Surgeons Disagree on Artificial Heart

Opinions range from going ahead with the device now in use while research continues, to stopping all use of the artificial heart until its design is improved

During the past 3 years, the artificial heart has been implanted in 11 patients, amid much fanfare but with decidedly mixed therapeutic results. The experiments to date have shown that the device can save patients from death, for a time at least, but it is also clear that a range of serious medical problems can follow implantation.

The appropriate role of the artificial heart in experimental medicine and, later, in medical practice remains very much in doubt. In fact, as was apparent at a recent meeting on Human Heart Replacement,* even leading transplant surgeons cannot agree on where to go next.

So far, only William DeVries of Humana Heart Institute International in Louisville is authorized by the Food and Drug Administration to implant permanent artifical hearts, but the FDA does allow others to use the device as a temporary measure to keep patients alive until a human heart becomes available. But patients are becoming increasingly reluctant to have the device implanted, even temporarily.

Jack Copeland, a surgeon at the Arizona Health Sciences Center in Tucson who pioneered the use of artificial hearts as a bridge until a permanent heart is available, said that since complications with the artificial hearts have become evident, "we do not get as many referrals." When Copeland tells patients with serious heart disease that the average waiting period for a human heart transplant is 10 days and then asks them if they would want a temporary artificial heart if their condition deteriorates, "most say no. They worry about bleeding, strokes, and kidney failure."

On the other hand, says O. H. Frazier, director of the cardiac and pulmonary transplant program at the Texas Heart Institute in Houston, the current difficulties with the artificial heart should be put in perspective. "The amazing thing to me is how well it's done," Frazier remarks. "We had a lot more problems with it in animals than we do in people. And you have to remember that these are dying patients." Frazier says that he and others in the field firmly believe that it is simply too soon to draw conclusions about the ultimate feasibility of the device. "We should probably do 100 artificial heart patients before we make a report," says Frazier.

Still, the question facing policy-makers and the public is, Should artificial hearts be implanted in any more patients and, if so, in whom and for how long? Despite the fact that the success rate for artificial heart implants may well improve, investigators by no means agree on what should be done now.

DeVries, a proponent of the device, states that the Jarvik 7 heart—the only one approved by the FDA for permanent use in patients—should continue to be implanted. "As soon as a patient comes along, we'll do another one [artificial heart implant]," DeVries remarks.

> Most heart patients say they do not want a temporary artificial heart if their condition worsens, says Copeland.

Copeland is more circumspect. The most logical course of action, he remarks, is to use the artificial heart only as a temporary measure. "The laboratory results indicate that it always fails. The longer you leave it in, the more likely it is that you will have trouble," he says. It is useful as a bridge until a donor heart is available because, he notes, "20 percent of the patients we see die before we can get a donor heart. Another 20 percent have a failure of their donor heart immediately after their transplant. So the artificial heart has a place. As an alternative to death, it is generally acceptable."

Of the surgeons at the meeting who have implanted Jarvik 7's, the most reluctant to use the artificial heart as it is now constructed is Bjarne Semb of the Karolinska Hospital in Sweden. Semb, the second physician to implant an artificial heart, gave a Jarvik 7 heart to a patient whose physical condition had so deteriorated that he was turned down for a human heart transplant. After the device was implanted, the patient did quite well and soon was climbing five flights of stairs and asking to be interviewed by American television hosts such as Walter Cronkite and Barbara Walters. "I was surprised myself to see that it was possible with the relatively crude technology of the artificial heart to get so far," Semb remarks. But the patient eventually developed thromboembolisms and cerebral bleeding. "He might as well have died," Semb says.

Robert K. Jarvik points out he is continually modifying the heart, but making each modification is a long process. He makes one change at a time so if the heart performs differently after he modifies it, he will know to what to ascribe the differences. For example, after the valve broke in Barney Clark's heart, Jarvik made future hearts with a much stronger valve and none have broken since. (Clark, the first artificial heart recipient, was operated on by DeVries in December 1982.) When Clark suffered from hemolysis, Jarvik reduced the force with which blood is expelled from the heart, thereby correcting that problem. Now he is working on modifying the heart to reduce the incidence of strokes.

Of course, Jarvik remarks, "If I had a choice between an artificial heart and a heart transplant, I'd take a transplant—we all would." But he foresees a time when some patients will opt for permanent artificial heart implants because transplants are simply not an option. Heart attack victims, he notes, "can't wait for donors. But these patients can be saved." They can be given artificial hearts and then put on a waiting list for a donor heart. Yet, he speculates, "I will bet you that the majority of those who get the heart transplants will be heart attack patients in their 20's and 30's. The older heart attack patients will not get donor hearts. There will be many situations where permanent artificial hearts make sense."

But many at the meeting were not so optimistic about the future of permanent artificial hearts. As matters stand now, the quality of life for permanent artificial heart recipients is simply too grim. The device is too crude and it will take a long time for its difficulties to be ironed out, they say. And some pointed out that even using artificial hearts as a temporary device can be questioned because there are only so many human hearts available and keeping legions of patients alive with artificial hearts would do noth-

*The meeting, sponsored by the Foundation for American Communications, was held in Washington, D.C., 24 to 25 October.

ing to alleviate the human heart supply problem.

