Clarence Walton Lillehei
Breaking the Barriers Surrounding Open-Heart Surgery

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Individual Exhibit
Exhibit - 498 words
Process Paper - 498 words
When my sister was doing History Day two years ago, I went to her state competition where I became inspired by the exhibit boards. One, in particular, titled, “Clarence Walton Lillehei” impacted me greatly, because I had open-heart surgery at the age of four. Lillehei was a surgeon and the first doctor to operate inside a beating heart. If it wasn’t for his breakthrough procedure, children like me may not be here today. The moment I saw that exhibit, I knew that would be the topic for my turn at History Day.

I began my research by reviewing websites for information about Lillehei. My next goal was to focus on primary sources. This was the most interesting research I did. I visited the Lillehei Heart Institute where I saw many artifacts, including the original heart-lung machine. Here is where I interviewed Dr. Moller, who worked with Dr. Lillehei. Additional personal interviews I conducted were with Dr. Garry, a researcher at the University of Minnesota, and two surviving patients of Lillehei who underwent surgery in the 1950s. This was fascinating. My final interview was with Lillehei’s own son, Dr. Craig Lillehei, who works at Boston Children’s Hospital and is a professor at Harvard. These personal interactions made me realize how much Lillehei impacted the world. There were multiple books where I found useful quotes, important dates, and small details that helped me understand how people viewed him at that time in history.

I went to White Bear Lake school libraries, the Rice Street Public Library in St. Paul, the University of Minnesota Wilson Library, and the Ramsey County Library in Roseville. I also watched numerous videos, documentaries, listened to recordings and read many archived newspaper articles. All of this helped paint a clear picture of Lillehei’s past, as well as how he influenced the advancements made with heart surgery.
I chose to do an exhibit, because I prefer to do hands-on projects. When I started searching for images, I chose words from my narratives, such as heart-lung machine, hypothermia, and cross-circulation that related to Lillehei. I chose the maroon and gold colors to represent Dr. Lillehei’s connection to the University of Minnesota. While on my History Day journey, I have learned how to improve research, organization, and note-taking skills, and how to create useful interview questions. Seeing another perspective about the criticism from others in the medical community, gave my exhibit a balanced view. All of these things have given me a better understanding about Dr. Lillehei and his breakthrough surgeries on the heart.

My topic relates to the theme, “Breaking Barriers in History,” because Dr. C. Walton Lillehei was the first person to operate, using his method of cross-circulation, on a beating heart. No one had ever dared to open the human and operate inside the heart prior to 1952. Dr. Lillehei was one to break that barrier, and because of him, heart surgeries are successful today. He was a true maverick and definitely the “King of Hearts.”
ANNOTATED BIBLIOGRAPHY

Primary Sources

Artifacts

While C. Walton Lillehei was still performing surgery, St. Jude Medical INC. gave this award to Lillehei because of the wonderful work he did and support he gave as director of medical affairs at St. Jude Medical. This artifact is the real award presented to Lillehei. This was a useful source, because it helps explain how society appreciated his fine work.

In a glass case inside the Lillehei Heart Institute, a magazine by the name of *Medical World News,* is displayed. On the front cover are C. Walton Lillehei and his brother, Richard C. Lillehei. They were honored for their great successes and medical breakthroughs. This is another source that explains how important and innovative they were in the medical community.

While in the Lillehei Heart Institute Museum, I was in the same room as the original DeWall Bubble Oxygenator that surgeons used to help perform open-heart surgery. It helped me know how they used it in real life without using diagrams and how complicated it looked. This artifact was useful because it helped me with my lower right panel.

In the Lillehei Heart Institute, there is an original pacemaker hanging on the wall with a written description. This artifact taught me what the original pacemaker looked like. It was very complex with the many buttons and switches doctors had to use to keep the heart pumping for the patient.

This headlamp was used in an open-heart surgery that was performed by Dr. Lillehei. The doctor himself wore this one. Headlamps help see the heart better, so they don’t make mistakes. This was a helpful source, because it gave me an understanding about some essential tools that are necessary during surgery.
The Lillehei Heart Institute, in Minneapolis, Minnesota, showed so many different things about Lillehei that I did not know before. For example, I did not know the prognosis of children with certain heart defects. The Institute, overall, helped me with properly organizing my information for all panels of my exhibit board, as well as for my process paper.

This model of a heart was inside the Lillehei Heart Institute. It showed the different parts of the heart so the doctors and surgeons could see what was wrong with the heart, or what could go wrong with the heart. This was a helpful source, because it helped me see where different defects were and what they looked like.

During open-heart surgery, a surgeon might implant a heart valve inside the heart to help keep the blood flowing in one direction. This artifact was a heart valve that was made by Tom Ivey. The artifact gave me a clear idea as to what a heart valve looks like, and how it functions in the heart.

While Dr. Lillehei was still a surgeon and in office, he received an award in appreciation of his devoted and praiseworthy contributions to St. Jude Medical Inc., as well as for his faithful and devoted service. This award showed me how valuable a doctor and how upstanding a man Dr. Lillehei was.

To help hear if a patient had a heart defect or even just to see whether or not their heart is healthy, doctors use a stethoscope. A stethoscope also helps to hear if there is a murmur in the heart, which would mean that they had a heart defect. This source gave me an idea of what another useful tool looked like during the time Dr. Lillehei was performing surgery.

During Dr. Lillehei’s time as a surgeon, he was recognized by his successful completion for membership in good standing. This was a helpful source because it shows that Dr. Lillehei was recognized for his successes. It was useful for my upper right panel.
This news magazine was made while Dr. Lillehei was still in office. It contributes to health, and especially the heart. The magazine talks about the heart, as it is also shown on the front cover. This artifact showed me how important and impactful heart surgery was.

Interviews

While researching patients who Dr. Lillehei had performed on, I was looking for patients that were still alive. I came across a patient named Tom Anderson in some journals I was reading. He had surgery with Lillehei at the age of five. I also found out he is a current member of the Board of Regents at the University of Minnesota. I emailed him with hopes of a response. He quickly responded, and shared more articles and personal information. His quote included the words, “breaking barriers,” which is the NHD theme, so it was a perfect connection.

