# Artificial Heart: The Beat Goes On

*An Institute of Medicine panel says the device may be a bad social bargain but recommends further federal research anyway*

MORE THAN A QUARTER OF A CENTURY AGO, a panel of heart specialists urged the government to finance the creation of an artificial heart, predicting the job would take just 5 to 10 years. Now—$260 million in federal funds later—comes another blue-ribbon panel, this one at the Institute of Medicine (IOM), offering the sixth major review since the program began and concluding (guess what?): The government should back another round of artificial heart research because questions about its efficacy can be answered in just 5 to 10 years for a few tens of millions of dollars.

If this sounds like the biomedical community's version of fusion research—years of promise, years of debate, ever-sliding deadlines for success—it is. And, like fusion, the costs of the effort (around $10 million a year)—and the potential cost to the medical system if such a device actually becomes widely available—have been controversial. Just 3 years ago, Claude Lenfant, director of the National Heart, Lung, and Blood Institute (NHLBI), tried to shut off funds for development of a totally implantable heart, only to be overruled by Congress.

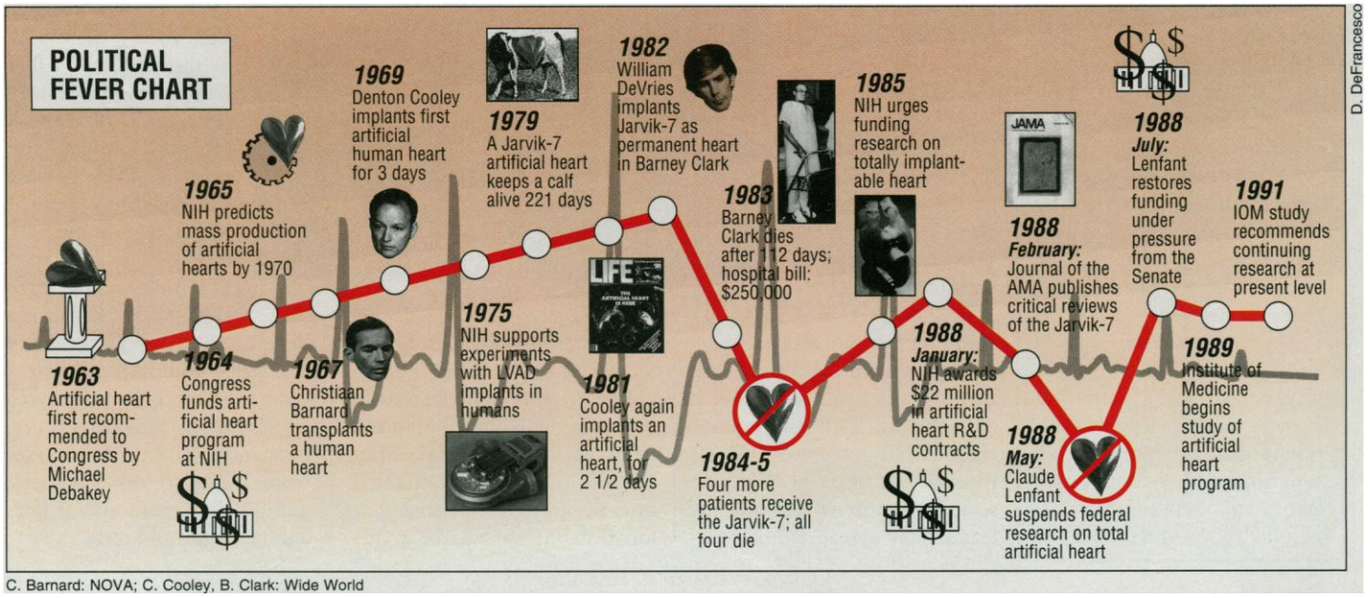
Lenfant then turned to the IOM for an appraisal of the costs and benefits of the program and advice on what his institute should do. What he got is a study*, chaired by John R. Hogness of the University of Washington's School of Public Health and Community Medicine, that concludes the projected costs would be greater, and the benefits lower, than for any medical procedure now in use, but that research should go on anyway. At a press conference on 23 July, members of the panel said that the artificial heart is worth pursuing because it holds out the hope of prolonging life for thousands of heart disease patients facing certain death. And, said panel member Neil Powe, a cardiologist at Johns Hopkins University, it's always possible that the costs will come down.

