The leading cause of death in the U.S. and in the world is heart disease. Why should the heart, that humble pump, be the main reason people die?

It was in 1968 at a table in Joe’s Restaurant that Arthur Kantrowitz suggested to David Lederman he might be able to do something great. Thirty-three years later, Lederman did. On July 3, 2001, surgeons implanted the first self-contained artificial heart in 59-year-old Robert Tools. Lederman’s company, Danvers, Mass.-based Abiomed Inc., invented the heart. “I always dreamt of the day,” Lederman says. “I dreamt what it would be like to shake the hands of a patient and say, ‘How are you doing?’ whose [dysfunctional] heart was in a bottle” on a shelf.

But in 1968, Lederman was a Cornell graduate student in aerospace engineering, only a few years removed from his native Colombia. He was president of the local chapter of the American Institute of Aeronautics and Astronautics, he had $1,000 to obtain a speaker, and he didn’t know whom, if anybody, he could bring to town on that sum.

By Kenneth Aaron

Matters of
the Heart
Renowned physicist Dr. Arthur Kantrowitz—the man whose work stretched from beyond the earth, having proved re-entry from outer space was possible, to beneath the skin, having invented the first successful heart-assist device—knew Lederman’s adviser and agreed to speak for free.

Earlier Kantrowitz had been an engineering professor at Cornell; he had since turned his attention to building an artificial heart at Avco Corp. Now he was looking for acolytes to join his quest, and after hearing him speak, Lederman wanted in.

“He came to Ithaca, and he gave a talk on what people who have studied fluid mechanics could do to advance the development of devices and technologies that help the failing heart and replace the failing heart,” Lederman recalls. The message: The heart, that humble pump, should not be the main reason that people die.

After the speech, Lederman took the visitor to Joe’s for dinner. He may have been awed to be seated alongside Kantrowitz, but he wasn’t too daunted to ask for a job at Avco.

“I asked him if he was interested in more than a job—I asked him if he was interested in a lifelong career,” says Kantrowitz, now a professor emeritus at Dartmouth College.

The answer must have been yes. When Lederman finished his doctorate in 1973, he signed on with Avco. And he started doing great things, which, in retrospect, doesn’t really surprise Kantrowitz.

“He was the best chance, by far,” Kantrowitz says. “You could see that he had a lot of drive, and you could see that he was a very intelligent person.”

Lederman grew up in Colombia and had never been to America before he arrived at Cornell. “I was given opportunities I never imagined,” he says. “I met people like Linus Pauling, Hans Bethe; I took lectures with Carl Sagan. It was just unbelievable.”

Lederman seems to cherish the opportunities he’s had and seeks ways to return the favor. Giving extra life to those facing the end is the most obvious manifestation. But he has also stocked his company with former Cornellians and every year opens its doors to current Cornell students looking for internships and co-ops.

The people who work at Abiomed can feel Lederman’s pulse coursing through it. “The character of the company is set by Dr. Lederman,” says Seana Richardson ’00 MSE, a Cornell graduate who has worked there since August 2000. “We are all motivated by our desire to save human lives, and are proud of our efforts to do so.”

Abiomed was established in 1981 and until releasing the AbioCor, the company had only one product: a heart pump that gives failing hearts a boost. The device, which is the company’s chief revenue source, has been used on more than 4,000 patients.

Six people thus far have been outfitted with an AbioCor. By the end of January, three were still alive. Four of them survived at least 60 days, the company’s goal for this first phase of human trials. One died after 57 days. One other person died on the operating table. Robert Tools, the first recipient, died after suffering a stroke and severe abdominal bleeding; he had his new heart 151 days.

Lederman has always been clear that all of the patients who received the artificial heart in this phase of testing would die. The qualifications to participate in the clinical trial practically assure it: To be accepted into the AbioCor program, patients must be within 30 days of death and have no other options. Yet all of them could glean more hope from the grapefruit-sized AbioCor than through their own failing hearts.

The patients, perhaps needless to say, are thrilled with their extra time. But Lederman and others at Abiomed are thrilled, too, with how well the tests have gone, despite having lost three patients. “It’s more than a success,” Lederman says. “It’s absolutely incredible. In the case of Bob Tools, we were able to give him minimal medication in the first four months.”

The statistics backing the need for such a device are sobering. Heart failure kills more than 700,000 Americans every year. Abiomed projects that up to 125,000 people a year would be candidates to receive its artificial heart. Congestive heart failure alone kills more than 50,000. Of the 4,200 people waiting for heart transplants, only about half ever get one.

To date, the Food and Drug Administration has approved 15 AbioCor implants; the company expects to finish those by the middle of the year. If those are successful, more could be authorized.

The notion of fashioning a man-made heart has been around for years. In fact, by the time Lederman had started his career at Avco, scientists had already been at work for nearly 20 years on the concept. In 1953, a heart-lung machine was used to support open-heart surgery. In 1958, a dog lived 90 minutes with a man-made heart. In 1965, the federal government declared an all-out effort to develop an artificial heart fit for humans by 1970. Officials earmarked $40 million for the project over the next four years.

