

THE DESTINY OF PROMINENT PHYSICIANS

John Heysham Gibbon and the 60th Anniversary of the First Successful Heart-Lung Machine: Brief Notes about the Development of Cardiac Surgery in Europe and Slovakia

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Abstract: The development of the heart-lung machine and its first successful clinical application in 1953 was the culmination of Dr. Gibbon's lifetime research project. Despite many technical obstacles, financial problems, and discouragement from colleagues, his goal was achieved after twenty tedious years of tireless work. Posteriorly, his academic contribution established him as a leader and pioneer in the field of cardiac surgery. Parallel to his achievement and Dr. Kirklin's surgical experience, several authors around the world attempted open-heart surgery with the heart-lung machine, particularly in Europe. In Eastern Europe and particularly in the former Czechoslovakia, the lack of access to foreign medical literature forced a group of emerging young physicians from the Second Department of Surgery at Comenius University to furtively collect data on the topic. After building the Simkovic-Bolf heart-lung machine, the first successful open-heart surgery with the new device was performed only 5 years after Dr. Gibbons' experience (Tab. 1, Fig. 4, Ref. 22). Full Text in PDF www.elis.sk. Key words: heart-lung machine, cardiac surgery, pioneer in the field of cardiac surgery.

Sixty years ago, at the Jefferson Hospital in Philadelphia, doctor John H. Gibbon Jr. performed the first successful open-heart surgery with a self-developed artificial machine to oxygenate and perfused blood during the surgical correction of a congenital heart defect (1) (Fig. 1). Earlier attempts of cardiac surgery whether on the beating heart or with the application of deep hypothermic circulatory arrest had exposed numerous technical and time limitations (2). Therefore, the idea of developing a device for extracorporeal circulation to allow the temporary exclusion of the heart and lungs during surgery became an imperative need (3). Experimentation on the development of the heart-lung machine was then initiated all around the world (4), but its successful clinical application was conditioned to many other engineering and medical achievements such as a) blood typing and transfusion (5) b) anticoagulation (6) c) continuous flow "roller" pumps and other perioperative techniques (7).

John H. Gibbon and the First Successful Heart-Lung Machine

While continuing to pursue his clinical career in surgery between Boston and Philadelphia, Dr. Gibbon dedicated all his spare

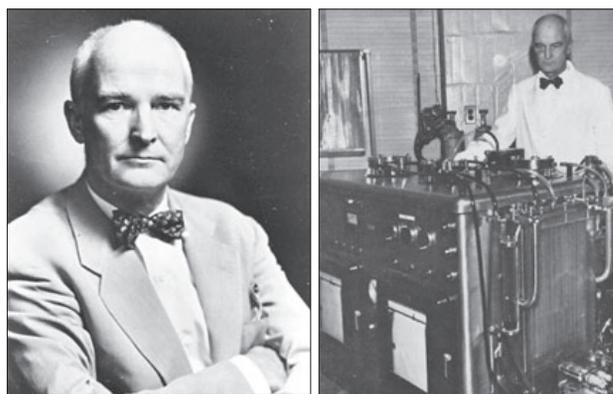


Fig. 1. John H. Gibbon, Jr. and the first successful heart-lung machine (images courtesy of the Thomas Jefferson University library, Philadelphia, PA).

time to develop the artificial heart-lung machine. After a year of full time research entirely devoted to build an extracorporeal circuit, and despite many technical obstacles, his initiative proved to be successful in 1934. Doctor Gibbon was able to perfuse a feline model of pulmonary embolism for 2 hours and 51 minutes (8). Later on, in 1939, long term survival of the experimental feline models after extracorporeal circulation became a routine (9). After a forced break due to World War II, several academic programs were encouraged to continue research and advance the medical field. In this regard, Dr. Gibbon also resumed his investigational activities with inherent technical and economic difficulties including hemolysis, the inability to oxygenate large

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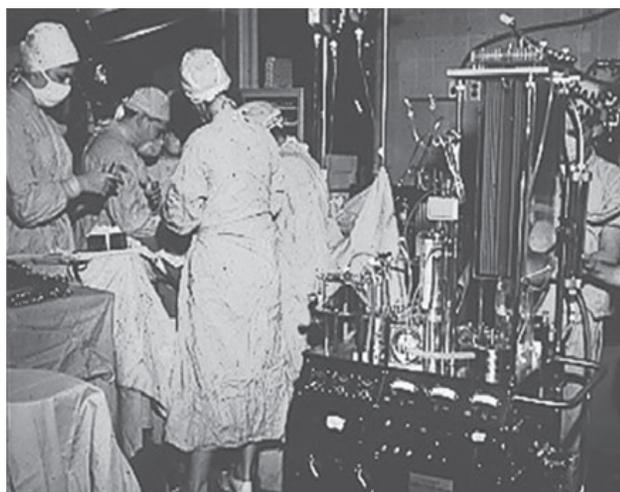