While this report still has some of the optimism of earlier studies, it is more cautious, reflecting a wariness about high-risk experiments of the kind that made the Jarvik heart infamous during the 1980s. That medical fiasco (not supported by federal funds) led to the public ordeal of five volunteer patients, including the Seattle dentist Barney Clark, and soured many on the prospect of artificial heart research. Since then, more than 90 additional patients have received Jarvik-7 implantable hearts, but only to keep them alive while awaiting a transplant (see box).

The Hogness committee says it is "very concerned about possible inappropriate uses" of artificial heart systems in patients for whom other approaches might be better. It urges the medical community to write explicit guidelines before the technology is released to the marketplace, identifying which patients should and should not get implants. The panel worries also that insurers may not be able to support the wide use of these machines, especially if the hardware costs more than $100,000 per person, as seems likely. Two decades from now, there could be 35,000 to 70,000 people qualified to receive artificial hearts each year. If the technology turns out to be as good as promised, says the Hogness panel, the demand could grow to 200,000 per year by 2020.

Then there's the problem of equity. Because these devices are being built with public funds, doctors must eventually grant equal access to all comers, regardless of their ability to pay. And the committee concedes that, by its own accounting system (which measures life extension in "quality-adjusted life years, or QALYs"), the artificial heart is a bad bargain. Its cost-effectiveness is about $105,000 per QALY gained—"substantially less favorable than...heart transplantation and other accepted forms of treatment for

*"The Artificial Heart: Prototypes, Policies, and Patients," National Academy Press, John R. Hogness and Malin VanAntwerp, eds., Washington, DC, 1991.




C. Barnard: NOVA; C. Cooley, B. Clark: Wide World

heart disease," which cost about one-third as much. Even hemodialysis is far cheaper in QALY terms.

So, with all these doubts and concerns, why continue with the program? It would be wrong, they say, to cut off R&D funds as a way of controlling the spread of an expensive new medical technology. Research funding decisions—at least at the agency level—should be based purely on technical merit. After "consulting widely among known experts" in the United States, said panel member George Thibault of the Roxbury, Massachusetts, veterans hospital, the group settled on a "consensus forecast": By 2010 the artificial heart will be able to prolong the life of an average user by 4.4 years. This is the promise that keeps the program going.

But it's a narrow promise, say critics like Thomas Preston, a cardiologist at the Pacific Medical Center in Seattle. He objected to the experiments with the Jarvik-7 heart in the 1980s and today compares the artificial heart to a supersonic transport plane. While it may represent "superior" technology, he says, "for very good economic reasons we may decide not to use it." The "great ethical question," he continues, is whether it is right to invest our limited medical resources in a system that will benefit so few people.

Because the program is fraught with ethical concerns, the Hogness panel set some conditions on its recommendation that funding be continued. First, the government should complete and perhaps expand trials of a partial heart system known as the left ventricular assist device (LVAD), financed through contract research. Second, it should lay the groundwork for clinical trials in the year 2000 by extending for a few years the preliminary contracts for designing and testing artificial hearts, now supporting four research teams. This "interim period," they say, should be used to collect data on the quality of the hardware and on the psychological and social problems that would accompany its use. Third, in 1993 or 1994, the government should take a fresh look at all these issues and possibly fund 5 years of additional experiments with the total artificial heart. All this could end up costing about $100 million through 2000. Then, by the turn of the century, the nation should be ready to make a well-informed and final decision about the artificial heart.

These conclusions may not be exactly what the heart institute wanted to hear. Lenfant welcomed the document, however, noting that "we have our areas where we wish it would have been different," but it is "going to be a useful report." Where does Lenfant disagree? He said he was disappointed that the panel said so little about other promising developments in cardiology—such as molecular biology and gene therapy—that may provide better means of treating heart disease in the next decade. "There is so much happening today" that the "challenge to the usefulness of the artificial heart is going to increase every year" between now and 2000, Lenfant predicts. When the panel was asked if it had considered such alternatives, Thibault replied that it had not, because the results would be "only conjectural at best."

Lenfant also said he would have preferred a more extensive discussion of philosophical and social issues, such as the question of whether the public is ready to spend several billion dollars a year on a new medical device—a rough estimate of what it might

## A "Bridge-to-Transplant"

Patients with end-stage heart disease have few options at present, but researchers haven't given up trying to create some new ones for them. In the United States, about 28,000 people become eligible for natural heart transplants each year, while only 2000 hearts are donated and available for use. The majority of patients thus have no hope of living out the year. Hence the rationale for the artificial heart.

