Children's Hospital of Philadelphia

CARDIAC CENTER ANNUAL REPORT 2023

Children's Hospital of Philadelphia℠
Cardiac Center

INTRODUCTION

We are again privileged to present the Annual Report of the Cardiac Center at Children's Hospital of Philadelphia. With more than 1000 employees, we remain one of the largest pediatric cardiac centers in North America with a celebrated history of novel clinical care, ground-breaking scientific discovery, and cutting-edge translational research that daily advances the care of our patients with complex congenital and acquired heart disease. The CHOP Cardiovascular Research Institute, under the direction of Daniel Kelly, MD, seamlessly enhances and accelerates bench-to-bedside innovation in partnership with the world-renowned University of Pennsylvania Cardiovascular Institute. 2023 marked the inaugural development of the CHOP Cardiac Center Biobank, a lifespan research resource collecting and banking specimens from patients and their families all the way from prenatal encounters through their transition to adult congenital care; these banked specimens will comprise a unique resource for later investigations into the genetic basis of congenital heart disease for generations to come.

In collaboration with the Center for Fetal Diagnosis and Treatment at CHOP, the Cardiac Center remains the highest volume pediatric center in the United States for neonatal cardiac catheter-based and surgical interventions. Our Transition and Adult Congenital Heart Disease programs, in partnership with the Hospital of University of Pennsylvania, assure continuity of care for our patients as they mature from birth to adulthood. CHOP is mid-construction for a New Patient Tower to be completed in 2028, which will facilitate expansion of our clinical footprint, and growth of our flagship programs including single ventricle care, lymphatics, advanced valve therapies, heart failure, pulmonary vein disease, transplantation and mechanical circulatory support. Our evolving heart failure/transplant intensive care unit, designed specifically to focus on the unique needs of this population, marks an important milestone.

As this report also helps to detail, the academic productivity of our faculty and staff is unparalleled internationally and fueled by our consistent and relentless drive toward clinical innovation and discovery. We take great pride not only in the strength and size of our advanced fellowship training programs, but also with our innovative platforms for nursing education and advancement.

We hope you will enjoy reading this Annual Report, which provides only a glimpse into the incredible achievements of the CHOP Cardiac Center, and a brief look into our future goals and plans for ongoing expansion. Yet, as impressive as this report is, it cannot fully portray the spectacular clinical care that is provided each and every day in the Cardiac Center and that forms the foundation of our inspiration.

Please enjoy.

Joseph Rossano, MD, and Jonathan Chen, MD — Co-Executive Directors, CHOP Cardiac Center

Children's Hospital of Philadelphia℠
Cardiac Center

TABLE OF CONTENTS

CARDIAC CENTER

MISSION

OUR MISSION

To promote the health and well-being of our patients with heart disease and their families through the provision of exceptional and compassionate care, the advancement of science through groundbreaking research, and the ongoing dissemination of knowledge.

OUR VALUES

Excellence	Strive for excellence in patient care, research, and education
Collaboration	Foster a workplace environment that respects diverse perspectives and promotes a sense of teamwork and well-being
Integrity	Demonstrate respect and accountability with our patients, families, and colleagues
Empathy	Deliver care with compassion - focused on the needs of our patients and their families

OUR VISION

Be the premier Cardiac Center that transforms the lives of children with heart disease, adults with congenital heart disease and their families.

CHOP CARDIAC CENTER

SERVICE LINE

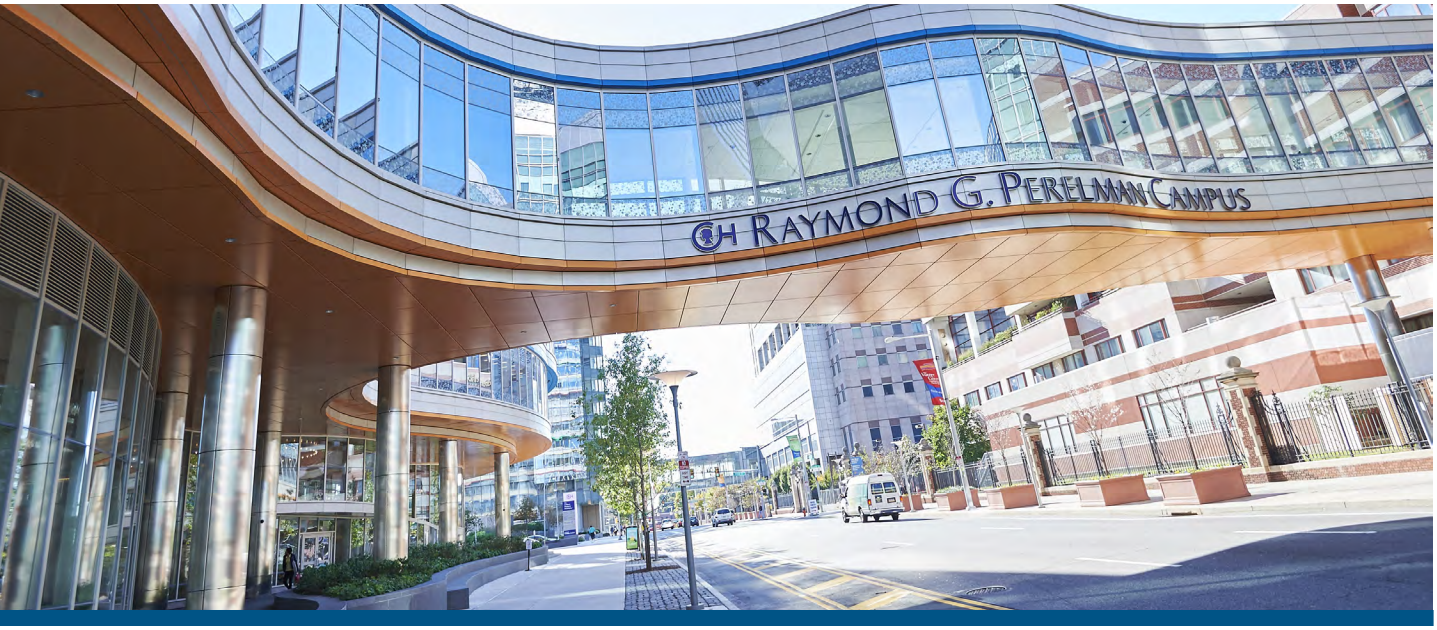
The Term "Service Line" is widely use in the Healthcare Industry. There are many definitions, but a common theme is the focus of caring for patients and families with medical/healthcare needs commonalities – for example heart disease, cancer, etc. By having this focus, coordination of care becomes a primary strategy, and bringing specialists and teams together from different modalities to maximize this effort is a key measure of effectiveness

Mark Schwartz, MBA, M.Ed.
Senior Director, Cardiac Center Administration and Service Line

The Cardiac Center at CHOP is an example of a Service Line - in that we have multiple teams (4 medical divisions, advanced practice teams, nursing staff, non-clinical support staff and extensive ancillary specialists) all unified for the common goal - working together to provide the best and most compassionate care possible for our patients.

While we have our "common" goal, we also have our uniqueness - our educational training, our areas of interest and career goals, how we identify ourselves professionally, and our diversity. How we embrace these differences, while working closely together to seamlessly provide the excellent care that we have become known for - is testament to each and everyone in the Cardiac Center. As the saying goes, "it takes a village", (more like "a city" for the Cardiac Center). We certainly have our challenges day to day, handling the high growth and volume, high acuity, complex care needs, managing staff wellness and stress with long hours and heavy workload at times, and more....but in the end, our common goal unites us to manage these challenges, working together to solve them we face while continually providing compassionate and skillful care for each and every patient and family.

See this video below which provides a glimpse into the many varied aspects of our Cardiac Center.
https://www.chop.edu/video/cardiac-center-childrens-hospital-philadelphia



CARDIAC CENTER

BY THE NUMBERS

Surgical Volume	
Cardiac Surgeries	964
Open Heart Surgeries	574
Adult Cases – HUP	52
Adult Cases – CHOP	23
Neonatal Cases	149
Heart Transplants	15
Lung Transplants	3
VAD Implants	17

Ambulatory and Imaging	
Outpatient Visits	40,983
Echocardiography Studies	39,908
Fetal Heart Echocardiography Studies	3,838
Fetal Heart Diagnosis of CHD	466
Special Delivery Unit Births	209
Cardiac MRI	1,288
Exercise Studies	9,488

Cases By Complexity	
Stat 5	40
Stat 4	74
Stat 3	102
Stat 2	123
Stat 1	352
No Score	273

Interventional Cardiology	
Cardiac Cath (all procedures)	1,652
Cardiac Cath (not EP or Lymphatics)	1,516
Interventional	714
Electrophysiology	258
Lymphatics	136

Cardiac Center Admissions	
CICU Cardiac Admissions	1,057
CCU Cardiac Admissions	1,468
CICU ADC	32.55
CCU – ADC	33.08

CHOP Cardiac Center Facilities	
36	Licensed Cardiac Critical Care Beds
Up to 40	CICU Surge Capability
25	Licensed Cardiac Care Unit Beds – 6th Floor
10	Licensed Cardiac Care Unit Beds – 5 East
15	Cardiac Prep and Recovery Unit (CPRU)
2	Dedicated Cardiac Operating Suites
3	Cardiac Catheterization Laboratories
1	Hybrid Cath/OR Suite
1	XMRI – adjacent to Cath Lab
1	Echocardiography Laboratory (IP and OP)
1	Exercise Physiology Laboratory (with satellite at KOP)
1	EKG/Holter Monitor Station
1	Fetal Heart Program (Main Clinic and Bryn Mawr SCC)
13	Satellite OP Cardiology Clinics
	Dedicated Bench Research Space in Abramson/Colkette and Roberts

CARDIAC CENTER

EXECUTIVE COMMITTEE

Left to Right

- Cara Rakow, MSN, Vice-President/Associate Chief Nurse Officer, Critical Care
- Daniel Kelly, MD, Director of Penn/CHOP Cardiovascular Institute
- Andrew Costarino, MD, Division Chief, Cardiac Critical Care Medicine
- Jonathan Chen, MD, Division Chief, Cardiothoracic Surgery and Co-Executive Director, Cardiac Center
- Vivek Allada, MD, Director, OP and Community Cardiology and Associate Chief of Cardiology, Director of Strategic Operations, and Senior Medical Director, Cardiac Center
- Mark Schwartz, Senior Director, Cardiac Center Service Line
- Joseph Rossano, MD, Division Chief, Cardiology and Co-Executive Director, Cardiac Center
- Sherri Kubis, RN, MSN, Senior Director, Cardiac Center Nursing
- Andreas Loepke, MD, Division Chief, Cardiac Anesthesiology
- Jan Boswinkel, MD, SVP/COO Hospital Operations (Not Pictured)

FLAGSHIP AND FRONTIER PROGRAMS

2023 Cardiac Center Annual Report

THE TOPOLEWSKI CENTER FOR PEDIATRIC HEART VALVE DISEASE

LEADERSHIP

Jonathan Chen, MD
Principal Investigator
Cardiothoracic Surgery

Michael Quartermain, MD
Co-Lead Investigator
Cardiology
Echocardiology

Matthew Gillespie, MD
Co-Lead Investigator
Cardiology
Interventional Cardiology

Sara Baumgarten, BA
Program Manager

FACULTY

Matthew Jolley, MD
Collaborator
Cardiac Anesthesiology

Lindsay Rogers, MD
Collaborator
Cardiology

Muhammad Nuri, MD
Collaborator
Cardiothoracic Surgery

Robert Levy, MD
Collaborator
Cardiology-Research

THE TOPOLEWSKI CENTER FOR PEDIATRIC HEART VALVE DISEASE

Established in 2020, the Topolewski Center for Pediatric Heart Valve Disease has continued to grow and revolutionize the diagnosis and treatment of pediatric heart valve disease. Vital to this work has been the ongoing development of novel imaging technology in the three dimensional and virtual reality domains to help create innovative interventional strategies (surgery or catheter-based) for complex valve disorders.

Our surgeons participated in a first-in-human implant of the MASA valve, an expandable, valved PTFE right ventricle to pulmonary artery conduit that offers hope for reducing the need for multiple reoperations for our patients needing an artificial connection to establish continuity between their heart and pulmonary arteries. Our interventional cardiologists continue to lead the nation in transcatheter valve therapies (nearly 70 in 2023), most notably in 2023 also advancing the use of MitraClip technology to address leaking atrioventricular valves in single ventricle patients.

The clinical-translational research arm of the program focuses on fundamental mechanistic causes of valve degeneration as well as leverages evolving technology to better assess structural valve (dys)function and thereby potential for surgical repair. Our investigators have focused their efforts specifically on the creation of new advanced imaging platforms (SlicerHeart) to better assess aortic, neo-aortic and atrioventricular valve incompetence. With the aid of these innovative imaging techniques, we have been able to tailor and guide our operative therapies to offer 'precision repairs' for individual patients as well as simulate complex catheter based strategies to better refine the exact catheter approach in the setting of complex congenital anatomy.

The Valve Center has two primary laboratories for research. Dr. Robert Levy's laboratory continues to examine the mechanism and potential targets for therapy of native and prosthetic valve calcification and degeneration, and last year was awarded an R01 grant from the NIH in this domain. Dr. Matt Jolley's laboratory in addition is comprised of software engineers and analysts who are continually developing novel imaging techniques to better model structural valve disease and even allow for 'virtual repair' options prior to actual surgical intervention. Wensi Wu in this laboratory was awarded an NIH K025 Mentored Quantitative Research Development Award for this work in 2023.

Finally, the Topolewski Pediatric Heart Valve Center has created several new resources for families https://www.youtube.com/watch?v=OoJSZHDKSFQ&t=5s whose child has valve disease which discuss (a) mechanical valves (b) aortic valve repair options and (c) the Ross procedure, and hopefully answer many of the concerns and/or questions your patients and families may have prior to meeting with our surgical faculty.

THE TOPOLEWSKI CENTER FOR PEDIATRIC HEART VALVE DISEASE

ANAYA'S STORY: A NEW PULMONARY VALVE, A NEW LIFE

PUBLISHED ON FEB 23, 2024

Anaya is in many ways a typical toddler. She loves finger paints and swinging – so much that her parents, Linet and Reji, put a swing in their family room. Sometimes, her big emotions evoke the familiar "terrible twos." But in one important way, Anaya is not so typical – at two years old, she's already made history.

In May 2023, Anaya became the first human patient to have to have a MASA polymeric pulmonary valve implanted in her heart. Cardiothoracic surgeon Katsuhide Maeda, MD, PhD, performed the procedure at Children's Hospital of Philadelphia (CHOP), the first step in an early feasibility clinical study that hopes to make groundbreaking progress in the treatment for congenital heart defects.

The MASA valve is more durable and consistent in quality than homograft valves currently in use, which are made of human tissue and can fail quickly. Anaya's encouraging post-surgery progress is a promising development for the clinical trial. "Frequent cardiac surgery can influence normal physical as well as mental growth in children," says Dr. Maeda. "Hopefully, this new conduit will last a long time, and it will avoid further frequent surgical interventions."

LIFE-CHANGING NEWS CONNECTS THE FAMILY TO CHOP

When Linet went for her 20-week anatomical scan in March 2021, she and Reji were devastated to hear that their unborn daughter had tetralogy of Fallot (TOF), a congenital heart defect characterized by, among other issues, a ventricular septal defect, a hole between the lower chambers of the heart, and pulmonary stenosis, a narrowing of the pulmonary valve that affects blood flow from the heart to the lungs.

Doctors at their local hospital referred the northern New Jersey couple to CHOP cardiologist Michele Cohen, DO. "From the very start, Dr. Cohen has been so helpful and given us confidence," Linet says. "Anaya loves to see her whenever we have an appointment."

Because her daughter's heart defect was diagnosed prenatally, Linet gave birth in July 2021 in CHOP's Garbose Family Special Delivery Unit (SDU) in the Richard D. Wood Jr. Center for Fetal Diagnosis and Treatment so Anaya could receive expert care immediately. Before going home, doctors inserted a temporary patent ductus arteriosus (PDA) stent to connect her aorta to her pulmonary artery to increase blood flow to the lungs. This gave her time to grow before her first heart surgery to implant the homograft valve.

THE TOPOLEWSKI CENTER FOR PEDIATRIC HEART VALVE DISEASE

FIRST HEART SURGERY AT 10 MONTHS OLD

When she was 10 months old, in June 2022, Dr. Maeda performed Anaya's first open-heart surgery to implant a homograft, or a pulmonary valve made of human tissue.

An echocardiogram in December 2022 showed that the valve had begun to fail, and a second homograft surgery was scheduled for April 2023, less than a year after the first. But in March, Dr. Maeda called Linet and Reji to ask if they wanted to enroll Anaya in a clinical trial to implant a new MASA polymeric pulmonary valve.

The MASA valve has several important benefits. It's made of a material designed not to be rejected by the body's immune system. And it can be manufactured with consistent quality, in different sizes to fit people of all ages. But it had never before been implanted in a human. Anaya would be the first.

A GROUNDBREAKING CLINICAL TRIAL OFFERS NEW HOPE

Clinical trials depend on a series of approval processes before getting underway, which made the timing of Anaya's surgery uncertain. Dr. Maeda believed it was safe for her to wait for the trial to be approved.

Both Linet and Reji work in the pharmaceutical industry on clinical trials, so they're familiar with the protocols. "We have some understanding of the pros and cons," says Reji. "Of course, it's a different matter when it's our own daughter." Dr. Maeda gave them reading material to review, and after days of deliberation, they ultimately decided to participate in the trial.

THE ROAD AHEAD FOR ANAYA

Anaya's surgery was a success, allowing her to return to normal life as an energetic toddler.Anaya had the MASA valve implanted in May 2023. The surgery was a success; the clinical team expects the valve to last at least 10 years. Linet and Reji are amazed that their daughter's rough early road has not dampened her sunny disposition or boundless toddler energy.

Anaya has had two open-heart surgeries in her first two years of life. At her last checkup Dr. Cohen was happy to hear a clear, strong heartbeat, with only a faint murmur. "I've been waiting to hear something like that," says Linet. "It made me quite emotional." Meanwhile, the early feasibility clinical trial continues, at 10 hospitals around the U.S.

THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

INTRODUCTION

The Jill and Mark Fishman Center for Lymphatic Disorders is currently in its ninth year and continues to be under leadership of Yoav Dori, MD, PhD. The center continues to thrive and in 2023 we received many referrals to our program from throughout the United States and Internationally. Dr. Dori and Dr. Smith continue to perform Lymphatic procedures regularly in the cardiac catheterization lab as well assisting surgical procedures with Drs. Pablo Laje and Katsuhide Maeda. To handle the increasing clinical volume the program is recruiting a new program manager, and has continued to collaborate with Interventional Radiology physicians Dr. Abhay Srinvasan, Dr. Fernando Escobar and Dr. Ganesh Krishnamurthy (Dr. Krishnamurthy now has his own lymphatic procedural schedule). In 2024 we will continue to educate teams domestically and internationally and have helped start lymphatic programs in Denmark, Austria, Poland, Italy, India, Germany, England, Israel, Columbia, Mexico, and Brazil. We will also host many domestic and international visitors. We also welcomed research engineering support in the Summer of 2023 and Dr. Mudit Gupta, who has joined us this year as a fellow, marking a significant milestone as we continue to develop our clinical training and education programs. In addition, faculty members continue to have very busy lecture schedules with multiple invited lectures and grand rounds given by all team members.

