

The Bionic Man Revisited

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1. Introduction

Cardiac transplantation is the mainstay therapy for patients with end stage congestive heart failure. Cardiac replacement therapy with the use of mechanical devices has made enormous strides in the past decade. Long term implantable Left Ventricular Devices (LVAD) are currently in use throughout the world with increasing frequency. The current accepted role for these devices is as a bridge to transplantation; however, as experience is gained with use of these devices, other applications may be feasible and desirable. Congestive heart failure (CHF) is a nationwide epidemic with a prevalence of 3 million victims' and more than 400,000 new cases per year. Severe heart failure unresponsive to even maximal medical therapy occurs in approximately 60,000 patients per year. Cardiac transplantation as treatment for CHF has been successful with a five-year survival in these patients approaching 70%, compared to 20-30% 2-year survival in patients with NYHA class 4 heart failure. However, because of a limited donor organ supply, cardiac transplantation will only treat 2300 patients in the United States this year. Approximately 30,000 patients are listed worldwide for cardiac transplantation every year, and only around 3500 cardiac transplantations are performed. Cardiac transplantation rates have reached a plateau since 1989 though older and more 'marginal' donors are being accepted. Unless society's perceptions towards organ donation radically changes, cardiac transplantation will remain an epidemiologic triviality.

Assist devices as a bridge to transplantation currently exacerbates this discrepancy, as the destination is still transplantation. Cardiac assist devices, total artificial hearts, xenotransplantation, and others will likely play important complimentary roles in the future treatment of CHF. These therapies need to be developed not only to prolong life but also to provide good quality of life, so the paradigm shift can occur and these alternative therapies become destination. Only then will we be able to make an epidemiologic impact on this epidemic.

2. Ventricular Assist Devices

Ventricular assist devices are currently used for three major indications. First, as a bridge to myocardial recovery. The assist system is implanted to decompress the injured myocardium allowing it to recover, as well as provide physiologic support for the patient during this time frame. Specific diagnoses include viral, post-partum cardiomyopathies, post cardiectomy, and reperfusion injury for cardiac allografts. As the heart recovers and sustains the circulation, the assist device may be explanted.

Cardiac transplant candidates who continue to deteriorate despite aggressive pharmacologic support can become candidates for assist support. The assist device is used as a bridge to cardiac transplantation and is explanted at the time of transplantation.

The third indication for assist systems is as an alternative to cardiac transplantation, though this use is only being defined now.

3. Total Artificial Heart

The total artificial heart has recently emerged from the laboratory to be used in a clinical trial for end stage heart failure patients who are not transplant candidates and not likely to live more than 30 days. The new pump recently introduced by ABIOMED (AbioCor) is a complex device which has implantable controller and energy transfer conduits attached to the pumping 'heart'. Early results from the clinical arena are promising, and cautious optimism for the reemergence of this type of therapy abounds.

4. Future

Newer and smaller pumps are reaching the clinical arena and are also being developed. These include higher efficient, lower mass, more reliable, and more versatile devices. This field is leaving its infancy and maturing into a viable and desirable therapy for many forms of end stage heart failure.

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