermia and circulatory arrest with limited cardiopulmonary bypass. This method was introduced in the 60's and 70's in order to decrease the exposure of the patient's blood and tissue to non-physiological surfaces of ECC and thus suppress the general inflammatory response. Upon returning to Prague, I was prepared for using this technique in clinical practice. Finally, a new HLM Sarns 5000 was delivered to our Department and we started experimental operations on dogs in the lab, testing Sarns 5000 and simulating the procedures of heart surgery and C-P bypass step by step before clinical application.

In 1977, a new Pediatric Kardiocentrum was founded in the Pediatric University Hospital Motol in Prague. It consisted of 3 departments: Departments of Cardiology, Cardiac Surgery and



cardiopulmonary lab. Prof. Šamánek, a cardiologist of great merit was instrumental in the foundation of this institution and he became its director. Dr Hučín was appointed as the chief of the Dept. of cardiac surgery.



After the opening of the Pediatric Kardiocentrum all patients with congenital heart defects in Czechoslovakia were referred there for treatment. This centralized treatment center allowed us to follow outcomes of individual cases and as a result the collection of statistics at a national level.

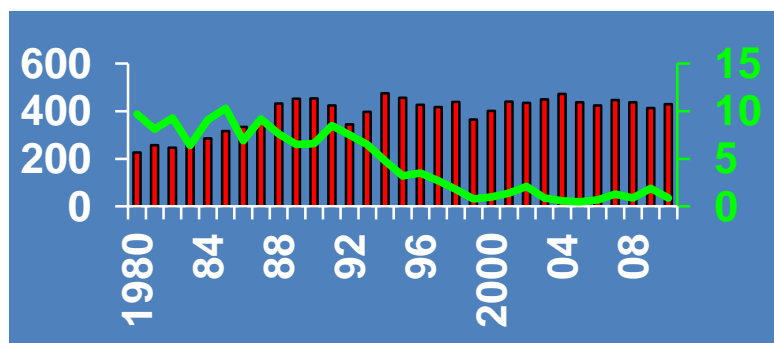


In 1978 we were ready to start repairs of congenital heart defects using extracorporeal circulation. In newborns and infants up to 10 kg of weight we used the technique of deep hypothermia and circulatory arrest. At that time the Bentley bubble oxygenator was available. Unfortunately, the priming volume of this type of oxygenator was still too large for small babies and the heat exchanger was not adequately effective and therefore we had to add a Sarns

metal heat exchanger to the circuit. The priming volume of this circuit was about 600 cc. Metal and glass components had to be cleaned, siliconized and sterilized thoroughly after each operation. The progress in the technology of newborn oxygenators was proceeding and soon we could use the smaller Bentley baby bubble oxygenator and in the late 1980s the Terumo newborn capillary membrane oxygenator. We could decrease the prime volume to 350 cc. The further progress was then achieved with miniaturization of CPB and the method of DHCA was abandoned. Patients now are operated on in moderate hypothermia or normothermia. Recently, for the perfusion of newborns and small infants we have been using coated capillary membrane newborn oxygenators Dideco Kid 100. We were able to shorten tip to tip coated tubing of 3/16 inch diameter in the custom packs and finally decrease the priming volume to 200 cc. We have been using deleucotized blood unit 2 or 3 days old and ultrafiltration. We prefer full blood flow and hematocrit of about 30 percent. We use cold blood Del Nido cardioplegia when we expect longer cross clamp period. These changes have had a great impact on our post-operative results. We have noted a decrease of the capillary leak and a lower accumulation of total body water. The stay in the postoperative ICU has also been shortened. Currently we correct all varieties of congenital heart defects. In the graph you can see the number of patients who had corrected



congenital heart defects between years 1980 and 2010. The total number was 12593. You can also see the number of operations performed each year together with the mortality rates. It has significantly decreased to 1 percent. Improving results were observed in the category of newborn open-heart surgery. Hospital mortality in recent years has decreased to 1,2%. This excellent result reflects effective interdisciplinary cooperation and progress in diagnostics, surgical technique, anaesthesiology, post-operative care and last not but least in cardiovascular perfusion. The method and technology of pediatric and newborn perfusion has improved so significantly in the last 20 years that it inevitably had to have a



positive influence on postoperative results.

Our Pediatric Kardiocentrum was invited to organize a programme of pediatric cardiology and cardiac surgery in Cuba at the William Soller Hospital in Havana in 1983. Cuban doctors were trained in Prague. In 1992 the team of doctors from Pediatric Kardiocentrum operated on children with congenital heart defects in Kuwait and in 2002 in Kyrgyzstan under the patronage of the European Association of Cardio-Thoracic Surgeons. We have also been receiving patients with critical congenital heart defects from many less developed countries including Iraq and Afghanistan for surgical correction. These outreach programmes to foreign countries have been supported and financed by the Czech Republic government.