During the interview, Dr. Lillehei talked about his problems in the operating room, which was useful for my lower left panel. Earl Bakken is also in the interview, and he talked about how the engineers in the operating room didn’t know much about electronics, so they were scared to use them. This interview helped me know more about my topic.

After I found the transcript of an interview with Lillehei on the Minnesota Historical Society, I searched to see if I could find more interviews. I came across this one, which is where Dr. Lillehei talks about open-heart surgery using hypothermia, cross-circulation, and the bubble oxygenator. This was useful for my lower middle panel and my upper right panel.

This interview was with heart researcher, Dr. Daniel J. Garry. He talked about all the different heart defects, how the different methods of open-heart surgery were used, what other machines were used during the surgery, what and how Dr. Lillehei became a surgeon, and what he does for research today. He also talked about the mortality rate, which was useful. He said some great quotes that were very useful for some of my panels. The meeting and interview with him was helpful for all of my panels, and helped me understand more about my topic and what else I should consider to include on my exhibit board.
This interview was on the phone with Dr. C. Walton Lillehei’s son, Craig Lillehei. He is a surgeon at the Children’s Hospital in Boston. This interview helped me gain more knowledge of why people were against him, the mortality for kids before Dr. Lillehei, and other useful information that helped me understand more about my topic. Dr. Lillehei shared quotes and amazing stories about his father. It was really special to talk with Dr. C. Walton Lillehei’s son, and what his father meant to him. This was a very useful source to help me connect all the panels on my board.

This interview was with cardiac pediatrician, Dr. Moller. He is one of the very few doctors that worked with Lillehei who is still alive. I visited his office in the Lillehei Heart Institute. From the interview, I learned a lot about Lillehei’s passion and determination to help children. Dr. Moller also talked about the importance of strong relationships Lillehei had with his patients and their families. He also gave me a tour of the Lillehei Heart Institute. I was able to see artifacts, pictures, books, and storyboards that explained the history and accomplishments of Lillehei.

This was another patient that Lillehei operated on in 1957. She was seven years old. She shared how complicated her heart defects were, and that without Lillehei she would not have survived a full life. She explained how she was connected to the first pacemaker invented by Earl Bakken. She was invited to Medtronic years later for a reunion with Lillehei, and Lillehei presented her miraculous story at the event. Having connected with Ms. Sims helped me understand how appreciative people are of their lives saved because of Dr. Lillehei.

I found this contact online, who happens to be the brother of one of Lillehei’s patients from 60 years ago. Mr. Vandersluis’ comments about Lillehei reiterated how families were so thankful for his bravery and skill in saving children with heart defects. This email helped me understand how much of an impact Dr. Lillehei had on others’ lives.

Newspapers

This newspaper talks about Joyce Wilder’s experiences at the University of Minnesota’s hospital. It also talks about how the heart-lung machine was used, what the doctors wore, and all of the surgery tools in the room (Dr. Hamrick was the one in control of the machine). It helped me understand how some of the machines in the room were used. This source was helpful because it showed me a photo of what the room looked like with all the machines, and how the machines and tools were used.
During Dr. Lillehei’s experiments with machines, he started with heart-lung machines. He used dog and cow hearts to experiment. Heart-lung machine researchers thought that maintaining the blood flow was impossible. It was interesting to see how Dr. Lillehei experimented with cow and dog hearts. This source was helpful because it showed me how some of the first heart-lung machines started.

At the University of Minnesota, Dr. C. Walton Lillehei and Dr. Richard A. DeWall worked on the DeWall Bubble Oxygenator, which was used on 240 patients. I got some good quotes from Dr. Lillehei, which I used for my upper right panel. This helped me understand that cross-circulation and the bubble oxygenator both worked. I used this for my lower left and middle panel.

At the University of Minnesota hospitals, a baby, Effie Hamilton, was the 24th operation on the heart using the cross-circulation method. She survived the open-heart surgery, and had a great chance of making it to her 1st birthday. The operation took 2 ½ hours, and Effie was hooked up to her aunt, Pearl Hamilton, for 12 ½ minutes. It helped me understand how long the surgery may be, but not at all as long with the patients connected.

While open-heart surgery was still new, the death rate for children with heart defects went down noticeably. When open-heart surgery was first introduced, the mortality rate for children was 25 percent. The new and better surgical technique helped with reducing the mortality rate. This newspaper helped me understand how important heart surgery was. This source was helpful because it proved that heart surgery can save many lives. I used this as a photo in my upper left panel.

This article announced the first ever open-heart operation using cross-circulation. Dr. Lillehei led the surgical team. The article explains how the procedure uses another human, in this case the father of the patient, to provide oxygen to the patient during surgery. The first patient was a 13-month old by the name of Gregory Glidden. He survived the surgery, but due to pneumonia, died 11 days post-surgery. This article explains how cross-circulation broke a huge bottleneck in cardiac surgery, because it allowed surgeons to have more time to work, as well as more clarity while working on more complex defects of the heart. I used this as a photo in my lower middle panel.
Dogs were often used as test subjects before open-heart operations, to see if the method of surgery would work. Tubes carried blood from the dogs’ side and back through an artificial heart, and tubes ran to a breathing machine in it’s head. This article helped me understand more about why they used dogs as test subjects.

A boy, Clavin, was the only person to have a heart operation using a dog as lungs. Dr. Norman W. Crisp and Dr. E. B. Brown Jr. started researching with animals, in which more than 100 dogs were used. The Minneapolis Star reported that, “a new step in heart surgery had been taken.” This article helped me understand that there are many ways to correct a heart defect.

On March 23, 1955, University of Minnesesota’s surgeons performed the first successful, and last, heart operation using a dog’s lungs to purify a woman’s heart. The surgery was to correct a defective mitral valve in the heart. Several months before the surgery, difficulties crossed paths that needed a larger opening into the heart. Surgeons usually insert a finger inside the heart, and with a small blade, force the valve open. This newspaper helped me understand that animals can help save human lives, and that there are many ways to help correct a heart defect.