While the potential demand is intense, the supply at present is nonexistent. These devices are now used only to provide a "bridge-to-transplant," in the terminology of the field. The government has approved using mechanical hearts only as a means to sustain life while the patient awaits a heart donation. Several hundred of these patients are temporarily connected to external heart pumps each year, and a handful of others receive one of several types of internal blood pump. All of these devices are cumbersome, of course, requiring that the recipient remain tethered to a power source.

The ultimate aim of the artificial heart program at the National Heart, Lung, and Blood Institute (NHLBI) is to develop a machine that's entirely enclosed within the body and capable of running continuously for 5 years. Even the optimists say it will take a decade of R&D before clinical trials begin. The main technical barriers still to be overcome are problems in the durability of valves, pump drives, and batteries; the tendency for blood cells to stick to artificial materials and form dangerous clots; and internal bleeding and infection.

However, the research program is about to enter a new phase. By September, heart surgeon Philip Oyer of Stanford University hopes to begin animal tests that could be critical for the program's future. These experiments involve a gadget called the left ventricular assist device (LVAD), which, simply put, is half of an artificial heart. The LVAD is connected to the heart's left ventricle (the hardest working chamber, where problems appear first), providing extra pressure to the entire circulatory system. These LVADs are designed to be entirely implanted within the body and to run for 2 years. Unlike all previous systems, they allow the patient to move about freely without being tied to an electric or pneumatic power line.

Oyer says he hopes that "within the next 3 months" he will begin implanting LVADs in a group of 12 sheep, providing the final data needed to win permission for human trials with LVADs scheduled to begin with 20 patients next year. Right now, Oyer says he's just waiting for the LVAD manufacturer, the Novacor Division of Baxter Healthcare, to complete the final mechanical checkout of its devices. Ultimately, Novacor hopes to build an electric-powered device that runs for 5 years.

Four groups have won contracts to work on total artificial hearts, and all are in the early stages of experimentation. These groups include:

- ABIOMED, Inc. of Danvers, Massachusetts, led by Robert Kung, in collaboration with the Texas Heart Institute of Houston, Texas.
- A group at the Hershey Medical Center of Pennsylvania State University, led by Gerson Rosenberg, in collaboration with the 3M Corp.
- A group at the Cleveland Clinic Foundation, led by Leonard Golding, with the Nimbus Corp. of Rancho Cordova, California.
- The Artificial Heart Laboratory of the University of Utah, Salt Lake City, led by Donald Olsen.

Meanwhile, the company that took over rights to manufacture the Jarvik-7—the tethered, pneumatic artificial heart that got all the attention in the 1980s—has disbanded. And the designer of that machine, Robert Jarvik, says he has come up with an entirely new "intra-ventricular" pump called the Jarvik-2000. But so far he hasn't been able to persuade NIH to fund his work. ■ E.M.

cost to achieve the goals described in this report. "I think the country is going to have quite a burden if it has to take care of 150,000 people with an artificial heart," Lenfant commented. And he wondered how many heart patients—or their families—are really eager to have this technology.

Doubts such as these may have played a part in Lenfant's decision in 1988 to cancel federal contracts for research on the artificial heart, while keeping the LVAD program alive (*Science*, 20 May 1988, p. 976, and 15 July 1988, p. 283). But Lenfant insists his main reason for acting was a shortage of money: His agency, he felt, just couldn't give adequate support to both a total artificial heart program and an LVAD, which in 1988 seemed more likely to yield practical results. But Lenfant's decision to cancel the contracts was effectively reversed when Senators Edward Kennedy (D–MA) and Orrin Hatch (R–UT), defending home-state research centers, stepped in and forced NHLBI to restore the funds.

Some day, says Lenfant, "somebody is going to look at all these [risks and costs], add them up, and see where we are going." This was precisely what NHLBI asked the IOM to do. But the Hogness panel has decided that it, too, is unqualified to pass final judgment on so large an issue, noting that it lacks adequate "hard information" on the risks and benefits of what is now an embryonic technology. The recommended solution, therefore: Stall for time and take a second look by 1995.■ ELIOT MARSHALL

# Sullivan Overrules NIH on Sex Survey

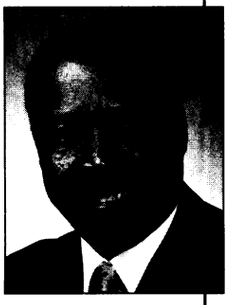
The Public Health Service rarely bows to politics as completely as it did last week when—hounded by a group of conservative congressmen—the secretary of Health and Human Services (HHS), Louis Sullivan, killed a research grant for a 5-year study of teenagers' sexual behavior. Neglected in the wide publicity about Sullivan's veto was the threat it poses to peer-reviewed research at the National Institutes of Health (NIH).

