The Physiology of Left Ventricular Assist Devices (LVADs)

John DiCecco
University of Rhode Island Biomedical Engineering
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There are an estimated 725,000 deaths a year resulting from heart disease in the United States. Another 21 million will develop symptoms and report to a physician as a result of heart disease. It remains the leading cause of death in the U.S., accounting for more than 200,000 more deaths than the second leading cause of death, cancer. The current number of U.S. citizens awaiting heart transplants is just over 4000, while the number of transplants performed last year was only half that. These figures indicate a very real and present need for an effective alternative to heart transplants, or at the very least, a means to allow patients to extend the waiting period by easing the burden on their failing hearts. In the late 1960's a promising technique was developed and implemented by Dr. Adrian Kantrowitz. The device was nothing more than an inflatable balloon that could be inserted through a femoral artery and positioned in the aorta. The intraaorta balloon pump (IABP) has since become involved in over 150,000 heart disease cases per year. The balloon works by relieving the pressure caused by the systemic peripheral resistance of the anatomical vascular structure. That is, the heart must pump a volume of blood, about 5 liters, through a network of blood vessels that have internal resistance and narrowing diameters, to say nothing of the viscosity of the blood. This generates a pressure of roughly 120 mmHg that the left ventricle must overcome in order to push the blood through the body. In a diseased heart, this is an extremely difficult task. In addition to the weakened state of the heart, the pulmonary arteries tend to be compromised. This reduces the amount of oxygen rich blood the heart needs to perform. By reducing the pressure, subsequently reducing the workload, the heart requires less O_2 and so is able to continue to be effective, even in the diseased state. Advances in this technology include the development of a modern version of the IABP known as the CardioVad^{TM}. This technique uses the same basic principles as the balloon pump but is a portable, implanted system. (In fact, the same doctor responsible for the first clinical application of the IABP developed this system.) The obvious benefit to the CardioVad^{TM} is that the patient is ambulatory rather than being tethered to a machine from a hospital bed. To date, both the IABP and the CardioVad^{TM} are regarded as long term but not permanent treatment options. The most significant advance has come in the form of the heart pump implant. This mechanism acts as a secondary left ventricle, contributing significant contractile pressure to the cardiovascular system. Clinical trials at Temple University in Philadelphia, PA, are underway to establish the feasibility of a version of the heart pump implant being permanent. The need for organ donors will always outpace the supply. With advances in LVAD, chronic heart failure patients will just be less needy.