Before Dr. Lillehei became a surgeon, he was going to follow in his father’s footsteps of becoming a dentist when he entered the University of Minnesota. He changed his mind and went into medical school because of his interest in engineering, law, and medicine. When at the University, Dr. Owen Wagensteen made Lillehei’s passion turn toward surgery. Lillehei was helping people with heart defects back to normal. After earning his M.D., Lillehei went to the army, was a resident in surgery, was the instructor in surgery, and became a fellow in the American College of Surgeons. This was a useful newspaper because it helped me understand how and why Lillehei became a surgeon.
While researching additional open-heart procedures, hypothermia was another huge breakthrough at this time. Many procedures were practiced on dogs, including this one. 40 dogs were operated on, in total, and over half survived the procedure. Although it is controversial to many, surgeons were able to make great progress on the human heart due to the dog labs. This article helped me understand the complex situations doctors were up against during operations.

A kitchen-type deep freezer was used to stop the heart of an 11-year old girl, Judith Schmidt. The surgeons decided to freeze her heart for three minutes not at ordinary temperatures, otherwise it would be stopping the heart and causing damage to the brain. For 12 hours at 50 degrees, Judith was removed from the freezer and placed onto the operating table. The surgeons stopped her heartbeat and sewed up a part of her heart to plug up a hole that made her a semiinvalid since birth. After the operation, she started playing with her dolls and read her greeting cards, stating that she felt fine. This article helped me understand how open-heart surgery using hypothermia was used, and was useful for my lower left panel, also as a photo.

The method of cross-circulation during an open-heart operation won a high-honor for the University of Minnesota surgeons. The Albert Lasker Awards is an award for outstanding achievement in medical research. It was presented to Dr. C. Walton Lillehei and his surgical teamworkers. The surgeons were praised for achieving the award for the cross-circulation method. They have performed 45 heart operations since the one on Gregory Glidden. This article helped me understand more about what methods they used after cross-circulation and how that method is used. This newspaper was useful for my upper right panel and my lower middle panel.

Two pediatricians at the University of Minnesota brought in a display that showed how family doctors can help identify babies with heart defects and head them towards open-heart surgery. Children with heart defects have early deaths if their heart defects are not corrected, and the survival rate on surgery cases is very high. Children who would have died then would be living today. In cross-circulation, the donor is used to circulate the child’s blood during surgery by connecting their blood systems. This was a helpful source because it made me understand how you can help identify someone with a heart defect and what the heart defect rate is. This was useful for my upper left panel.
On September 30, 1952, a five-year-old girl, Jacqueline June Johnson was going to die if her heart defect would not be corrected. The surgeons used the method of cross-circulation and cooled her body down to 79 degrees. About 28 days after being operated on, she was putting on her roller blades that Dr. F. John Lewis gave her when she left the hospital. This article helped me understand that the first surgery was a success, and that the child is living today. I used this as an image for my lower left panel.

The method of cross-circulation - “parent and child” operation - grabbed national attention. The television audience watched movies and scenes made during two of the University operations plus some interviews. Lillehei and his colleagues operated on seven boys and girls, all born with fatal heart defects and in poor conditions. In these operations, four were successful, three died. In an open-heart operation using cross-circulation, the donor is usually the father, but in the seventh surgery, the mother was used for the first time. This article helped me understand more about the patients in the cross-circulation operation, and how it spread nationally. This helped me with my lower middle panel.

In this piece of the article, they explain about how the Life Insurance Medical Research fund granted $9,000 to the University of Minnesota. They gave the money to the University for heart disease research. The money was used by C. Walton Lillehei, so he could study intracardiac surgery. This newspaper helped me understand more about who helped Dr. Lillehei and his team to learn more about the heart and perform surgery on the open heart. This was useful for my lower left panel.

A five-year-old girl, Pamela Schmidt is nicknamed the ‘Queen of Hearts’. A year after Pamela’s surgery, she was like every other child. In January, 1955, Dr. C. Walton Lillehei reported that 32 cross-circulation operations were successful that corrected all types of heart defects. Surgeons around the country are starting to use the cross-circulation method. Before the method of cross-circulation, they used the deep cold method, or used hypothermia. Surgeons have started to learn how to work inside the heart faster, too. This article helped me understand more about how many operations there were, and what other methods there were. This was useful for my lower middle panel.
Before open-heart surgery existed, surgeons thought it was impossible to perform surgery inside the heart. For 18 months in 1954 and 1955, doctors and surgeons worked hard to turn the answer to yes. There were heart operations that were on the heart, but surgeons never dared to go inside the heart. On September 2, 1952, Dr. F. John Lewis operated inside the heart using the method of hypothermia. After that surgery, many new methods of open-heart surgery approached. Most of these methods were successful, and were used more than once. This article helped me understand more about all of the different methods used during surgery, and why surgeons resisted to perform surgery inside the heart. This was useful for my lower middle panel and lower right panel.

During the open-heart operations, the surgeons used mostly three types of methods. One was the deep freeze, or hypothermia method. Another was the cross-circulation method. The third was using a mechanical heart-lung machine. Each of these methods had an advantage and some drawbacks, too. But, the new techniques make it possible to fix multiple heart defects and help save children. This article helped me understand more about the different methods, and how they're used. This was useful for my lower middle and left panel.

The new open-heart surgery method, cross-circulation, was a successful method to use during surgery. The father usually has the same blood type as their child, so they are used as the donor. The new method allows the surgeons to see and repair the defects for about 27 ½ minutes. The first successful operation using this method was performed on Gregory Glidden, a 13-month old baby boy. This article helped me understand more about how the cross-circulation method is used. It was useful for my lower middle panel.

