

# Commentary: Cavopulmonary assist: Closing in on the white whale of single-ventricle palliation



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Improving the long-term survival and quality of life for patients with single-ventricle heart disease remains the single greatest unmet need in pediatric heart surgery and pediatric cardiology. Although the surgical outcomes of single-ventricle palliation have been celebrated and have steadily improved over time, the unsightly truth is that the Fontan circulation is a grossly abnormal circulatory configuration, which leads to a myriad of progressive, debilitating, and ultimately fatal medical problems that accumulate over time. Although the Fontan circulation currently is, and has been, the best we can do for patients with single-ventricle heart disease, it is not good enough.

In the absence of heart transplantation or biventricular conversion (options that are available for only a sliver of the single-ventricle population), technologic advances in mechanical circulatory support remain the only realistic option for most patients. Although durable ventricular assist device implantations for Fontan patients with systolic failure are increasing in frequency and success as a bridge to transplantation,<sup>1</sup> subpulmonary mechanical support of the Fontan circulation remains the elusive white whale of single-ventricle heart disease (Figure 1), and has thus far been relegated to sporadic case reports.

In the current issue of *The Journal of Thoracic and Cardiovascular Surgery*, Dr Rodefeld and colleagues describe the design and in vitro testing of a cavopulmonary assist device specifically designed to power the Fontan circulation and achieve "biventricular equivalency."<sup>2</sup> In the in vitro physiologic mock loop testing, the device was shown to impart energy to the pulmonary circulation thereby decreasing central venous pressure, increasing pulmonary artery pressure, increasing ventricular preload, and increasing cardiac output. In the Fontan circulation, these hemodynamic alterations are thought to be sufficient to decrease end-organ injury from chronically elevated splanchnic venous pressures and improve total cardiac output. Further, there was no obstruction to blood flow when the pump was stopped, indicating a safety feature in



Tailored cavopulmonary support represents the elusive white whale of Fontan palliation.

### Central Message

A novel mechanical impeller designed specifically for subpulmonary support of the Fontan circulation might revolutionize the care of single-ventricle heart disease.

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the event of device failure. Despite these encouraging results, which represent the culmination of nearly 20 years of tenacious study by Dr Rodefeld and colleagues, much work remains. Remaining engineering issues to be evaluated include hemolysis performance, thrombogenicity, power source, and durability. Clinical trials will be needed to determine the efficacy of the device, complication profile, optimal timing of implantation, and need for device exchange with time or somatic growth.



**FIGURE 1.** Tailored cavopulmonary support represents the elusive white whale of Fontan palliation.

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The importance and significance of this emerging technology and investigative effort cannot be overstated for our single-ventricle patients and for the field of congenital heart surgery. Although billions of dollars have been invested in the design and optimization of ventricular assist devices for adult patients with heart failure, the comparably miniscule size of the single-ventricle patient population has precluded any significant industry investment in the design of mechanical support devices for these patients. Thus, children remain a disadvantaged patient population, and, like most things in pediatric medicine and surgery, it is up to us to devise our own solutions for our patients. The investigators are to be congratulated for their determination and

engineering ingenuity in achieving the current pinnacle of cavopulmonary assist device design reported in this study. Together, we need to work to promote the continued funding, development, clinical testing, and success of this technology.

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