RESEARCH AND INNOVATION

As we embark on exploring our recent research breakthroughs, let's first reflect on the journey that led us here. Our center is dedicated to delivering highly specialized care for patients experiencing lymphatic leaks and disorders. This commitment is bolstered through a collaborative, multidisciplinary approach, involving key departments at CHOP, including, but not limited to, the Comprehensive Vascular Anomalies Program (CVAP), Radiology and Interventional Radiology, Surgery, and the Center for Applied Genomics. A cornerstone of our patient care is the development of cutting-edge imaging and intervention technologies. These innovations are crucial for accurately mapping the lymphatic system's flow. While traditional methods primarily utilized CT or MRI in lymphangiography, our CHOP experts have taken a significant leap forward. Pioneers in the field at CHOP have developed an innovative imaging method, dynamic contrast MR lymphangiography (DCMRL), which enhances visualization of the lymphatic system relative to traditional methods. This advanced technique which includes Intranodal (IN), Intramesenteric (IM), and Intrahepatic (IH) DCMRL - has been successfully integrated into the lymphatics treatment pathway (Dori Y, Zviman MM, Itkin M (2014). Our team has been at the forefront in adopting and refining these techniques, advancing our comprehension of the etiology of conditions like Protein-Losing Enteropathy (PLE), Plastic Bronchitis, and Chylothorax. Visualizing the hepatic and mesentery lymphatics has fundamentally changed our understanding of various lymphatic disease processes. Mapping the hepatic lymphatic system has led to the discovery of previously unrecognized sources of pulmonary lymphatic perfusion, which has been implicated in the cause of plastic bronchitis and chylothorax (Biko DM, Smith CL, Saul D et al (2019), Sheppard et al, 2023). Our recent breakthroughs in mesenteric imaging have led to the discovery of new causes of Protein-Losing Enteropathy (PLE), notably identifying the intrahepatic and duodenal perfusion leak. Furthermore, our studies have highlighted the mesentery's crucial role in contributing to lymph leakage into the duodenum, as detailed by Dori et al. 2020. These findings have augmented our comprehension of PLE and other lymphatic disorders, thereby paving the way for more targeted therapies.

THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

TEAM

Yoav Dori, MD, PhD
Lymphatic Interventionalist

Fernando A. Escobar, MD
Lymphatic Interventionalist

Ganesh Krishnamurthy, MD, DNB
Lymphatic Interventionalist

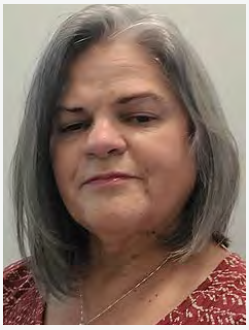
Jonathan J. Rome, MD, FACC
Lymphatic Interventionalist

Christopher L. Smith, MD, PhD
Lymphatic Interventionalist

Abhay S. Srinivasan, MD
Lymphatic Interventionalist

Lauren Biroc, MSN, RN, CCRN, CPNP-AC
Lymphatic Center

Vanessa Bustard, BSN, RN, CPN
Lymphatic Center



Diane Garofalo
Lymphatic Center

Melissa Lyons, BSN, RN
Lymphatic Center

Erin M. Pinto, MSN, RN, CCRN, FNP-BC
Lymphatic Center

THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

TEAM

Aaron G. DeWitt, MD
Lymphatic Attending

Emmanuelle Favilla, MD
Lymphatic Attending

David J. Goldberg, MD
Lymphatic Attending

Chitra Ravishankar, MD
Lymphatic Attending

Samuel Rosenblatt, MD, MSEd
Lymphatic Attending

Rachel Shustak, MD
Lymphatic Attending

Jennifer Danzig Silverman, MD
Lymphatic Attending

Danish Vaiyani, MD
Lymphatic Attending

Pablo Laje, MD
Lymphatic Surgeon

Katsuhide Maeda, MD, PhD
Lymphatic Surgeon

Joseph Piccione, DO, MS
Pulmonary

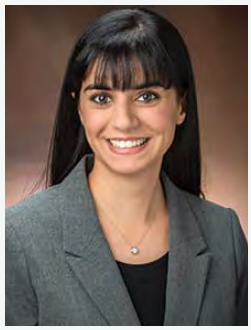
THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

TEAM

Jefferson N. Brownell, MD
Gastroenterology

Petar Mamula, MD
Gastroenterology

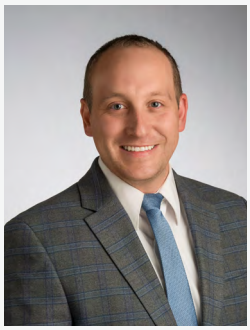
Melanie Savoca, MS, RD, CNSC, LDN
Dietician



Dalal Taha, DO
Neonatology

Denise Adams, MD
Oncology/Hematology

Alexandra Borst, MD
Oncology/Hematology

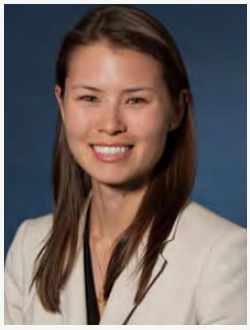


Michael D. Fox, MD, MEd
Oncology/Hematology

Allison Britt, MS, LCGC
Genetics

Hakon Hakonarson, MD, PhD
Genetics

Dong Li, PhD
Genetics



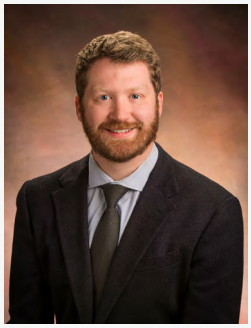
Sarah E. Sheppard, MD, PhD, MSTR, FAAP, FACMG
Genetics

THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

TEAM

David Matthew Biko, MD, MBA
Radiology

Hansel J. Otero, MD
Radiology



Jordan B. Rapp, MD, MMS
Radiology

Ammie M. White, MD
Radiology

LYMPH BIOREPOSITORY INITIATIVE

In our pursuit of advancing lymphatic disorder research, we would like to highlight our lymph biorepository. Our first patient dates back to 2018 and this initiative has been ongoing ever since. This initiative a key aspect of our lymphatic evaluation process and is crucial for gathering comprehensive data and biological samples that are instrumental in driving forward our understanding of lymphatic disease. Currently, we have 461 participants enrolled for potential fluid collections during lymphatic procedures.

CHOP LYMPHATIC DISORDER CONFERENCE: 2023

The Third Annual Lymphatic Disorder Conference, held at the Children's Hospital of Philadelphia (CHOP) on Friday June 2nd, 2023, was a resounding success. Attended by leading experts, researchers, clinicians, and patient advocates from around the world, the conference provided a platform for innovation, collaboration, and thoughtful discussions in the field of lymphatic disorders. The conference featured nearly 100 attendees. Presenters at the conference represented various countries across the globe, such as Denmark and Belgium.

Over the course of the day attendees engaged in panel discussions and presentations segmented into different subspecialties and organ systems with a focus on the lymphatic system, such as: Imaging of the lymphatic system, surgical management, ocular lymphatics, lymphatics in GI diseases, lymphatic involvement in human disease in the brain and lymphatics in kidney health and disease; bringing us closer to better understanding, diagnosing, and treating these complex conditions. After the success of our 2023 conference, the Jill and Mark Fishman Center for Lymphatic Disorders at the Children's Hospital of Philadelphia (CHOP) will be hosting the 4th Annual CHOP Lymphatic Disorder Conference. This year, the focus will be: New Horizons in Lymphology: Lymphatic Imaging, Intervention, Medical Therapy and Microsurgery. For additional information and registration, please visit: chop.cloud-cme.com.

THE JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

PATIENT STORIES - CAMERON KEMPTON

During Shannon Kempton's 32nd week of pregnancy, an unexpected discovery shocked her family. The sonographer found fluid in baby Cameron's lungs; a condition known as pleural effusion. This would be the beginning of a profound medical journey for her and her family. After being referred to the local hospital for an overnight stay, Cameron Kempton and his mother were transferred to the Children's Hospital of Philadelphia (CHOP) on January 11th, 2023. In the subsequent days, Cameron underwent several evaluations and rounds of testing at CHOP's Richard D. Wood Jr Center for Fetal Diagnosis and Treatment. Cameron was diagnosed with Non-Immune Hydrops Fetalis and a potential Chylothorax. Despite the atmosphere of uncertainty and their limited knowledge obtained through online searches, the family remained optimistic that Cameron's story would inspire others with similar conditions. The medical team decided on two key procedures: an amniocentesis and a thoracentesis to test the fluid, which turned out to be lymphatic fluid, confirming a diagnosis of chylothorax. Nine days later, the clinical team decided to place a shunt in Cameron's chest to aid in fluid drainage, given that his lungs were only 33% developed. On January 21st, Cameron showed signs of distress, and Dr. Christina Paidas Teefey performed an emergency fluid drainage prior to delivering him via C-section. Cameron's initial days were critical. He required extensive support, including high-frequency oscillatory ventilation (due to respiratory failure) along with bilateral chest tube placement for large volume pleural effusions. Shannon recalls having to wait a month to finally hold him, which itself became a much-needed reprieve from the hospital's tense atmosphere. During this time, the Kempton family found solace in documenting their journey on their Instagram page @baby.kempton, The Neonatal Intensive Care Unit (NICU) felt like a void, and sharing their experiences on this page became a window to the outside world.

Dr. Yoav Dori, Director of the Jill and Mark Fishman Center for Lymphatic Disorders, was instrumental in Cameron's recovery. He and the lymphatics clinical team conducted an MR Lymphangiogram on February 8th to map out Cameron's lymphatic system, which noted bilateral pleural effusions, dermal backflow, flow into head/neck, bilateral pulmonary lymphatic perfusion, patient thoracic duct to vein outlet, and dilated cutaneous lymphatic channels. His central venous pressure (CVP) was 5 at the time and lipiodol was injected for pleural effusions. Despite the hesitations, Dr. Dori, Erin Pinto CRNP, and the rest of the clinical team continued to reassure and provide confidence to the Kempton family. Cameron's improvement began in March, a gradual process marked by small victories and setbacks. He extubated on March 8th, which was a significant milestone in his medical journey. He was finally discharged to home in early April. Since his last follow-up with the CHOP team in July, he has been doing well. At 11 months old, his family notes that Cameron is thriving and bonding with his older brother, Donovan. His early struggles have not hindered his growth; he's exceptional in both height and weight for his age. The multidisciplinary effort led by the CHOP lymphatics team has shown how innovative solutions and advancements in lymphatic imaging can save lives in the most critical of moments. While sharing her experiences on this journey, Shannon Kempton has noted that "they are not only medical professionals but an integral part of our family's story. Cameron's journey is a testament to the power of medical science, the resilience of the human spirit, and the strength of family."

FONTAN **FORWARD**

PROGRAM

OVERVIEW

Today most individuals diagnosed with single ventricle malformation will survive surgical reconstruction resulting in a successful Fontan operation. As greater numbers of patients survive, so has the recognition that individuals with Fontan circulation face a variety of challenges. The goal of a normal quality and duration of life will unfortunately be a challenge for many to achieve. The hurdles fall into a variety of domains. From a cardiovascular perspective, the Fontan circulation is fundamentally flawed by its inherent state of chronically elevated venous pressure and congestion, accompanied by a relatively low cardiac output. Ventricular dysfunction, atrioventricular valve regurgitation, and arrhythmia may directly impact cardiac performance and can progress with time. Problems are not limited to the cardiovascular system, and in fact non-cardiovascular challenges often dominate health concerns.

Fontan circulatory physiology impacts a multitude of biological processes and health parameters outside of the heart. The lymphatic circulation is under strain manifesting as variable degrees of protein rich lymph loss and immune system dysregulation. Organ system dysfunction develops through altered perfusion profiles. Liver fibrosis is ubiquitous and a process of systemic fibrogenesis in response to circulatory stressors may affect other organs as well. Somatic growth and development can be delayed. Behavioral and mental health problems are common, presenting as clinically important levels of anxiety and depression. Most striking is the high variability in prevalence and magnitude of these complications within the population of individuals with Fontan circulation.

The Children's Hospital of Philadelphia has always been and continues to be a leader and pioneer in the care of single ventricle care and Fontan patients. To care for and manage the emerging complications of this unique population, we created the first of its kind multidisciplinary model of Fontan care in 2011 and then expanded and rebranded this program in 2019 to the Fontan FORWARD Program. The "Fontan rehabilitation, wellness and resilience development" or FORWARD Program is a unique multidisciplinary clinic combining the expertise of dedicated clinical providers in the realms of cardiology, hepatology, endocrinology, immunology, psychology, exercise physiology, dietary and nutritional science, and social work. The CHOP Cardiac Center FORWARD Program is the first in the nation and now the model that many other centers have emulated to provide specialized care specific to the unique needs of growing number of individuals with Fontan circulation.

The FORWARD program is led by Dr. Jack Rychik, Medical Director, and Katie Dodds, MSN, CRNP, Clinical Program Manager and supported by an exceptional team of experts experienced and dedicated to advancing knowledge and providing care to individuals with single ventricle and Fontan circulation.

METRICS

Total Full Multispecialty clinic visits..... 60
Total Targeted FORWARD clinic visits 9
Total Patients Evaluated in 2023 119

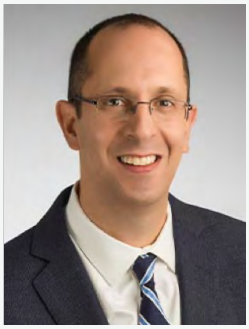
FONTAN **FORWARD**

PROGRAM

LEADERSHIP

Jack Rychik, MD
Medical Director

Katie Dodds, CRNP
Clinical Manager



Dave Goldberg, MD
Cardiology

Elisabeth Rand, MD
GI/Hepatology

Edna Mancilla, MD
Endocrine

Jennifer Heimall, MD
Immunology

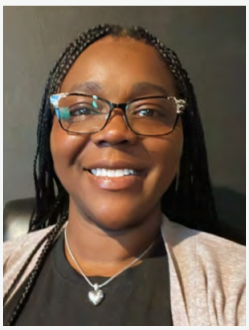
Nick Seivert, PhD
Psychology

Danielle Campbell, LDN
Nutrition

Shannon O'Malley, MS
Exercise Trainor

Lynn Callaway, MSW
Exercise Trainer

Nancy Ebaid
Program Coordinator



Linda King, BBA
Financial Counselor

FONTAN **FORWARD**

PROGRAM

HIGHLIGHTS/ACCOMPLISHMENTS

Since inception, the FORWARD clinic has cared for and evaluated over 800 patients with single ventricle Fontan circulation and their families. FORWARD is the first in the nation program dedicated to the unique multidisciplinary care needs of patients with Fontan circulation and their families. As such, the FORWARD program has become the model very much emulated by other centers around the world, focused on the services vital for the health and wellness of these individuals and their families.

Specific accomplishments include:

- Promoting the standard for testing and surveillance evaluations that are uniquely age based for those with Fontan circulation.
- Creating mechanisms for targeted serial follow up surveillance of patients who have undergone initial comprehensive evaluation, thus creating greater opportunities for patients and families to be seen serially and sequentially and continue targeted care within the FORWARD clinic service model.
- Increasing surveillance strategies to younger and younger patient populations starting at 2-3 years following Fontan operation [ages 5-6 and above]
- Providing standards and modeling protocols for creation of a nation-wide registry on surveillance of individuals with Fontan circulation through leadership within the "Fontan Outcomes Network."
- Leading creation of a quality improvement project within the Fontan Outcomes Network focused on physical activity & exercise including development of tools to promote these goals
- Release and distribution and of a unique 18-minute patient and family based educational video to introduce the concepts, challenges and hurdles of living with single ventricle and a Fontan circulation.

RESEARCH HIGHLIGHTS

The FORWARD group is actively involved and in the forefront of several research activities in areas that include:

- Understanding the origins of liver fibrosis and other organ fibrogenesis in the Fontan circulation
- Publication of a multidisciplinary collaborative landmark paper outlining the genomic and metabolic atlas of Fontan-associated liver disease through single cell nucleolar sequencing [manuscript in press: Hu P, Rychik J, Zhao J, Bai H, Bauer A, Yu W, Rand EB, Dodds KM, Goldberg DJ, Tan K, Wilkins BJ, Pei L. Single cell multiomics guided mechanistic understanding of Fontan-associated liver disease. Science Translational Medicine 2024]
- Determining the genetic basis to fibrogenesis in the Fontan circulation
- Exploring the pathophysiology of Fontan associated liver disease through study of nearly 200 patients with liver biopsy specimens and cardiac catheterization data and comprehensive characterization of FORWARD surveillance testing to explore cross domain associations
- Identifying optimal sophisticated tools such as 3D MRI and other techniques to best quantify Fontan-associated liver disease
- Investigating the magnitude of somatic growth limitations and association with Vitamin D deficiency and parathyroid hormone dysregulation in the Fontan circulation
- Exploring relationships between Fontan clinical and emotional wellness such as the role of exercise in both clinical and psychological wellbeing.

FONTAN **FORWARD**

PROGRAM

FUTURE DIRECTION

The FORWARD program continues to innovate and lead the congenital heart community in developing optimal strategies of care and management to allow for creation of a normal quality and duration of life for individuals with Fontan circulation

Specific areas of future focus include:

- Understanding the interplay and relationship between emotional health challenges and physiological limitations of the Fontan circulation
- Targeted therapy of poor somatic growth through careful initiation of individualized strategies of care (eg. nutrition, selective use of growth hormone, etc)
- Evolution and development of detailed database characterization of patients including creation of electronic healthcare record methods for automation and potential ease of data collection.
- Continued leadership and direction of the Fontan Outcomes Network database registry and quality improvement initiative for those with Fontan circulation
- Development of specific age-based instructional video demonstrations of recommended strength and conditioning activities for those with Fontan circulation
- Wide-spread utilization of our Fontan circulation educational video and further enhancement of patient and family-based educational programs
- Expansion of access to our unique specialized clinical services through growth of the targeted visit program and extension of FORWARD clinic access to younger patients that are 3-4 years out from their Fontan operation

FETAL HEART PROGRAM

OVERVIEW

The Fetal Heart Program at CHOP is one of the first programs in the nation dedicated specifically to the evaluation, diagnosis and treatment of heart disease before birth. Now in our 22nd year, we perform over 4,000 fetal echocardiograms annually throughout the Cardiac Center enterprise and treat over 400 unique patients with a variety of forms of prenatal cardiovascular disease each year, making our program one of the largest of its kind in North America. We offer every resource possible to expectant families in need — from expert evaluation and diagnosis to innovative strategies of fetal care to planning for delivery and care after birth and beyond.

We believe optimal care includes both state-of-the-art imaging and management of fetal heart conditions as well as attention to family education, distress and trauma associated with fetal heart disease. Our multidisciplinary group includes a team of fetal heart nurse coordinators and a dedicated social worker and psychologist who focus on family education and psychological support. This essential service is just one feature that distinguishes our program from others like it. Due to the unique nature and specific dedicated needs of prenatal care, the Fetal Heart Program functions independently from our world class pediatric ECHO lab and includes dedicated state of the art obstetrical ultrasound equipment with a dedicated and experienced team of seasoned, incredibly experienced fetal cardiovascular sonographers. Accompanying the imaging is a highly-skilled team of fetal heart nurse coordinators dedicated to optimizing clinical care and family focused service throughout the prenatal experience.

The CHOP FHP is a sister program to the CHOP Richard D. Wood Jr. Center for Fetal Diagnosis and Treatment, world renowned for innovative fetal surgery and therapy. Patients cared for by the FHP are able to deliver at the Garbose Family Special Delivery Unit at CHOP, the first free-standing children's hospital in the nation to have a dedicated birthing unit solely for mothers carrying a fetus with a birth defect.

Our breadth of experience, depth of knowledge and commitment to ongoing innovation and creation of state-of-the-art management strategies allow us to offer the utmost care for all types of fetal cardiovascular conditions. From those with simple conditions to the most complex, the Fetal Heart Program offers access to the most compassionate and knowledgeable providers, advanced treatments, and innovative technologies available — with outcomes among the best in the world!

At the Fetal Heart Program, we believe collaboration within a team of providers leads to the best care. Throughout delivery and all types of cardiovascular care, close contact with referring obstetricians and pediatric cardiologists is essential to ensure the highest level of collaborative, multidisciplinary care to our patients.

At the Fetal Heart Program, our objectives are to provide:

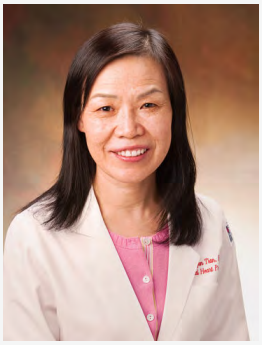
- High-quality, high-resolution imaging to allow for detection of all forms of cardiovascular conditions form the simplest to the most complex.
- Early fetal cardiovascular imaging when indicated, as early as 13-14 weeks of gestation.
- In-utero treatment of fetal conditions.
- Management strategies that allow for optimal transition to neonatal care to provide for the best possible outcomes.
- Guidance and prenatal counseling for patient and family
- Family education and psychosocial support.