This article has people talk about their children with heart defects, and how laboratory dogs contributed to help save not only their children, but others too. They talk about how 40 - 50 dogs were used, and about 12 were killed, just to save one little child. The rest that were living were used for other experiments. The people who were in the article voiced their opinion. This article helped me understand what people thought about using dogs to save little children. This was a good source for my upper right panel, which I used as a photo, too.
While at the University of Minnesota, Dr. Clarence Dennis attempted to create a heart-lung machine and operate on a child using his machine. Those surgeries were unsuccessful. On September 2, Dr. F. John Lewis performed the hypothermia method on a five-year old child, and the surgery was a success. This article talks about other types of methods that were used during surgery, so I learned more about the methods. This newspaper also had this year’s theme, ‘breaking barriers’. I used this article for my lower middle panel, and also as a photo.

**Photos**

While looking for an image to go with my lower left panel, I found this picture of a patient cooled down in an ice bath getting ready for hypothermia surgery. This image helped me understand how patients got ready for open-heart surgery using hypothermia.

For an image to go with my lower right panel, I received this image from Tom Anderson on the birthplace of open heart surgery at the University of Minnesota. This image helped me understand that there is a memorial of the first successful heart operation.

While looking for an image to go with my upper right panel, I found this photo online of Cecil James Watson, the chairmen of the department of medicine, who was against Lillehei doing cross-circulation in the operating room.

“Children With Congenital Heart Disease Were Hospitalized for Long Periods of Time and Received Visits From Entertainers Who Would Visit the Patients in the Hospital. Circa 1945s. *Congestive Heart Failure and Cardiac Transplantation.*
For an image to go with my upper left panel, I found a photo of a child with a heart defect getting visited by entertainers in the hospital. The boy in this image was Dr. Daniel J. Garry’s friend, who died of heart disease. This helped me understand that people in the hospital helped cheer the children with heart defects up.

While looking for an image to go with my lower right panel, I found this pacemaker made by Medtronic. This helped me understand what a pacemaker looked like one year after the first one was created.
“Deaths From Heart Disease.” September 2014. The Epidemic of the 20th Century: Coronary Heart Disease.
While looking for an image to go with my upper right panel, I found this one of the death rates going up then down from 1900 to 2010, it’s highest point in 1950. This image helped me understand how the rate went high up, but back down when open-heart surgery came into the world.

While looking for an image to go with the bottom right panel, I found this picture of the original open heart by-pass machine. Also known as the “bubble oxygenator” this machine was used for 175 open-heart operations at the University of Minnesota. It helped me know what the Bubble Oxygenator looked like, and how it looked so complicated to operate.

For my lower middle panel, I wanted to have a photo explaining how cross-circulation was used, so I found this one that involved laboratory dogs. This helped me understand more on how the method is used during surgery.

For my lower middle panel, I wanted to have a photo that portrayed the procedure of cross-circulation. I found this one with Dr. Lillehei next to an instructional board used for demonstrating the method. This helped me understand how the method of cross-circulation is used on a human.

For my thesis, I wanted to have a photo of Dr. Lillehei. I found this picture online of him in his outfit he wore during surgery. It helped me see what surgeons wore while performing surgery during the 1950s through 1960s.

“Dr. Lillehei, assisted by Dr. Varco, Performs the first cross-circulation operation in 1954.” 1954. The Journal of Thoracic and Cardiovascular Surgery.
While looking for an image to go with my lower middle panel, I found this colored image of the first open-heart operation using the method of cross-circulation. This helped me understand what the surgeons used during the operation, how many surgeons were in the operating room, and what the operating room looked like.

“Dr. Owen Wangensteen.” Circa 1950s. Photo: ACS. The Norwegian American.
For my upper right panel, I wanted to have a photo of Dr. Wangensteen to go with a quote on that panel. This photo showed me what he looked like.
While looking for a photo to go with my lower left panel, I found this image of Dr. Clarence Dennis working his machine during an operation in 1951. This helped me understand that there were unsuccessful surgeries before Dr. Lillehei.

“Heart surgeon, C. Walton Lillehei (front) looking at x-rays at University of Minnesota hospital.” Photo Credit: Al Fenn. *Getty Images.*
During my time looking for more photos, I wanted to have a clear image, so I went into Getty Images. I wanted to have a photo of surgeons researching ways to fix the damaged heart. This photo helped me see how surgeons found ways to see the heart and find out ways they could correct the defect. I used this image on my lower left panel.

“Illustration of the azygos flow concept for open heart surgery.” Circa 1950s. *University of Minnesota Libraries.*
While looking for an image to go with my lower middle panel, I found this image of the Azygos vein flow concept. It helped me understand more in how the vein is used and what it looks like inside the heart.

“Medical Illustration Demonstrating the Connection Between Donor and Patient During Open Heart Surgery Using the Controlled Cross Circulation Method.” 1955. *University of Minnesota Libraries.*
For my lower middle panel, I found this photo of a written diagram of how the method of cross-circulation works. This method was used for 45 open-heart operations, with 32 successful. This photo helped me understand how the method works by transporting blood and oxygenation.

While looking for an image to go with my lower right panel, I found this picture of Dr. Christiaan Barnard in his surgical outfit. He studied under Dr. Lillehei and went on to perform the world’s first heart transplant. This helped me understand what Dr. Barnard looked like as a surgeon.

While looking for an image to go with my lower middle panel, I found an image of cross-circulation with the patient and the donor. This helped me understand how the method is used during surgery with the connection between the two humans.
“Strange as it Seems.” 1952. Elsie Hix.

At the Lillehei Heart Institute, I found a drawn image of the hypothermia method during surgery. It describes a short summary of the operation. This helped me understand how people viewed the operation and more about the operation. I used this for my lower left panel.

“Surgeon Dr. C. Walton Lillehei performing a cross circulation heart operation.” August 1, 1954. Photo credit: Al Fenn. Getty Images.

I found this image of Dr. Lillehei performing a cross-circulation operation in August. This helped me understand that cross-circulation was a success and they used it for the rest of the year. I used this image for my lower middle panel.

“Surgeons Dr. C. Walton Lillehei(R) and Dr. Richard L. Varco(L) Performing a Cross Circulation Heart Operation.” Circa 1954. Getty Images.

While looking for an image to go with my lower middle panel, I found this picture of Dr. Lillehei and Dr. Varco shaking hands after a successful cross-circulation heart operation. This image helped me know that the method of cross-circulation was successful during surgery.