Indeed, in 1969, an artificial heart was implanted for two and a half days into Haskell Karp, a 47-year-old dying of heart disease. After 65 hours, he received a heart transplant and died shortly after.

But scandal tainted the Karp case. The doctor responsible for implanting Karp’s heart, Denton Cooley, did so without permission from regulators or the man who spearheaded the development of that heart. Cooley had actually commandeered a heart intended for animal trials and used it in Karp.

In the wake of the Karp episode, ardor for the artificial heart project cooled for several years. Then, in 1982,
Dr. William DeVries implanted the Jarvik-7 artificial heart in Barney Clark, a retired dentist. Lederman and the rest of Abiomed’s staff followed the case with great clinical interest but certain misgivings: the media frenzy surrounding the surgery seemed sure to give the public unrealistic expectations. Clark’s heart was air-driven and needed a dishwasher-sized pump to make it beat. A series of tubes would forever connect every Jarvik-7 patient to the 350-pound machine. And every spot where those tubes entered the patient’s body provided opportunity for infection, which indeed tormented Clark, who died after 112 days. The man who lived the longest with the Jarvik was William Schroeder. He lasted 620 days, and was decimated by strokes and infections that made his extra time very painful.

As Lederman’s group had anticipated, the public’s high expectations were dashed and pessimism set in. The New York Times dubbed artificial heart research the “Dracula of Medical Technology.”

“It set this field back at least 10 or 15 years,” Lederman says of the Jarvik-7 experiments. But not for any medical reason. “It was a public relations disaster,” Lederman says, “but it was a very important first step.”

He was so affected by the media circus surrounding the Jarvik-7 trials—one reporter went so far as to sneak inside the hospital in a laundry cart—that he tried to implant his first AbioCor under a near-total press blackout. His goal, Lederman says, was to keep a lid on public expectations. “We knew in 1982 that the expectations of the public at large were of a technology that was impossible to meet,” he says.

The Jarvik experiments taught Abiomed’s researchers other valuable lessons. Prime among them was that the heart needed to be entirely internal. They also needed to do more work to prevent clotting that occurs when platelets collect on foreign surfaces.

Even now, clotting remains an issue. Abiomed said at the end of January that two patients had strokes that may have been caused by the heart’s design, which the company will change.

But if the AbioCor succeeds, it will surely find a vast market. There are no bulky units a patient must tow around. The heart runs on electricity, not air. The pump that drives the heart gets its power from a battery pack worn by the patient. But instead of cords that puncture the skin, the electricity is transmitted across the skin via a coil.

That electricity passes to a computer module implanted near the abdomen. It keeps a constant watch on a patient’s physical activity, automatically adjusting how quickly the pump beats—and how much blood is circulated. While AbioCor recipients might not be able to play football, lower levels of exercise are entirely possible.

The heart itself shares some characteristics with its natural counterpart. Blood enters and exits both hearts through ventricles. A natural heart relies on muscular contractions to pump blood through the ventricles, however, while the AbioCor uses a tiny motor to pulse a gel against the ventricle walls, forcing it to close, pushing blood out.

When Lederman saw Tools after the surgery, the heart pulsing inside him, “It was the most extraordinary time in my professional life,” Lederman says. He called his wife. “I said it’s just incredible,” he recalls now. He tried to explain the euphoria he was feeling, but she already understood. “To her, it sounded like the equivalent of a woman who’s giving birth,” he says.

Over the next weeks, the Abiomed team became close with Tools and his family. “He really was a remarkable guy with a zest for life that was incredible,” Lederman says. “He was so happy. And he enjoyed life so much. He didn’t complain.”

Lederman remembers how one day shortly after the surgery, he approached Tools with some questions. “We spent a lot of time trying to make sure that this heart would make a very good quality of life,” Lederman says. There were four valves in it, and engineers wanted to make sure the flaps didn’t click upon opening and closing. “It could drive a person crazy.”

So Lederman asked if Tools could feel the heart beating. No, Tools said.

“I was really happy,” Lederman says. “He kept saying, ‘No.’”


“You didn’t ask me if I hear a sound,” Tools replied. But it was OK with him.

“Bob was glad it had the noise,” Lederman says. “Because it told him it was working.”

By 2004, the company hopes to have a smaller heart ready for use in all adults; the current model fits about half the male population and 20 percent of the female population. It is expanding its trials internationally and plans to implant nine more AbioCor devices by midyear.

“We are proving what we expected we could do,” Lederman says of the current generation of AbioCor hearts. “Does that mean that we’re done? Nowhere near. This is the first good quality flight.” The next generation, Lederman promises, will last longer; someday, they’ll last for years.

Kantrowitz, he of the lofty goals, has still loftier ones for the artificial heart, which he is convinced can be built even better than an organic one. He wants to see an AbioCor recipient run a mile in under four minutes. “Surely it’s possible,” he says.

Why not; he was right about Lederman.

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