THE HARTWELL FOUNDATION

2016 Individual Biomedical Research Award

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Hybrid Dual-Support Ventricular Assist Device for Heart Failure

Each year more than one million U.S. babies are born with a congenital heart defect with approximately 40,000 infants requiring surgery within the first days-to-years of life. While most will benefit in the short-term, those with complex heart defects ultimately develop heart failure due to complications from electrical arrhythmias or infections. Often, heart transplantation, when available, becomes the only lifesaving option. Fortunately, many children benefit from short or long-term mechanical circulatory support in the form of a ventricular assist device (VAD) designed to assist the heart's left ventricle in pumping blood to the body or the right ventricle to pump blood to the lungs. Problematically, VAD technology for children lags behind that for adults and while many adult devices have been utilized in children, their operation is not designed for blood pressure and flow requirements of children; thereby, increasing the potential for irregular blood flow, hemolysis (blood cell rupture) and thrombosis (clotting). Consequently, there is an unmet need for a specifically designed pediatric VAD to support a wide range of dysfunctional states of heart failure (moderate-to-complete). The need is compelling because adapting adult technology for children has so many limitations, including that existing devices cannot support the anatomic and physiological heterogeneity of childhood heart defects, and cannot adapt to patient size or the increased cardiovascular demands of physical growth; to say nothing of the bulkiness, electrical power requirements, heat generation, and mechanical failure of moving parts. To address the limitations, Amy proposes to develop a small, versatile dual-pump mechanical device with only two moving parts and a long operational lifespan, which will function effectively in multiple configurations to support the growth of the patient from infancy to adolescence. Her innovation will utilize the latest generation of magnetic bearing technology to levitate impellers that drive blood flow across biocompatible surfaces having wider clearances and lower fluid shear to ease hemolysis, while retaining surface washing to reduce the risk of thrombosis. Her design will avoid the use of at-risk mechanical valves, further mitigating blood cell damage and clotting; have the flexibility to produce continuous and pulsatile flow through control algorithms; and incorporate self-monitoring with Wi-Fi sensors. A wireless energy transfer system will advantageously eliminate the commonly deployed hardline connections through the stomach to access a microprocessor controller and electrical power. If Amy is successful, her hybrid dual-support VAD will offer hope for improved outcomes to the many thousands of affected children who require lifesaving support, as a bridge-to recovery, a bridge-to-transplantation, or as a means of long-term survival.