MEDICINE

Stop Hearts to Save Lives

Heart-lung machines completely take over the function of the human heart, leaving surgeons free to repair the "sick" heart. There are various types of these machines.

By JOHN W. ROBINSON

➤ COMPLETE heart failure is now saving life instead of taking it. In all parts of the country an increasing number of people have had their hearts stop altogether, and then start up again 15 or 30 minutes later.

Ten years ago they would have been dead on the spot, but today they are not only alive, but healthier than ever before. Their thanks go to an ingenious maze of tubing, motors and plastic known as the mechanical heart.

The mechanical heart, or heart-lung bypass machine, as it is more properly called, is a device considered impossible a few short years ago, but nevertheless, it is a lifesaving reality in a growing number of hospitals today.

The Mayo Clinic, Rochester, Minn., alone has successfully used the machine on nearly 175 seriously ill patients. It is helping to conquer one of the last great frontiers of medicine, surgery on the human heart. The machine pinch-hits for two of the body's most vital organs and supplies rich, red blood to a human being whose own heart lies motionless in the surgeon's hands.

Heart-Lung Combination

Heart-lung bypass machines, as their name implies, are really a combination of two artificial organs, heart and lungs. Many types of them are being developed and used throughout the country, but they all perform the same two necessary functions. First, they drain the "used" venous blood from the body and oxygenate it, or replenish its supply of life-giving oxygen. Second, they pump the revitalized blood back into the body, just as the normal heart would do.

In this way the heart and lungs are "bypassed" and allowed to rest, giving the surgeon an open, dry area in which to work.

The history of present day heart-lung machines is a relatively short one, but it is a history filled with the drama of human life. Much of the pioneering credit goes to Dr. John H. Gibbon Jr., Jefferson Medical College, Philadelphia, Pa., who has been working on mechanical hearts for the last 30 years.

On May 6, 1953, he successfully used his apparatus on a human patient, probably for the first time in this country. The beneficiary was an 18-year-old girl, born with a damaged heart. Dr. Gibbon and his associates at Jefferson Medical College repaired the defect while the machine took over for the girl's heart and lungs. Her recovery was classed as "uneventful."

Although today's mechanical heart is saving lives, it is still a long way from perfection. In the words of one surgeon, we will soon look back on today's heart-lung machines as we now do the Model T Ford.

Machines Modified

An expression frequently heard when the machines are discussed is "This is a modified such-and-such," the key word being "modified." Each group of researchers is constantly making changes and improvements here and there, hoping to speed the day when the mechanical heart and lung will be as foolproof and efficient as its human counterpart.

A close look at how the machine actually does its job points out the many problems encountered in this never-ending process of development.

The oxygenator or "breathing" section of the apparatus has perhaps been subject to more change than any of the other parts. The designer's goal has been a device in which blood and oxygen will be brought together as quickly and completely as they are in the human lung.

Various mechanical approaches to achieving this ready transfer of oxygen have been tried. The three main methods are dialysis, bubbling and filming.

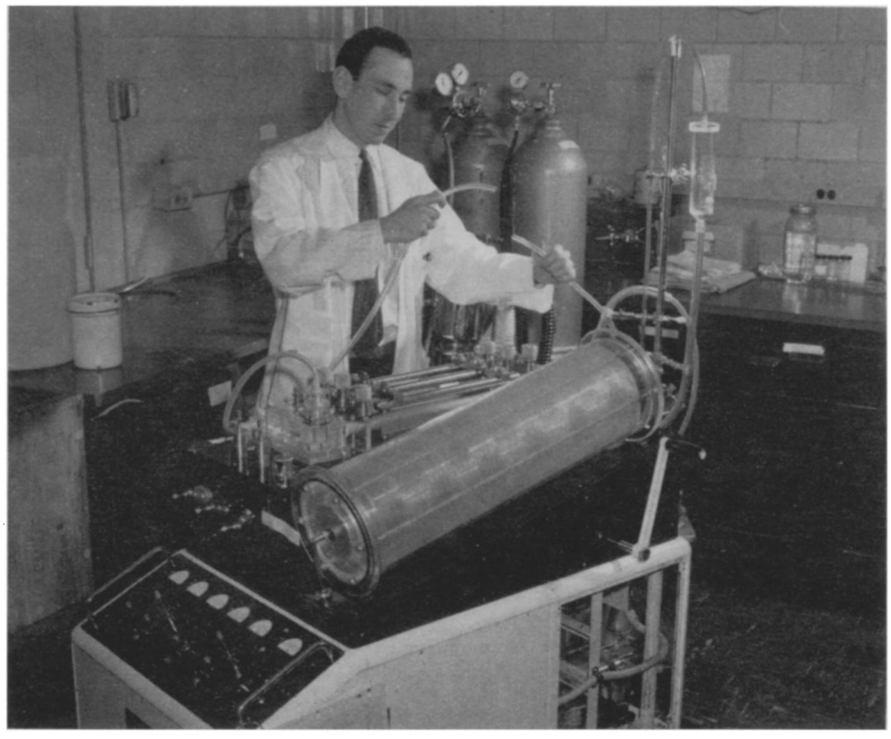
Dialyzing methods are those in which the gas is made to pass through an artificial membrane much like the lung. They use a long length of cellophane-like plastic tubing through which the blood travels. The tubing is coiled and enclosed in an airtight drum through which pure oxygen is pumped. The gas then passes through the plastic membrane as it would through a normal lung.