FETAL HEART PROGRAM

LEADERSHIP

Jack Rychik, MD
Medical Director

Jill Combs, MSN, RN
Program Manager



Zhiyun Tian, MD, RDCS
Chief, Fetal Cardiovascular Imaging

Amanda Shillingford, MD
Director Fetal Heart Community Outreach

FACULTY & TEAM

Stephanie McNelis, BSN, RN
Nurse Clinical Coordinator

Peter (Yajun) Guo, RDCS
Fetal Cardiovascular Sonographer

Elizabeth Coulter, MS, BSN, RN
Nurse Clinical Coordinator

Elizabeth Smith, BSN, RN
Nurse Clinical Coordinator

Fetal Heart Program Attendings:
Jack Rychik, MD, Medical Director
Shivani Bhatt, MD
Meryl Cohen, MD
Michele Cohen, DO
Karl Degenhardt, MD
Stan Ewing, MD
Christine Falkensammer, MD
Elizabeth Goldmuntz, MD
Shobha Natarajan, MD
Chandni Patel, MD
Michael Quartermain, MD
Lindsay Rogers, MD
Jill Savla, MD
Amanda Shillingford, MD
Anita Szwast, MD

Program Manager:
Jill Combs, MSN, RN

Social Workesr:
Lucia Figueroa, MSW, LSW
Sasha Rose Relyea, MSW

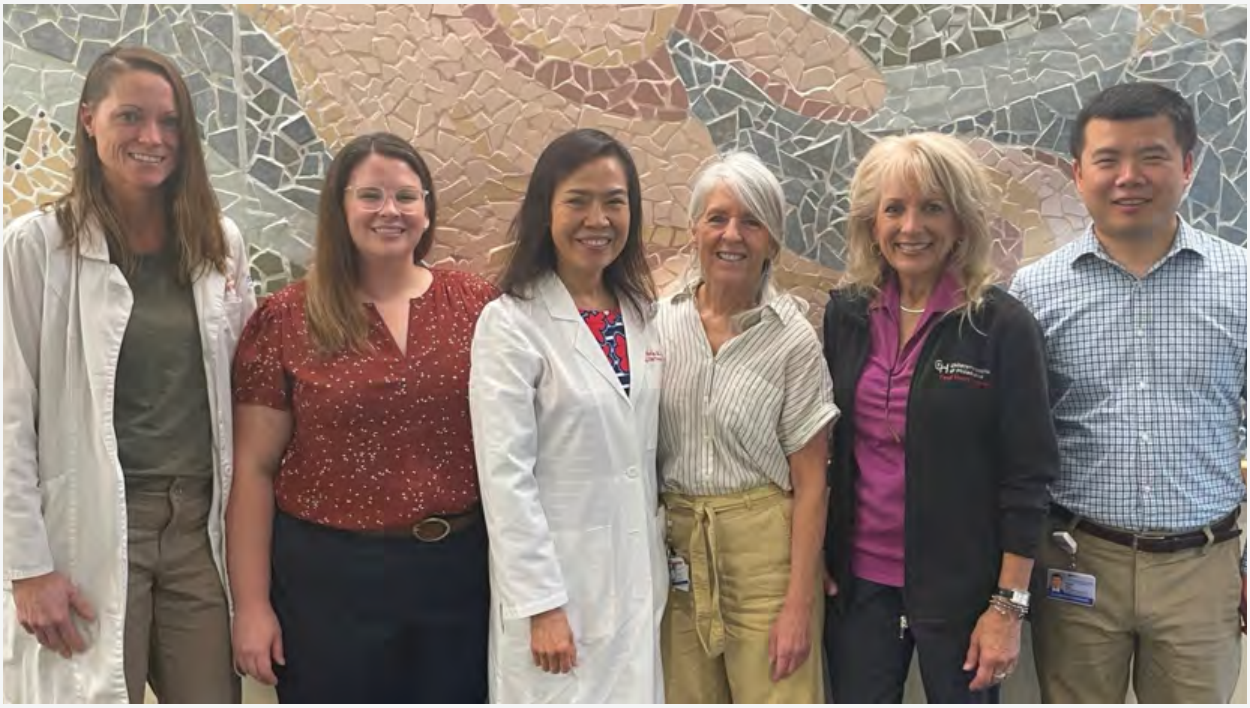
Chief, Fetal Cardiovascular Imaging:
Zhiyun Tian, MD, RDCS

Fetal Cardiovascular Sonographers:
April Hamilton, RDCS
Margaret McCann, RDCS
Debbra Soffer, RDCS
Christina Werth, RDCS

Administrative Assistants:
Cynthia Baker
Lorri Dippel

FETAL HEART PROGRAM

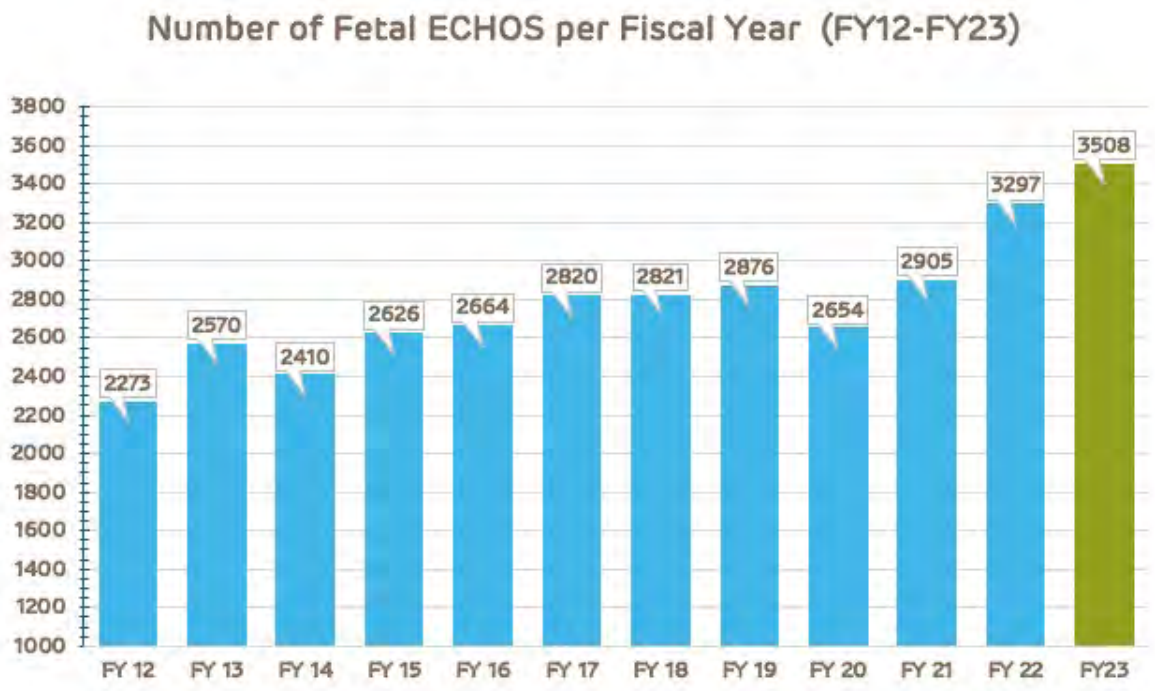
From left to right: *Sasha Rose Relyea, Lucia Figueroa*

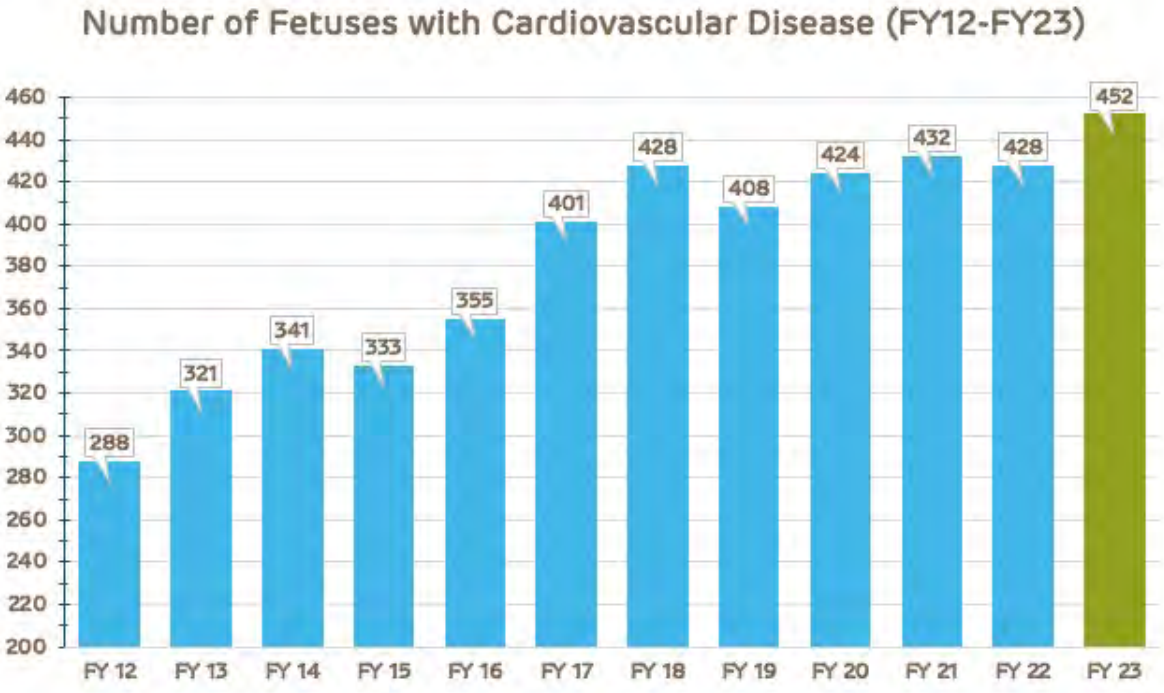


From left to right: *April Hamilton, Christina Werth, Zhiyun Tian, Peggy McCann, Debbra Soffer, Peter Guo*

FETAL HEART PROGRAM

METRICS





FETAL HEART PROGRAM

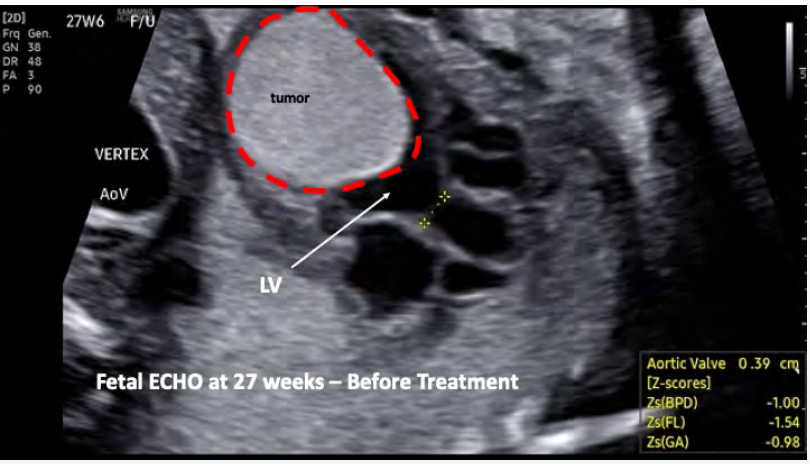
RESEARCH HIGHLIGHTS

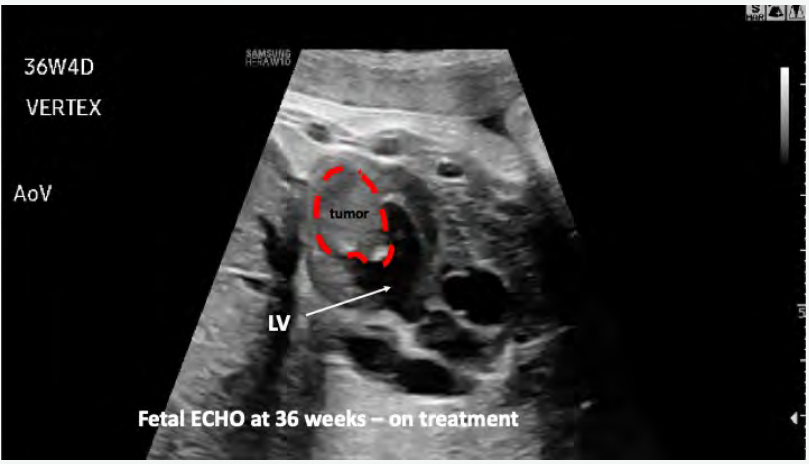
1. Investigation of placental abnormalities in association with congenital heart disease. We are studying placental blood flow in utero in complex CHD such as transposition of the great arteries and hypoplastic left heart syndrome and inspecting their placentas at birth, with a variety of interesting important findings that convey the presence of placental insufficiency in association with complex CHD.
2. Mental health when there is prenatal diagnosis of CHD. We are exploring the relationship between severity of fetal heart disease and various aspects of maternal psychological health at different points of time before birth and right after birth of a fetus with heart disease, this in a very large-scale collaborative study between CHOP Fetal Heart Program and Center for Fetal Diagnosis & Treatment.
3. Exploration of the role of maternal hyperoxygenation in better defining outcomes for complex fetal heart disease. In an effort led by Dr. Anita Szwast, we are investigating whether maternal hyperoxygenation can better predict need for newborn early intervention in conditions such as transposition of the great arteries.
4. Release and distribution of a unique educational video for patients and families following diagnosis of sing le ventricle congenital heart disease.

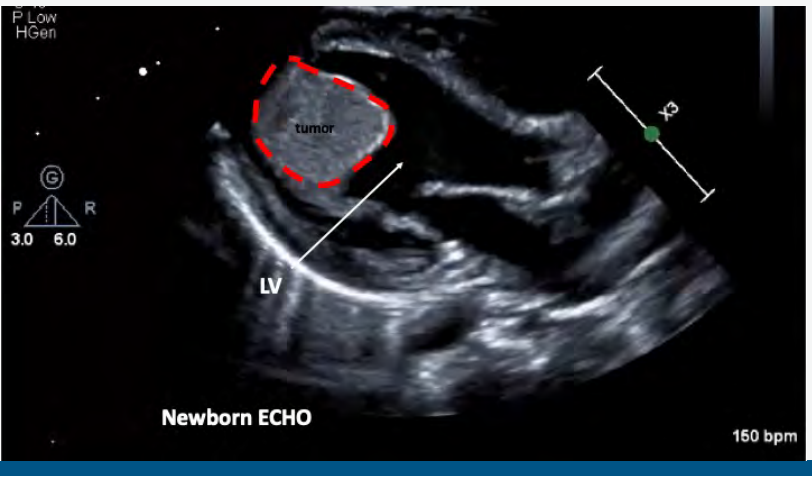
FETAL HEART PROGRAM

EXAMPLES OF EXTRAORDINARY INNOVATIVE CLINICAL CARE

This past year we successfully treated 2 extraordinary cases that highlight the innovative collaborative clinical care offered in the Fetal Heart Program. Without this bold innovative treatment strategies, the fetuses likely would not have survived. Following treatment with these individual strategies of care, both are now born and doing exceptionally well.







CASE 1:

Fetal surgery treatment of life-threatening giant pericardial teratoma.

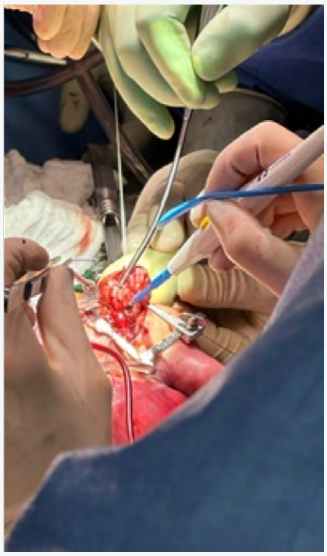
Shown are images of fetal tumor before in-utero treatment, after 6 weeks of fetal treatment and as newborn. Treatment with maternal sirolimus resulted in dramatic reduction of tumor size from initial in which it was obstructive to left ventricle (LV) inflow to a much smaller insignificant size with improvement in left ventricle cavity volume and function.

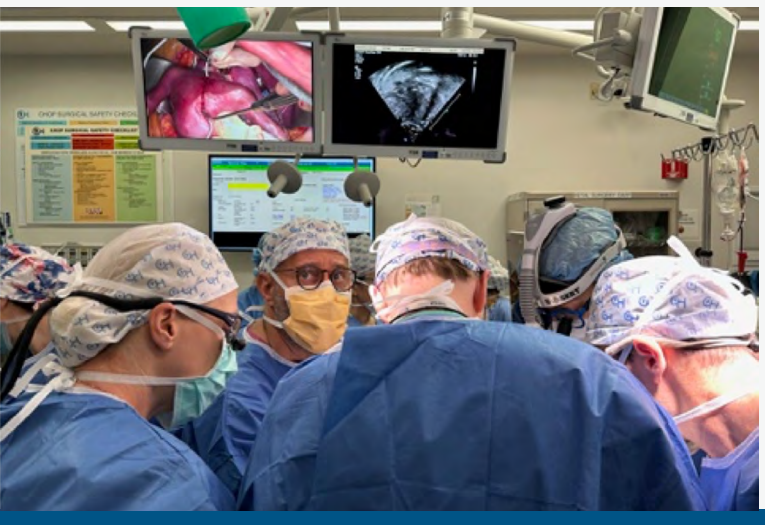
FETAL HEART PROGRAM

CASE 2:

Treatment of a giant fetal cardiac tumor, a rhabdomyoma with maternal sirolimus therapy.

Open fetal surgical resection of pericardial teratoma performed with continuous fetal echo imaging. A collaborative effort between fetal cardiology, fetal surgery, maternal-fetal medicine, cardiac surgery, anesthesia, nursing and psychology teams.





FETAL HEART PROGRAM

FUTURE DIRECTION:

We are excited about the future of the Fetal Heart Program as the introductory gateway of care and entryway to the Cardiac Center, with plans for:

- Expansion of unique programs such as early fetal cardiovascular imaging, maternal hyperoxygenation and placental evaluation and incorporation into management strategies
- Focused attention on prenatal family education and counseling
- Strengthening family psychological support
- Continued improvement of services that offer delivery of premier state-of-the-art diagnostic and management care to the fetus and family with cardiovascular disease

HEART FAILURE/ HEART TRANSPLANT AND ACT ICU

CLINICAL AND PROGRAMMATIC HIGHLIGHTS

The Advanced Cardiac Therapies for Heart Failure program has focused on implementing novel approaches to clinical care, as well as research to support targeted, evidence-based medical management for pediatric patients with heart failure related to congenital, genetic, or acquired cardiac diseases. These children often require complex and innovative approaches to treatment, including use of mechanical circulatory support through ventricular assist devices (VADs) and heart transplants. With the launch of the Advanced Cardiac Therapeutic Intensive Care Unit (ACT ICU) in November 2022, heart failure and VAD patients are being cohorted to a single ICU team, with program initiatives now expanded to heart failure patients across the cardiac center. The program is supported by cohesive multidisciplinary care team to provide a comprehensive approach to management with improved continuity of care throughout the patient's hospitalization. We have implemented a structured approach to VAD management with a formalized VAD evaluation process and weekly mechanical circulatory support (MCS) rounds to address VAD related issues and optimization of support and medical management, as well as workgroups to support standardization of anticoagulation management for VAD patients, which has resulted in significant improvement in the incidence of stroke in this vulnerable patient population.

Knowing that patient health at the time of transplant is one of the greatest modifiable risk factors for successful outcome, the team has implemented a structured Intensive Rehabilitation program to bring comprehensive rehab services to the bedside and optimize patient skill and conditioning before and after surgery, which includes a novel approach to support developmental progress of our infant population through a specialized Developmental Intensive Program. Despite the need for extended hospital stays, the program has had a significant impact on patient progress, with improved clinical outcomes for even those at highest risk.

