Funding Pumps Life Into Pediatric VAD Research

BY JEFF EVANS
Senior Writer

New pediatric circulatory support devices may be ready for clinical trials beginning in 2009, facilitated by grants issued in 2004 by the National Heart, Lung, and Blood Institute. The majority of these devices are based on modifications of currently available heart support systems used in adults.

NHLBI committed $22.4 million during 2004-2009 to the teams to produce devices intended to be ready for clinical trials at the end of the 5-year period.

Each of the five teams that received a contract in the NHLBI's pediatric circulatory support program has reported steady progress in the development of devices, with most already conducting animal studies only 1.5 years into the funding period. The contracts stipulated that pediatric circulatory support devices should be able to support infants and children weighing 2-25 kg for at least 6 months.

Very few options exist for pediatric patients in need of circulatory support, unlike the situation for adults in which ventricular assist devices (VADs) have revolutionized the care of patients with heart failure, said Dr. Brian Duncan, a pediatric heart surgeon who is primary investigator for the Cleveland Clinic's pediatric circulatory device contract.

About 1,800 infants in the United States die from congenital heart defects each year. Another 350 children under 1 year of age develop cardiomyopathy, many of whom require transplantation or die. A total of 1,600 infants have been added to the heart or heart/lung transplant list during the last decade, but fewer than half received a donor organ, which means that fewer than 80 infants on average received a transplant each year, said J. Timothy Baldwin, Ph.D., a biomedical engineer at NHLBI and project officer for the pediatric circulatory support program.

Researchers from the University of Pittsburgh, Carnegie Mellon University, Launchpoint Technologies, and a corporate partner, WorldHeart Corp., are collaborating to develop the PediaFlow, a pediatric VAD for infants.

The device is a miniaturized, fully implantable, turborotary pump that uses suspended magnetic levitation technology. A single wire would penetrate the skin to provide electrical power to the pump, said the principal investigator for the contract, Harvey S. Borovetz, Ph.D., chairman of the department of bioengineering at the University of Pittsburgh.

At the Cleveland Clinic, the "PediPump" team headed by Dr. Duncan is developing several fully implantable VADs for pediatric patients. One pump is about 7 mm in diameter and 70 mm in length, and an even smaller pump is in an earlier stage of design. To test the fit and configuration of designs, the team has been constructing three-dimensional models of the chest cavity based on CT and MRI scans obtained from children who have undergone imaging for clinical purposes. A 3D printer also allows them to create a "biomodel" of the heart that can be held.

Jarvik Heart Inc. is designing the child- and infant-sized Jarvik 2000 booster VADs in which the blood pump is the only implanted part, and the electronics are outside the body, said Dr. Robert Jarvik, president and chief executive officer of Jarvik Heart Inc., in New York.

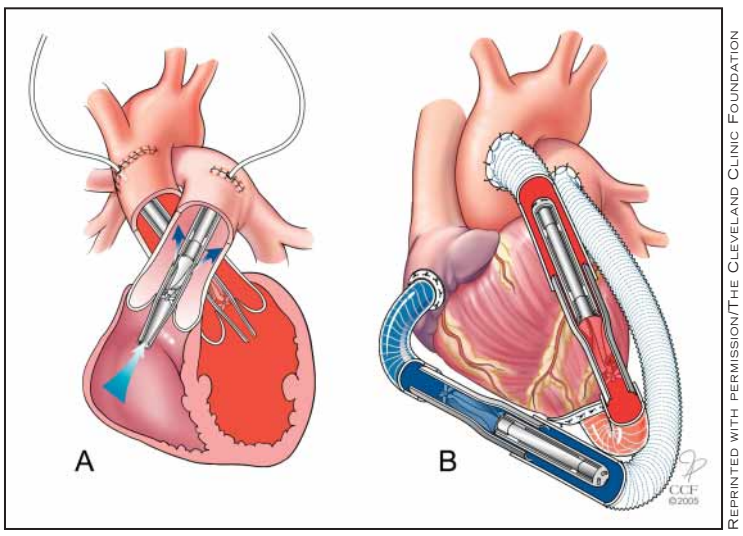
Both of the new VADs are being designed as permanent implant pumps, with the expectation that they will be durable for at least 5 years. The pump has an output capacity of nearly 5 L/min.

A team at the Pennsylvania State University Medical Center in Hershey has redesigned the mechanical heart valves and flow patterns in a pediatric pulsatile pump it had started developing about 20 years ago based on the Thoratec VAD. The team ran into problems with the earlier pump's valve design and abandoned the project. The researchers are investigating two VADs: a small, extracorporeal device for children under age 1 year that is designed to have a 12-mL stroke volume and a larger device with a 25-mL stroke volume for implantation in older children.