“Walt, By All Means, Go Ahead OHW (Owen H. Wangesteen).” 1954. Owen H. Wangensteen.

While at the University of Minnesota Lillehei Heart Institute, I found an image of Dr. Wangensteen’s writing to Dr. Lillehei, allowing him to do the cross-circulation operation. This helped me understand that Dr. Wangensteen agreed with Dr. Lillehei and let him do the surgery. I used this image for my upper right panel.


For finding an image to go with my lower right panel, I wanted to have a photo of the first pacemaker in the world. This photo helped me understand what the first pacemaker looked like.

Videos


In this short film, they talked about the events that lead up to the world’s first open-heart operation, and the events that happened during the historic event. They used a fictional character named Nancy.
This video was a very useful source for me. It had interviews from Dr. Lillehei, where he talked about the different methods of surgery and different heart defects. It also had a lot of helpful photos that let me understand more about my topic, and clips of a surgery on the beating heart. This helped me understand more about the methods of surgery and about Dr. Lillehei.

This video had clips from actual open-heart operations, some including the first two successful heart surgeries, hypothermia and cross-circulation. It also had an interview with a mother of one of the first unsuccessful operations (before 1952), and her experience through the time. It had photos of different children that had heart surgery performed on them. This helped me understand more about the experience during an operation and how family members felt.

In this video, you watch a machine being used in the operating room, and a surgeon operating on one of their patients with a heart defect. This video helped me understand how the machine was used during surgery.

During this video, you see surgeons operating on a patient, using a method that involves a machine, trying to save the child and correct the heart defect. This video helped me see and understand how the machine was used during surgery.
Secondary Sources

Books

This book was given to me by one of the authors, who I interviewed, Dr. Daniel J. Garry. This book talked about the different doctors who came up with ideas on ways to correct a heart defect and what method they came up with, and the first two successful open-heart operations using cross-circulation and hypothermia. It also talked about many different surgeons that helped contribute to the successful surgeries. This book had useful images and descriptions to help me understand more about the different surgeries. This helped me understand more about the successful heart surgery methods and amazing surgeons.

This book talked about many different surgeons and surgeries, but it also talked about people who were against open-heart surgery on dogs. That part of the book was helpful for my upper right panel. It showed me two different sides of the story, my side and the people against the surgery.

The author of this book told a colorful story of Dr. Lillehei from his schooling, to being in the military, onto his life as a breakthrough surgeon. There was a great deal of information on other doctors and surgeons with which Lillehei worked and was inspired. This source helped me with writing and organizing my narratives and quotes.

Interviews

Carter, Christopher M.D. Email Interview. February 17, 2020.
When I had my own open-heart operation, Dr. Carter was assigned as my cardiologist, and I continued to see him today. I decided to contact him via email. He also responded with helpful information. He even used this year's theme words of “breaking barriers” when he emailed back. This interview was helpful because Dr. Carter talked about how Dr. Lillehei impacted his career and life.
Journals

When Lillehei was alive, he was known for his contributions to open-heart surgery and his cardiac technology. While at the University of Minnesota, he had 4 degrees. After the breakout of WWII, he joined the Army Medical Corps, and received the Bronze Star award. In 1949, Dr. Lillehei was nominated a full-time instructor of surgery at the University. He turned his attention to cardiac surgery, and was fascinated at the possibility of performing an operation himself. Later, in 1954, he found himself performing a successful open-heart surgery on a baby boy. This journal helped me understand how Dr. Lillehei became a surgeon, all the different methods that were before and after the first successful heart operation using cross-circulation, and how Dr. Lillehei was determined to find ways to fix someone's damaged heart.

“The Cutting Edge or the Cliff: on Which Do You Stand? Spring 2020. Kristin S. Held, M.D.
This journal helped me with my lower right panel. It talked about Dr. Lillehei’s life as a surgeon, and helped me understand more on what happened at the University when Lillehei was there.

This journal really helped me with my upper right panel. It gave good statistics, images (one where I used it on my board), and helpful information. It talked about the mortality rate, and when it was at its highest. This helped me understand more about the child mortality rate itself and when it became the most common death in the United States.

In this journal, it mostly talks about the method of cross-circulation, and how it was used in surgery. I learned more about cross-circulation, and how many patients lived and died during, and after, the operation. It gave good statistics, and a table showing the results after surgery of deaths and the ones who lived. It also had the long-term results, which was useful. This helped me understand more about the cross-circulation method.

I read about a patient of Dr. Lillehei from 1963, Tom Anderson, from this journal. He survived a 50-50 chance of success surgery, but is still alive today, living in Alexandria, Minnesota. In 1963, the people in his hometown helped his family raise the 30 pints of blood needed to do the surgery, which Tom keeps a list of. This gave me some good quotes to use. I also wanted to try and get an interview with him via email, and I did. This helped me understand more about Dr. Lillehei’s patients, and what they thought of him.
While reading this journal, I read about multiple open-heart surgeries that used different methods, and which ones were successful and unsuccessful. I got some good quotes and statistics out of this journal. There were also tables that showed the successfulness of the surgeries, and images of the operations. This helped me understand more about how the type of method used during surgery was used. I used this for my upper and lower right panel, and my middle panel.

Newspapers

During the open-heart operation using cross-circulation, the type of surgery could help repair other heart defects. Forty-five operations were done by the method of cross-circulation. It also talks about how cross-circulation was used. The DeWall Bubble Oxygenator was also mentioned. Richard DeWall found that large bubbles that were furnished to a quite enough contact surface were easier to eliminate later. This newspaper helped me understand how the DeWall Bubble Oxygenator and cross-circulation were used. This was a good source because it helped prove that the methods of cross-circulation and a bubble oxygenator could work.