VOLUME/METRICS

In 2023, the Heart Transplant Program performed 15 heart transplants in patients with cardiomyopathy and congenital heart disease, with 11 successful transplants from VAD. We continue to have a high volume of patients with ventricular assist devices (VADs), with 20 devices implanted in 18 patients and a total of 30 VAD patients in the program over the past year. These devices included the Impella, CentriMag, Berlin Heart, and HeartMate3 with novel cannulation strategies to support patients with heart failure in the setting of complex congenital heart disease. These include one patient with single ventricle physiology who underwent a hybrid procedure with simultaneous VAD placement, and another with complex 2-ventricle physiology who underwent placement of Berlin biventricular assist devices as a neonate, both of whom have now been successfully transplanted. Two patients moved on to successful VAD explant, one of whom underwent simultaneous cardiac resynchronization therapy (CRT) and is now thriving at home with normal biventricular function.

RESEARCH HIGHLIGHTS

The Cardiomyopathy, Heart Failure, Heart Transplant, and Ventricular Assist Device Program continues to be very active academically, with multiple publications and presentations at national and international meetings, including the 8th International World Congress of Pediatric and Cardiothoracic Surgery, American Academy of Pediatrics, and the American Heart Association. Implementation and clinical outcomes from the new Intensive Rehabilitation and Developmental Intensive Programs has also been shared at multiple conferences.

HEART FAILURE/ HEART TRANSPLANT AND ACT ICU

A major component of the ACT-HF Frontier Program is support for research led by Drs. Jonathan Edwards and Zoltan Arany, which focuses on discovering molecular mechanisms of right ventricular failure using a multi-omics strategy to characterize patient and preclinical models. Highlights from their research has shown evidence for: 1) inflammation driven capillary expansion, 2) suppression of lysosomal/autophagy pathway in immune cells, 3) depletion of high energy precursors, 4) accumulation of essential amino acids, and 5) inhibition of thin filament maintenance programs.

ON THE HORIZON – NEW DEVELOPMENTS COMING IN 2024

CLINICAL PROGRAM

Moving forward, we're excited to continue optimizing our surgical approach and medical management for VAD patients, focusing on opportunities to use reverse-remodeling medications to support heart recovery and potential for VAD explant, as well as implement a standardized approach to anticoagulation management and antiplatelet strategy, including use of the new IV antiplatelet agent Cangrelor. We also hope to continue expanding our Intensive Rehab and Developmental Intensive programs to support optimal health and conditioning and improve patient outcomes.

RESEARCH

As the Pediatric Heart Analytical Biobank (PHAB) reaches critical mass to provide a platform for pediatric-specific molecular discovery efforts, a focus will be on characterizing the response to mechanical unloading at a single cell resolution. Using preclinical models of right ventricular failure, we will test the efficacy of some newer medications including the blockbuster SGLT2 inhibitors and direct troponin activators. Alongside these, we will test whether these recent discoveries can be leveraged to develop novel therapies for right ventricular failure.

PATIENT STORY: KAI

Kai - now 20 months old - was born with severe congenital heart disease requiring placement of two ventricular assist devices (BiVADs) at just 7 days old to support his heart while awaiting transplant. Through the new Developmental Intensive Program created as part of the Advanced Cardiac Therapies for Heart Failure (ACT-HF) Program, Kai was able to continue building the strength and skills he needed to support him through a successful heart transplant. Kai has now made a remarkable recovery and continues to thrive at home.

HEART FAILURE/ TRANSPLANT & ACT FRONTIER PROGRAM

LEADERSHIP

Kimberly Lin, MD
Cardiomyopathy Program
Medical Director

Matthew O'Connor, MD
Heart Transplant Program
Medical Director

Katsuhide Maeda, MD, PhD
ACT Frontier Program
Principal Investigator

Joseph Rossano, MD
ACT Frontier Program
Principal Investigator

Aaron DeWitt, MD
ACT ICU Medical Director

Jonathan Edwards, MD
ACT Frontier Program
Co-Investigator

Zoltan Arany, MD, PhD
ACT Frontier Program
Co-Investigator

Daniel Kelly, MD, PhD
ACT Frontier Program
Co-Investigator

Farrell Weiss, MSN, CRNP
Clinical Program Manager

Sara Baumgarten, BA
Program Manager

Debra Lefkowitz, PsyD
Psychology

Charisse Rhone, MSS
Social Work

HEART FAILURE/ HEART TRANSPLANT AND ACT ICU

FACULTY

Cardiology
Joseph W. Rossano, MD
Matthew J. O'Connor, MD
Kimberly Y. Lin, MD
Jonathan B. Edelson, MD
Carol A. Wittlieb-Weber, MD
Jonathan Edwards, MD
Justin Berger, MD PhD
Chitra Ravishankar, MD

Cardiothoracic Surgery
Katsuhide Maeda, MD
Jonathan Chen, MD
Stephanie Fuller, MD
Muhammad Nuri, MD
Constantine Mavroudis, MD
J. William Gaynor, MD
Cardiac Critical Care
Aaron DeWitt, MD
Benjamin W. Kozyak, MD

Physical Medicine and Rehabilitation
Sarah (Sally) Evans, MD

Nursing/Advanced Practice Providers/ Allied Health Professionals
Lynne Ha, CRNP (Heart Transplant)
Carley Boyle, CRNP (Heart Transplant)
Bree Kyncl, PA-C (Cardiomyopathy)
Madi Baublis, RN (Heart Transplant)
Farrell Weiss, CRNP
Jessica Eichner, CRNP
Katherine Montgomery, RN (VAD Coordinator)

ACT PT/OT Leads
Amanda Waples
Kristin Caputo
Sarah Stevens

PT/OT Team Members
Rebecca Hoffritz
Emily Roberts
Tabatha Rudzinski
Jordan Porter

Speech Therapy
Amy Colin
Julia Welc
Christina Minkoff

Psychology
Debra Lefkowitz, PsyD

Social Work
Charisse Rhone, MSS

Program Manager
Sara Baumgarten

CHOP CARDIAC CENTER

AROUND THE WORLD

Many of our Cardiac Center Faculty and Clinical Professionals traveled to other countries throughout the world to collaborate and support other professionals in the care of Congenital and Pediatric acquired Cardiac Disease. Last year some visits included trips to South America, Asia, and Africa to provide education, support, and guidance for programs there. Here are some of the highlights and pictures.

INDIA, ASIA

In July 2023, the cardiac center team of medical volunteers (Joe Rossano, MD, Maully Shah, MBBS, Venkat Shankar, MD Katsuhide Maeda, MD and Sherri Kubis, MSN) visited Amrita Hospital in Faridabad, India to kickstart an important humanitarian partnership with Children's HeartLink. The aim is to transform Amrita Hospital Faridabad into a tertiary care referral site and Center of Excellence for pediatric cardiac care. This multi-year partnership is designed to ensure lasting, sustainable impact in the availability of heart care for children with congenital heart disease in India. During the visit, a comprehensive assessment at Amrita Hospital cardiac program was conducted by the CHOP cardiac center team, including meetings with hospital leadership, cardiologists, cardiac surgeons and nursing leadership as well as observation in the ICU, NICU, cath lab, inpatient wards and outpatient clinics.

In the first year of this newly formed relationship, our team has conducted virtual case conferences to discuss patient management and surgical strategies with surgeons and cardiologists from Amrita Hospital. We are also in the process of helping them procure a cath lab data base system. Another site visit to Amrita Hospital is planned in April which will be focused on ICU care.

CHOP CARDIAC CENTER

AROUND THE WORLD

COLOMBIA, SOUTH AMERICA

Jessica Fuentes and Teresa Stegman were invited by the Nursing team from the CICU at LaCardio Hospital in Bogota, Colombia. They participated in the 8th International Nursing Conference "Challenges to sustain nursing development: a vision towards the future of Nursing" from May 24-26th 2023. They were able to lecture on various topics of nursing and ICU competencies and discuss evidence-based practice and participated in a leadership panel focused on the nursing professional practice model as it relates to Magnet. The team in LaCardio shared a tour of their Cardiac ICU and ideas for the future of nursing professional development. It was an incredible opportunity to share our workflows and experiences and learn about the many similarities we have.

NIGERIA, AFRICA

In October 2023 Emily Schwartz, CRNP, Erin Price, BSN, RN and Jess Eichner, CRNP traveled to Orafite Nigeria with the Vincent Obioma Ohaju Memorial (VOOM) Foundation, a private organization that serves the Nigerian population with open heart surgical missions. This was only the second pediatric open heart surgical mission in the country. The team included others from multiple organizations and was led by previous CHOP cardiac center congenital surgical fellow Andrew Goldstone. The team provided nursing education and training, preoperative imaging and counseling, cardiac intensive care recovery and management through discharge. In five operating days, the team completed 15 bypass cases.

CHOP CARDIAC CENTER

AROUND THE WORLD

BOTSWANA, AFRICA

Chitra Ravishankar, MD, Joe Rossano, MD and Meryl Cohen, MD traveled to Gabarone, Botswana to spend a week with Dr. Endale Tefera, the chief of pediatric cardiology at Princess Marina hospital. In addition to learning about the program, we came to morning report each morning to hear about new admissions and spent time in the cardiology clinic where Dr. Cohen even scanned some patients with fascinating disease. Dr. Tefera is starting a pediatric cardiology training program there and we will be collaborating with him as Adjunct professors. It was an incredible experience and now we have our first cardiology fellow, Helen Stanley, MD – who is going to spend a month there on a global health rotation!

PAKISTAN, ASIA

Tahir Heart Institute is the 90- bed cardiac facility that is situated in the semi urban/ rural setting of Pakistan. Patients present to the outpatient setting on a walk -in basis with approximately two hundred adult and pediatric patients seen daily. It is an adult cardiac facility that performs approximately 100-125 pediatric cardiac cases per year. The pediatric surgical program has been supported by two US trained congenital cardiac surgeons (part time basis) since its inception and was co-founded by CHOP congenital surgeon Muhammad Nuri.

In the calendar year 2023-2024, we undertook three pediatric surgical trips and performed 40 cases. The trips were well supported by the CHOP cardiac OR nurses (Jill Bacher/ Gail Keyser) who were instrumental in gathering surgical supplies and materials for these trips. On the last trip in February 2024, our cardiology fellow Anila Chaudhry joined us. She shared her experience

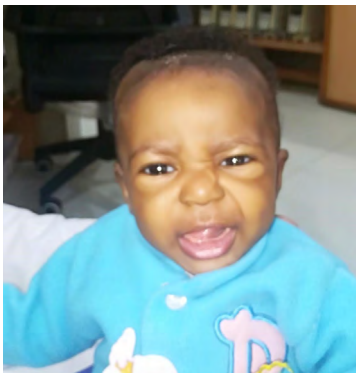
" My experience at the Tahir Heart Institute was incredibly transformative and one that allowed me to be a learner and a teacher. I had the opportunity to interact with a diverse group of patients who were in dire need of medical attention and a phenomenal group pf medical staff dedicated to providing the best care they could, despite limited resources. I worked closely with sonographers. I shared echo skills learnt in my cardiology fellowship to diagnose complicated congenital heart disease. I was able to review the pathophysiology of post operative patients in the ICU. At the same time, I was able to appreciate the importance of shared decision making and family education with low medical literacy. It was an honor to serve these families and witness the life changing effects of treatment they received under the care of Dr Nuri and his colleagues."

CHOP CARDIAC CENTER

AROUND THE WORLD

PAKISTAN, ASIA (CONTINUED)

Below are some pictures of the Dr. Muhammed and Dr. Chaudhry as well as a pictorial journey of an orphan infant from Benin West Africa who underwent surgery at Tahir Heart Institute for Total Anomalous Pulmonary Venous Return. It captures her journey from pre surgery, during and most recent pictures.



INNOVATION AWARDS

The Cardiac Center Innovation Awards are funded solely through the annual fundraising event, Philly Spin-In. These awards are awarded annually to support highly innovation and transformative approaches to major challenges in Pediatric Cardiac Disease. The proposals submitted are unique, innovative, and have a creative emphasis to solve significant problems within our field. Most applications focus on scientific research and programmatic ideas.

Seven out of the twelve applications were given awards in 2023, though all the proposals were excellent and well received.

Project Leads	Project Title
Nick Pratap, MB, BChir Renee Willett, MD	CHD Panorama
Matthew Jolley, MD Alison Pouch, Ph.D	Systemic Semilunar Valve Mechanics and Simulated Repair in Congenital Heart Disease
Ryan Callahan, MD Danish Vaiyani, MD	Calculating Wall Shear Stress in Pulmonary Veins of Infants Using Cardiac Magnetic Resonance Imaging: A Pilot Study
William Gaynor, MD Audrey Odom, MD, Ph.D	Fecal Volatile Organic Compounds and Necrotizing Entercolitis in the CICU
Stanley Stachelek, MD	Progression of Mitral Valve Regurgitation in the Pediatric Population
Amy Shultz, MD Danielle Campbell, MS, RDN, LDN Sara Baumgarten, BA Katelyn Zeoli, BSN	Cardiac Center Feeding Tube Weaning Program
Colleen Driscoll, Ph.D Amanda Shillingsford, MD Marissa Bremer, MSN Amy Jo Lisanti, Ph.D, CCNS	Inpatient Family-Centered Neurodevelopmental Program

INNOVATION AWARDS

This year we hosted our first annual Innovation Day Panel where we asked previous award winners to present updates to the larger patient community. This was a way for us to steward, cultivate and recruit Philly Spin-In support. We were able to hear from:

- **Natalie Bernard, BSN** – Cardiac Center Care Management Program: Addressing the Gap for Complex Patient Care Coordination
- **Sherri Kubis, MSN** – Cardiac Center for Resourced Education and Simulation Training
- **Matthew Jolley, MD** – Quantitative 3D Analysis to Inform Systemic Semilunar Valve Repair in Children
- **David Frank, MD** – Leveraging an Omics Approach for Discover of Molecular Mechanisms and Therapies for Pulmonary Vein Stenosis

MEDICAL DIVISIONS & CLINICAL PROGRAMS

2023 Cardiac Center Annual Report

DIVISION OF CARDIOTHORACIC SURGERY

INTRODUCTION

The CHOP Division of Cardiothoracic Surgery remains one of the highest volume centers in North America, performing over 600 open cardiac procedures and more than 1000 total cases each year at both CHOP and the Hospital of the University of Pennsylvania (where we perform approximately 60 adult congenital heart disease (ACHD) operations annually). Our cases cover the full spectrum of cardiac surgery, including fetal interventions, neonatal reconstruction, advanced pulmonary vein repairs, thoracic organ transplantation, mechanical circulatory support, lymphatic procedures, complex aortic arch reconstruction, and management of adults with congenital heart disease. The division is consistently among the top three busiest programs in the country by volume, but most notably the highest volume program for neonatal bypass and neonatal total cases. Our overall STS reported STAT mortality in 2023 was 0.88% for Benchmark Procedures and 1.88% for all STAT Procedures), despite our case mix favoring more complex procedures.

Our group continues to explore new surgical solutions to complex problems including lymphatic surgical decompression, complex valve repair, innovative mechanical assist alternatives and two-ventricle conversions. Our surgeons are also part of a new pulmonary vein disease intervention program, specializing in the development of innovative surgical and transcatheter approaches to these high-risk problems. In addition to open heart surgery procedures, our surgeons (Fuller) lead the field in resection of rare airway and lung tumors, as well as work in conjunction with our otolaryngologists to perform extensive slide tracheoplasties. Dr. Maeda also serves as Surgical Director of the Pediatric Lung Transplant program at CHOP, where last year he performed 3 double lung transplants.

Our team includes nine Cardiac Perfusionists who help to drive program initiatives in blood conservation surgery, minimization of cardiopulmonary bypass technology, and advanced short and long-term mechanical circulatory support. Our Chief of Perfusion, Tami Rosenthal, is the immediate past-President of the American Society of Extracorporeal Technology (AmSECT) and Rich Melchior is the Vice President of the American Academy of Cardiovascular Perfusion (AACP). Our team of physician assistants contribute to the pre-operative, intraoperative and postoperative care of our patients, with each focusing their academic work within subspecialty sections of the Cardiac Center. The team also has a new addition (Alex Ahern)

DIVISION OF CARDIOTHORACIC SURGERY

LEADERSHIP

Jonathan Chen, MD
Division Chief

Stephanie Fuller, MD

Muhammed Ataunur Khalid Nuri, MD

Katsuhide Maeda, MD, PhD

J. William Gaynor, MD

Constantine D. Mavroudis, MD, MSc, MTR

Christine Welch, PA-C
Lead Physician Assistant

Jill Bacher, RN, MSN
CT OR Nurse Manager

DIVISION OF CARDIOTHORACIC SURGERY

RESEARCH HIGHLIGHTS

The Division of Cardiothoracic Surgery maintains a broad portfolio of research interests. Our faculty have presented their data nationally and internationally at all of the major meetings, including the Congenital Heart Surgeon's Society (CHSS), the European Association of Cardio-Thoracic Surgery, The American Association for Thoracic Surgery (AATS), and the Society for Thoracic Surgeons (STS). Some of our most mature research projects are detailed below:

- **MASA Valve:** Currently, there are no optimal prosthetic valves for use in children. All current devices are subject to early failure and/or a risk of thrombosis. The MASA Valve is a novel bi-leaflet valved conduit constructed using an expanded-poly-tetrafluoroethylene (ePTFE) conduit and valve material. Dr. Maeda performed the first-in-human implantation of the valve at CHOP. The conduit has been implanted in 3 subjects at CHOP.
- **CHOP HLHS Inception Cohort:** Since 1984, over 2,000 patients have undergone surgical therapy for hypoplastic left heart syndrome (HLHS) at CHOP, the largest experience in the world. We are contacting adult survivors and asking them to participate in study evaluating long-term outcomes. This project is also supported by a grant from Big Hearts to Little Hearts (Quest for Precision Medicine in Hypoplastic Left Heart Syndrome). An abstract describing the long-term survival has been accepted for presentation at the American Association for Thoracic Surgery 2024 Annual Meeting.
- **Effect of Cardiopulmonary Bypass and Deep Hypothermic Circulatory Arrest (DHCA) on Cerebral Mitochondrial Function:** This a longstanding collaboration for translational research with Dr. Todd Kilbaugh to investigate mechanisms of peri-operative brain injury in neonates with CHD, which is led by Dr. Mavroudis. Using a post-operative neonatal swine. survival model to investigate the time course of mitochondrial dysfunction in the post-operative period we found that even continuous CPB results in mitochondrial dysfunction which persists over 24 hours into the post-operative period. The paper has been accepted for publication by The World Journal for Pediatric and Congenital Heart Surgery. Dr. Mavroudis is the recipient of Cardiac Center Innovation Award to test inhaled nitric oxide (iNO) as a neuroprotective strategy during CPB.
- **Surgical Creation of a Lympho-Venous Anastomosis to Treat Lymphatic Failure in a Swine Model of Right Heart Failure:** The central hypothesis is that the surgical creation of a thoracic duct-to-pulmonary vein lympho-venous anastomosis will effectively treat lymphatic failure and provide relief from its clinical manifestations by promoting sustained decompression of the lymphatic circulation. In the last year, Dr. Maeda and his team have developed an innovative surgical technique to create a lymphovenous anastomosis (thoracic duct to pulmonary vein) in infant swine and demonstrated patency in a survival model.
- **Comprehensive Valve Registry:** Dr Fuller is leading development of a registry collecting data on all patients undergoing valve replacement at CHOP or the Hospital of the University of Pennsylvania since 2010. This unique resource will provide data to answer important questions about durability of different prosthetic and biological valves, need for reintervention, and long-term outcomes. Projects supported by this effort include reintervention after the Ross Procedure, an analysis of in incidence and outcomes of prosthetic valve endocarditis, and participation in a multi-institutional pivotal trial of a synthetic surgically implanted balloon expandable pulmonary valve (Autus Valve).

