machine with a heart

The artificial heart-lung machine at the University of Missouri Medical Center is an assortment of motors, pumps, and tubes. It is not particularly impressive in appearance. To an engineer or a person mechanically inclined, it is the essence of simplicity. Yet it is an important contribution to heart surgery techniques, giving the surgeon unimpeded use of his skill in the repair of heart defects.

Prior to the heart-lung machine, the surgeons worked by touch alone. Now, with the patient's circulatory system shunted through the machine, the surgeon operates on a relatively dry heart for an extended period of time; he sees the inside of the heart he is trying to mend. The heart virtually drained of blood and temporarily deprived of motion, is cut open for a direct view of an interior defect.

The new technique is possible because of equipment that substitutes for the heart and lungs and maintains circulation in the body while the heart is stopped.

Only one other hospital in Missouri has a heart-lung machine. There are relatively few in use in the country. The first successful use of a machine was in 1953. Through experimental stages vari-

HOW THE MACHINE WORKS

A plastic tube (1) leading from the large vein of the patient's heart carries blood to the first pump (2). The pump transfers the blood into a larger tube (3) where oxygen is bubbled into the blood from a tube (4) attached to oxygen tanks beneath the machine. After oxygen is added, the blood flows through a coiled tube surrounded by a water jacket (5) where it is heated slightly above normal body temperature. By the time it has flown through the second pump (6) and through another tube (7) back into the patient's body, the blood has returned to body temperature. *(Photo courtesy Columbia Daily Tribune)*

ous models have taken on different features. The Medical Center's apparatus, developed after many months, has added refinements of its own.

The machine is required to pump the venous blood from the patient's body, mix oxygen with this blood in a manner such as is performed by the lungs, and pump the blood back into the patient's arteries in such a fashion that the vital organs are well supplied with oxygen.

There are several methods which allow adequate mixing of blood and oxygen. The method used at the Medical Center is known as the bubble-oxygenator type where oxygen is allowed to flow into a column of blood and the bubbles are allowed to mix with the blood, the oxygen being absorbed into the red blood cells.

The machine was used on a patient for the first time last January 24, when seven-year-old Paula Marie Seymour of Cainsville underwent open-heart surgery. In the week that followed two more operations using the heart-lung machine were completed. The patients were Sharon Gumpenberger, 12, of Boonville; and Roland Studer, 4, of Paris. All were discharged in satisfactory condition.

Unusual interest attached to the case of Paula. She was born with an egg-shaped hole about one and one-half inches long in the vertical wall which separates the chambers of the heart. The wall separates the blood brought in the heart by the veins from the blood which is to be distributed through the arteries. The blood from the veins is pumped through the right cavity of the heart to the lungs, where it is oxygenated before going back to the left side of the heart. From the left side the blood is distributed throughout the body. In Paula's case, the hole in the wall allowed the oxygenated blood to flow from the left side back to the right side and through the oxygenation process again before being circulated through the body. Thus, the right side of the heart gradually enlarged because of the overwork.

To correct the condition, the hole in the wall had to be closed. During Paula's operation the large vein and the large artery, which carry the blood to and from the heart respectively, were disconnected and attached to the heart-lung machine, while the hole was sewn shut. The machine was in use eleven minutes, all the time required to close the hole in Paula's heart. Without the machine, the surgeon would have had to close the hole without being able to see it, because he could not make an incision to open the heart while there was blood in it. The operation lasted three and one-half hours. Much of that time was required in getting to the heart and, after the hole in the heart was closed, closing the incision in the chest cavity.

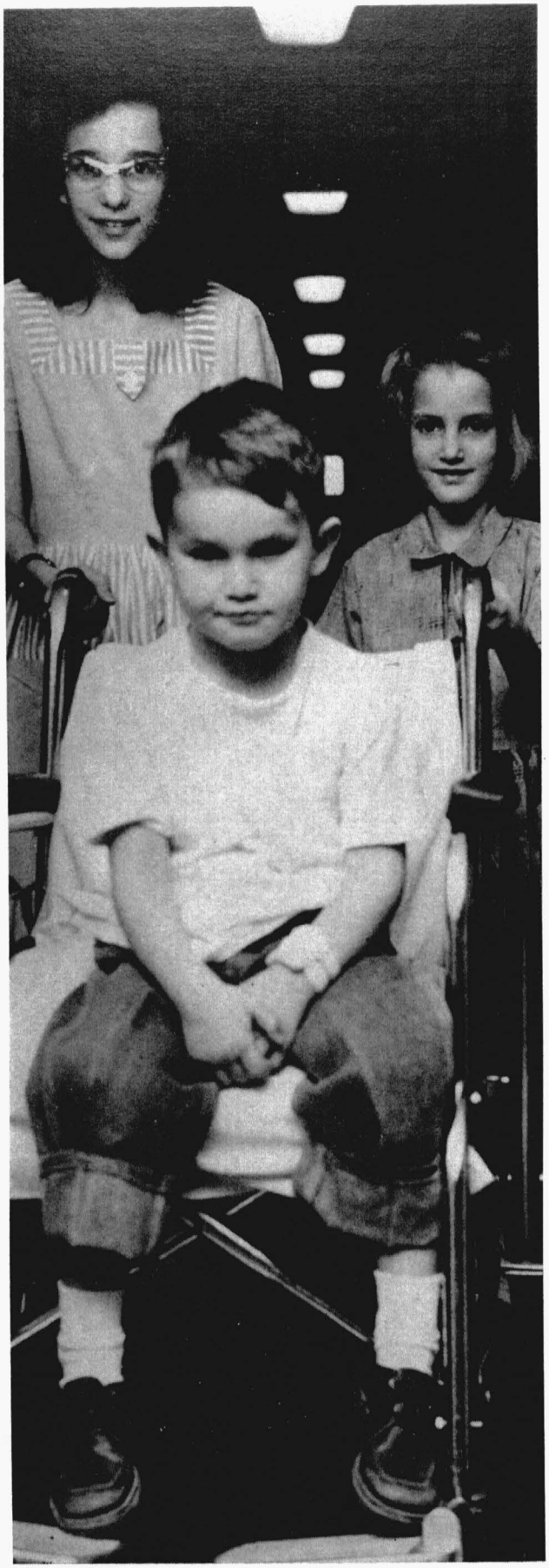
The machine must be filled with fresh blood before the operation. In preparing for Paula's operation it was necessary to have sixteen donors ready to give a pint of blood each. The sixteen donors (there were thirty-four volunteers), with Paula's parents, Mr. and Mrs. H. Wayne Seymour, traveled in four cars to Columbia over 200 miles of snow-covered roads the morning of the operation.

