

## Special Article

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# Clarence Walton Lillehei: The Pioneer Open Heart Surgeon

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### Key Words :

*Walton Lillehei, Open heart surgery.*

*(Cardiovasc. j. 2020; 12(2): 145-148)*

### Introduction:

Heart as an organ was always a difficult territory for the surgeons. Famous surgeon Stephen Paget in 1895 wrote, "Surgery of the heart has probably reached the limit set by the nature, no new methods, and no new discovery can overcome the natural difficulties that attend a wound of the heart". But surgeons like Axel Cappelen of Norway in 1895, Ludwig Rehn of Germany in 1896 did the job very well by repairing stab injuries of the heart. But these were rare achievements. Virtually there was no safe surgical approach or method to deal the heart well before the 1950s. C W Lillehei and his colleagues brought about these changes to make cardiac surgery a reality.<sup>1</sup>

### Early life:

Clarence Walton Lillehei was born on 23<sup>rd</sup> October 1918 in Minneapolis, Minnesota, USA. He was the son of Dr. Clarence Ingvald Lillehei and Elizabeth Lillian (Walton) Lillehei. He attended the University of Minnesota at the age of 17. There he earned 4 degrees; his B.S. in 1939, his M.D. in 1942, his M.S. in physiology in 1951, and his PhD. in surgery in 1951.

After the outbreak of Second World War, Dr. Lillehei joined Army Medical Corps and eventually became a lieutenant colonel in the US army. Upon returning at the end of the war in 1945, he completed his residency at the University of Minnesota under the direction of legendary Professor of Surgery Dr. Owen Wangensteen. As chairman of the department of surgery,

Wangensteen provided a creative environment that produced many brilliant surgeons, and he took a special interest in young Lillehei.

In 1949, Dr. Lillehei was appointed a fulltime instructor of surgery at the University of Minnesota Medical School. He began to work his way up the academic ladder towards a clinical professorship. The following year, however fate dealt him a cruel blow: he was diagnosed with lymphosarcoma of the parotid gland and was given at most, a 10% chance of surviving for 5 years. The day after he finished his senior residency, Lillehei underwent extensive head and neck surgery at the hands of Dr. Wangensteen and Dr. Richard Varco. This operation left him with a permanent slight disfigurement. After completing radiation therapy, he slowly regained his health. Upon resuming his career in late 1950, Dr. Lillehei turned his attention to cardiac surgery. He was specially intrigued by the possibility of performing open heart operations. And he contributed in open heart surgery with introduction of numerous techniques like hypothermia, hemodilution, and equipment and prostheses like bubble oxygenator, pacemaker, heart valves.<sup>2</sup>

About early days of his surgery, one of his operated patients Cindy Lander (Fig 1A & 1B) in 2007 said after a long time of her surgery, "He was a presence, he was definitely a presence in the room. No matter how many doctors were in there, there was something about him," Lander recalled. "And looking now with older eyes, I think he was just

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**Fig-1:** A. Young patient Cindy Lander with surgeon Walton Lillehei in 1955. Fig 1B. Many years later Cindy Lander her 2 daughters thanking the surgical team in 2007. (Photo credit: the patient herself).

driven to do something for children, to do something so that they could actually have a full life, a healthy life and not die young.”<sup>3</sup> Cindy Lander was operated when she was 11. At age of 27 she developed arrhythmia and underwent permanent pacemaker implantation, a device again invented by Lillehei in collaboration with Medtronic. Lillehei, Cindy said, saved her life twice!

#### **Early history of open-heart surgery:**

On 29 November 1944, Alfred Blalock with Helen Taussig and Vivien Thomas at John Hopkins University Hospital had performed the first successful palliative surgery of great vessels around the heart to relieve the symptoms of Tetralogy of Fallot of a one-year old girl, demonstrating that heart surgery could be possible. Cardiac surgery changed significantly after the Second world war. In 1947, Thomas Sellors of Middlesex hospital in London operated on a Tetralogy of Fallot patient with pulmonary stenosis and successfully divided the stenosed pulmonary valve. In 1948, Russel Brock, probably unaware of Sellors’ work, used a specially designed dilator in three cases of Pulmonary stenosis. Later that year, he designed a punch to resect a stenosed infundibulum. Many such blind operations were performed until the introduction of cardiopulmonary bypass. In 1951, Dodrill performed mitral valve surgery under left heart bypass and he again operated to relief pulmonary stenosis under right heart bypass.<sup>4</sup>