DIVISION OF CARDIOTHORACIC SURGERY

- **Birth Defects Biorepository (BDB):** Since the last report, enrollment of mother/fetus dyads where the fetus has a birth defect has increased to 1,260. Total enrollment (including parents and siblings) has increased to 3,380 total subjects. Whole genome sequencing (WGS) has been completed by the Broad Institute for 2,589 subjects. We have received and approved 26 investigator-initiated data requests. With support from the Cardiac Center and the CHOP CVI, we have begun collection of myocardial tissue in the operating room. Seven grants using BDB resources have been funded, including a Cardiac Center Innovation Award to investigate fecal volatile organic compounds (VOCs) as a biomarker for necrotizing enterocolitis. VOCs are organic substances which evaporate at room temperature, can be inhaled, and are associated with adverse health outcomes.
- **Fetal Hypoxemia:** The initial studies show that chronic fetal hypoxia leads brain development changes similar to the neuropathological findings observed in children born with CHD. A paper investigating the impact of fetal hypoxia on bile duct development has been published in The Journal of Hepatology. With Dr. David Frank, our paper describing the impact of fetal hypoxia on lung development has been submitted to The American Journal of Respiratory Cell and Molecular Biology.
- **Fetal Neuroplasticity and Neuroprotection (Maternal Progesterone Study):** Maternal Progesterone Study is a randomized clinical trial of pharmacological fetal neuroprotection in CHD. It is the first in humans randomized clinical trial of pharmacological neuroprotection when the fetus has CHD. Enrollment is complete (n=102) and the neurodevelopmental evaluations completed.
- **Exposure to Environmental Toxins from Medical Devices:** Every critically ill child is exposed to multiple medical devices which may be sources of environmental toxins. We have shown that exposure to these toxins at a very high level is ubiquitous during and after cardiac surgery. We collaborated with The Centers for Disease Control on a project examining exposure to volatile organic compounds (VOCs) in neonates undergoing heart surgery. VOCs are organic substances which evaporate at room temperature, can be inhaled, and are associated with adverse health outcomes. A paper based on this project was presented at the Annual Meeting of the American Association for Thoracic Surgery describing exposure of infants undergoing cardiac surgery to volatile organic compounds from medical devices and has been published in the Journal of Thoracic and Cardiovascular Surgery.

OR NURSING

The Cardiothoracic Operating Nursing Team currently consists of eighteen full-time nurses. The nursing team supports all complex cardiac and thoracic surgical procedures on the 6th floor, as well as general and lymphatic cases that require cardiac support and bedside procedures in the CICU. There has been substantial growth and reorganization of the team as the cardiac center grows. This team partners with other surgical teams such as perfusion and anesthesia to provide additional support to our heart failure patients through ongoing treatment. The Cardiac OR Team is comprised of nurses who demonstrate a commitment to upholding standards in patient safety by being certified in perioperative nursing (CNOR) and following the Association of perioperative Registered Nurses (AORN) guidelines. Several team members participate in organizational councils and are active members in shared governance committees.

DIVISION OF CARDIOTHORACIC SURGERY

OR NURSING TEAM


Jessica Bilbow, RN, BSN


Jean Ennis, RN


Marie Galvin, RN, BSN


Carly Glover, RN, BSN


Gail Keyser, RN


Sageeb Khan, RN, BSN


Dallas Lupo, RN, BSN


Kevin McLane, RN, BSN


Deborah Slutter, RN


Emily Smith, RN, BSN


Robert Tomlinson, RN


John Vallieres, RN, BSN

DIVISION OF CARDIOTHORACIC SURGERY

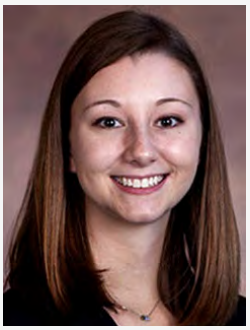
The cardiothoracic surgical service is supported by our Physician Assistant (PA) team. The PA team consists of 12 Mastered Prepared Advanced Practice Providers (APP) who support all aspects of the cardiothoracic program. The cardiac PA team work in many areas of the center and provide 24/7 care in our CTOR, CICU and CCU. The PA team are leaders in their field as evidenced by publications, abstract presentations, lectures and preceptors for PA students from the local programs. The PA team is active in preceptorship of APP Students in partnership with PA programs. All members who qualify for the APP Advancement program participate as either a clinical expert or master clinician.

SURGICAL PHYSICIAN ASSISTANT TEAM


Alexandra Ahern, PA-C


Sarah Bond, PA-C


Christy Bosler, PA-C


Melissa Damiano, PA-C


Laura Murphy, PA-C


Mikayla Pierra, PA-C


Kaitlyn Rubnitz, PA-C


Elizabeth Trovato, PA-C

DIVISION OF CARDIOTHORACIC SURGERY

SURGICAL PHYSICIAN ASSISTANT TEAM (cont.)


Christine Welch, PA-C


Kirsten Young, PA-C


Taylor Zulli, PA-C


Tami M. Rosenthal, MBA, CCP, LP, FPP
Chief Perfusionist

PERFUSION

OVERVIEW

The Perfusion team is currently a team of 9 full time and 4 per diem pediatric perfusionists. The Perfusion team supports all cardiac surgery cases in the cardiac OR with cardiopulmonary bypass support and point of care testing. In the CICU and the CCU, the Perfusion team supports all mechanical circulatory support and cardiac ECMO patients with initiation of support, in-hospital transport, troubleshooting and clinical education. Members of the Perfusion team are active in professional organizations-The American Society of Extracorporeal Technology, The American Academy of Cardiovascular Perfusion, and the Pennsylvania State Perfusion Society. The team presents current topics in Perfusion at national and international perfusion and cardiac surgery conferences.

HIGHLIGHTS/ACCOMPLISHMENTS

In 2023 the Perfusion team supported 592 open heart procedures and 32 patients for cardiac ECMO care. A focus on circuit miniaturization and blood conservation, as well as integrating new technology to improve the safety and quality of perfusion, position us as a leader in the perfusion industry.

Supporting the ACT program, the Perfusion Team managed 30 mechanical circulatory support patients this year. Use of the new Berlin Heart EXCOR Active Driver was initiated which is an upgraded model of the existing IKUS device. The EXCOR Active driver allows children more mobility and independence while on the mechanical support device. In partnership with the ECMO Team, the Perfusion Services upgraded the ECMO technology to provide the ultimate inpatient safety and mobility. The Spectrum Medical Quantum ECLS system with centrifugal pump technology is now being used throughout the hospital.

DIVISION OF CARDIOTHORACIC SURGERY

PERFUSION TEAM


Justin Farr, CCP, LP


Richard Melchoir, BS, MPS, CCP, LP, FPP


Brandon Shade, MPS, CCP, LP


Kellie Shiavo, BS, CCP, LP, FPP


Molly Dreher, BSE, BS, CCP, LP


Min-ho Lee, PhD, CCP


Alex Chappell, CCP, LP


Celia Gagnon, CCP, LP, MLS(ASCP)


Krysta Parker, DBA, MBA, MS, CCP, FPP


John Kernan, CCP


Marc DeCarlo, CCP, LP

NOT PICTURED:
Joseph Schimmel, MS, CCP

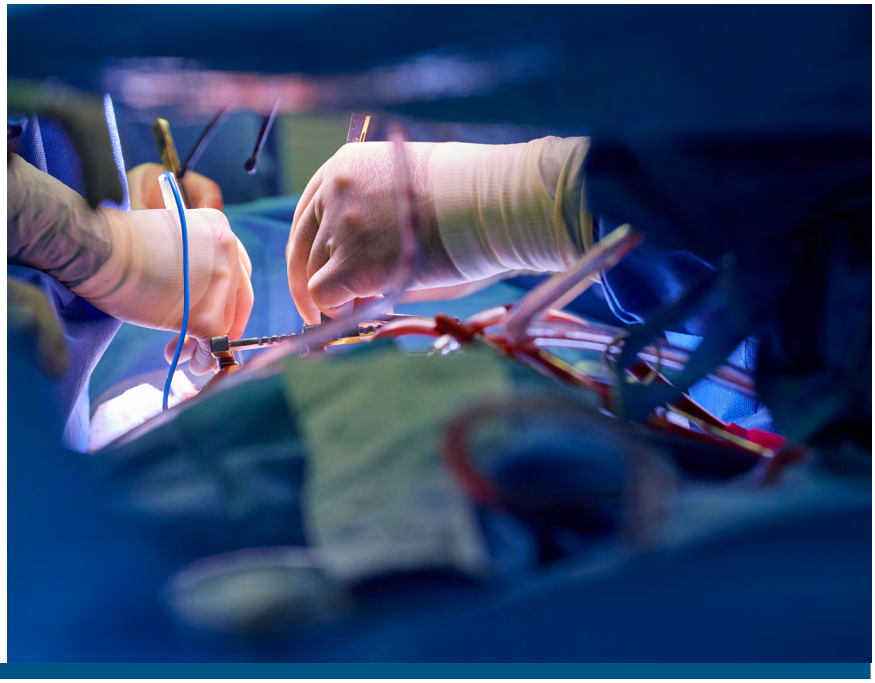
DIVISION OF CARDIOTHORACIC SURGERY

FELLOWS IN THE DIVISION OF CARDIOTHORACIC SURGERY

PAUL DEVLIN MD completed his adult cardiothoracic integrated residency at Northwestern University. Paul spent two years as the Congenital Heart Surgeon Society's Kirklin-Ashburn Fellow at the Hospital for Sick Children in Toronto, performing longitudinal clinical outcomes research for children with congenital heart defects during which he published several seminal papers on outcomes in congenital heart surgery, most notably those on late outcomes after the arterial switch operation, and in the context of pulmonary artery banding.

MRINAL PATEL, MCH., graduated from B.J. Medical College, Ahmedabad India in 2011 and later specialized in general surgery and later in cardiothoracic and vascular surgery. She joined the Department of Pediatric Cardiac Surgery at U.N. Mehta Institute of Cardiology and Research, Ahmedabad, India and from 2022-2024 pursued research in the Department of Surgery at University of Pennsylvania involving basic science and translational projects in novel targeted therapies for heart failure.

KATSUNARI TERAKAWA, MD, PH.D is the inaugural J. William Gaynor Endowed Cardiothoracic Surgery Research Fellow, who finished both his M.D. and Ph.D. at the University of Tokyo where he trained in General and Cardiac Surgery. As part of collaborative research in the laboratory of Todd Kilbaugh, M.D., Dr. Terakawa's research has focused on several swine models: (1) the study of non-invasive neurometabolic optical monitoring during VA-ECMO, (2) evaluation of the effect on the cerebral mitochondrial function after cardiopulmonary bypass and deep hypothermic circulatory arrest in neonates, (3) novel surgical techniques to decompress the lymphatic circulation system for the establishment of surgical strategies to treat lymphatic circulation failure (4) the examination of gene regulation and cell types contributing to the pathology of pulmonary vein stenosis and (5) analysis of cerebral perturbation during ex-vivo support of fetal lambs ("artificial womb").



DIVISION OF CARDIOLOGY

OVERVIEW

Established in 1947 by Dr. Rachel Ash, the first cardiologist at the Children's Hospital of Philadelphia (CHOP), the Division of Cardiology has grown to become one of the foremost clinical divisions within the Department of Pediatrics. Today, it boasts a distinguished team of over 86 faculty members.

Throughout its history, the Division of Cardiology has remained steadfast in its commitment to innovation, earning an international reputation as a leading institution for cardiac care, research, and education. The past two decades have witnessed remarkable expansion in the Division's research activities, clinical services, training programs, and initiatives aimed at community outreach.

This document will provide further details on our specialty programs, showcasing the Division's dedication to excellence and its ongoing contributions to the field of pediatric cardiology.

SENIOR LEADERSHIP

Joseph Rossano, MD
Chief, Division of Cardiology

Vivek Allada, MD
Associate Chief
Community Cardiology and Outreach

Meryl Cohen, MD
Associate Chief
Education

Chitra Ravishankar, MD
Associate Chief
Inpatient Cardiology

Jonathan Rome, MD
Associate Chief
Clinical Affairs

Jack Rychik, MD
Associate Chief
Academic Affairs

Lawrence Barnes
Senior Administrative Director,
Division of Cardiology

DIVISION OF CARDIOLOGY

HIGHLIGHTS & ACCOMPLISHMENTS

- 2023 CHOP Conference (Jill Hsia best abstract, faculty awardee)
- Dr. Meryl Cohen awarded American Heart Association Young Meritorious Achievement Award for significant impact in field of congenital heart disease
- Dr. Therese Giglia awarded Silver Abstract Award in Cardiac Intensive Care Track at 8th World Congress of Pediatric Cardiology and Cardiac Surgery
- Dr. Ramiro Lizano awarded the Paul Weinberg Award for Excellence in Teaching
- Dr. Victoria Vetter awarded the Pediatric and Congenital Electrophysiology Society (PACES) Lifetime Achievement Award for extraordinary contributions and management of arrhythmias in children and patients with congenital heart disease
- Dr. Victoria Vetter received the CHOP Cares EXCEL Grant: Healthy Hearts, Healthy Lives, Health Schools and Communities
- Dr. Matthew Elias collaborated with multiple institutions from Pediatric Heart Network (PHN) to publish article regarding safe use of COVID-19 Vaccinations in children with MIS-C
- T32 successfully refunded for an additional 5 years, continuing for 30 years of total funding.
- Dr. Meryl Cohen, Chitra Ravishankar, and Dr. Joseph Rossano traveled to Botswana in April 2023 to help build their pediatric residency and cardiology fellowship program
- Dr. Thuso David from University of Botswana traveled to CHOP in September 2023 to observe our Pediatric Cardiology Fellowship Program and delivered lecture on “Providing Paediatric Cardiology Care in a Low Resource Setting-Botswana”
- Dt. Amy Schultz appointed the Medical Advisor for Stutman Discharge Follow-up Program
- Dr. Maully Shah, Joseph Rossano, Kats Maeda, Venkat Shankar, and Sherri Kubis traveled to Amrita Faridabad, India with Children’s Heart Link for humanitarian efforts to establish a center of excellence in congenital heart disease and partnership
- Dr. Laura Mercer Rosa appointed Associate Medical Director of Echocardiography Lab
- CHOP CVI/Cardiac Center Biobank launched as Dr. Laura Mercer Rosa as Director
- Andrey Sakharchenko, PhD awarded Second Century Early Faculty Independence award from American Heart Association
- Dr. Rachel Shustak and Jordy Martino MSN CRNP joined Podcast CHOP Primary Care Perspective on “Lipid Management”
- Nikia Toomy, MD received CHD Coalition grant for Machanistic Studies of Bioprosthetic Heart Valves
- Donna Sylvester’s clinical research team had achieved 25 medical school acceptances since 2017
- Dr. Victoria Vetter spoke at Pennsylvania Capital to advocate for legislation requiring Sudden Cardiac Arrest detailed emergency plans and AED within each school building, sporting events, and activities

DIVISION OF CARDIOLOGY

NEW RECRUITS

The Division continued to grow with on new recruits who started in 2023 and two anticipated in 2024.

Started in 2023:

- Humera Ahmed, MD – Heart Failure/Transplant

Starting in 2024:

- Mudit Gupta, MD – Interventional Cardiology & Lymphatics
- Ezequiel Sagray, MD – Outpatient, St. Peters University Hospital

The Division of Cardiology continues to grow – now with **87 physicians**. in the Division. With clinics at the main campus and at 13 outpatient locations, the Center sees over 37,000 visits annually, performs over 32,000 echocardiography studies, over 1,200 cardiac MRI studies and over 1,400 cardiac catheterizations. Details and more statistics can be found later in this report in each specialty section.

- Preeminent clinical programs including Cardiomyopathy, Heart Failure, and Transplantation which was recently awarded a Frontier Program by CHOP, the third Frontier Program in the Cardiac Center, joining the Jill and Mark Fishman Center for Lymphatic Disorders and the Pediatric Heart Valve Center.
- Strong commitment to education with top ranked cardiology training program and advanced fellowship in cardiac catheterization, electrophysiology, advanced imaging including MRI, lymphatic system diagnostic and intervention, and adults with congenital heart disease.
- T32 research training program that has provided excellent training for post-graduate fellows for over 20 years. Currently there are 18 fellows plus 5 advanced 4th year fellows in the program. The fellows participated in numerous research activities including numerous publications in major journals, abstracts and poster sessions including at the AHA (American Heart Association) Scientific Sessions

FELLOWSHIP HIGHLIGHTS

Dr. Lindsay Rogers was appointed Director of Pediatric Cardiology Fellowship Program and Dr. Christopher Janson was appointed the Associate Director of Pediatric Cardiology Fellowship Program in 2022.

CURRENT CARDIOLOGY FELLOWS

First Year	Second Year	Third Year	Fourth Year	Graduated June 2023
Sunakshi Bassi	Elizabeth Carter	Anila Chaudhary	Ivor Asztalos	Kate Restaino
Grace Lee	Rodrigo Cardoso Cavalcante	Marc Delaney	Rebecca Josowitz	Ari Gartenberg
Radhika Rastogi	Ehssan Faraj	Rebecca Moore	Jeremiah Joyce	Alicia Kamsheh
William Russell	Avital Ludomirsky	Maria Niccum	Scott Weinreb	Mudit Gupta
Maliha Naeem	Andrew Freddo	Ilana Schwartz	Mudit Gupta	Jill Hsia
Matthew Schreier	Emily Olson	Helen Stanley	Imran Masood	Trevor Williams
			Yuval Barak Coren	

2023 Ann Newman Fellow: Anila Chaudhary, MD
2023 Ann Newman Lecturer: Shelley Miyamoto, MD
"Does the Shoe Fit? Adult GDMT and the Failing Pediatric Heart"

OUTPATIENT CARDIOLOGY

OVERVIEW

The Division of Cardiology's Outpatient program represents the CHOP Cardiac Center face to the community of patients, families, our referring providers and hospitals. The vision is simply "**best care for all children**." This vision is achieved by giving the community *access* to the world class *services* provided by clinicians of the cardiac center and is an integral part of the CHOP Cardiac Center Regional Network.

LEADERSHIP

provides comprehensive oversight for the entire CHOP Cardiology Outpatient regional clinics, labs and programs. This leadership team is charged with overseeing one of the largest outpatient cardiology services in the country and creating a programmatic approach to Outpatient Cardiology similar to other cardiology specialties and includes sections in clinical operations, education, quality/research and well-being.