Paula had shown symptoms of a congenital heart condition when she was seven months old. The symptoms were shortage of breath at the slightest exertion, strong heart palpitation, and listlessness. It was feared that she would live the rest of her life as an invalid and that her life would be shortened by the defect.

The girl was first brought to the Medical Center in July, 1957 for observation. The doctors had to know where the hole in her heart was and what abnormality it was causing in the functions of her heart. She was taken to the Medical Center's heart station where extensive tests were begun. In this diagnostic clinic, operated by the Department of Internal Medicine, such a series of tests includes an electro-cardiogram, a pulse-analyzer, a heart-beat sound recorder, a cardiac catheter with pressure recorder and multi-chain recorder of blood pressure, electric potential and blood oxygen, and testing blood samples. (Since the station opened in October, 1956, more than 600 special heart studies, 300 cardiac catheterizations, and 3,000 cardiographs have been cared for).

When the findings of the doctors in the heart station were shown to the surgeon, he could predict what he would find when the heart was opened in the operation. Paula was sent home to wait until the heart-machine was perfected for use, and returned on January 14 to begin preparation for surgery.

On the big day, a 19-member heart-lung surgery team combined their experience and knowledge to correct the defect in Paula's heart. The team included Dr. Hugh E. Stephenson, Jr., head surgeon; Dr. William Wade, first assistant surgeon; Joseph Spalding, senior student assistant; Dudley Conley Miller, Jr., junior student assistant; Dr. Kenneth K. Keown, anesthesiologists; Mrs. Alice Prince, scrub nurse; Mrs. Marilyn Wade, operating room supervisor; Mrs. Pat Missler, circulating nurse; James Turner, heart-lung machine engineer; B. J. McClatchey, surgical technician; Herbert McDonald, pump assistant; Dennis Semkin, student assistant anesthetist; Dr. Jack Martt, cardiologist; Dr. Vincent Perna, assistant professor of



—Columbia Daily Tribune Photo.

pathology in charge of the hospital blood bank; and Dr. Constantine Anast, pediatrician.

Paula should soon be able to live the life of other seven-year-old girls. Next fall she will enter the second grade, after being out of school a year. Similarly, Sharon Gumpenberger and Roland Studer can be expected to enjoy normal activities.

Additional refinements have been added to the heart-lung machine since the first three cases, and full-scale use of the machine is expected to begin in April, with one day a week being devoted to open-heart surgery. Three patients (two of them are adults) are in the Medical Center now awaiting open-heart surgery. There is a considerable backlog of other patients waiting at their homes to be called in for an attempt to correct their heart disease. The Medical Center is a center for the heart program of the State Crippled Children's Program.

Work on the machine at the Medical Center has been progressing almost since the day the Medical Center was opened. It is a slightly modified pump oxygenator along the lines of that developed at the University of Minnesota. Several additions to this machine have been contributed by Dr. Wade, chief resident and instructor in surgery, and through the close cooperation of Mr. Turner, shop supervisor at the Medical Center. Mr. McClatchey, surgical technician, has long worked closely with the machine.

Because of the precise nature of the functions of the heart-lung machine a team of considerable efficiency is required. The pumping function and the oxygenating function of the machine must be carefully regulated as well as the blood volume and flow, the control of temperature, the control of coagulation of the blood and the prevention of hemolysis, or breakdown of red cells. In addition, the problems related to the anesthesia of a patient undergoing an open-heart operation are those requiring special attention and at the University they are under the direction of Dr. Keown, formerly of Philadelphia, who probably has given anesthesia to more patients undergoing heart surgery than anyone else in the United States. The multitude of instruments and procedures employed calls for increased nursing assistance on the team and great coordination of the surgical team.

The operations usually take from three to six hours with the heart-lung machine substituting for the heart for a period of ten to 45 minutes or more. Additional refinements have included methods of chemically stopping the heart, allowing the surgeon to work on a completely quiet organ. Holes are being patched with a plastic type of material and work on artificial valves has been progressing. The indications for the use of the heart-lung machine are probably still in their infancy. If an entirely rational approach to surgery for coronary artery disease develops, it is possible that the heart-lung may be used.

They face a brighter future: Sharon Gumpenberger, Paula Marie Seymour, and Roland Studer.