Heart Failure Treatment by Device

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"Science can amuse and fascinate us all, but it is engineering that changes the world."
– Isaac Asimov, 1920–1992

Technological breakthroughs, particularly advances in devices, are changing the course of heart failure (HF) management. Implantable devices have been used for decades to treat heart disease. The first pacemaker was implanted over 60 years ago (October 1958), and implantable defibrillators were first used in the early 1980s. Cardiac resynchronisation therapy appeared at the turn of the century. However, the past few years have witnessed a surge in both the types of devices being tested for HF treatment and the optimism of experts about their usefulness.

This HF Special Focus Section reviews novel devices used for advanced, symptomatic HF. Destination left ventricular assist devices (LVADs) in non-transplant centres, interatrial shunts to treat HF and MitraClip in HF are discussed by Bayés-Genis, Rodés-Cabau and Linderfeld.

The history of mechanical circulatory support began in 1953, when John H Gibbon reported the first successful use of extracorporeal circulation by means of an oxygenator. In 1966, DeBakey implanted the first pneumatically driven LVAD,[1] and in 1969, Cooley implanted the first total artificial heart, intended as a bridge to transplantation.[2] It was not until 1982 that the Jarvik-7 artificial heart was implanted for the first time with the intention of permanent treatment, although the patient died within 4 months of severe sepsis and multi-organ failure.[3]

A shift from the concept of a complete artificial heart towards the development of single chamber pumps as cardiac support initiated the LVAD era. First-generation ventricular assist devices were either pneumatically or electrically driven membrane pumps, such as the Berlin Heart EXCOR (Berlin Heart) and Thoratec PVAD (Thoratec).

In the past decade, LVAD systems have undergone substantial progress in size, durability, reliability and noise emission, such as the HeartMate 3 (Abbott Structural Heart). LVAD implantation became a new treatment option for end-stage HF, as destination therapy for patients either too old or not suitable for transplantation due to other medical conditions. Consequentially, an exponential increase in LVAD implantations has occurred in the past 5 years.

The history of the MitraClip begins with advances in the surgical treatment of mitral regurgitation. The MitraClip technology draws on experience with surgical edge-to-edge mitral valve repair, which was first reported by Alfieri et al. in 1995.[4] This technique involves the placement of sutures to anchor the free edge of a leaflet to its corresponding opposite leaflet, creating two valve orifices without the need for annuloplasty.

Based on these findings, investigators at major academic institutions, in concert with private industry (Evalve; later Abbott Vascular), developed the MitraClip percutaneous transcatheter method to reapproximate the anterior and posterior mitral leaflets as a therapy for mitral regurgitation. This method was first described in pigs in 2003, and several trials have since tested the value of MitraClip in the treatment of severe mitral regurgitation, with controversial results.

In this HF Special Focus Section, these data are discussed and put into a clinical context to better understand the real clinical value of MitraClip in 2020.

The interatrial shunt is the newest of the three devices discussed in this special issue. Increased left atrial pressure leading to pulmonary congestion is the common mechanism precipitating symptom worsening and acute decompensation in chronic HF patients. Some evidence supports interatrial shunting to relieve the excess volume from the left to right atrium regulated by the interatrial pressure gradient.

Two different interatrial shunt devices are currently being tested in large randomised clinical trials: the interatrial shunt device (Corvia Medical) and the V-Wave device (V-Wave). Both are intended for symptomatic HF; the interatrial shunt device is focused on heart failure with preserved ejection fraction, whereas the V-Wave device is being tested in both heart failure with preserved ejection fraction and heart failure with reduced ejection fraction.[5]

We have truly entered the era of devices in HF, and I believe there will be rapid progress on multiple fronts in the next few years. These devices would have been completely unimaginable a few decades ago, and exemplify the role that industry and technology play in modern medical care.

Furthermore, while advances in devices are impressive, it is likely that we are only in the early stages of their development. These new devices may just be the second wave designed for different aspects of HF treatment, after implantable defibrillators and cardiac resynchronisation therapy. What we do now may be called a 'passive' bridge to recovery, where we place devices and hope that whatever is wrong with the heart naturally works itself out. What we may see in the future is an 'active' bridge to recovery, where we not only place the device, but administer cells, genes or new (or even old) drugs to help repair the heart. ■

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