Dual-Pump Continuous-Flow Total Artificial Heart

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Technology description

Overview

PAGE SUMMARY

Congestive heart failure (CHF) is a progressive and debilitating disease that affects over 7.5 million people in the US alone, and more than 670,000 new cases are typically diagnosed each year. While early stages of CHF can be treated pharmacologically, treating the end stage disease requires a heart transplant. Unfortunately, many CHF patients in need of a heart transplant cannot receive either because they do not meet some of the stringent qualifying criteria or because of the shortage of matching donor hearts. As a result, more than 15% of qualifying patients succumb to their disease before they can receive the transplant.

To provide at least a temporary and potentially a long-term alternative to heart transplantation Drexel’ s biomedical engineers and clinicians have created a combined continuous flow total artificial heart (TAH) that can replace patient’ s own heart for prolonged periods of time. The Drexel TAH is fully implantable and is available in several sizes ranging from 100 mm to 50 mm in both external diameter and length, which makes it suitable even for pediatric patients with BSA <1.3 m2. This offers distinct advantage over clinically available TAH that are not suitable for patients with small pericardial cavity and require patient BSA of at least 1.7m2.

Drexel TAH has been designed on the basis of anatomic and physiologic cardiovascular needs. The device comprises two separately controlled impellers, an axial flow impeller and a centrifugal impeller providing continuous flow pumps to circulate blood in both the pulmonary and systemic circulations, respectively. The TAH is designed to be implanted into the pericardial cavity replacing the native ventricles by connecting to the left and right atria or the apex of the left and right ventricles through cannulae. The operating range for the axial flow pump is 1-7 L/min with a pressure generation of 0-30 mmHg at 3000-10,000 RPM. The operating range for the centrifugal pump is 1-7 L/min with a pressure generation of 80-140 mmHg at 3000-10,000 RPM. Several new technologies have been employed to overcome known shortcomings of existing total artificial hearts and blood pumps, including:

1) Magnetic bearings suspending both impellers to prevent hemolysis and thrombogenesis that typically occur in mechanical bearings. Magnetic bearings suffer little wear and will extend the operating lifetime of the device to 15 years or longer.

2) Compact size, permitting the use of Drexel TAH in patients with thoracic cavities of small and varying sizes such as pediatric patients, persons of Asian descent and some female patients.

3) Biocompatibility, achieved through the use of biopolymer coatings such as Carmeda Biopolymer, Parylene, or MPC. These reduce the risk of thrombogenesis and eliminate the need for the use of cyclosporine or other immunosuppressive drugs.
4) Streamlined flow design preventing downstream thrombogenesis and the breakdown of blood cells.

Application area

A bridge to a heart transplant affording longer wait times for finding a matching donor heart;
Potential alternative to heart transplantation.

Advantages

Greatly reduced device size, making TAH available to patient populations for whom current TAH are too large;
Single motor design operating two separately controlled impellers to independently support both pulmonary and systemic circulations;
Improved design reduces thrombogenicity and blood cell breakdown ;
Use of biocompatible materials eliminates the need for the use of immunosuppressants.

Institution

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