Vivek Allada, MD
Medical Director,
Outpatient and
Community Cardiology

Matthew Elias, MD
Medical Director,
Pennsylvania Cardiology
Satellite Operations

Aaron Dorfman, MD
Medical Director,
New Jersey Cardiology
Satellite Operations

Amy Schultz, MD
Director of Outpatient
Cardiology Quality

Carol Wittlieb-Weber, MD
Cardiac Center Physician
Wellness Lead

Nursing/Managers

- Lisa Mitchell, RN
  Subspecialty Practice Nurse Manager
- Mychele King
  Cardiology Advanced Practice Manager
- Jessica Macker
  Practice Operations Manager
- Esther Williams
  Practice Manager – Allentown, Pennsylvania
- Kim Perry
  Practice Manager – St. Peters University Hospital, New Jersey
- Leigh Ann Fiore
  Practice Manager – Voorhees, New Jersey

Cardiology Labs

- Mike McBride
  Senior Director Cardiac EKG, Echo, and Exercise Lab
- Christine Pascua
  Program Director, Cardiac Echo Lab
- Valerie Capone
  Supervisor, Cardiac Echo Lab
- Michael Convery
  Program Manager, Cardiac Echo Lab

Business/Practice Management

- Lawrence Barnes
  Senior Administrative Director, Division of Cardiology
- Erin Rissler
  Business Manager
- Carl Summers
  Senior Business Manager
- Sam Jackson
  Business Manager
- Jesenia Cruz
  Community Hospital Coordinator

OUTPATIENT

CARDIOLOGY

CLINIC SITES:

Buerger Center Clinic (General Cardiology and Specialty Clinics & Noninvasive Cardiology Labs)
3500 Civic Center Blvd. 12th Floor Main Building, Philadelphia, PA 19104

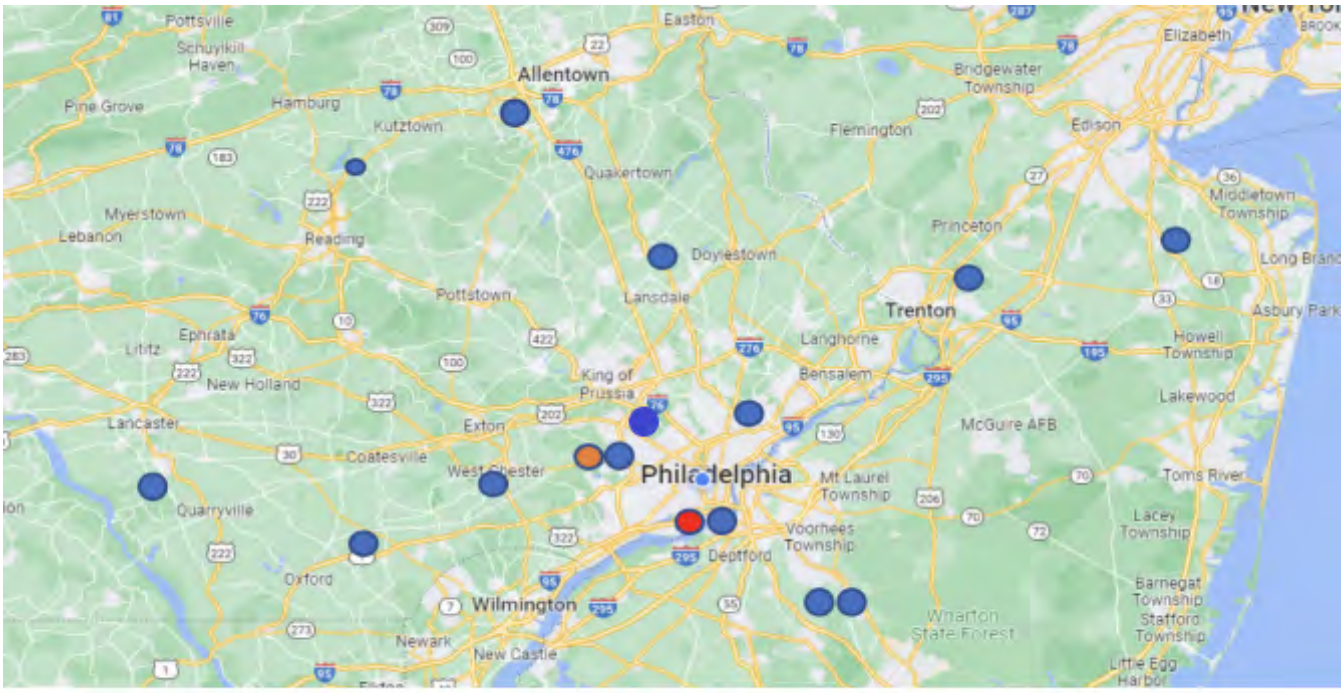
SATELLITE CLINICS:

PENNSYLVANIA:

- Abington Specialty Care Center, 1840 Susquehanna Rd Abington, PA 19001
- Allentown Pediatric Cardiology Practice, 1605 N. Cedar Crest Blvd., Ste 117, 119, Allentown, PA 18104
- Brandywine Valley Specialty Care Center, 819 Baltimore Pike, Glen Mills, PA 19342
- Bryn Mawr Specialty Care Center, 135 S. Bryn Mawr Ave, Suite 240, Bryn Mawr, PA 19010
- Bucks County Specialty Care Center, 500 W. Butler Ave., Chalfont, PA 18914
- Exton Specialty Care Center, 481 John Young Way, Oaklands Corporate Center, Exton, PA 19341
- King of Prussia Specialty Care Center, 550 South Goddard Blvd., King of Prussia, PA 19406
- Lancaster Specialty Care Center, 2104 Harrisburg Pike, Suite 300 Harrisburg Pike, Lancaster, PA 17601

NEW JERSEY

- Atlantic County Specialty Care Center, 4009 Black Horse Pike, Mays Landing, NJ 08330-3133
- Princeton Specialty Care Center at Plainsboro, 101 Plainsboro Road, Plainsboro, NJ 08536
- St. Peters Hospital Cardiology Practice, 254 Easton Ave, Med Office Bldg, 2nd Fl, New Brunswick, NJ 08903
- Virtua Hospital, 200 Bowman Drive, Health & Wellness Center, 2nd Fl, Ste D260, Voorhees, NJ 08043
- Voorhees Specialty Care Center, 1012 Laurel Oak Rd, Laurel Oak Corporate Center, Voorhees, NJ 08043



OUTPATIENT

CARDIOLOGY

COMMUNITY HOSPITAL OUTREACH PROGRAM:

The Division of Cardiology faculty provides consultation, electrocardiography & echocardiography services at many community hospitals throughout Pennsylvania and New Jersey. Currently, this includes remote consults in neonatal intensive care units, newborn nurseries, emergency departments and for selected inpatient infants and children at thirty-two hospitals. This comprehensive network covers the cardiology needs for nearly 40% of all the newborns in Pennsylvania and nearly 20% of deliveries in New Jersey.

PENNSYLVANIA:

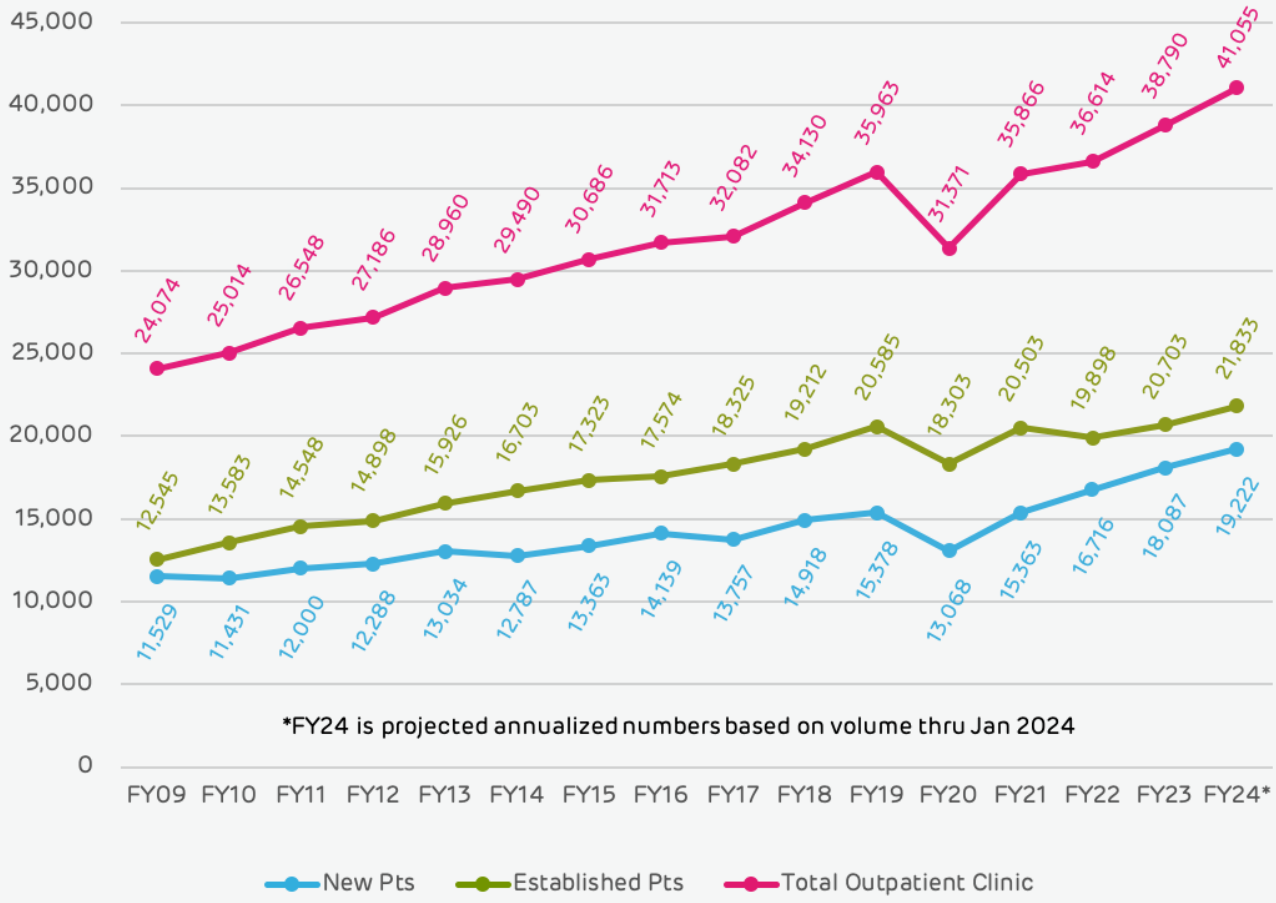
- Chester County Hospital – 701 E Marshall St, West Chester, PA 19380
- Chestnut Hill Hospital – 8835 Germantown Ave, Philadelphia, PA 19118
- Doylestown Hospital – 595 W State St, Doylestown, PA 18901
- Einstein Montgomery – 559 W Germantown Pike, East Norriton, PA 19403
- Grand View Hospital – 700 Lawn Ave, Sellersville, PA 18960
- Holy Redeemer Hospital – 1648 Huntingdon Pike, Meadowbrook, PA 19046
- King of Prussia Hospital – 550 S Goddard Blvd North Entrance, King of Prussia, PA 19406
- Lancaster General Hospital – 555 N Duke St, Lancaster, PA 17602
- Lancaster Women & Babies Hospital – 690 Good Dr, Lancaster, PA 17601
- Main Line Health Lankenau Medical Center – 100 E Lancaster Ave, Wynnewood, PA 19096
- Main Line Health Bryn Mawr Hospital – 130 S Bryn Mawr Ave, Bryn Mawr, PA 19010
- Main Line Health Paoli Hospital – 255 W Lancaster Ave, Paoli, PA 19301
- Main Line Health Riddle Hospital – 1068 W Baltimore Pike, Media, PA 19063
- Hospital of the University of Pennsylvania – 3400 Civic Center Blvd, Philadelphia, PA 19104
- Pennsylvania Hospital – 800 Spruce St, Philadelphia, PA 19107
- Lehigh Valley Health system, including:
  - Lehigh Valley Hospital - Allentown – 1200 S Cedar Crest Blvd, Allentown, PA 18103
  - Muhlenberg, Pocono, Hazelton, Schuylkill
- St Luke's Hospitals (Allentown, Bethlehem, Anderson)
- St. Mary Medical Center – 1201 Langhorne-Newtown Rd, Langhorne, PA 19047

NEW JERSEY:

- AtlantiCare Medical Center, City Campus – 1925 Pacific Ave, Atlantic City, NJ 08401
- AtlantiCare Medical Center, Mainland - 65 W Jimmie Leeds Rd, Pomona, NJ 08240
- Cape Regional Medical Center – 2 Stone Harbor Blvd, Cape May Court House, NJ 08210
- Penn Princeton Medical Center – 1 Plainsboro Rd, Plainsboro, NJ 08536
- St. Peters University Hospital – 254 Easton Ave, New Brunswick, NJ 08901
- Virtua Health System
  - Our Lady of Lourdes Hospital – 1600 Haddon Ave, Camden NJ 08103
  - Voorhees Hospital – 100 Bowman Ave, Voorhees, NJ 08043
  - Marlton Hospital – 90 Brick Road, Marlton NJ 08053
  - Mount Holly Hospital – 175 Madison Avenue, Mount Holly, NJ 08060

OUTPATIENT CARDIOLOGY

OUTPATIENT VOLUME: BY THE NUMBERS



Cardiology outpatient volume continues to show significant growth (briefly interrupted by COVID in FY20) with 71% increase in outpatient visits over 15 years. In FY24, we are on track to have over 40,000 cardiology clinic visits for the first time in our history.

OUTPATIENT CARDIOLOGY

OUTPATIENT CARDIOLOGY OPERATIONS: THE POWER OF PROCESS

The Outpatient Operations undertook a major initiative to improve clinic flow at the busy Buerger Cardiology clinic. The 3 phases included the move to Buerger clinic (March 2023), a clinic flow optimization quality improvement project, and development of a new nursing coverage model for general cardiology (named 'POD RN model').

- Clinic flow process improvement project – led by Lisa Mitchell, RN and Amy Schultz, MD. This project aims to improve the flow thru clinic for patients, families and providers.
- POD RN support model – led by Lisa Mitchell, RN and Carol Wittlieb-Weber, MD. A new RN coverage model was created to support general cardiologists. Nine new RNs were hired providing support to physicians and patients/families both in and out of clinic.

The results have been significant:

- ✓ A 20% increase in volume: monthly clinic appointments with ECG and Echo
- ✓ A 17% reduction in appointment duration
- ✓ A 22% increase in Press-Ganey patient/family satisfaction Top Box Scores for "Moving thru your visit"

OUTPATIENT CARDIOLOGY PROGRAM HIGHLIGHTS

The year 2023 has been celebrated by numerous successful initiatives in outpatient pediatric cardiology:

- **Outpatient clinics & labs move to the Buerger building** (3/27/23): We successfully moved the Cardiology outpatient clinic from 3rd floor of the Main Hospital to the 12th floor Buerger building, including a new echo reading lab and an expanded exercise and rehabilitation center.
- **CHOP Community Hospital Outreach Program** was rolled out in 2023. This dedicated model provides 24/7/365 coverage of 13 regional hospitals with neonatal, pediatric and emergency room cardiology support services including ECG, echocardiogram interpretations and physician-to-physician consultation. The program has received many positive reviews from our partner hospital providers.
- **CHOP-Cardiology - Main Line Health Partnership:** A major accomplishment spearheaded by the CHOP Cardiology division, is an agreement to provide CHOP subspecialty services to the Main Line Health system. Our Cardiology group covers four Main Line Health inpatient hospitals for inpatient consults. A CHOP Specialty Care Center was opened in Bryn Mawr. This clinic includes general cardiology and some subspecialty services, ECG & transthoracic echocardiograms. The CHOP Fetal Heart program opened the first Fetal heart annex site at the Bryn Mawr clinic site.
- **Outpatient Cardiology Advanced Practice Nurse Practitioner (APP) program** was successfully launched in 2023. The goal for this program is meet the increasing demand for cardiology services and to improve access for new patients. This program includes four APPs (Monica Gianopulos, CRNP, Kaitlin Lewis, CRNP, Rachel Keashen, CRNP and Lou Ann Fromuth, CRNP).
- **Process Improvement** We continue to work on improving the patient-family and provider experience in the outpatient cardiology clinic with a number of initiatives:
- Successful launch of our **Ambulatory Cardiology Conference**, led by Drs. Ramiro Lizano and Amy Schultz
- New Hires: The Outpatient Pediatric Cardiology program continues to expand the Pod RN program:
  - Jill McNamee, RN – Abington
  - Julianne Bacher, RN – BWV
  - Maureen Canalley, RN – Bucks

The Outpatient Cardiology Team serves our patients and achieves our vision: "Best care for all children".

OUTPATIENT

CARDIOLOGY

ALLENTOWN CARDIOLOGY PRACTICE

It has been an eventful year in Allentown!

An alliance between Lehigh Valley Reilly's Children's Hospital and Children's Hospital of Philadelphia has finally come to pass! We now have a signed formal agreement which will solidify LVH's commitment to CHOP. This occurred in a very timely fashion due to the more recent merging of Jefferson University Hospital and Lehigh Valley Hospital. We have statements from both institutions that pediatric subspecialty (including the MFM program) will continue to be through CHOP. Work with the LVH and CHOP steering committee is ongoing....

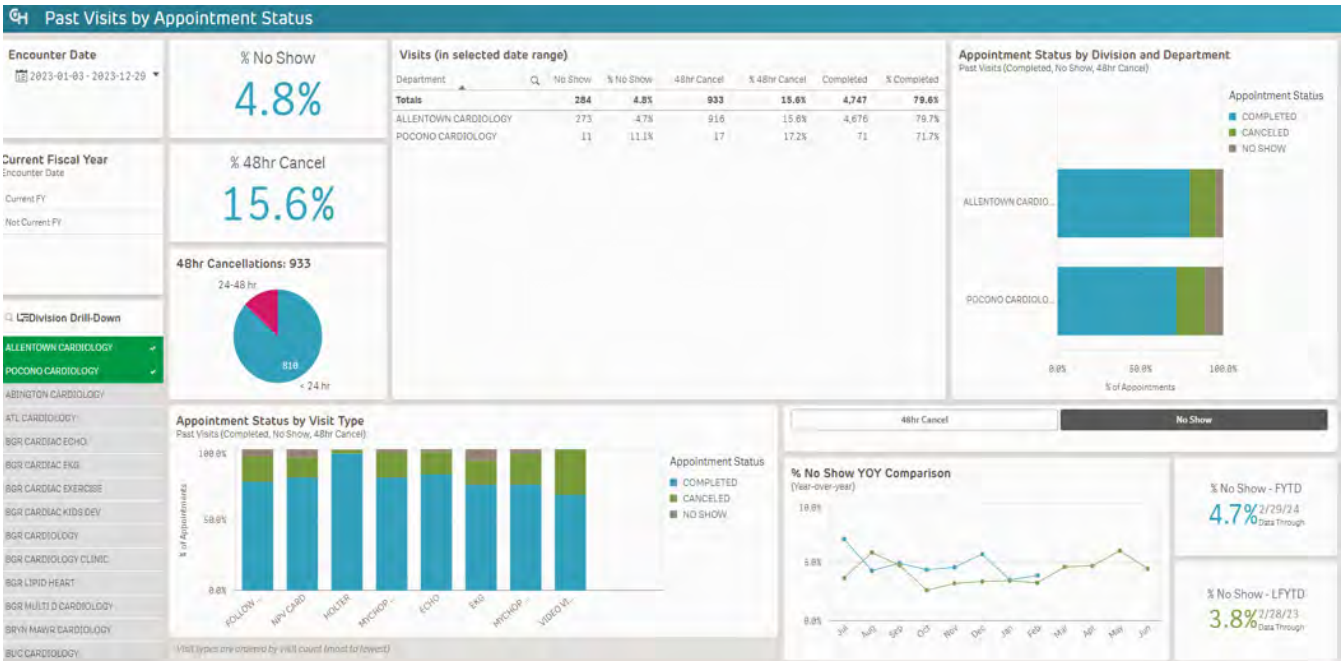
Construction in our shell space (conversion of that space to two exam rooms) continues to proceed at a snail's pace (although, formal bids for the construction have been completed). We hope to see construction begin in late spring or early summer.

Due to the increased volume in both our Pocono Medical site and MFM cardiac program, we have added one day to each program each month. We will begin the additional clinical day at Pocono Medical Center in March of 2024. MFM has been plagued with a shortage of staff and therefore, the additional clinical day is currently on hold.

Over the last year and one-half we have been working with the ACHD group at CHOP/HUP and LVHN adult cardiology to begin a monthly program in the Lehigh Valley. While initially all parties were in agreement (and enthusiastic with the concept), efforts came to an abrupt halt, due to the lack of available ACHD personnel.

We are gratified to welcome two new members to our team, Esther Williams (who will be replacing the wonderful Jessica Macker, (in the role as onsite Office Manager) and Ashley Huber, RN, as our PODS nurse. To date both are performing wonderfully.

On the whole, the Allentown site remains productive. Our fill rates are better than this time last year (the slowest period being January through mid-March). Please refer to the annual productivity report below.



OUTPATIENT

CARDIOLOGY

ALLENTOWN CARDIOLOGY PRACTICE (CONTINUED)

Individual achievements and ongoing projects:

- Dr. Ruchi Gupta: mentoring a pediatric resident from LHN in the utility of EKGs during ED visits
- Dr. Robert Palermo: Epic Clinical Champion -Tasked with Epic soft ware updates and cardiology support.
- CHOP annual cardiology meeting talk entitled "CHATcpt and AI in Ambulatory Care"
- Dr. Yalile Perez: Mentoring LVHN resident case studies for LVHN
- Dr. Louis Hansrote: Steering committee CHOP/LVHN alliance/ Chief of Pediatric cardiology at Reilly Children's
- Hospital/board member AHA Lehigh county
- Maria Pero RCS/RCCS: On hands training of LVHN echo sonographers
- Ashley Huber RN: NPV lag report for CHOP
- All physicians are responsible for pediatric resident teaching (the cardiology rotation is mandatory for LVHN residents and lasts for one month).

