



Trawick Pediatric Cardiology Research Fund – Supporting Single Ventricle Research

Research Progress Report – May 8, 2023

Over the past year, the Trawick Pediatric Cardiology Research Fund has directly supported the creation of a “first-ever” research assistant position in Pediatric Cardiac Imaging to lead research efforts focused on the care of single ventricle patients. The “Trawick Family Post-Baccalaureate Research Fellow” for 2022-24 is Ms. Sydney Collins, BSE (Duke Biomedical Engineering, ‘22). With funding support, research has been directed towards three main aims:

1. Support for completion and dissemination of research in progress
2. Support for ongoing research or research at the proposal stage
3. Support for studies investigating novel concepts and techniques

Completion and Dissemination of Research in Progress

1. “Making it Work for All: Equity in Single Ventricle Monitoring” led by Dr. Meredith Sooy-Mossey (Duke Pediatric Cardiology fellow) in collaboration with Dr. Andrew McCrary and Sarah Tallent (Duke Pediatric Cardiology).
 - The Single Ventricle Home Monitoring at Duke has evolved since the Single Ventricle program was formalized in the last four years, with transition from nurse phone calls to a dedicated nurse practitioner with telehealth visits. Most recently, the Duke Kids Health App was created for app-based biometric and symptom monitoring.
 - With the addition of these resources, it is important to ensure equitable availability and usage of app- or technology-based solutions across racial and ethnic groups as well as socioeconomic strata. Dr. Sooy-Mossey and her team are investigating telemedicine and app usage by various sociodemographic factors. Trawick Research funds are being directed towards statistical support, national presentation, and publication of these findings to ensure close and equitable monitoring of all single ventricles patients.

Ongoing Research

1. “Assessing the Accuracy of Fetal Aortic Valve Range Phantom Measurements” led by Sydney Collins and Dr. Alex Bowers (Duke Pediatric Cardiology Fellow) in collaboration with Dr. Cooper Moore (Duke Biomedical Engineering), and Dr. Piers Barker and Dr. Andrew McCrary (Duke Pediatric Cardiology).
 - This project investigates the accuracy of aortic valve annulus measurements in fetal echocardiography using a phantom model. These measurements are key for accurate prenatal diagnosis of congenital aortic stenosis and variations of Hypoplastic Left Heart Syndrome, and errors in the tenths of a millimeter can be the difference between diagnosing a normal or a hypoplastic structure, which in turn affects counseling, pregnancy and delivery plans, and



postnatal intervention. An abstract and manuscript for this project has been accepted as a finalist in the Arthur E. Weyman Young Investigator's Award Competition at the 2023 American Society of Echocardiography Scientific Sessions. Trawick Research funds have supported statistical analysis and will support the presentation of this work in both poster and oral presentation format. A manuscript is in the process of being submitted to the Journal of the American Society of Echocardiography.

2. "Measuring 3D Global Longitudinal Strain in Functional Single Ventricles" led by Sydney Collins with faculty collaborators in Duke Biomedical Engineering.
 - This work focuses on developing a novel geometry-agnostic algorithm to calculate 3D strain in single ventricle patients with complex anatomy not permitting measurement of strain using current commercially available 2D systems. The novel algorithm has demonstrated good agreement with 2D measurements in control cases, and has successfully calculated 3D strain in a single ventricle case. Refinement is ongoing. Successful validation will allow for cardiac strain to be used as an additional longitudinal measurement of cardiac function in both critical care and outpatient settings.
 - An abstract of this work has been accepted for presentation at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery taking place in August 2023. Trawick Research funds will support presentation of these results at this international meeting and subsequent manuscript publication.
3. "Racial and Socioeconomic Variability in Advanced Cardiac Imaging & 3D Printing" led by Dr. Alex Bowers with collaborators Sydney Collins and Gregory Sturgeon MS, RDCS (AE, PE, FE).
 - This project investigates the use of advanced cardiac imaging and 3D printing, techniques which are becoming essential for the care of patients with complex congenital heart disease including single ventricle patients, particularly for pre-interventional and pre-surgical planning.
 - More specifically, this project focuses on ensuring that these emerging technologies are being equitably distributed to patients within the Duke Pediatric and Congenital Heart Center.
 - An abstract of this work has been accepted for presentation at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery taking place in August 2023.
 - A second abstract from this work focusing on understanding the primary indications for cardiac 3D printing as well as timing and stage of repair is in the process of being submitted to the 8th World Congress of Pediatric Cardiology and Cardiac Surgery. This work is crucial for developing Appropriate Use guidelines as these techniques become standard of care.
4. "Validation of Ventripoint 3D Imaging Software in Single Ventricle Patients" led by Sydney Collins with collaboration from the Duke Pediatric Echocardiography Lab and Ventripoint Diagnostics Ltd.



- Ventripoint technology uses a hardware marker to co-register echo images from multiple echo windows into a 3-dimensional coordinate system to create ventricular volumes and measure function. This technology has been validated in several biventricular circulation anatomies, but has not been validated for patients with functional single ventricle anatomy.
- Examining the heart in 3-dimensional space from different windows is analogous to the approach used in cardiac MRI, but with the portability, accessibility, and avoidance of sedation that are strengths of echocardiography.
- The research protocol is established and underway, with patients with single ventricles having a routine echocardiogram and a routine cardiac MRI within 6 months of each other being enrolled in the study. If successful, this will open up use of this tool for the clinical assessment of single ventricle patients in all areas – ICU to outpatient.

Novel Concepts and Techniques

Lastly, research in the conceptual stage includes the following three projects:

1. Collaboration with Duke Biomedical Engineering to determine patient-specific ideal aortic arch geometry in single ventricle patients to minimize power loss using real-patient data.
2. Investigating the center of volume of the ventricle throughout the cardiac cycle as a quantitative assessment of function in patients with congenital heart disease, including single ventricle patients.
3. Collaboration with Duke Biomedical Engineering to test a novel technique to assess diastolic function using ultrafast echo imaging.

Attachments:

Bowers A et al. Racial and Socioeconomic Variability in Advanced Cardiac Imaging & 3D Printing. Abstract accepted for presentation at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery 2023

Collins SD et al. Measuring 3D Global Longitudinal Strain in Functional Single Ventricles. Abstract accepted for presentation at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery 2023

Collins SD et al. Assessing the Accuracy of Fetal Aortic Valve Range Phantom Measurements. Abstract and manuscript accepted for poster and oral presentation at the American Society of Echocardiography Scientific Sessions 2023 as a finalist in the 2023 Arthur E. Weyman Young Investigator's Award Competition