Dr. Lillehei was going to become a dentist, just like his father, but changed his mind into becoming a surgeon. Lillehei’s passion was to correct heart defects in children. In 1953, Dr. John Gibbon invented a heart-lung machine, which had many complications. In 1954, Dr. Lillehei introduced the method of cross-circulation. Lillehei reached out to Earl Bakken in 1957, and together they made the first pacemaker. This article was a good source because it helped me understand more on the different techniques that they used for open-heart surgery, and how Lillehei’s life was as a surgeon.

This newspaper includes stories of six open-heart surgery survivors, quotes from them, and more great information. This also includes what the survivors were like before, during, and after the surgery, and how they changed mentally and emotionally. This helped me understand what and how open-heart surgery does to people, and how they respect the operation. This article was used for my lower right panel.
In the fall of 1963, a five-year old boy, Tom Anderson, was accepted into the Variety Club Heart Hospital at the University of Minnesota to undergo an open-heart operation, which was one of the only Universities to perform heart surgery. Tom’s surgery was a success and he is still living today. In 2015, he was elected into the Board of Regents at the University. This article helped me understand more about Lillehei’s patients and what they have to say about him. This was useful for my upper right panel.

At age 80, Dr. C. Walton Lillehei died in St. Paul. While working at the University of Minnesota, he created many innovative heart techniques that helped during open-heart surgery. On September 2, 1952 five-year old Jacqueline Johnson underwent the first successful open-heart operation at the University. Before then, surgeons thought going inside the heart and operating inside of it was impossible. In 1955, Dr. Lillehei and some researchers developed a heart-lung machine, and in 1957, Lillehei and Earl Bakken created the first portable pacemaker. This helped me understand more about Dr. Lillehei and the different technologies that were used during surgery and after.

Photos

While looking for an image to go with my lower right panel, I found an image of the plaque of the Lillehei Heart Institute. This helped me understand how important Dr. Lillehei was to people and how they are inspired by him. I used this image for my lower right panel.

After my interview with Dr. Daniel J. Garry, he invited us to look around at the display boards to read more about Dr. Lillehei and what he did. I found this image of Medical Alley, so I thought that the image would be great for my lower left panel. This image explains the different medical communities in Minnesota. It helped me understand how many medical fields there are in Minnesota.

While looking for an image to go with my upper left panel, I wanted and found an image of a common heart defect, a VSD (Ventricular Septal Defect), which is the defect that Gregory Glidden had. This helped me understand what a VSD heart defect looks like.
**Videos**

While watching this documentary, I saw videos of real surgeries from around 1952-1955. I learned more about the types of surgery, and saw some photos that I had never seen before watching this video. These visuals helped me realize the complexity of open-heart surgery. I also obtained more useful photos.

In this video, there was a man who knew a lot about Dr. Lillehei, so he talked about him in front of a crowd of people. I learned more about the types of methods used during surgery, and more about the doctors. This video helped me see and understand how people thought of Dr. Lillehei.

This video had a film of an actual open-heart operation from 1959. It also included clips of before, during, and after the surgery. This helped me see what an open-heart surgery looked like, and what the surgeons and doctors did to care for their patients.

In this video, an open-heart operation could be watched live on TV. A crowd of people were watching the beating heart get cut open and corrected. There was also a drawing of what method that was being used during the operation. This helped me understand more about how and what the heart looks like during an operation.

This video included an interview of a researcher that knew all about Dr. Lillehei and his surgical team, and many other doctors. He talked about the different types of methods used in heart surgery and how they worked, and the mortality rate of children before Dr. Lillehei. This video had great images that helped me understand more about what the researcher was talking about. Overall, this helped me know more about the methods in heart surgery.
In the field of heart surgery, advancements in technology are made every day. It helps make surgery easier and safer, and has a faster and less painful recovery. Before being treated with minimally invasive heart procedures, open-heart surgery was the only way to perform heart surgery. This helped me understand how much the world of open-heart surgery medical technology has changed over the decades.

This website explains about the different types of inventions for heart surgery in 1951-2000s. During 1951-1956, when the first two successful open-heart operations happened, there was the heart-lung machine, the hypothermia method, cross-circulation method, and the Lillehei-DeWall bubble oxygenator. This had some good images and information that I used. This helped me understand more about the first different types of methods used in heart surgery.

This website explains about infants with congenital heart defects (CHD) mortality rate. Before Dr. Lillehei came into the view, and even before the 1940s, 90% of infants died well before reaching adulthood. Cardiac advancement helped more than 90% of infants survive to 18 years old. This helped me understand how heart surgery has helped save many lives throughout the years. I used this information for my upper left panel.

This website explained Dr. Lillehei’s time at the University and what he did. It also focused on the successful open-heart operations using hypothermia and cross-circulation, and the first-ever portable pacemaker. Dr. Lillehei educated more than 150 cardiac surgeons over the world from 40 different nations, and earned 4 awards as a surgeon. Dr. Lillehei has many living family members, one of whom we contacted and had a delightful phone conversation with, and that was his son, Craig Lillehei. This website was the first website that I ever found, and it helped me understand how the method of cross-circulation was developed, used, and who it was used on.

While looking for an image to go with Medical Alley, I found this image of Minnesota’s governor, Tim Walz, who proclaimed April 24, 2019 as Medical Alley Day. This helped me understand how important the medical technology and advancements are in Minnesota. I used this image for my lower right panel.
This website explains how Minnesota is home to the medical-technology hot spot with a long history of experimentation, problem-solving, and influential leadership. In the 1950s and '60s, an outbreak of innovations established Minnesota's medical-device industry as a world leader. This website helped me understand the advances in medical technology.

This website explains Dr. Lillehei’s whole lifetime, and his experiences as a doctor and surgeon. It also talks about the hypothermia and cross-circulation procedures. Dr. Lillehei also invented and implanted the world’s first artificial heart valves. This website helped me understand more about Dr. Lillehei’s life as a doctor and what he did at the University.

This website was the most useful out of all of my sources. It talked about each method used in open-heart operations, had more than 15 photos for each section, and had the best descriptions. I learned so much on this website, all of it was helpful. For my board, most of the photos I used were from this website. This website helped me understand everything more clearly, and it was used for all of my panels.