We continue to look for more opportunities for growth.

Lou Hansrote, MD
Medical Director

Ruchi Gupta, MD

Rob Palermo, MD

Yalile Perez, MD

ST. PETER'S UNIVERSITY HOSPITAL CARDIOLOGY PRACTICE

STAFF:
Sumekala Nadaraj MBBS
Medical Director North New Jersey Pediatric Cardiology
Michele Cohen, DO
Chandni Patel, MD

RECRUITMENT:
Ezequiel Sagray MD
(planned start date September 2024)

OFFICE MANAGER:
Kim Perry

CLINICAL NURSE COORDINATOR:
Elizabeth Bohrer

PSR:
Marlene Esteves
Debra Coppa

MEDICAL ASSISTANTS:
Jessica Olarte
Catherine Martinez

PEDIATRIC SONOGRAPHERS:
Nicole Reyes
Aimee Campo
Melissa Wasserman

OUTPATIENT

CARDIOLOGY

HIGHLIGHTS

NEW BRUNSWICK:

The Children's Hospital of Philadelphia Cardiac Center satellite at Saint Peter's University Hospital is uniquely located within a busy longstanding community hospital. Saint Peters University Hospital is a major regional labor and delivery center and operates one of the largest tertiary neonatal intensive care units in the state. Additionally, The Children's Hospital at Saint Peter's University Hospital runs one of the largest pediatric ERs in New Jersey and offers inpatient and outpatient services in many specialties. Saint Peter's University Hospital is affiliated with Rutgers Medical school and offers many residency programs, including a thriving pediatric residency program.

Cardiology consult service at Saint Peter's University Hospital:
Our team works in close collaboration with the Pediatric Department at Saint Peter's University Hospital, providing inpatient, emergency room, nursery, PICU and NICU cardiology consultations. Saint Peter's is home to a 60 bed Level 3 NICU and a robust labor and delivery unit, with over5000 deliveries a year. There is a well-established maternal fetal medicine unit with whom we work closely to provide prenatal fetal cardiac counseling.

Medical Education:
Affiliation with Saint Peter's University Hospitals provides a unique opportunity to be involved with pediatric resident education at the bedside, during morning reports and at noon conferences. Residents can rotate through our outpatient clinic as part of their clinical rotations. We offer mentorship to those interested in a career in pediatric cardiology and have successfully matched several residents to pediatric cardiology training programs.

Fetal cardiology:
We work closely with the maternal fetal medicine program, performing approximately 800- 850 fetal echocardiograms per year and providing comprehensive fetal cardiology consultations. Patients carrying a complex critical fetal cardiac diagnosis are referred to the fetal heart center at the Children's Hospital of Philadelphia for evaluation for delivery in the special delivery unit and neonatal intervention. Upon discharge, these patients can seamlessly be followed at our outpatient centers for ongoing care and management close to their homes and families.

Outpatient cardiology services:
Our cardiac satellite service began in 2004 with a single cardiologist and minimal support staf . The team has now expanded to four full time cardiologists, three full time sonographers, an office manager, two clinical medical assistants, two office support staff and a clinical nurse coordinator. We provide outpatient cardiology services locally in central NJ, facilitating interventions, procedures and advanced cardiac imaging as needed at the main campus in Philadelphia.

Patients are seen at our outpatient offices equipped with 3 patient exam rooms and two echo rooms five days of the week. Historically we have performed above the outpatient visit goals expected by our institution. We expanded our services to perform comprehensive outpatient cardiology services at the CHOP specialty care center in Plainsboro 4-5 days a week.

Our patients have access to our services 24/7 with a cardiologist on call every night.

In addition to our responsibilities at the satellite offices, our cardiologists have additional responsibilities the Fetal Heart Center and CHOP cardiology echo lab at Philadelphia

OUTPATIENT CARDIOLOGY

PENN MEDICINE AT PRINCETON MEDICAL CENTER – PLAINSBORO

Consult service:

Princeton Medical Center is a level 3 NICU with a high-volume delivery rate of almost 2,000 per year. We provide cardiac consultation services with echocardiogram for the NICU, inpatient units, emergency rooms and nursery.

Fetal cardiology:

We work with the Perinatal center at Princeton medical Center providing prenatal fetal echocardiogram assessment and consultations, having taken over form Dr Anderson (Voorhees) in 2023. With recent affiliations of OBGYN groups with Penn medicine, we are anticipating an increase in fetal echocardiogram referral in the coming years.

REMOTE SERVICES:

St. Mary's Medical Center

We provide pediatric cardiac care to St Mary's Medical Center Hospital via reading EKG and echocardiograms remotely and provide cardiac guidance to help them manage their patients as needed.

Hunterdon Medical Center

We read pediatric EKGs for Hunterdon Medical center and are always ready to help guide the management of their patients as needed.

TRIBUTES AND TRANSITIONS: PASSING THE TORCH AT ST. PETER'S

Cheryl Kurer, MD, FAAP, FACC

"Dr Kurer retired after an illustrious 34-year career in pediatric cardiology and electrophysiology. She founded the Northern New Jersey presence for the Cardiac Center and served as the Section Chief for the Central and Northern New Jersey Satellites from 2004 until her retirement. She is a brilliant clinician, teacher and mentor. Incredibly, she simultaneously built the CHOP Cardiology program at St. Peters University Hospital as well as maintained her care of children with complex arrhythmias and implanted cardiac devices at the Main Hospital."

– Aaron Dorfman, Medical Director, New Jersey Cardiology Satellite Operations

Sumi Nadaraj, MBBS, MPH, FAAP

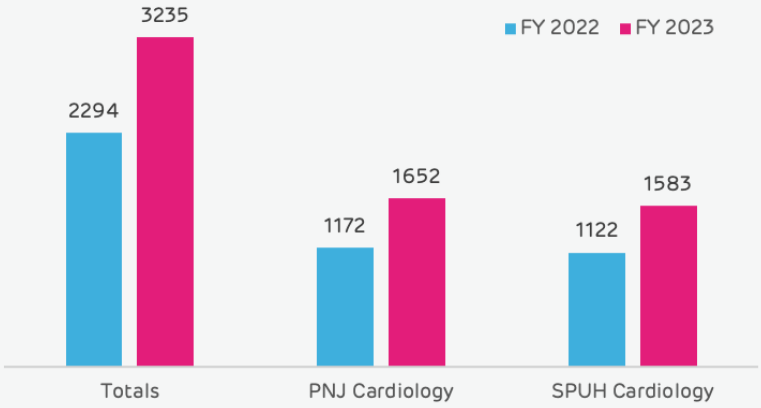
"Dr. Nadaraj has been appointed as the Medical Director for our Central New Jersey Cardiology Practices at St. Peter's Hospital and Princeton. She is a clinical associate professor of Pediatrics, Perelman School of Medicine at the University of Pennsylvania. Dr. Nadaraj joined the New Jersey group in 2005 after completing her fellowship at Schneider's Children's hospital. She brings a wealth of expertise and experience to this new role."

– Joseph Rossano, MD, Division Chief, Cardiology and Co-Director of the Cardiac Center

OUTPATIENT

CARDIOLOGY

'FY 2022 TOTAL VISITS', 'FY 2023 TOTAL VISITS' BY 'DEPARTMENT'



Combined site volume increased by 941 patients in FY23 compared to FY22

Fetal Volume

- FY 2022 total – 856
  - PMC - 92
  - SPUH - 764
- FY 2023 total – 953
  - PMC - 84
  - SPUH – 869

Combined site volume increased by 97 patients in FY23 compared to FY22

'AVAILABLE SLOTS', 'FILL RATE', 'NO SHOW RATE' BY 'FISCAL YEAR'

OUTPATIENT CARDIOLOGY


Sumekala Nadaraj, MD


Michele Cohen, MD


Chandini Patel, MD

OP CARDIOLOGY PUBLICATION HIGHLIGHTS

*(*highlighting physicians with significant outpatient leadership and outpatient activity):*

Khoury M, Harahsheh AS, Raghuveer G, Dahdah N, Lee S, Fabi M, Selamet Tierney ES, Portman MA, Choueiter NF, **Elias M**, Thacker D, Dallaire F, Orr WB, Harris TH, Norozi K, Truong DT, Khare M, Szmuszkovicz JR, Pagano JJ, Manlhiot C, Farid P, McCrindle BW; International Kawasaki Disease Registry. Obesity and Outcomes of Kawasaki Disease and COVID-19-Related Multisystem Inflammatory Syndrome in Children. *JAMA Netw Open*. 2023 Dec 1;6(12):e2346829.

Sperotto F, Gutiérrez-Sacristán A, Makwana S, Li X, Rofeberg VN, Cai T, Bourgeois FT, Omenn GS, Hanauer DA, Sáez C, Bonzel CL, Bucholz E, Dionne A, **Elias MD**, García-Barrio N, González TG, Issitt RW, Kernan KF, Laird-Gion J, Maidlow SE, Mandl KD, Ahooyi TM, Moraleda C, Morris M, Moshal KL, Pedrera-Jiménez M, Shah MA, South AM, Spiridou A, Taylor DM, Verdy G, Visweswaran S, Wang X, Xia Z, Zachariasse JM; Consortium for Clinical Characterization of COVID-19 by EHR (4CE); Newburger JW, Avillach P. Clinical phenotypes and outcomes in children with multisystem inflammatory syndrome across SARS-CoV-2 variant eras: a multinational study from the 4CE consortium. *EClinicalMedicine*. 2023;64:102212.

Vaiyani D, **Elias MD**, Biko DM, Whitehead KK, Harris MA, Partington SL, Fogel MA. Patients with Post-COVID-19 Vaccination Myocarditis Have More Favorable Strain in Cardiac Magnetic Resonance Than Those With Viral Myocarditis. *Pediatric Cardiology*. 2023;44(5):1108-1117.

Zuckerberg JC, Matsubara D, Kauffman HL, Chang JC, Calderon-Anyosa R, **Patel C, Hogarty AN, Falkensammer CB**, Mercer-Rosa LM, Quartermain MD, Wang Y, Banerjee A. Left atrial stiffness and strain are novel indices of left ventricular diastolic function in children: validation followed by application in multisystem inflammatory syndrome in children due to COVID-19. Eur Heart J Cardiovasc Imaging. 2023 Aug 23;24(9):1241-1251. doi: 10.1093/ehjci/jead087. PMID: 37159912.

Jacobwitz M, **Favilla E**, Patel A, Giglia TM, Taing K, Ravishankar C, Gaynor JW, Licht DJ, McGuire JL, Beslow LA. Neurologic complications of infective endocarditis in children. Cardiol Young. 2023 Mar;33(3):463-472. doi: 10.1017/S1047951122001159. Epub 2022 May 12. PMID: 35546418; PMCID: PMC9652479.

Jones AL, Faerber J, Huang J, Ampah S, Wang Y, DeCost G, Gardner M, Naim MY, Reddy S, Goldmuntz E, Mercer-Rosa L. Biomarkers, Socioeconomic Factors, and Right Ventricular Function After Surgical Repair for Tetralogy of Fallot. Pediatr Cardiol. 2023 Aug;44(6):1232-1241. doi: 10.1007/s00246-023-03108-x. Epub 2023 Feb 16. PMID: 36797379; PMCID: PMC10330615.

Reddy KP, **Jones AL**, Naim MY, Mercer-Rosa L. Association of race and ethnicity with resource utilisation among children with CHD: an evaluation of the National Health Interview Survey, 2010-2018. Cardiol Young. 2023 Aug;33(8):1471-1473. doi: 10.1017/S1047951123000033. Epub 2023 Jan 13. PMID: 36636921.

Jones AL, Campbell MJ, Abernathy B, Neubert S, Hager A, Collier H, Ramsey EZ, Simon A, Schachtner S, Natarajan S. Improvement in Palivizumab Administration Prior to Discharge for Hospitalized Infants with Hemodynamically Significant Congenital Heart Disease: A Quality Improvement Initiative. Pediatr Cardiol. 2023 May 5:10.1007/s00246-023-03163-4. doi: 10.1007/s00246-023-03163-4. Epub ahead of print. PMID: 37145121; PMCID: PMC10625646.

Avitabile CM, Flohr S, Mathew L, Wang Y, Ash D, Frank DB, **Tingo JE**, Rintoul NE, Hedrick HL. Quantitative Measures of Right Ventricular Size and Function by Echocardiogram Correlate with Cardiac Catheterization Hemodynamics in Congenital Diaphragmatic Hernia. J Pediatr. 2023 Oct;261:113564. doi: 10.1016/j.jpeds.2023.113564. Epub 2023 Jun 15. PMID: 37329980.

Shustak RJ, Huang J, Tam V, Stagg A, Giglia TM, Ravishankar C, Mercer-Rosa L, Guevara JP, Gardner MM. Neighborhood Social Vulnerability and Interstage Weight Gain: Evaluating the Role of a Home Monitoring Program. J Am Heart Assoc. 2023 Sep 19;12(18):e030029. doi: 10.1161/JAHA.123.030029. Epub 2023 Sep 13. PMID: 37702068; PMCID: PMC10547291.

Mitchell SE, Martin RP, Terry P, **Drant SE**, Valle D, Dietz H, Sobreira N. Systemic artery to pulmonary artery aneurysm malformations associated with variants at MCF2L. Am J Med Genet A. 2023 May;191(5):1250-1260. doi: 10.1002/ajmg.a.63141. Epub 2023 Feb 9. PMID: 36760094.

Kamsheh AM, Meyers KE, **Palermo RA**, Wu L, Burstein DS, Edelson JB, Lin KY, Maeda K, Rossano JW, **Wittlieb-Weber CA**, O'Connor MJ. Hypertension: An Important But Reversible Cause of Systolic Dysfunction in a Cohort of Pediatric Patients. Pediatr Cardiol. 2024 Feb;45(2):331-339. doi: 10.1007/s00246-023-03313-8. Epub 2023 Oct 26. PMID: 37884820; PMCID: PMC10872510.

Perez Y, Qureshi MY, Babovic-Vuksanovic D, Cannon B. Aortic Dissection in a Young Patient With Unsuspected Aortopathy. Pediatrics. 2023 Aug 1;152(2):e2022057694. doi: 10.1542/peds.2022-057694. PMID: 37449331.

Marino BS, Cassedy A, Brown KL, Franklin R, Gaynor JW, Cvetkovic M, Laker S, **Levinson K**, MacGloin H, Mahony L, McQuillan A, Mussatto K, O'Shea D, Newburger J, Sykes M, Teele SA, Wernovsky G, Wray J. Long-Term Quality of Life in Congenital Heart Disease Surgical Survivors: Multicenter Retrospective Study of Surgical and ICU Explanatory Factors. Pediatr Crit Care Med. 2023 May 1;24(5):391-398. doi: 10.1097/PCC.0000000000003190. Epub 2023 Feb 21. PMID: 37140331.

CARDIAC CENTER FOR DIGITAL HEALTH

Sumekala Nadaraj, MD
Director, Cardiac Center for Digital Health

CHOP DIGITAL HEALTH TEAM:

- **Bimal Desai, MD, MBI**
  Assistant Vice President and Chief Health Informatics Officer
- **John Chuo, MD**
  Co-Director, Digital Health Innovation Core, CHPS, Research Institute
- **Kate Fuller**
  Digital Health Portfolio Leader (TM)
- **Sarah Hadley, MBA, RN**
  Digital Health Portfolio Leader (RPM)

The Cardiac Center for Digital Health was established in August 2019, with the initial vision funded via a Cardiac Center Innovation grant. This digitally enabled care model combines all virtual care modalities of telehealth and remote monitoring that seamlessly integrate with a hybrid of in-person and telemedicine visits thereby working together to build a strong patient/caregiver-provider relationship. We started with Infant Staged Monitoring Program patients who are known to be at high risk for interstage morbidity and mortality and account for high use of healthcare resources. Telemedicine eliminates travel time and expenses, avoids wait times, minimizes potential infectious exposures, and can reduce caregiver burden and physical stress for infants related to equipment needs and transport to in-person appointments. Moreover, telemedicine can be deployed quickly and minimizes family disruption, particularly associated with hospitalization. Finally, it creates medical homes that promote continuity as care is received from trusted clinicians with access to the child's electronic medical records in a hopefully more equitable manner. We aim to improve access to care, education, empowering patients and caregivers ultimately enhancing their cardiac conditions.

The results from our initial experience with telemedicine in these infants with palliated congenital heart disease demonstrated a significant decrease in median monthly ED visits/patient compared to the pre-telemedicine era and showed that telemedicine for this high-risk cohort was feasible, sustainable, and effective in identifying clinical concerns. It allowed rapid access to expert evaluation with expedited identification of potentially serious issues and resolution of nonacute problems which previously would have resulted in ED visits and/or hospitalization. Telemedicine accurately assessed the patient's clinical status with no missed events. These data were presented at the 2020 Scientific Sessions of The American Heart Association and published in 2022. Thereafter, in 2021 we added use of digital stethoscopes to these visits which has been additive in 12% of visits over telemedicine alone in assessing need for ED visits/admissions, especially in expediting needed interventions (see below).

As this has become our standard of practice, with increasing telemedicine visit volume, these results have been maintained. Under the leadership of Tamar Preminger, MD. The Center continues to grow now completing nearly 13,000 telemedicine visits since its inception with excellent provider and caregiver satisfaction. Our Center involves the talents of multiple integrated team members including cardiologists, nurse practitioners, digital health and quality analytics members.

PROGRAMMATIC HIGHLIGHTS

We continue to expand our efforts and incorporate telemedicine throughout the Cardiac Center with the following notable achievements and unique services offered to our patients and families in 2023:

1. EXPANSION OF TELEMEDICINE IN OUR INFANT STAGED MONITORING PROGRAM (ISVMP):

A. Clinical Champions: Alyson Stagg CRNP, Therese M. Giglia, MD, Monique Gardner, MD, Shobha S. Natarajan, MD, David A. Hehir, MD, MS, Anita L. Szwast, MD, Jonathan J. Rome, MD, Chitra Ravishankar, MD, Tamar J. Preminger, MD

B. Use of telemedicine has become standard practice with 1-2 visits per patient/month. We continue to experience excellent results with no missed events, expedited care when indicated and an ongoing decrease in avoidable ED visits. We use remote patient monitoring through the use of Epic Care Companion.

C. Use of Digital Stethoscopes: In 2021 we introduced digital stethoscopes to our video visits. We have shown this to be feasible in this fragile cohort with high rates of inter-rater reliability and high provider and parental satisfaction. As above, in 12% of visits the digital stethoscope provided additional significant information as compared to our routine telemedicine visits and was truly life-saving in some. These data were published in 2023 (see below). We have now completed ~ 600 telecardiology visits, ~300 using digital stethoscopes.

ISVMP: MOST IMPACTFUL CASES

Patient 1	Patient 2	Patient 3
25 day old : (S,D,S) tricuspid atresia, VSD, PS	5 month-old : (S,D,D)TGA, huge VSD (common ventricle), PS s/p PDA stent	3 month old : heterotaxy, unbalanced AV canal, PA, s/p PDA stent
Expedited TM visit, with lower oxygen saturations; correlated HR via auscultation	Routine TM visit with lower oxygen saturations and increased cyanosis; correlated HR via auscultation	Routine TM visit with mild decrease in saturation; correlated HR via auscultation
Change in murmur concerning for a smaller VSD	**Change in murmur concerning for decreased flow through the PDA stent**	**Significant diminution in murmur concerning for decreased PDA stent flow**
Direct admission, with cardiac surgery for ***aortopulmonary shunt placement*** **prior to clinical deterioration**	**Urgent readmission : BDG prior to clinical deterioration.** Intraoperative inspection: ***nearly occluded PDA stent***	**Urgent readmission** : cardiac catheterization with ***PDA stent dilation, increase in proximal stent from 2 mm to 4 mm*** **prior to clinical deterioration**

Expansion of digital stethoscopes can provide high quality telemedicine appointments as well as address our overall goal of increasing access and equity in specialized care. This technology could be adopted on a larger scale and to other cardiac subspecialties. Longer term use of this technology will further establish its role in telecardiology

2. TELEMEDICINE LIPID PROGRAM:

A. Clinical champion: Julie Brothers, MD, Jordy Martino, CRNP, Tamar Preminger, MD.

B. This program continues to evolve with our initial efforts focused on feasibility, acceptability and health care disparities. It has been successful at the outset with several presentations most recently at the 2023 World Congress of Pediatric Cardiology and Cardiac Surgery and SEARCH (Society for Education and the Advancement of Research in Connected Health) The National Telehealth Research Symposium highlighting that Telemedicine in a pediatric lipid clinic is feasible. There was a significant decrease in 48-hour cancellation rates overall, most notably for Non-Hispanic Black patients. No major technical difficulties were encountered. Telemedicine in our pediatric lipid clinic was effective; non-HDL-c levels were significantly decreased in this cohort. Telemedicine was also efficient, allowing for time and travel-related cost savings. Both parents and providers reported high satisfaction with many parents opting for future visits to occur by telemedicine. A manuscript describing this experience is in preparation. We have now conducted ~ 2000 telemedicine lipid visits.

