

CELEBRATING 50 YEARS WITH THE TOTAL ARTIFICIAL HEART

If you could have just one thing in this entire world, what would that be? Most of us could answer that question based on what we already have in front of us and what we have yet to achieve. Perhaps it is to have your dream car or job, to meet your favorite celebrity, or to travel to the one place you have always dreamed about.

Now imagine you have heart disease—that you are fighting for your life in a hospital bed. You are constantly in pain, having difficulty breathing, and feeling like a pincushion from each lab draw stick and IV start you need to help sustain your life. Your family members visit you constantly, but you still feel despondent because when their visit ends, you are unable to go with them. You feel helpless because you can barely find enough strength to get up and walk to the chair next to your bed.

Would your answer change then? Would you wish you were able to take another breath without hesitation, or perhaps for a perfect heart? But if that perfect heart was not available yet, would you at least want some sort of support that could give you one more day to spend with your loved ones? The further improvements of the total artificial heart (TAH) throughout the years have given hope to those patients in need.

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With every step that Dr. Denton A. Cooley and Dr. Domingo S. Liotta took toward the operating room on April 4, 1969, the gravity of the situation intensified; however, the composure of Dr. Cooley kept their feet as light as if they were walking on the low-gravity surface of the moon. Dr. Cooley was about to perform the first implantation of a TAH into a patient, marking a triumphant victory for humanity against a disease that ravages the world. Dr. Cooley executed this feat with poise and described it as being any other operation, and the results were indicative of that. The patient was in critical condition and had exercised every other option available before concluding that the newly developed TAH was his best chance of survival. Dr. Cooley performed this miracle not to embroider his name and legacy but simply to extend this patient's life. The patient lived with the TAH for three days until a donor heart was found. This sensational achievement was attributable to the patient's own courage and Dr. Cooley's bravery.

Perceived reality is the enemy of imagination, and the stance of the few is often propagated as undeniable truth. Dr. Cooley's imagination and charisma challenged the stance that an artificial heart was merely science fiction, and he overcame that dogma. It has been fifty years since this accomplishment, and it has paved the way toward more feasible and prolonged modes of artificial cardiac support. Per Dr. Jack G. Copeland, a temporary TAH (SynCardia Systems, Inc., Tucson, AZ) has been implanted in more than 1,100 patients and is currently being used at approximately 100 different health care centers across multiple countries. Currently, the longest duration of support stands at 3.75 years, in a male patient who later received a heart transplant and is living well. Dr. Jack Copeland, an American cardiothoracic surgeon who specializes transplanting both human and artificial hearts, declares that out of the 1,100 pa-



tients, more than 47 have survived for more than a year with the artificial heart, and 72% of them received a heart transplant. The 1-year survival rate among these patients after transplantation was 80%-86%.

Although the TAH has continued improved since its genesis of, many challenge their usefulness, stating that ventricular assist devices can be and are superior. Further research, however, has suggested that most patients with biventricular failure require a TAH. As Jason A. Cook, an established author in cardiothoracic surgery, points out, "As experience with TAH advances, growing evidence supports its use in patients with biventricular heart failure. Patients with concurrent right ventricular failure in addition to left ventricular failure have poorer outcomes with left ventricular assist devices (LVAD) than patients with isolated left ventricular failure. Initial biventricular assist devices (BiVAD) for critically ill patients usually provides higher cardiac output at lower doses of inotropes, which can help resuscitate end organ malperfusion. One small retrospective study even showed no differences in mortality for patients with a TAH compared with BiVADs."

Although TAH implantation success and patient survival rate with the TAH is high at 80%-86%, there is still a chance for complications. The major complications of TAH implantation include strokes, infections, bleeding, renal failure, and chronic anemia. In an article in the *Journal of Thoracic Disease*, Jason Cook and others state that ^{1,3} ± of TAH-supported patients had strokes, 63.4% had infections (most commonly in the lungs and urinary tract) requiring treatment, and 42.6% had bleeding episodes of varying severity. These episodes included mediastinal bleeding requiring mediastinal exploration in 24.7% of patients, of whom 44% died within a month. Despite the complications of the



TAH, the necessity and inspiration to achieve success in this field is continuing to expand, and new ideas are being challenged and tested to further improve the field and rid it of obstacles.

Dr. O. H. "Bud" Frazier was a fellow pioneer in many of the advancements made in TAH devices and was a friend and colleague of Dr. Cooley. Our class had the opportunity to interview Dr. Frazier, and he provided us with valuable insights about the conception of the TAH and of what is to come with this technology. He further elaborated on the character of Dr. Cooley, and it became abundantly clear to us why these trailblazers achieved the level of success that they did. Dr. Frazier informed us that "the most important thing from con-

ception until now is chance." He further elaborated that every achievement, whether past, present, or future, is driven by the chance of discovery and the motivation of the individual to act. Dr. Cooley dared to inspire by challenging the dogma of his time, and when given the chance, he capitalized by implanting the first TAH. While there are still challenges to overcome with the technologies of TAHs, thanks to Dr. Cooley humanity will continue to be inspired and take advantage of its chances until heart disease is overcome.

References

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Dr. O. H. "Bud" Frazier and the student perfusionists (authors).