#### **Career:**

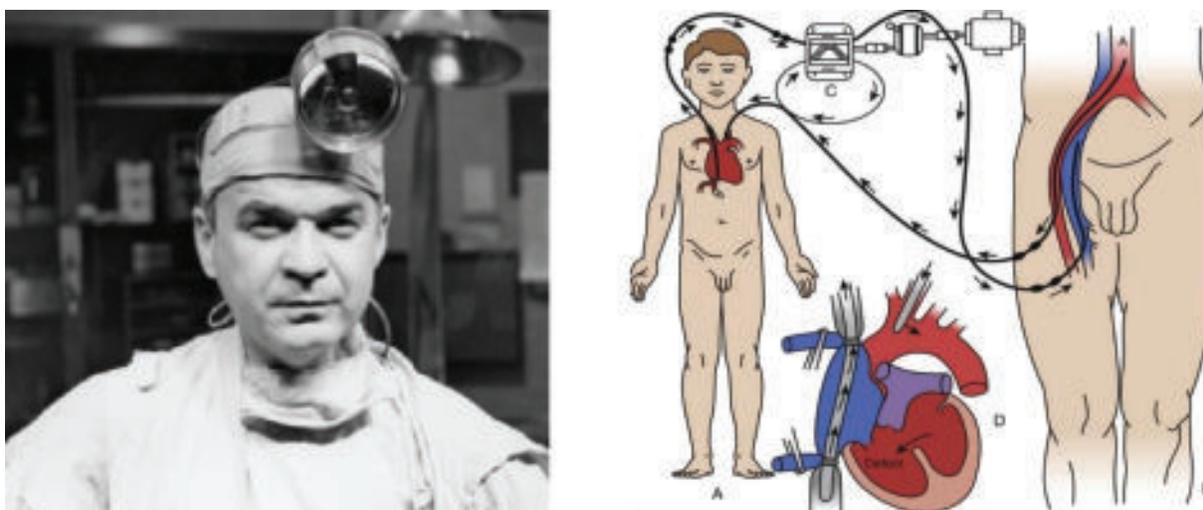
Lillehei served as professor in the Department of surgery at the University of Minnesota from 1951 to 1967. He participated in the first successful surgical repair of atrial septal defect on 2<sup>nd</sup> September 1952. That historic operation, using hypothermia and inflow occlusion of vena-cava, was led by his longtime friend and colleague, John Lewis. However, hypothermia gave only a relatively brief time, up to 10 minutes, during which surgery could be performed and was therefore not suited for complex congenital defects within the heart. In 1953, May 6, Dr. John Heysham Gibbon first used his own invented pump oxygenator (heart-lung machine) to close atrial septal defect of a girl named Cecilia Bavolek. Unfortunately, the next few cases operated by Gibbon didn’t survive and he had to give up cardiac surgery.<sup>5</sup>

On 26<sup>th</sup> March 1954, C W Lillehei successfully closed a ventricular septal defect under controlled cross circulation. In this technique a donor, usually one of the parents was used to take up the pumping and oxygenation functions of the patient who was being operated on. Using this technique, Lillehei led the team successfully but the patient, 13-month-old Gregory Glidden, died 11 days later of suspected pneumonia. Lillehei and his team continued to use cross circulation for a total of 44 open heart operations in the following year, of which 32 patients survived. These operations included the first repair of the atrioventricular

canal and tetralogy of Fallot. Cross-circulation was never widely practiced, because it was too risky also for the anaesthetized donor. Dr. Lillehei continued to seek a better method. In 1955, he and Dr. Richard A. Dewall introduced the first clinically successful bubble oxygenator, which remained the device of choice through the 1970s. Dr. Lillehei also helped pioneer hemodilution and moderate hypothermia techniques for open heart surgery. Later he directed his efforts towards the treatment of heart block and cardiac valve disease. In 1957, he and Earl Bakken (cofounder of Medtronic), introduced the first transistorized, battery powered, small, external wearable, portable permanent cardiac pacemaker. After the

introduction of the first widely used prosthetic heart valves by Albert Starr in 1961, Dr. Lillehei also developed and implanted several innovative designs: Lillehei-Nakib toroidal disc, the Lillehei-Kaster pivoting disc (1967), and St. Jude Medical bi-leaflet prosthetic heart valve (1968).

On March 16, 1955, Dr. Lillehei and Dr. Varco successfully repaired the ventricular septal defects of 13-year-old Calvin Richmond. This was the first-time heart surgery was successfully performed with the support of an animal lung for extracorporeal oxygenation.<sup>6,7</sup> This unique technological miracle of that period had received elaborate media coverage (Fig 3).



**Fig.-2:** Dr. Lillehei after surgery with hypothermia & Controlled Cross-Circulation



**Fig.-3:** Newspaper report on surgery with Dog's lung as extracorporeal oxygenator by Dr Lillehei.

### Lillehei as educator:

As a dedicated educator, Lillehei trained more than 150 cardiac surgeons from 40 nations, including Norman Shumway, Christian Barnard, Christian Cabrol, Richard Lower and Adrian Kantrowitz. In 1967, he was appointed Lewis Atterbury Stimson Professor and Chairman of the surgery department at Cornell University Medical Center and surgeon in chief at New York Hospital. Unfortunately, however his vision began to deteriorate as a late result of his cancer radiotherapy. For this reason, he was forced to end his surgical career at age 55 and he remained active as a lecturer, writer, and consultant in Minneapolis. After returning to Minnesota, in 1975, he became the Director of medical affairs at St. Jude Medical. He was also named a Clinical Professor in the department of surgery at the University of Minnesota.<sup>8</sup>



**Fig.-4:** In this famous photo from reputed magazine 'The Saturday Evening Post' Dr Lillehei is portrayed with a young patient and an updated version of the original battery powered wearable pacing device.

In 1955, Lillehei was honored with Albert Lasker Award, the Order of Health Merit Jose Fernandez Madrid by the government of Colombia in 1959, induction in 1993 into the Minnesota Inventors Hall of Fame, and the 1996 Harvey prize in Science and Technology. In 1966-67, he served as President of the American College of Cardiology. Lillehei was also honored with Bronze Star for World War II service in Anzio, Italy.<sup>9</sup>

Dr. C W Lillehei was a memorable personality. He made many contributions in various arenas of Cardiac Surgery. Even Cardiac Surgery legend Denton Cooley wrote, 'Because he pioneered a direct approach to open heart operations in the 1950s, Clarence Walton Lillehei may justifiably be called the "Father of open-heart surgery"'.<sup>9</sup> Throughout his career, he showed great ingenuity, imagination and boldness. Because he resisted tradition and was somewhat of a maverick, he tended to attract criticism. However, he was warm, affable and compassionate, specially to his patients. He even treated some children whose parents could not afford his services. Over the years, surgeons who trace their precept real lineage to Lillehei have introduced major advances in almost every era of cardiac diagnosis and treatment. Salute to the spirit of this great cardiac pioneer, who, in Wangenstein's words, will always be "one of the Surgical Immortals".

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### Conflict of Interest - None.

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