Transplant Roundup

Cardiac Replacement in Our Lifetime

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During the last 50 years, the field of cardiac replacement has evolved. It started with transplantation and continued with efforts to develop a total artificial heart (TAH).

In spring 1965, I joined the surgical laboratory of Dr. Richard R. Lower at Stanford University, where he and Dr. Norman E. Shumway were transplanting animal hearts. They had just described the first long-term survival achieved in dogs after their use of a technique similar to the modern operation.[1] As a first-year medical student, I helped Dr. Lower with every step in subsequent procedures. By the time I was a senior medical student, I had learned enough to operate on my own and transplanted my first animal heart. Transplant surgery would be my specialty.

Meanwhile, in summer 1967, Dr. Shumway told a California newspaper that he was ready to transplant human hearts. We were shocked when Dr. Christiaan Barnard of South Africa was first to do so, on December 3 that year. On 6 January 1968, Dr. Shumway completed the 4th such operation.

Sadly, 100 consecutive heart transplants failed worldwide, causing most centers to abandon further attempts. However, Dr. Shumway persisted, as did Dr. Lower (by then at the Medical College of Virginia).

We transplanted 18 hearts while I was chief resident at Stanford (1974–1975). The one-year survival rate was 65%. We had improved our selection of potential recipients. We learned that acute graft rejection resulted in severely compromised cardiac function, but also that too much immunosuppression uniformly led to death from infection. Accordingly, we began adding rabbit antithymocyte globulin to the usual immunosuppressants (corticosteroids and azathioprine) in hopes of improving rejection rates without too much immunosuppression.

I joined the Department of Surgery at the University of Arizona as chief in 1977. In 1979, we began the 8th heart transplantation program in the world. Our first 12 cardiac recipients survived long-term. By 1983, cyclosporine, a new drug, was markedly reducing the severity and frequency of rejection. The number of cardiac transplantation programs increased worldwide, and by the 1990s, the procedure was a standard of care for selected heart failure patients.

I was a proponent of transplantation. From the little that I had heard about mechanical hearts, I saw no obvious need for them. However, when our 13th recipient died on the operating table of acute graft failure and another died later of the same, I vowed to overcome this challenge. Finally, after another patient experienced primary graft failure in March 1985, I urgently called for a TAH. Dr. Cy Vaughan and Dr. Kevin Cheng provided a Phoenix Heart, and Dr. Donald Olsen supplied a Jarvik Heart. The Phoenix Heart arrived first, so we implanted it in the patient, even though the device lacked approval from the U.S. Food and Drug Administration (FDA). It worked well, supporting the patient for one day until we could place a second donor heart. Although the patient soon died of sepsis transmitted by the first donor heart, our introduction to the TAH was positive.

Our team then began training to use the FDA-approved Jarvik-7 TAH. In August 1985, we implanted it in a 25-year-old man who was dying of dilated cardiomyopathy. Ten days later, he received his donor heart. The intense international media attention disrupted our hospital's operations, and we felt highly pressured to succeed. Fortunately, the patient was discharged in good condition and lived for more than 5 years. This was the first successful use of a TAH as a bridge to transplantation.

Knowing now that TAHs could save lives, we routinely placed them, as well as left ventricular assist devices (LVADs) and biventricular assist devices (BiVADs), to

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bridge patients to transplantation. We developed a selection algorithm that we used for more than 20 years. Patients with biventricular failure were treated with a TAH if they met size criteria, or an extracorporeal BiVAD if they were too small. We used LVADs only in more stable patients with no right-sided heart failure and no renal failure. Of the patients who underwent mechanical circulatory support, 75% who were treated with a TAH survived, as did 50% of the LVAD patients and 38% of the extracorporeal-BiVAD patients. Overall, approximately one third of our patients received a TAH; another third, an extracorporeal BiVAD; and the rest, an implanted LVAD.[2]

In 1991, the FDA prohibited use of the TAH in the United States. Our mortality rates increased when we used VADs in patients who were better candidates for a TAH—further convincing us of the value of the banned device.

Our center had a major role in reinstating a TAH study, and it concluded in 2002. In 2004, the FDA again approved the use of TAHs.[3] Since then, nearly 1,900 TAHs have been implanted worldwide, and experienced centers are achieving one-year survival rates of approximately 85%. The TAH indeed remains crucial in saving severely ill cardiac patients.

References

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