3-R: Innovative Designs for Pediatric Ventricular Assist Device Cannulas that Improve Outcomes for Infants

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Category: Research

PROBLEM / OPPORTUNITY

Mechanical circulatory support is a bridge to transplantation for patients in end-stage heart failure. This takes the form of ventricular assist devices (VADs) that take blood from the non-functioning ventricle and pump it into the aorta to maintain proper circulation. In infants and small children, the only device small enough that functions in this way is a Berlin Heart. However, due to the very small size of infant ventricles, portions of the ventricular wall can get sucked into the cannula in what is referred to as a **"suction event."**

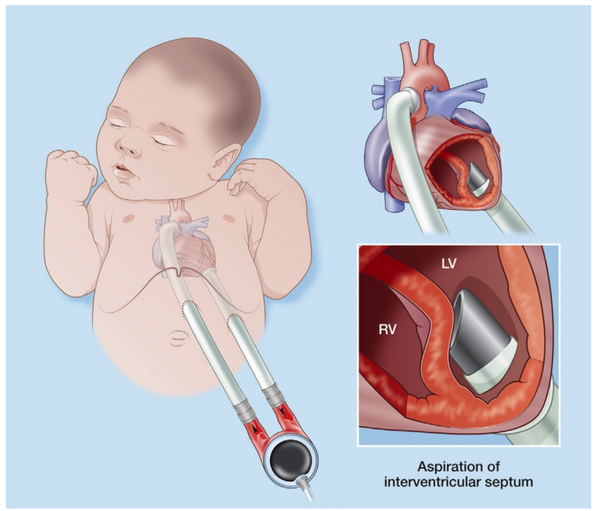


Figure 1. Graphical depiction of a suction event. Figure credit Davis et. al 2021 (1).

Suction events have severe hemodynamic consequences as blood is no longer able to enter the cannula and be pumped into systemic circulation, and they can cause tissue damage to the ventricular wall. Infants can suffer rehospitalization, reoperation, and death.

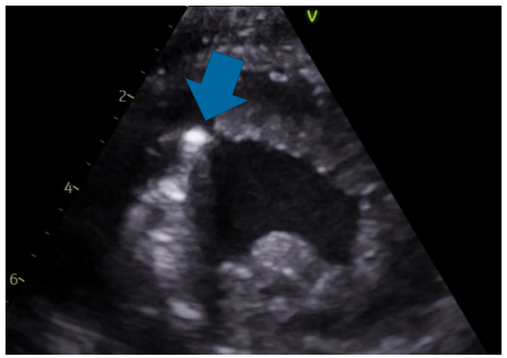
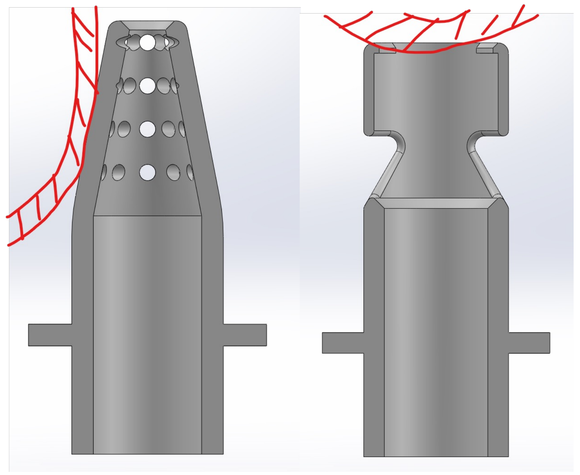


Figure 2. Echocardiogram of a baby with a suction event. Parasternal short axis view of the cannula sucking to the lateral wall of the heart. Cannula denoted with an arrow (left).

Figure 3. Static designs of a cannula tip that would allow blood flow in the presence of a suction event (below).



IDEA SUMMARY

We propose a change to the geometry of the tip of the cannula to prevent suction events from occurring.

PATENT PENDING

Designs available upon request.

We have multiple preliminary designs ranging from static geometries that maintain blood flow in a suction event to dynamic mechanisms that also disengage the suction event.

STRATEGY / AIMS

In collaboration with the Zucker Institute, we have developed multiple different tip shapes that are currently in pilot testing. We are currently 3D printing these models and aim to test them in artificial circulation to ensure that they adequately disengage suction events.

VALUE PROPOSITION / BENEFITS

Our idea will prevent unfavorable hemodynamic consequences, hospitalization, reoperation, and death for babies with a Berlin Heart VAD.

BUDGET / FINANCIALS

3D printing ~$2,000, pig hearts ~$1000, manufacturing of cannula and creation of artificial circulation ~$12,000

METRICS / RESULTS

If funded, the expected results of this project are:

- Intellectual property in the form of a patent
- A scientific publication of hemodynamic results in mock circulation
- Preliminary data to obtain extramural funding for large animal experiments
- A licensing agreement with an industry to produce our cannulas

LESSONS LEARNED / NEXT STEPS

Case numbers of neonates that require a VAD are orders of magnitude smaller than those of adults. As such, there is limited interest in the industry to solve this problem. MUSC efforts are necessary to change what is possible for these babies.

ADDITIONAL INFORMATION

Entity: Medical University of South Carolina

Departments: College of Medicine, Department of Surgery, and Zucker Instituite

1. Davis LM, Lee MGY, Sheridan BJ, d'Udekem Y, Brizard CP, Konstantinov IE, Mathew J, Brink J. Berlin Heart EXCOR Support in the First Year of Life: A Single Centre Experience. Heart Lung Circ. 2021 Mar;30(3):446-453. doi: 10.1016/j.hlc.2020.05.104. Epub 2020 Jun 23. PMID: 32665171.