Roger Evans of the Battelle Institute estimates that there are potentially 1000 heart donors in the country each year. Four hundred human hearts were transplanted last year. So, even if all 1000 hearts were to be used, the majority of patients would not get human hearts.

"There are at least 100 people waiting for hearts now," says Arthur Caplan of the Hastings Center. "The use of artificial hearts could potentially skew the distribution toward giving those hearts that become available to those most desperately in need. Since the artificial heart is still a crude device, people with artificial heart implants are desperate." The possiblity is that patients who opt for the artificial heart transplants will jump to the top of the list of human heart recipients, edging out those who would have gotten the human hearts if the artificial heart patients had not had their implants.

There are no easy answers, of course. And the artificial heart may soon be used in more institutions than it is now. Clinical investigators from about a dozen medical centers have been trained to use the Jarvik 7, and several other centers here and abroad are preparing for artificial heart implants. Some of the U.S. investigators are seeking FDA approval to use the device as a permanent implant. Other researchers are designing new types of artificial hearts, including a centrifugal force heart that does not beat but pumps blood continuously. "As scientists, we are trying to determine what can be done," DeVries says. "The people will determine how much of what can be done will be done."—GINA KOLATA

Americans Scarce in Math Grad Schools

Kenneth Hoffman, a mathematician at MIT, has noticed a striking change in the backgrounds of math graduate students. "When you go into our common room these days, no one is speaking English," he remarks. Out of 125 MIT mathematics graduate students, only 65 are American.

It is a trend that is becoming more and more pronounced. Americans are now in the minority in many mathematics graduate departments. The proportion of foreign mathematics graduate students at American universites is unknown, but anecdotal evidence suggests that the more elite the math graduate school, the fewer Americans attend it. Yale has 21 new math graduate students this year. Five are Americans. New York University's Courant Institute has five Americans among its 25 graduate students with financial support. Further evidence of this phenomenon is in mathematics Ph.D.'s—which reflect the graduate student make up of several years ago. Last year, 55 percent of the mathematics Ph.D.'s awarded in this country were given to Americans. In 1979 to 1980, 73 percent of the math Ph.D.'s went to Americans.

The majority of the foreign students come from Taiwan, China, South and Central America, and India, and usually are excellent students. "They are highly motivated and motivation is a big part of being successful," says Ronald Graham, who is director of mathematics and statistics research at AT&T Bell Laboratories.

Yet the lack of Americans "is a matter of concern," says Richard Beal, chairman of Yale's math department. "I don't think there's anyone you can talk to who won't have some version of this problem." The difficulty is that no one is certain why Americans are shunning graduate studies in mathematics nor what can be done about it.

One popular hypothesis is that mathematically talented Americans choose not to get Ph.D.'s because they can make more money in other fields. Academic salaries for mathematicians dropped 20 percent in real dollars from 1970 to 1985, says Donald Rung of Pennsylvania State University, who is chairman of the American Mathematical Society's committee on employment and educational policy. Salaries of full professors at the most elite universities went from $57,000 to $48,800 in 1985 dollars, and the salaries of full professors at other schools dropped from $54,000 to $44,000 in 1985 dollars in the past 15 years. "I agree we're not poor," Rung says. "But industries are luring away prospective students before they get Ph.D.'s. Why start as an assistant professor at $21,000 when you can get more than that from industry with just a bachelor's degree?"

Other hypotheses are that because mathematics teaching in elementary and secondary schools is so poor, many potential students are never really introduced to mathematics. They never see any interesting mathematical work. Or perhaps, some mathematicians propose, students turn away from mathematics because other fields, such as molecular biology and elementary particle physics, seem much more dynamic. "Some of the other sciences are in periods of seemingly explosive growth while mathematics is chugging along at the same old rate," says Beals.

No matter what the explanation, however, it seems clear to both academic and industrial mathematicians that the situation is of real concern. There is a shortage of mathematicians in this country which is expected to get even worse in the next 5 years as the mass of mathematicians who entered the field in the Sputnik era retire. About one-half of the foreign students return home immediately after getting their Ph.D.'s, says Hoffman. And many of those who stay tend not to be interested in teaching, says Percy Deitt of the Courant Institute. "In my view, what's really being killed is the teaching of the discipline at the grass roots level," Deitt remarks. The Department of Defense will also be affected, Rung points out, because many of the foreign mathematicans will not be able to get clearances. "In case of an emergency, what kind of a group of scientists could you have?" he asks.

As might be expected, mathematicians do not know how to remedy the situation. Some wish for better publicity, glamorizing their field, but, being realistic, do not expect it to happen any time soon. One of the more intriguing suggestions is from Beals. He was recently at a meeting in Albany where, at dinner, eight mathematicians were discussing the lack of American graduate students and what to do about it. Each in turn told how he had gotten interested in the field and, without exception, there had been a specific teacher or course that first sparked each one's interest. But, says Beals, "the kind of course was exactly the kind of abstract and rigorous course that turns most people off. So perhaps one way to get mathematicians is to give such a rigorous course. The students who float to the top will be confirmed as mathematicians."—GINA KOLATA