Editorial

Fifty Years of Open-Heart Surgery

Lawrence H. Cohn, MD

On May 6th, 2003, we celebrate the 50th anniversary of the first successful open-heart operation performed with the use of the heart-lung machine, one of the most important forms of therapy in the history of cardiac disease. On that spring day in Philadelphia, John H. Gibbon, Jr, MD, of the Jefferson University Medical Center, using total cardiopulmonary bypass for 26 minutes, closed a large secundum atrial septal defect in an 18-year-old woman. Beginning with this case, generations of cardiac surgeons have been able to operate on millions of human hearts with alacrity, efficiency, and consistency to correct complicated congenital heart defects, cardiac valve disorders in the young and old, atherosclerotic coronary artery obstructions, and large aneurysms of the thoracic aorta.

Until 1953, cardiac surgery was in its infancy and was more of a curiosity, except for treatment of rheumatic mitral stenosis, beginning in 1923 with Cutler’s successful case of a closed mitral commissurotomy with a tenotomy knife at the Peter Bent Brigham Hospital in Boston.1 The only successful heart operations done before 1953 were closed techniques for mitral stenosis,2 a few clinical experiments in 1952 with “open” heart by deep hypothermic arrest by John Lewis at the University of Minnesota,3 and the “blue-baby” operations of University of Minnesota,4 performed by Dr Churchill, but to no avail; the patient died. This dramatic clinical experience had a profound and lasting effect on Dr Gibbon and determined his lifetime academic research interest.5 He labored at the Massachusetts General Hospital and later at Jefferson in attempts to develop a machine that could interrupt the circulation by taking over the functions of the heart and lungs, allowing surgeons to remove a clot from the pulmonary circulation and then restore normal hemodynamics.

There obviously had been no machine like this, but a number of investigators in the early years of the 20th century had been working on isolated animal heart support with oxygenated perfusion, perhaps the most famous being that of Charles Lindbergh working with Alexis Carrel in the 1930s.6 While relatively little had been done to support the circulation in the way that Gibbon foresaw, even the detail of precisely and consistently anticoagulating the blood was a difficult project in the 1930s, though McLean had discovered heparin in 1916.7 Gibbon persisted for 5 years at the Massachusetts General Hospital fabricating pump after pump to support his thesis and then continued his work in Philadelphia at the University of Pennsylvania in the late 1930s. After World War II, during which he was a distinguished military medical officer, Dr Gibbon returned to Penn for a short time and then became Professor of Surgery at his alma mater, Jefferson. He did his clinical work in the morning and his research work in the surgical laboratories in the afternoon to develop his heart-lung machine (without, I might say, the advantage of National Institutes of Health–supported grants).

In the late 1940s, continuing his work on several different versions of the ever-improving heart-lung machine, he contacted the IBM Corporation to collaborate on manufacturing the possible first human version. This occurred because one of his medical students had been very friendly with Thomas Watson, who was then the Chairman of the Board of IBM. IBM worked with him in developing Model I of the heart-lung machine. Though relatively successful in extensive experimentation in animals,8 it was ineffective in supporting the total cardiopulmonary bypass system in volumes large enough to support a human being. Many notable peripheral events related to cardiac surgical techniques and technologies occurred during those 23 years of research. He had to decipher every aspect of artificial circulation we now take for granted: how to drain the blood from the body, how to pump it back, how to clear air from the inside of the heart, how to anticoagulate successfully without clotting the machinery, etc.

After the first IBM model failed to work as well as he had hoped, Dr Gibbon developed a second model in his own laboratory, which was the successful machine that eventually allowed human bypass operations. The final design of Model II (Figure) developed in the early 1950s9 consisted of a screen oxygenator, which allowed blood on both sides of the screen mesh to interface with oxygen, and three roller pumps modified from Dr Michael DeBakey’s original transfusion pump design10 to pump the blood back into the body. The
tered, which was closed with a running cotton suture. The
entire upper thoracic to expose the heart—
the so-called clamshell incision, which lifted up the
superior vena cava were cannulated with plastic tubes. All
placed in the left subclavian artery, and the inferior and
complete heparinization, the arterial inflow cannula was
at the atrial level. On that fateful spring morning, after
her cardiac catheterization revealed a large left-to-right shunt
woman who had symptoms of right-sided heart failure, and
of a heart-lung machine. The patient was an 18-year-old
successful truly open-heart operation performed with the use
of the heart-lung machine.5 After these two cases, Dr Gibbon, quite upset at these failures, declared a
moratorium on open-heart surgery with his heart-lung
machine. Curiously, Dr Gibbon’s momentous successful case
was not published until one year later in a state medical journal, Minnesota Medicine.11

Dr Gibbon never again did open-heart surgery, leaving his
trainees and countless others in the field to carry out the
prodigious cardiac feats that we all know and take for granted
today. He maintained only a research interest in the develop-
ment of subsequent models of the heart-lung machine, but it
was immediately apparent that others in the field, who were
primarily interested in cardiac surgery, such as Clarence
Dennis of Downstate University in Brooklyn,12 John Kirklin
of the Mayo Clinic,13 and C. Walton Lillehei at the University
of Minnesota,14 would pick up the gauntlet, refine Dr
Gibbon’s original heart-lung machine, and use it extensively.
With the improvement of diagnosis and preoperative prepara-
tion, uniform anticoagulation, and improved postoperative
care, heart surgery blossomed in the late 1950s and early
1960s. Dr Gibbon’s Model II heart-lung machine was the
framework on which other applications were modeled. The
first truly commercial heart-lung machine was the Mayo-
Gibbon device, which was the most widely used heart-lung
machine of the 1950s and early 1960s and was developed by
Kirklin and coworkers at the Mayo Clinic after the design of
Dr Gibbon.13

After the development of the heart-lung machine, Dr
Gibbon returned to the active practice of general thoracic
surgery, leaving cardiac surgery to others, recalling that his
primary interest had always been thoracic surgery and that his
sentinel case of pulmonary embolism was a complication of
general surgical operation. He became Professor and Chair-
man of Surgery at Jefferson and was President of the
American Surgical Association in 1954 and the American
Association of Thoracic Surgery in 1961. He gave his last talk
on the development of the heart-lung machine at Baylor in
late 1972 and shortly thereafter passed away in early 1973 at
the age of 69 from a fatal heart attack.5

The world owes John H. Gibbon, Jr, MD, an enormous
debt of gratitude for pioneering the technology of cardiopul-
monary bypass and persisting for 23 years in its develop-
ment—until he got it just right, on the morning of May 6th,
1953.
References


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