This $18-million project, run by sociologists Ronald Rindfuss and Richard Udry at the University of North Carolina, was an investigator-initiated proposal to collect data that might be useful in fighting AIDS and preventing teenage pregnancy. The authors planned to interview 24,000 children in grades 7 through 11, with parental consent. And, indeed, their project was fully "approved"—it was put through peer review at the National Institute of Child Health and Human Development, passed by several layers of administration at NIH, personally cleared by NIH director Bernadine Healy, and okayed by James Mason, the assistant secretary of health. Scientists were particularly intrigued that Mason gave his approval, because he has carried the conservative banner in biomedicine—on fetal research, for example—for the Administration.

But then, the secretary of Health and Human Services did something no secretary seems to have done before. He revoked financing for the sex survey on 23 July, 2 months *after* Rindfuss and Udry had cashed their first check and begun work. Rindfuss says he still hasn't received any written notice that the project has been killed, although a public affairs person from HHS called him to say it is dead. According to an official statement released by HHS, Sullivan decided the study "could inadvertently convey a message undermining [Sullivan's] warnings about the dangers of promiscuous sex."

Healy was well aware of the controversy this research might provoke and apparently was ready to defend it. *The Boston Globe* quoted her before the furor broke saying that it was "a wonderful study....I knew it would be controversial....I read the whole thing myself and I think it's an excellent study." Later, she told *Science* that in cancelling the project, Secretary Sullivan had "exercised his authority under the law, and I honor his decision." Now this research can go forward only in the "private sector," she said. Has NIH lost some independence? "I cannot comment on that," replied Healy.

The reversal sent a shock wave through NIH, which has long sought to keep politics out of peer-reviewed research. One NIH official, speaking on condition of anonymity, said Sullivan's action could invite more political meddling. NIH staffers have begun combing the records for other recent grants that might draw political fire. The damage may be spreading already.



*Louis Sullivan*

To one outside observer, Howard Silver of the Consortium of Social Science Associations, it looks as though Sullivan ignored the advice of a special panel put together to help recruit an NIH chief after James Wyngaarden's departure. One of the panel's main recommendations was to insulate NIH from politics and the HHS bureaucracy. But in this case, just the opposite happened, Silver says: Sullivan "caved in" to "know-nothingism" and overrode NIH's leadership.

Neither Sullivan nor Mason would discuss the decision. However, Paul Simmons, Mason's spokesman, brushed aside a suggestion that NIH is being politicized. "I wouldn't read anything into one action like this; there's no history of political decisions like this being made" at NIH, he said.

Sullivan learned about the project when he was asked about it by a viewer who called in during his appearance on a TV talk show run by the Coalition for America. Sullivan told the audience he hadn't been told about the study and would look into it. At this point, Representative William Dannemeyer (R–CA), a fervent opponent of abortion and of research involving human fetal tissue, obtained copies of some of the survey questions and excerpts soon appeared in the press. Dannemeyer also drafted an amendment to the NIH authorization bill, due to reach the floor of the House last week, blocking all sex surveys. But even before the debate began, Sullivan killed the North Carolina project.

To ensure that this survey—or another like it—would not be resurrected, Dannemeyer asked for a vote on his amendment, saying he feared the purpose of such studies was "to develop statistical data with a subtle inference to the interviewees that this perverse type of conduct [homosexuality] is okay." Rep. Henry Waxman (D–CA) proposed substitute language that would permit sex surveys, but only if they clear many layers of ethical and peer review. Waxman's amendment passed by a large margin (283-137).

What are the long-range consequences likely to be? Charles Turner, former chief of staff for studies of the AIDS epidemic by the National Academy of Sciences and the Institute of Medicine, worries about the toll in human terms. He says, "We still don't have many of the basic facts we need to understand the patterns of sexual behavior in the population that transmits the [AIDS] epidemic." Many panels have urged the government to collect such data. Without it, says Turner, "we're going to be less effective in preventing the spread of the epidemic; in short, more people are going to die." ■ ELIOT MARSHALL