The HeartMate: A New Pulse in Bioengineering

A Look into the Importance and Long-Term Potential of Left Ventricle Assist Devices

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What are Left Ventricle Assist Devices?
• The left ventricle is the most important of the four chambers of the heart because it pumps blood into the aorta, which directs blood to the rest of the body
• When the left ventricle begins to fail, the heart itself cannot pump blood. It requires external assistance.
• Replacing a lower chamber of the heart, this device, consisting of synthetic, biocompatible materials, utilizes systemized suction catheters, motors, and pumps to help circulate blood.
• The HeartMate series is an example of an LVAD, and, through its evolution, has proven to be a sustainable biomedical device.

Evolution of the HeartMate Series
HeartMate XVE → HeartMate II → HeartMate III

The HeartMate XVE
Pulsatile generator – uses tiny electric impulses to regulate rotation of spinning blood
Powered by lithium-ion battery, converts mechanical energy to electrical energy to propel blood

The HeartMate II
One-quarter of the weight of the HeartMate I; more comfortable for patients
Smaller, more compact body
Non-pulsatile device, uses continuous blood-flow through the device – reduces chances of clotting

The HeartMate III
Levitated rotor reduces friction and wear by using dual hydrostatic and electromagnetic system.
Even smaller than the HeartMate II, has new attachment areas for easier implantation
In clinical trials currently

Both devices use flexible cannulas for the flow of blood into and out of the heart. Both devices are also non-pulsatile and use electromagnetism to rotate the impeller.

Cardiothoracic Surgery of HeartMate LVADs
• To access the heart, surgeon first performs a midline sternotomy to the umbilicus, perform cardiopulmonary bypass
• Longitudinal incision made in the upper part of the heart across the upper aorta to allow the surgeon to attach an outflow tube
• Apex of the heart cored to allow insertion of inflow tube, secured with Teflon sutures
• Drive line is lead out from the LVAD out of the lower left quadrant of the abdomen to connect to power source.

Similarities Between All Three Devices
Use titanium as a primary biocompatible material, helps form pseudointima (a biocompatible film along the passages)
Has battery pack included for power

All are implanted with very similar surgical procedure. The general structure is also the same, with an inflow tube, titanium rotor body, and outflow tube into the heart.

Common Terms with Left Ventricular Assist Devices

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<th>Meaning</th>
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<td>Pseudointima</td>
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Evolution of HeartMate XVE, HeartMate II, and HeartMate III diagrams

Ethical Concerns for LVADs
• Procedures involving LVADs cost up to $150,000 according to the National Institute of Health, and it can cost $60,000 annually to maintain (socioeconomic advantage for others).
• Surgeons are required to provide both the pros and cons of LVADs to the patient, allow them to make an educated decision based on the information given.
• This process does not eliminate the bias a surgeon may have towards a particular LVAD, whether due to cost or preference in the LVAD’s insertion
• The LVAD implantation can overwhelm the caregiver of the patient, especially with the risks of the device malfunctioning
• Infection caused the death of 41% of patients and 17% died from device failure during a study of LVADs