This website explains the research on laboratory dogs, and how they researched them. They tried the method of cross-circulation on the dogs, and it turned into success. Later in 1954, they brought their experiment into the operating room to operate on a 13-month old infant, where it was a success. This website helped me understand more on how testing on dogs led up to the first successful open-heart surgeries.
<table>
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<th>Clarence Walton Lillehei: Breaking the Barriers Surrounding Open-Heart Surgery</th>
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<td>Annika Hellmark</td>
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<td><a href="Milestones%20of%20Open-Heart%20Surgery%20at%20the%20University%20of%20Minnesota">Milestones of Open-Heart Surgery at the University of Minnesota</a></td>
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On March 26, 1954, Dr. Clarence Walton Lillehei performed the first successful open-heart surgery using his cross-circulation technique developed at the University of Minnesota. Once deemed impossible, this major medical breakthrough paved the way for the era of open-heart surgery. Lillehei’s breakthrough into the barriers surrounding open-heart surgery led to medical advances and established Minnesota as a world leader in medical devices.

“Early research in this field was difficult in developing these methods of open-heart surgery. There were many failures, frustrations, discouragements, but I think we persisted. In looking back, that did lead to success in terms of developing the simple and effective methods for repairing these defects inside the heart. I certainly would like to be remembered as one that left the field of open heart surgery in a much better condition than we found it in the beginning.”

-Dr. C. Walton Lillehei
In the early 1900s, children born with heart defects had little chance for survival. By the 1930s, the leading cause of death in the United States was heart disease. The idea of operating inside a beating heart was considered impossible and an immediate death sentence, because doctors needed to empty the heart of blood to repair it before the child bled to death or suffered brain damage. Doctors felt an urgency to develop ways to overcome the barrier of open-heart surgery.

“For these kids the prognosis is dismal. It’s the same as it was here in the United States in the years before cardiac surgery. About a quarter of the infants die in their first year. Most of the rest die before their teens. I looked up the numbers. About forty percent die by age three, and seventy percent by age 10.”

-Dr. James S. Forrester, author of “The Heart Healers”

“Surgeons had done surgery on the heart but they never opened it up. They always believed that that was not possible. That patients couldn’t survive by opening up that heart.”

-Dr. Daniel J. Garry, Researcher at the University of Minnesota, quote from personal interview
“Heart defects are the most common of all life-threatening birth defects, affecting 1 in every 110 babies. Roughly one in every three kids born with a heart defect requires surgery...These days, in the United States, over 85 percent of kids with deformed hearts survive surgery into adulthood. Still, congenital heart defects remain, of all birth defects, the number one cause of infant death.”

-Gabriel Brownstein, Author and Professor at St. John’s University in Queens, New York

“The biggest barrier had to do with the notion about the heart. At that time the thought was that the heart itself was an impenetrable barrier. The attitude was if you cut into the heart, it was a lethal injury and bad things were going to happen.”

-Dr. Craig Lillehei, son of Dr. C. Walton Lillehei, and Surgeon at Boston Children’s Hospital, quote from personal interview
As a young surgeon at the University of Minnesota, Lillehei witnessed two unsuccessful attempts in 1951 to repair a hole inside 6-year-old Patty Anderson and 2-year-old Sheryl Judge using a heart-lung bypass machine. On September 2, 1952, Dr. Lillehei, Dr. John Lewis, and Dr. Richard Varco successfully repaired a hole inside 5-year-old Jacqueline Johnson using hypothermia. The repeated failures of the complex heart-lung bypass machine and the insufficient few minutes hypothermia offered on more complicated heart defects made Lillehei more determined to find an alternative solution.

“But the complexity of the heart-lung machine troubled Lillehei. So many parts, so many possibilities for error, as Sheryl Judge had tragically demonstrated.”

-Dr. G. Wayne Miller, author of “King of Hearts”

“It [hypothermia surgery] opens the way for more such operations on the type of defect repaired. But even more significant and exciting, it seems to give surgeons a method-long sought-of putting the knife into the live human heart, in plain sight and unclogged.”

-Minneapolis Tribune, September 23, 1952

“He did it with hypothermia: deep cold. Chilling the body so lowers the oxygen needs that blood flow to the heart can be stopped for six of eight minutes. Enough time for a simple repair. Not enough time for a difficult one.”

-Victor Cohn, writer for the Minneapolis Tribune

“Boy, there’s got to be a better way to do open-heart surgery than with total body hypothermia.”

-Dr. C. Walton Lillehei
Picture of Center Panel of Exhibit
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-Dr. C. Walton Lillehei
After Lillehei experimented on dogs in his lab, he discovered that if all blood to the heart was stopped except for the azygos vein, he would have more time to operate than with the hypothermia method. He also discovered that when connecting tubes and pumps between two dogs, the donor dog provided oxygenated blood to the recipient dog. He believed his “cross-circulation” technique would also work in humans. Lillehei finally broke the barriers surrounding open heart surgery on March 26, 1954, when he successfully repaired a hole inside 13-month old Gregory Glidden’s heart using the father as the donor. Cross-circulation opened the doors for many more technological advancements.

“The single most important discovery that made clinical open-heart surgery successful was the realization of the vast discrepancy between the total body flow that was thought necessary, and what was actually necessary.”

-Dr. C. Walton Lillehei

“Using a laboratory pump, catheters, and plastic tubing, they connected an artery in the neck of a recipient dog to an artery in the thigh of a donor. Another tube was connected between major veins in both animals. Deoxygenated blood from the recipient was pumped through the tubing to the donor, where it was carried to the donor’s lungs to be oxygenated. Oxygen rich blood was then returned to the recipient’s body through the vein connection. The method maintained circulation in the recipient while by-passing the heart, which was clamped off at the major vessels.”

-Open Heart: Intracardiac Surgery at the University of Minnesota
“I, the undersigned, hereby grant permission for an operation or any procedure the University staff deems necessary upon my son, Gregory Glidden.”

-Lyman and Frances Glidden

“Don’t find another patient, find two. We’ll schedule them immediately, one right after the other. Before anyone can blink, we’ll prove this thing works.”