I would now like to inform you a little more about adult cardiac surgery and the education of perfusionists in Czech Republic.



This is the map of Czech Republic with its largest cities. In the late nineteen fifties there were only 3 departments of surgery where cardiac operations were performed. Those cities were Brno, Hradec Králové and Prague. Soon thereafter another cardiac surgery department began functioning in Bratislava in Slovakia. In the sixties 2 new cardiac centers were founded in Prague. In the early

nineties 3 new centers were again established in Prague and subsequently 1 each in Ostrava, Třinec, Plzeň, České Budějovice and Olomouc. Since 2004 we have had a total of 13 cardiac centers in the Czech Republic (12 adult and 1 pediatric). The heart transplant programme is centralized in 2 centers, one in Prague and one in Brno with the total number of procedures to date being around 1500. The number of cardiac operations in the Czech Republic has been increasing, from about 2000 in 1990 to more than 12,000 in 2004.

A rather peculiar situation occurred during this time in the Czech Republic, in that, the number of cardiac operations was increasing as well as the demand for perfusionists, but the profession of clinical perfusionist did not officially nor legally exist. The title of a clinical perfusionist could not be found in Czech medical legislation.

I organized a meeting of senior perfusionists from other centers around the country to meet during one weekend in January 1991 in Prague. At that time we decided to establish the Czech Society for Extracorporeal Circulation. I was elected as president and 4 other perfusionists were elected as members of the committee. At that time there were about 20 perfusionists in the country but we also accepted associated members from the ranks of cardiac surgeons and cardioanesthetists. In December 1991 we received registration approval from the Ministry of Internal Affairs and the life of our society began. This is the logo of our Society. Since 1992, together with Slovak perfusionists we have organized 15 scientific conferences with international participation.



In January 1992 we worked out the status of the profession, its aim and educational programme and sent it to the authorities in the Ministry of Health and to the Society of Czech Cardiac Surgeons.

The bureaucratic authorities in the Ministry of Health could not understand or accept the varied educational backgrounds of people currently working in the field of extracorporeal circulation. The Ministry could not comprehend their responsibility in the management of patient's vital functions, or their role in the administration of drugs and blood. They argued that only medical doctors could have such a responsibility according to the Czech Medical legislation. These never ending discussions lasted until the year 2004 when finally our parliament approved the status of the profession of Perfusionist to be written into medical legislation. We reached an agreement with The Ministry of Health that only two professional categories would be allowed to enter the educational process to become perfusionists: 1/Nurses who have a bachelor's degree and 2/ biomedical engineers who have a master's degree or a biomedical technicians who have a bachelor's degree.

In the Czech Republic we have a Faculty of Biomedical Engineering where the students are taught in addition to their technical subjects, in anatomy, physiology, biology and biochemistry.

We have also developed a detailed educational programme for our student perfusionists.

Let me present a brief overview of the content of this educational programme:

1. Education and practical training is accomplished on the job. The creation of a School of Perfusion is impractical in Czech Republic due to low number of perfusionists required annually by the cardiac centers.
2. The total length of the educational programme is 36 months. It consists of a minimum of 640 hours of practical and theoretical learning. Practical learning must be minimally 50% (320 hours) and it has to take place in the cardiac center where the student will eventually be employed. Students must conduct at least 100 C-P perfusions under supervision.
3. Students must undergo 3 full time weeks of theoretical and practical learning at a Cardiac Center which has been accredited by the Ministry of Health. We currently have 2 accredited adult centers, one in Prague and one in Brno and 1 accredited pediatric center in Prague.
4. Students must attend an organized 14 day perfusion course with lectures led by professionals teaching such important subjects suitable for perfusionists as anatomy, physiology, biology, biochemistry, hematology, cardiology, technology of CP bypass, conduction and strategy of CP bypass etc. At the end of the course students must write and pass a multiple choice exam.
5. When a student fulfills all of the above requirements he/she can apply for a Board oral examination in front of a commission which is composed of senior perfusionists appointed by the Minister of Health.
6. Upon successful completion of the above the student will receive a license as a Clinical Perfusionist and he/she can then practice at this job. Once

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registered, in order to maintain one's license they are obliged to attend ongoing continuing educational events during their clinical practice.

Our effort to secure an adequate officially approved education for perfusionists in Czech Republic and to anchor this profession in the Czech Health Medical Legislation has been successful. At the present time we have 67 registered clinical perfusionists in our society. The Czech Society of Extracorporeal Circulation was founded in 1991 and the struggle took us 13 long years to reach today's result.