



# HEALTHY HEART

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**Honorary Editor :**  
Dr. Amit Chandan



Due to the lack of organ donors, technology is being developed to overcome the long waiting lists of heart transplants. The answer to this deficit is mechanical circulatory support which could be temporary or permanent i.e. Destination Therapy. LVADs and Artificial hearts have been developing and improving to meet the needs of people who cannot undergo heart transplant due to some or the other underlying reason.

## MECHANICAL CIRCULATORY SUPPORT

### IMPLANT STRATEGIES FOR MECHANICAL CIRCULATORY SUPPORT (MCS)

When considering MCS placement, five broad indications can be defined with regard to the clinical intent at the time of implantation.

#### ■ Bridge to Transplant (BTT)

BTT is a strategy for patients actively listed for heart transplant who would not survive or would develop endorgan dysfunction as a result of low cardiac output before an organ becomes available. While the patient remains on the waiting list, insertion of a durable LVAD can improve survival, functional status, and quality of life.

#### ■ Destination Therapy (DT)

DT is a strategy for patients requiring long-term, lifelong circulatory support who are not eligible for heart transplant because of relative or absolute contraindications.

#### ■ Bridge to Candidacy

MCS may be used for patients who are not currently listed for heart transplant, with no absolute or a permanent contraindication to transplant. MCS may allow these patients to be eligible for transplant.

#### ■ Bridge to Decision

In circumstances when a patient is in acute cardiogenic shock, it may not be possible to determine the candidacy for transplant, long-term VADs or myocardial recovery. A short-term MCS may be used to stabilize the patient's condition and to assess reversibility, as a bridge to more definitive therapies. The next step can be planned while the patient is on the MCS.

#### ■ Bridge to Recovery

MCS may be used as a temporary circulatory support to unload the ventricle. During this time, MCS use may enhance myocardial recovery from an

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acute injury enough to wean off the device without the need for transplant.

### TYPES OF DEVICES:

#### A. Short-Term Mechanical Circulatory Support

Recent innovation of continuous flow technology contributes to the development of various types of short term MCS, which can be distinguished by the method of placement (i.e., percutaneous or surgical).

#### Percutaneous circulatory support devices include:

- **Intra-aortic balloon pump (IABP):** Its mechanism of action involves inflation of the balloon in the descending aorta during diastole, which reduces afterload, increases coronary artery perfusion and pressure, improves myocardial oxygen supply and decreases myocardial oxygen demand.
- **Extracorporeal membrane oxygenation (ECMO):** For patients in circulatory and respiratory failure, ECMO is a viable option. This system uses a centrifugal pump with an

oxygenator and a heat exchanger in the circuit, yielding complete cardiopulmonary bypass. A veno-venous ECMO is used for respiratory failure with preserved native heart function. To support the failing heart, a venoarterial (VA) ECMO is required.

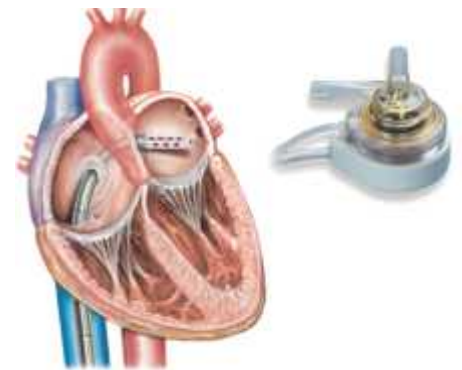
- **The Impella:** The Impella is an intravascular microaxial rotary pump that can be inserted across the aortic valve to provide forward blood flow from the left ventricle into the ascending aorta.



#### Abiomed Impella

- **Tandem-Heart:** The TandemHeart is another percutaneously inserted device that uses a centrifugal pump. Two cannulas are inserted percuta-

neously with inflow from the left atrium—via a trans-septal puncture from a catheter entering from the femoral vein to the inferior vena cava to the right atrium and left atrium, and across the interatrial septum—and outflow into the femoral artery.



#### Tandem Heart

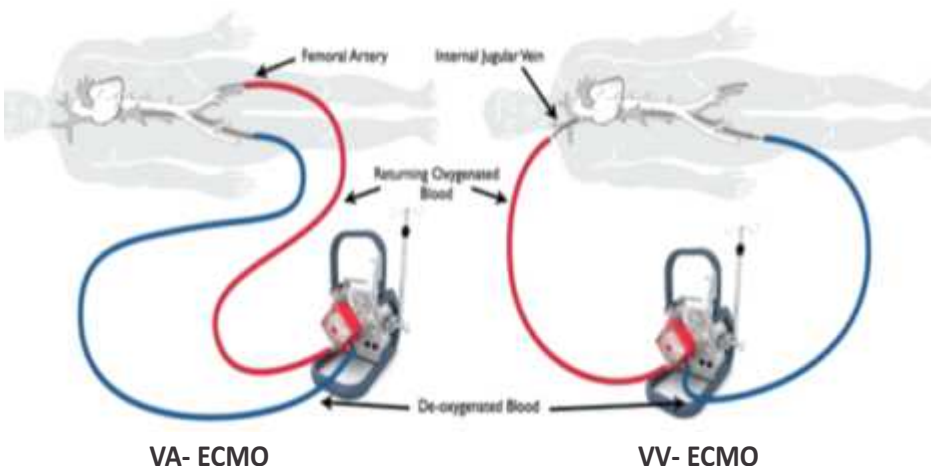
#### Surgical options include:

- 1) **CentriMag:** The CentriMag blood pump is an extracorporeal centrifugal pump operates without mechanical bearings or seals. The system combines the drive, magnetic bearing, and the rotor function into a single unit.
- 2) **Abiomed BVS 5000 and AB 5000:** The Abiomed BVS 5000 is a dual-chambered, pneumatically driven, extracorporeal pump that can be used for short-term support as a univentricular or biventricular assist device. The Abiomed AB5000 is the next-generation device after the BVS 5000 and is fully automated and has a vacuum assisted console.

#### B. Long-Term Mechanical Circulatory Support

##### 1) Pulsatile Devices:

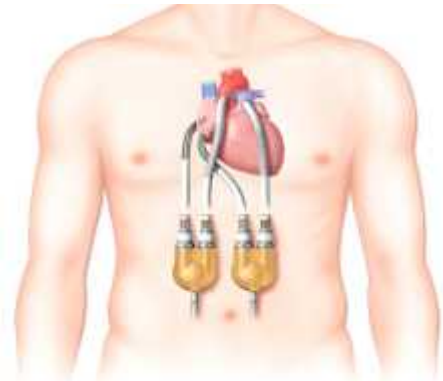
- a) **Thoratec HeartMate XVE:** This device is electrically vented and contains a portable console and batteries, giving patients more mobility.



Extracorporeal Membrane Oxygenation (ECMO)



**b) Thoratec Paracorporeal Ventricular Assist Device:** The paracorporeal placement of the pumping chamber allows the device to be implanted in patients with body surface areas of less than 1.5 m<sup>2</sup> and can be used for univentricular and biventricular support



**Paracorporeal biventricular assist device**

**c) Thoratec Intracorporeal Ventricular Assist Device:** It is an implantable device that can provide isolated left, right, or biventricular support.

**2) Axial Flow Pumps:**

**a) Thoratec HeartMate II:** The Thoratec HeartMate II VAD is an axial flow rotary pump constructed of titanium, its inflow is via the LV apex, and outflow is via the ascending aorta.

**b) Jarvik 2000:** The Jarvik 2000 is an electromagnetically actuated pump constructed of titanium. The pumping chamber is implanted in the left ventricle and the outflow graft is anastomosed to the descending thoracic aorta.

**Jarvik 2000**



**3) Newer (Third-) Generation Pumps and Future Devices:**

**a) HeartWare HVAD:** The HeartWare HVAD is a centrifugal pump with no mechanical bearings. The inflow cannula is integrated into the left ventricle. The device is implanted in the pericardial space.



**HeartWare HVAD**

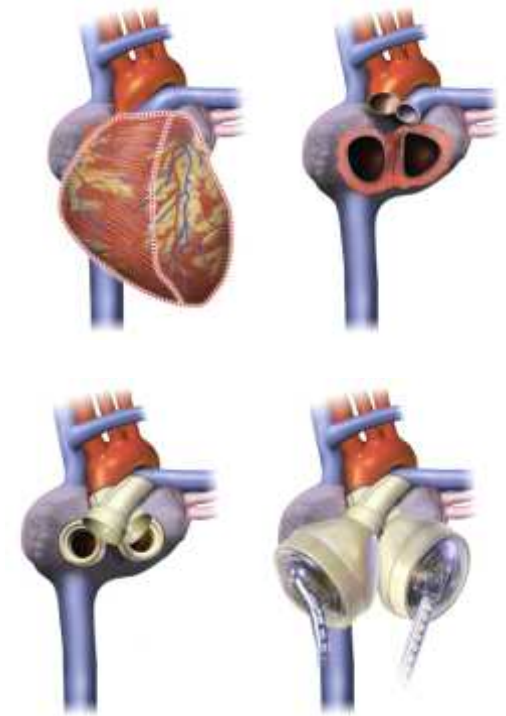
**b) Thoratec HeartMate III:** The Thoratec HeartMate III device is also a magnetically suspended centrifugal pump, powered by a magnetically levitated centrifugal impeller. This device has the ability to produce a pulsatile flow.



**HeartMate III**

**C. Total Artificial Heart:**

TAH completely replaces the failed ventricles and the four native valves in the orthotopic position. By replacing the failing heart, the TAH can eliminate the native heart complications such as valve dysfunction and arrhythmias. The use of TAH is indicated in transplant candidates at risk of imminent death from nonreversible biventricular failure.



**Total Artificial Heart**

**INDICATIONS FOR MECHANICAL CIRCULATORY SUPPORT**

Major indications for MCS include acute cardiogenic shock after acute MI, postcardiotomy cardiogenic shock, myocarditis, refractory ventricular arrhythmias, acute on chronic heart failure, and chronic heart failure. Patients can be roughly divided into the following two categories depending on the trajectory of heart failure progression and overall clinical status: (1) patients with acute cardiogenic shock, or (2) patients with chronic advanced heart failure.



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