Fig. 2. Modification of the Mayo-Gibbon heart-lung machine used at The Mount Sinai Hospital (New York City) in 1967 (author's personal collection).

volumes of blood and the lack of financial support. The latter was immediately overcome with the invaluable support of Thomas J. Watson, Sr., Chairman of International Business Machine – IBM. This collaboration led to great achievements including increasing the size of the oxygenator, the development of a negative pressure respirator to prevent metabolic acidosis and the addition of a rudimentary filter to prevent clot formation (10). However, the new device still was a heavy stainless steel piece of engineering that weighed over a 1,000 kg and required two technicians to be operated (Fig. 1). Soon after, a 70 % decrease in experimental mortality rates made the team feel ready for the application of the heart-lung machine in humans.

In February 1952, a 15-month-old female presented with decompensated right ventricular failure thought to be secondary to the presence of a large atrial septal defect. After the initiation of cardiopulmonary bypass, her right atrium was successfully exposed but no defect was found. Her condition deteriorated, and

she passed away on the operating table (11). The autopsy demonstrated an error in diagnosis since the patient had a large patent ductus arteriosus. This experience not only reinforced the need for a successful heart-lung machine but also exposed the urge for a better preoperative workup thus providing a role to preoperative cardiac catheterization (12). More than a year later, on March 27th, 1953, another 18-year-old girl with severe right ventricular failure underwent cardiac catheterization and was found to have a large atrial septal defect. On May 6th, 1953, Dr. Gibbon performed a primary closure of the defect and the patient recovered uneventfully (1). Total cardiopulmonary bypass time was 45 minutes, and the circulation was fully supported for 26 minutes. This event marked the first successful open-heart operation using extracorporeal circulation facilitated by the heart-lung machine and the origin of cardiovascular surgery (13). After this operation, Dr. Gibbon attempted several surgeries unsuccessfully and thus decided that the technique might be too premature to be used safely. Since then, he turned his interest towards general surgery and abandoned the idea of developing the heart-lung machine to extent of being utilized routinely (14).

Five months later, Dr. Gibbon presented his clinical experiences with open-heart surgery for the first time in Minnesota (15). In 1955, he was named Professor of Surgery and Chairman of the Surgical Department at the Jefferson Medical College of Philadelphia. In addition, he made several contributions to the cardiovascular field such as authoring the book *Gibbon's Surgery of the Chest* or serving as editor-in-chief for the *Annals of Surgery*. In September 1968, Dr. Gibbon was awarded the Lasker Award by Dr. Michael De Bakey at the Pierre Hotel in New York (13). The citation for the award was as follows “*The vast impact of Dr. Gibbon's discovery on medical science exemplifies the way in which new knowledge gained from a single research project can trigger a chain reaction of inquiries leading to additional knowledge and ultimately to the prevention and cure of human disease*”.

A professional relationship between Dr. Gibbon and the Mayo Clinic was developed in order to transfer knowledge and experience to potential researchers with the overall goal of further

Tab. 1. Worldwide clinical experience with extracorporeal circulation before Dr. Siska's first successful application of the heart-lung machine in Bratislava, Czechoslovakia (1958). Adapted with permission (20).

	Physician	Year	City	Procedure
1	John H. Gibbon	1953	Philadelphia	Atrial septal defect
2	C. Walton Lillehei	1954	Minneapolis	Ventricular septal defect
3	Clarence Crafoord	1955	Stockholm	Left atrial tumor
4	John W. Kirklin	1955	Rochester	Series of patients with congenital heart disease
5	Earl B. Kay	1956	Cleveland	Series of patients with congenital heart disease
6	Donald B. Effler	1956	Cleveland	Series of patients with congenital heart disease
7	Denton A. Cooley	1956	Houston	Series of patients with congenital heart disease
8	Manabe H. Isao	1956	Osaka	Tetralogy of Fallot
9	Charles Dubost	1956	Paris	Atrial septal defect
10	William Clelan	1957	London	Atrial septal defect
11	Geoffrey Wooler	1957	Leeds	Mitral insufficiency
12	Alexander A. Vishnevsky	1957	Moscow	Tetralogy of Fallot
13	Rudolf Zenker	1958	Marburg	Series of patients with congenital heart disease
14	Su Hong-XI	1958	Shanghai	Series of patients with congenital heart disease
15	Euryclides J. Zebrini	1958	Sao Paulo	Tetralogy of Fallot
16	Karol Siska	1958	Bratislava	AV canal



Fig. 3. Second Department of Surgery, Comenius University, Bratislava, Czechoslovakia (1962). Left to right; first row: Drs. Simkovic, Kostolny, Pivkova, Siska, Vanzurova, Hutan, and Papp; second row: Drs. Krajcovic, Tumara, Trancik, Demjan, Misek, and Oravetz; third row: Drs. Sevcik, Cervenakov, Dimov, Silvay, and Schnorrer; fourth row: Drs. Treger, Holoman, Licko, Mikulas, and Kuzela (author's personal collection).