Researchers at Ension Inc. are making a compact extracorporeal membrane oxygenation (ECMO) system that is smaller than available systems so parents can hold their infant. The scaled-down pediatric cardiopulmonary assist system (pCAS) will also be more portable for children who can move around, said Mark J. Gartner, president of Ension and primary investigator for the contract. The team is creating two sizes of the pCAS that can be adjusted as the child grows. It is also is working on a biocompatible coating for the pCAS to help reduce blood clotting. ■

Courtesy Dr. Robert Jarvik

Pumps for the Jarvik 2000 booster VAD for adults (left) are being developed for children (center) and infants (right).



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The intravascular PediPump (A) is used as a bi-VAD in patients over 15 kg; the extravascular pump (B) is for patients under 15 kg.

Catheter Ablation Urged in Some Children With Asymptomatic WPW

BY BRUCE JANCIN
Denver Bureau

Stockholm — The natural history of asymptomatic Wolff-Parkinson-White syndrome in younger patients is not as benign as previously believed, Dr. Giuseppi Augello said at the annual congress of the European Society of Cardiology.

A subset of these patients with asymptomatic Wolff-Parkinson-White syndrome (WPW) is at high risk for syncope, cardiac arrest, and sudden death at an early age. These patients can be identified through a combination of risk factors that involves invasive electrophysiologic testing. At that point, they ought to undergo prophylactic catheter ablation of accessory pathways to reduce their risk of life-threatening arrhythmias, according to Dr. Augello of San Raffaele University Hospital, Milan.

He presented a prospective observational study in 477 patients with asymptomatic untreated WPW. During 2,070 patient-years of follow-up after baseline electrophysiologic testing, 16.8% experienced a first arrhythmic event. Ventricular fibrillation occurred in 1.3% of the cohort, atrial fibrillation in 3.8%, and supraventricular tachycardia in nearly 12%. Arrhythmic symptoms began at ages 12-25 years; WPW patients who reached the age of 35 years without developing symptoms were very unlikely to do so subsequently.

Cardiac arrest, syncope, or sudden death occurred in 5.5% of patients. Three risk factors independently predicted these events: young age, inducibility of atrioventricular reciprocating tachycardia or atrial fibrillation during electrophysiologic testing, and the presence of multiple accessory pathways.

Catheter ablation in children with WPW is not without risk. It should be performed only by those who are highly experienced.

Of the WPW patients, 23% had all three risk factors and were therefore classified as high risk. There is a compelling argument for prophylactic radiofrequency catheter ablation of accessory pathways in this group, in Dr. Augello's view.

Another 10% of the patients were rated moderate risk, meaning they were young and had inducible arrhythmias but only a single accessory pathway. Arrhythmic events are rare in such patients, and if they occur at all, it is usually later in life.

The remaining two-thirds of patients were categorized as low risk.

The San Raffaele investigators, led by Dr. Carlo Pappone, are widely viewed as world leaders in the field of catheter ablation of arrhythmias. Last year, they published the results of a randomized trial in which prophylactic catheter ablation of accessory pathways in a group of high-risk children aged 5-12 years with asymptomatic WPW was associated with a 5% incidence of arrhythmic events during the first 2 years of follow-up, compared with a 44% incidence among those randomized to no ablation (N. Engl. J. Med. 2004;351:1197-205).

Dr. Augello noted that the risk-stratification strategy he and his colleagues advocate, which is based on routine electrophysiologic testing of all young, asymptomatic WPW patients, is more aggressive than that recommended in current European and American guidelines. But he argued that those guidelines need to be revisited in light of recent evidence of the early lethality of WPW in a subgroup of asymptomatic patients.

He stressed, however, that radiofrequency ablation in children with WPW is not without risk. In the randomized trial, there was a 3% rate of anesthesia-related complications and a 15% incidence of complications related to the ablation procedure, all minor, except for one case of permanent right bundle-branch block. The procedure should thus be performed only by those who are highly experienced.

"We are the referral center for all of Italy for catheter ablation. We do three or four cases per day of ablation in patients with WPW," Dr. Augello said.

The San Raffaele group's current policy is to routinely do electrophysiologic studies in all asymptomatic WPW patients who are at least 6 years old or 80 cm in height. In younger, smaller patients, the risk of vascular damage related to an ablation procedure is too great, he said. ■