One big drawback to this method is the amount of tubing needed to insure sufficient oxygenation. For oxygenating the five quarts of blood in an adult human, an impractical number of drums would be needed.

Bubbling Oxygenation

Bubbling oxygenators perform their job by actually bubbling pure oxygen up through a reservoir of "used" venous blood. The gas divides into hundreds of tiny bubbles which foam up through the blood, and create a frothy mixture that changes color from blue at the bottom to bright red at the top.

This mixture is then defoamed, and the



MECHANICAL HEART — Dr. John Ross Jr., Cardiac Surgical Service, National Institutes of Health, Bethesda, Md., holds up the two tubes which connect the Melrose type heart-lung bypass machine to the human body.

freshly oxygenated blood is sent to the pump for return to the body.

Two problems of the bubblers are ensuring complete defoaming and the necessity for perfect bubble traps to remove any stray gas bubbles which might otherwise find their way back into the human blood stream.

Oxygenation by Filming

The filming method of oxygenation works by spreading the blood out into a fine surface film which is surrounded by oxygen. In some oxygenators of this type the blood is allowed to run down a series of fine wire screens which spread it across their hundreds of tiny open sections. In another type, plastic discs dip into the blood and become covered with a thin film of blood on their surface.

Filming oxygenators are capable of a high degree of speed and efficiency, but one of their drawbacks is the large amount of blood needed to "prime" the machines before they are put into use.

All the oxygenators are still in the developmental stage with different research teams preferring different types. Here, as in other aspects of the mechanical hearts, the trend is toward simplification. Many "disposable" type lungs, mostly bubblers, have been developed. These are cheap enough to be discarded after one use, rather than being sterilized and reused.

For the most part, the pumping mechanisms of the heart-lung machines are their simplest parts. They all move blood along by alternately squeezing and releasing a flexible tube through which the blood flows. In this way no metallic parts actually touch the blood, and a minimum amount of "shock" is transferred from motor to fluid.

If two pumps are used, one to pump blood out of the body and the other to pump it back, the problem of balancing the output of the two becomes difficult. For this reason some machines now include only the pump for pushing blood back into the body. A gravity feed system is used to keep blood flowing to the machine.

The basic problems of blood transport and oxygenation have been solved, but now the major problem is one of gentleness. The whole blood circuit must be made as non-injurious as possible.

The blood must be kept free-flowing in the machines by adding heparin, a powerful anti-clotting substance produced by the body. Then, when the patient is once again "off the machine," his normal heparin level must be quickly restored by adding protamine, a protein substance that restores the clotting property of the blood.

Blood platelet destruction resulting from the turbulence created by sharp corners in the blood's path has been a problem in some machines. Hemolysis, or the separation of the oxygen-carrying hemoglobin from the red cells, also occurs.

These are some of the operational difficulties that still have to be worked out, although not all researchers have trouble with the same ones. Different machines and techniques present different problems.

Although most of the presently used machines have price tags in the thousands of dollars, their cost will no doubt drop as they become more standardized and simplified. Some disposable type lungs are now available for approximately $25.

The mechanical hearts have now unquestionably passed the stage of being used only as a last resort. Their possible applications include immediate revival after apparent death, major repair of worn-out circulatory systems, and healing rest for tired hearts.

The mechanical heart has given medical science a new and powerful ally against the nation's number one killer, heart disease.

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● RADIO

Saturday, March 16, 1957, 1:45-2:00 p.m., EST

"Adventures in Science" with Watson Davis, Director of Science Service, over the CBS Radio Network. Check your local CBS station.

Dr. Bernardo A. Houssay, nobelist in medicine, 1947, and Professor, Medical School of Buenos Aires, Argentina, will discuss "Medicine in South America."