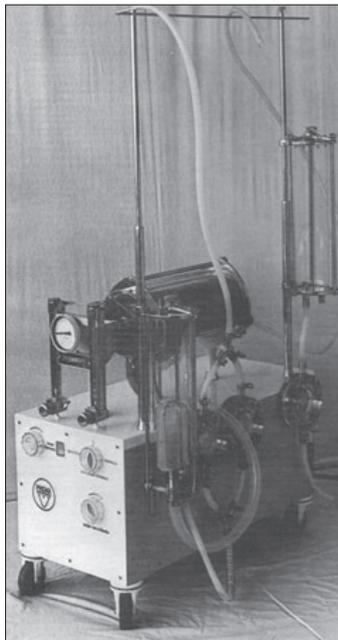


Fig. 4. The Bolf-Simkovic extracorporeal heart-lung machine with disc oxygenator was used for the first successful open-heart operation in Bratislava, Czechoslovakia in July 1958 (reproduced with permission from CHIRANA Stara Tura, formerly PREMA Co.)

reproducing the heart-lung machine and performing open-heart surgery. On March 23rd, 1955, Dr. John Kirklin used a substantially modified heart-lung machine (Mayo-Gibbon) to successfully repair an atrial septal defect. This was just the first in a series of operations applying the novel technology that eventually deemed extracorporeal circulation as the gold standard (16) to perform open-heart surgery. By 1958, the Mayo-Gibbon IBM machine was made available by Custom Engineering and Development in

St. Louis. The machine was complex, expensive, and difficult to operate. The pump required large priming volumes, and its maintenance was so time-consuming that never became available for emergency operations. This circumstance led to sequential modifications of the device (Fig. 2).

Parallel progress in Europe and Slovakia

Before cardiac surgery became safer and more effective, much more experience was required. The literature played a key role in reporting and describing adverse events such as the embolization of denatured plasma proteins, fibrin, fat and gas produced by bubble oxygenators (17) (Tab. 1). In this regard, access to foreign medical literature in the former Czechoslovakia was very limited behind the "Iron Curtain". The diffusion of medical knowledge was censured by the communist regime as was the importation of surgical devices and instrumentation. However, this circumstance did not interfere with a group of emerging physicians led by Professor Ivan Simkovic (Second Department of Surgery, Comenius University, Bratislava, Czechoslovakia) which rapidly started the collection of available literature on cardiac surgery and the heart-lung machine (Fig. 3). In 1956, Prof. Simkovic was able to leave Czechoslovakia and visit Stockholm and Paris where he observed experimental and clinical work with the heart-lung machine. On his return, he convinced the engineer Juraj Bolf (member of the Slovak Academy of Medicine, Bratislava, Czechoslovakia) and others to start working on the development of the heart-lung machine. Professor Karol Siska, Chairman of the Second Department of Surgery, was able to arrange a place for animal experimentation as well as secure financial support. After overcoming multiple technical aspects (18), the Simkovic-Bolf heart lung machine was built and set for animal experimentation (Fig. 4). Daily experiments with canine models gave confidence and experience to the researchers (19). Shortly after, the first successful operation (AV canal repair) with the Simkovic-Bolf heart lung machine was performed in July 8, 1958 (20). The device was made commercially available by Prema Co, currently Chirana Stara Tura (21). The same team would perform the 25th world heart transplantation in 1968 (22).

In summary, the development of the heart-lung machine and its first successful clinical application in 1953 was the culmination of Dr. Gibbon's lifetime research project. Despite many technical obstacles, financial problems, and discouragement from colleagues, his goal was achieved after twenty tedious years of tireless work. Posteriorly, his academic contribution established him as a leader and pioneer in the field of cardiac surgery. Parallel to his achievement and Dr. Kirklin's surgical experience, several authors around the world attempted open-heart surgery with the heart-lung machine, particularly in Europe. In Eastern Europe and particularly in the former Czechoslovakia, the lack of access to foreign medical literature forced a group of emerging young physicians from the Second Department of Surgery at Comenius University to furtively collect data on the topic. After building the Simkovic-Bolf heart-lung machine, the first successful open-heart surgery with the new device was performed only 5 years after Dr. Gibbons' experience (Tab. 1).

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