-Dr. C. Walton Lillehei

“And that was a revolutionary procedure, where they undertook that first surgical repair. What this did is that it really opened up this huge opportunity, and so what Lillehei ended up doing is because he was working in the lab, he started to think about things that he could do, and what he came up with was essentially a human heart-lung machine.”

-Dr. Daniel J. Garry, Researcher at the University of Minnesota, personal interview
Although Gregory Glidden died from pneumonia eleven days after the surgery, Lillehei and the University’s Chief of Surgery, Owen Wangensteen, considered cross-circulation a success. Others within the medical community criticize Lillehei’s method that endangered the lives of two people as “highly experimental, too risky, immoral, and unethical.” As the only surgeon in the world using cross-circulation in numerous successful surgeries that year, doctors from around the world, like Dr. Christiaan Barnard, traveled to Minnesota to learn Lillehei’s technique and implemented it worldwide.

“Though it is so hard not to feel bitter that Little Greg couldn’t have lived to rejoice with the other two, we just have to accept it as the Lord’s will and we know his death wasn’t in vain as it has given these two children another chance to live and no doubt many more...May God bless and guide you in the wonderful work you are doing.”

- Frances Glidden, mother of Gregory Glidden

“Walt, by all means, go ahead.”

- Dr. Owen H. Wangensteen, Chief of Surgery, University of Minnesota

“This criminal must be stopped!”

- Dr. Helen Taussig, Cardiologist at John Hopkins University, during Dr. Lillehei’s presentation at a medical conference
“The doubters once again were alarmed. Certain cardiologist at Lillehei’s own hospital refused to refer his patients, lest they die on his table. Behind Lillehei’s back, nurses had started calling him ‘murderer.’”

-Dr. G. Wayne Miller, author of book “King of Hearts”

“Operating on a terribly sick child is conceivably justified, but risking the life of a second healthy person is ethically unacceptable. How could such and experiment be allowed? With a machine, you might lose one person, but with cross-circulation, you could lose two, one in the bloom of health.”

-Dr. Cecil J. Watson, Chairman of the Department of Medicine, after discovering that Lillehei used cross-circulation in the operating room

“Lillehei was mobbed by surgeons who were suddenly considering cross-circulation themselves. Surgeons arrived from Baltimore, Philadelphia, and Los Angeles. Dennis returned from New York, and some of Kirklin’s people made the two-hour trip north. Dwight Harken came east from Harvard, and the distinguished Lord Russell C. Brock flew over from London”

-Dr. G. Wayne Miller, author of book “King of Hearts”

“Dr. Walt Lillehei was one of the unsung heroes of surgery in the twentieth century.”

-Dr. Christiaan Barnard, South African doctor, who performed the first human heart transplant
“MINNESOTA’S MEDICAL ALLEY”

Others who came to Minnesota to study Lillehei’s breakthrough procedure created a pathway for surgical and technological advances. Dr. Richard DeWall’s work with Lillehei on the bubble oxygenator replaced the need for a human donor. In 1958, Lillehei’s collaboration with Earl Bakken led to the first battery-powered wearable pacemaker. These breakthroughs have kept millions of people alive, inspired further research, and established Minnesota as a world leader in medical devices.

“Worldwide, millions of patients with implantable pacemakers and prosthetic valves owe their lives to him. But his greatest legacy may be the generations of surgeons he educated, inspired, and encouraged, who will advance the surgical treatments of heart disease into the next millennium.”

- The Journal of Thoracic and Cardiovascular Surgery

“DeWall brought to fruition a dramatic technological breakthrough in 1955 by developing the first bubble oxygenator with a unique method for removing bubbles from freshly oxygenated blood.”

- Atlas of Human Cardiac Anatomy, University of Minnesota

“That invention is what led to Minneapolis becoming a center in the medical technology business spawning our community’s nickname in medical circles as ‘Medical Alley’. Thousands of jobs have been created in Minnesota over the past 75 years because of the barriers broken by Lillehei and Bakken.”

- Tom Anderson, former open-heart surgery patient of Dr. Lillehei & quote from personal interview

“Medical Alley’s unique contributions to healthcare delivery and management, medical technology invention, innovation, and entrepreneurship have earned it recognition as the global epicenter of health innovation and care.”

- Governor Tim Walz of Minnesota, Proclamation of Medical Alley Day on April 24, 2019
BREAKING BARRIERS

Open Up Interactive (as if you’re opening up a newspaper to read):
Image: Newspaper clipping of cross-circulation

“‘U’ Has Played Key Role In Attempts To Break the ‘Heart Barrier’.”
-Minneapolis Star Tribune, May 1, 1954
Video of March 26, 1954 Heart Surgery:  
Milestones of Open-Heart Surgery at the University of Minnesota

Survivor Quotes Display:

“"He operated on me in 1957 when I was 7 years old. I had an atrium septum defect and years later, an issue with my mitral valve. I was lucky indeed that my dad took me to him. Dr. Lillehei was a pioneer of open heart, and gave me a full life I would have never had. I developed a complete heart block and was connected to the first pacemaker which was a huge box I was tethered to. Earl Bakken, founder of Medtronic, developed it working with Dr. Lillehei. I have corresponded with Dr. Lillehei as I became older and went back for his advice after I was married and wanted children. Medtronic years later reunited us for a Christmas function for Medtronic, and Dr. Lillehei presented my case."”

-Sheena Sims, survivor of open-heart surgery and former patient of Dr. Lillehei, quote from personal interview

“I can’t explain what the value of research at the University of Minnesota and the life of Dr. C. Walter Lillehei mean to my life. It was, probably because of Lillehei’s work, the only place in the world where my medical condition could be corrected in 1963. I probably am here today simply because I was born in the shadow of the University of Minnesota and my family physician had a relationship with the University and Dr. Lillehei. Fifty-seven years have passed since that surgery and continue to be extremely grateful for the genius of Dr. Lillehei and the care I received from him and his team at the University of Minnesota.”

-Tom Anderson, survivor of open-heart surgery and former patient of Dr. Lillehei, quote from personal interview.