3. TELEMEDICINE TRANSITION TO ADULT CONGENITAL HEART DISEASE PROGRAM:

A. Clinical Champions: Emily Ruckdeschel, MD, Tamar Preminger, MD

B. Advances in the diagnosis and treatment of congenital heart disease have led to dramatic increases in survival to adulthood and a secondary rise in the need to provide age-appropriate care throughout their lives. The transition from pediatric to adult congenital heart disease is known to be associated with a significant attrition rate with secondary significant morbidity and mortality. We developed a telemedicine program for our adolescent patients and their families to prepare them for this transition of care. Annual visits are performed with a multidimensional emphasis on self-management and self-advocacy skills including education regarding their underlying congenital heart disease, long term risks, medications and evolving future issues such as pregnancy, employability, etc. It is critical to streamline and maintain optimal care for our maturing patients and their families during this transition to adult care. This novel program successfully launched in December 2021/January 2022 with over 100 visits completed.

The implementation of the program and the successful transfer of care to our Adult Congenital Heart Disease Program is being monitored by our Quality Improvement team.

4. THROMBOSIS

A. Clinical Champion: Therese Giglia, MD. Over 100 visits completed; quality metrics in progress

5. ELECTROPHYSIOLOGY

A. Clinical Champions: Maully Shah, MBBS, Director; Ramesh Iyer, MD, Christopher Janson MD, Chandra Srinivasan, MD, Victoria Vetter, MD

Over 650 visits completed; quality metrics in progress

6. THE CHOP DIGITAL HEALTH TEAM WAS AWARDED A COVID 19 TELEHEALTH GRANT (JANUARY 2022, $879,000) through the Federal Communications Commission. These funds continue to enable use of novel technologies including within the Cardiac Center.

We seek to expand remote patient monitoring and telemedicine services while evaluating the impact of telehealth on disparities in access to care. Our overarching goal is to maximize our ability to provide high quality care for all.

FUTURE DIRECTIONS

1. Cardiology CATCH Program: we are creating a telemedicine program following discharge from our Cardiac Care Unit to optimize continuity of care as patients transition from hospital to home, potentially allow for earlier discharges and reduce readmissions
2. Neonour device/NIH Grant Telehealth Neoneur Device: Demonstrating Clinical Unity in both Hospital and Home, to Improve High Risk Infants Transition to Oral Nutrition and Growth. Under the direction of Barbara Medoff Cooper PhD, RN we are currently investigating a new device to assess feeding patterns and energy expenditures in our infant single ventricle patients to maximize nutrition in this fragile cohort. Our initial use of this device was presented at the 2023 World Congress of Pediatric Cardiology and Cardiac Surgery. We anticipate adding this to our telemedicine visit protocol, partnering with a feeding specialist.
3. Expansion of our ACHD Transition Program: we anticipate addition of a nurse navigator, remote patient monitoring and QI metrics
4. Further expansion of RPM and technologies within the Cardiac Center including use of digital stethoscopes, home echo devices, etc

Through improved care coordination and management of chronic medical conditions, we anticipate decreased downstream costs and increased care satisfaction. Ultimately, a hybrid model of digitally enabled care can allow for practice flexibility in optimizing in-person visits (including diagnostic testing) and virtual care that will maintain clinician-family relationships, ensure earlier escalations of care to avoid decompensation, and preserve the medical home while integrating emerging technologies that support detailed home assessments. We anticipate further research exploring and evaluating innovative remote monitoring and diagnostic technologies (e.g., digital stethoscopes, echo, wearable devices, smart phone-enabled devices and apps, artificial intelligence etc.) to optimize decision-making and demonstrate the value of telemedicine to other subspecialties in the Cardiac Center.

The mission of the Cardiac Center for Digital Health is to optimize patient clinical care, safety and education, filling the gaps in health care and improve the quality and accessibility of health care in a cost-effective manner; right-sizing health care. We aim to impact disparities to health care and manage the medical complexity of chronic health conditions via creating a medical home, forming a hybrid model of care. Our research focuses on determining the impact of digital technology in the care of our patients, caregivers, healthcare providers and to develop standards of digital health for our field. We are also assessing how flexible health care models can promote well-being, hiring and retention of our skilled health care providers.

RESEARCH HIGHLIGHTS

Stagg A, Giglia TM, Gardner MM, Offit BF, Fuller KM, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Laskin BL, Preminger TJ. Initial Experience with Telemedicine for Interstage Monitoring in Infants with Palliated Congenital Heart Disease. Pediatr Cardiol. 2023 Jan;44(1):196-203. doi: 10.1007/s00246-022-02993-y.

Stagg A, Giglia TM, Gardner MM, Shustak RJ, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Preminger TJ. Feasibility of Digital Stethoscopes in Telecardiology Visits for Interstage Monitoring in Infants with Palliated Congenital Heart Disease. Pediatr Cardiol. 2023 Dec;44(8):1702-1709. doi: 10.1007/s00246-023-03198-7. Epub 2023 Jun 7. PMID: 37285041; PMCID: PMC102465461.

CARDIAC CENTER

FOR DIGITAL HEALTH

Stagg A, Giglia TM, Gardner MM, Shustak RJ, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Preminger TJ. Feasibility of Digital Stethoscopes in Telecardiology Visits for Interstage Monitoring in Infants with Palliated Congenital Heart Disease. Presented at SEARCH (Society for Education and the Advancement of Research in Connected Health) The National Telehealth Research Symposium, Telemedicine and e-Health, volume 29 (3), March 2023 https://doi.org/10.1089/tmj.2023.29087.abstracts.index

Stagg, A, Preminger TJ: Digital Health Innovation in the Infant Single Ventricle Monitoring and Management Program, Cardiac Center QI Forum, Philadelphia, PA, May 2023

Brothers JA, Martino G, Minetola J, Huong K, Preminger T : Telemedicine in a Pediatric Lipid Clinic: Feasibility, Acceptability and Health Care Disparities. Presented at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery, Washington DC, August 2023 as well as SEARCH (Society for Education and the Advancement of Research in Connected Health)The National Telehealth Research Symposium November 2023.

Medoff-Cooper, B, Preminger TJ: The Development of a Post-surgical Feeding Recovery Model for Infants with Complex Congenital Heart Disease. Presented at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery, Washington DC August 2023.

INTERVENTIONAL CARDIOLOGY

INTRODUCTION

The CHOP Interventional Cardiology Section is among the busiest and most forward-thinking congenital interventional programs in the world. The team of seven interventional cardiologists treated over 1500 patients in 2023. In the Cardiac Center's 4 state-of-the-art catheterization labs, they perform the most advanced procedures, including innovative valve and lymphatic interventions that aren't available anywhere else in the world.

INTERVENTIONAL CARDIOLOGY TEAM

Matthew J. Gillespie, MD, FSCAI, FPICS
Medical Director, Interventional Cardiology and Cardiac Catheterization Laboratory

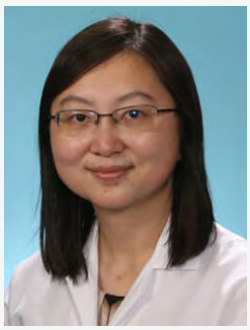
Jonathan J. Rome, MD, F.A.C.C.

Yoav Dori, MD, Ph.D

Michael L. O'Byrne, MD, M.S.C.E

Ryan M. Callahan, MD, FSCAI, FPICS

Christopher L. Smith, MD, Ph.D



Jessica Tang, MD

Lauren Ford, CRNP

Erin Pinto, MSN, RN, CCRN, FNP-BC

Donna Calfin, BSN, MHL, CPN

INTERVENTIONAL CARDIOLOGY

THE TEAM'S RECENT AREAS OF FOCUS INCLUDE:

Advances in Catheter-based Heart Valve Therapies. The CHOP CathLab is a center of excellence for advanced Transcatheter Pulmonary Valve Replacement (TPVR) procedures, and among only a few in the world that participated in the groundbreaking Harmony TPV and Alterra Adaptive Pre-stent trials. **Matthew J. Gillespie, M.D.**, Director of Interventional Cardiology, is leading the expansion of these TPVR technologies both locally and internationally, and is also working to introduce new therapeutic options for congenital heart disease patients suffering from atrioventricular valve regurgitation. The team has recently published a paper detailing their early experience using MitraClip to perform transcatheter edge-to-edge repair in a series of patients; the only free-standing pediatric hospital in the world to do so.

Transcatheter thoracic duct decompression. **Jonathan J. Rome, MD** along with Lymphatic specialists **Yoav Dori, MD Ph.D**, and **Christopher L. Smith, MD, Ph.D,** have pioneered a minimally invasive technique in order to decompress the lymphatic system in patients suffering from multicompartment Lymphatic failure after Fontan palliation for complex congenital heart disease. Thus far, nearly 40 patients with end stage heart disease and few or no other treatment options have benefitted from this new therapy. This represents one of the most important, novel advances in interventional cardiology over the last decade. Currently, this procedure is only performed at CHOP.

Stenting of the PDA for patients with ductal-dependent pulmonary blood flow. As one of the busiest PDA stenting programs in the world, under the leadership of Michael **L. O'Byrne, MD, M.S.C.E**, CHOP is a participating center in the **COMPASS** ***(Comparison of Methods of Pulmonary Blood Flow Augmentation: Shunt versus Stent)*** trial. This trial is funded by the NIH/NHLBI represents the first of its kind randomized multi-center trial comparing a transcatheter to a surgical intervention in congenital heart disease.

Minimally invasive PDA closure in Extremely Low Birth Weight (ELPBW) Infants. The CHOP CathLab is a leading center for catheter-based closure of PDA in these fragile infants, and has ongoing research focused on the longer-term outcomes in this population. The CHOP CathLab performed more premature PDA closure procedures than any other program in the world in 2023.

Outcomes research/CQI/Registries. The CHOP CathLab participates in all of the major data registries, including the IMPACT Registry and C3PO, both of which demonstrate that CHOP is one of the busiest, most effective, and safest congenital interventional programs in North America.

Pulmonary Vein Stenosis Program. **Ryan M. Callahan MD** serves as the Medical Director of the Pulmonary Vein Stenosis (PVS) Program and is recognized as an international leader in the care of these complex patients. The program provides comprehensive and personalized state-of-the-art care to patients with PVS at CHOP. The CHOP CathLab doubled their PVS case volume in 2023 with further growth expected in 2024.

State-of-the-Art Patient, Clinician, and Staff Education. In addition to leading the work on catheter-based pulmonary flow restriction in infants with complex single ventricle disease, **Jessica Tang, M.D.** is also leading the efforts modernize the teaching in the cathlab to further the educational mission of the Interventional service.

The CHOP Cath Lab is also focused on advancements on multiple other fronts, including:

- minimizing radiation exposure
- novel procedural anticoagulation strategies
- treatment pathways for procedure-associated pulse loss

INTERVENTIONAL CARDIOLOGY

NURSING – INTERVENTIONAL TEAM SUPPORT

Registered Nurses, cardiovascular technicians, an electrophysiology technician, and an electrophysiology specialist work side by side with physicians in cath, lymphatics, and EP cases. The team is supported by a Lead Materials Management Analyst, perioperative core techs, IS, and biomed. The cath lab more than doubled the number of staff over the past three years to support the additional cath lab. This year we onboarded a Business Resource Manager to support our inventory management and billing processes. Several members of the team, led by the Clinical Nurse Expert, worked with the IS and EPIC team to build our processes and roll-out plan for EPIC CUPID, which will go-live this March.

Our Educational Nurse Specialist along with the leadership team is continuing to improve the orientation and ongoing education program. In partnership with the physician and simulation teams, the leadership team implemented quarterly interdisciplinary simulations. Leaders are continuing to work on leadership development and professional development for the staff. The cross-training program with the CPRU has continued to grow and the lab will have 4 nurses participating by the spring. Three techs achieved certification as either a Cardiac Interventional (CI) Radiographer or as a Registered Cardiac Invasive Specialist (RCIS). A few additional nurses and techs achieved PEAK this past year.

"The goal of the CHOP CathLab is to provide best possible clinical outcomes for our patients, while simultaneously striving to move the field of congenital interventional cardiology forward through research and innovation." – Matthew J. Gillespie MD

PULMONARY VEIN STENOSIS PROGRAM

The Pulmonary Vein Stenosis (PVS) Program provides individualized therapies for patients with PVS, including innovative interventional techniques and the latest medical therapies. The program includes three interventional cardiologists, two pulmonary hypertension specialists, two cardiothoracic surgeons, a radiologist, nurse practitioner, nurse coordinator and program coordinator. The PVS program has seen significant growth over the past year, including 26 new patients during 2023, the highest total at CHOP to date (see figures below). The enthusiasm for improving outcomes in PVS within CHOP is palpable, with many thoughtful and curious investigators working towards expanding our knowledge of the disease. Despite the challenges of PVS, we are optimistic that the future is bright.

LEADERSHIP/FACULTY

Ryan Callahan, MD
Medical Director
Interventional Cardiologist

Catherine Avitabile, MD
Attending Cardiologist,
Pulmonary Hypertension
Specialist

David B. Frank, MD, PhD
Attending Cardiologist
Pulmonary Hypertension
Specialist

Michael L. O'Byrne, MD, M.S.C.E
Interventional Cardiologist

Jonathan J. Rome, MD, FACC
Interventional Cardiologist

Stephanie Fuller, MD
Cardiothoracic Surgeon

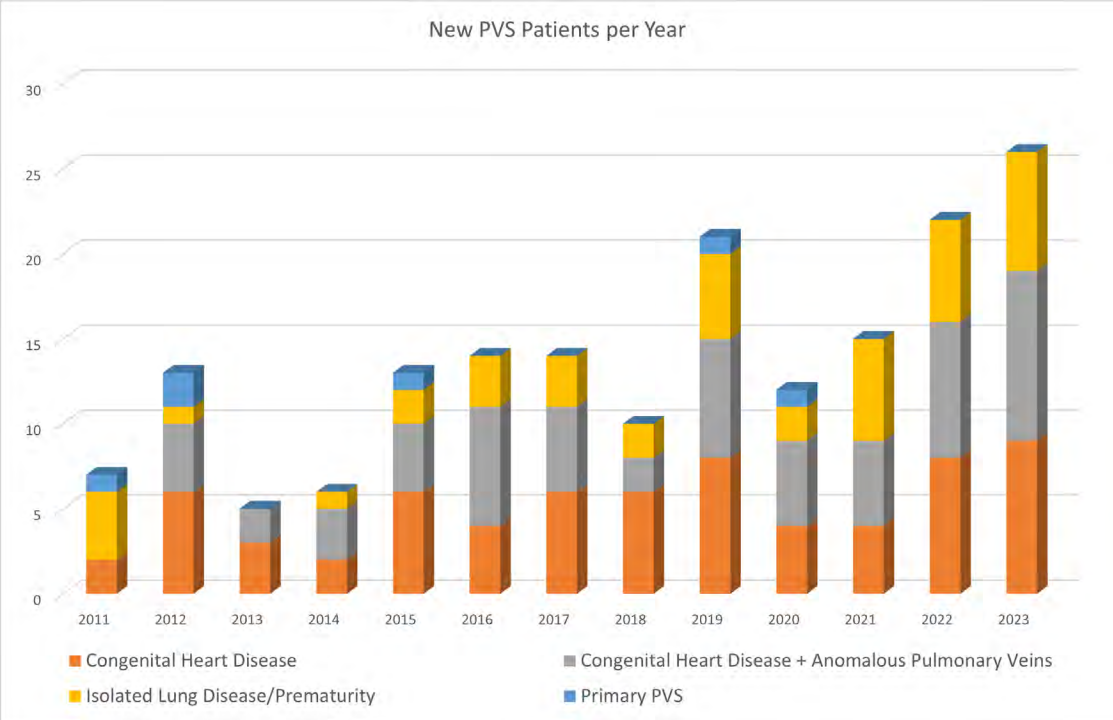
Constantine D. Mavroudis, MD, MSc, MTR
Cardiothoracic Surgeon

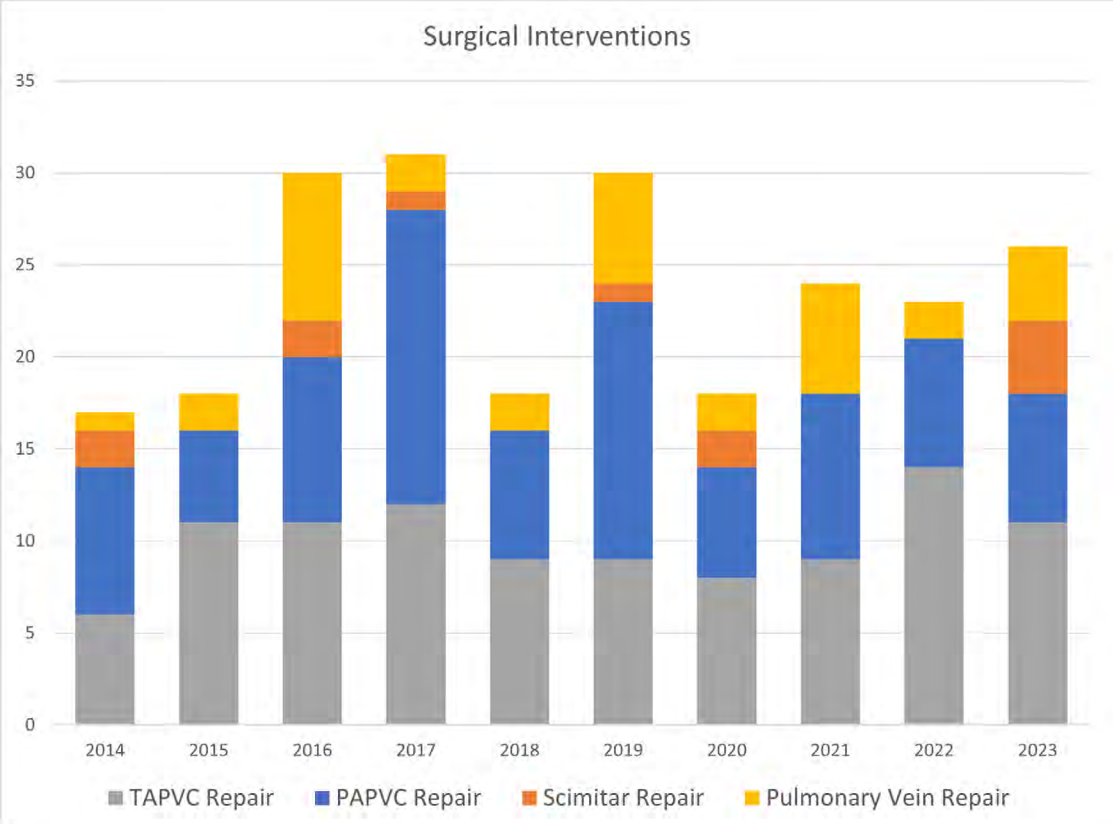
Heather L. Meluskey, CPNP-AC, MSN
Nurse Practitioner

Jihee Lee, BS
Program Coordinator

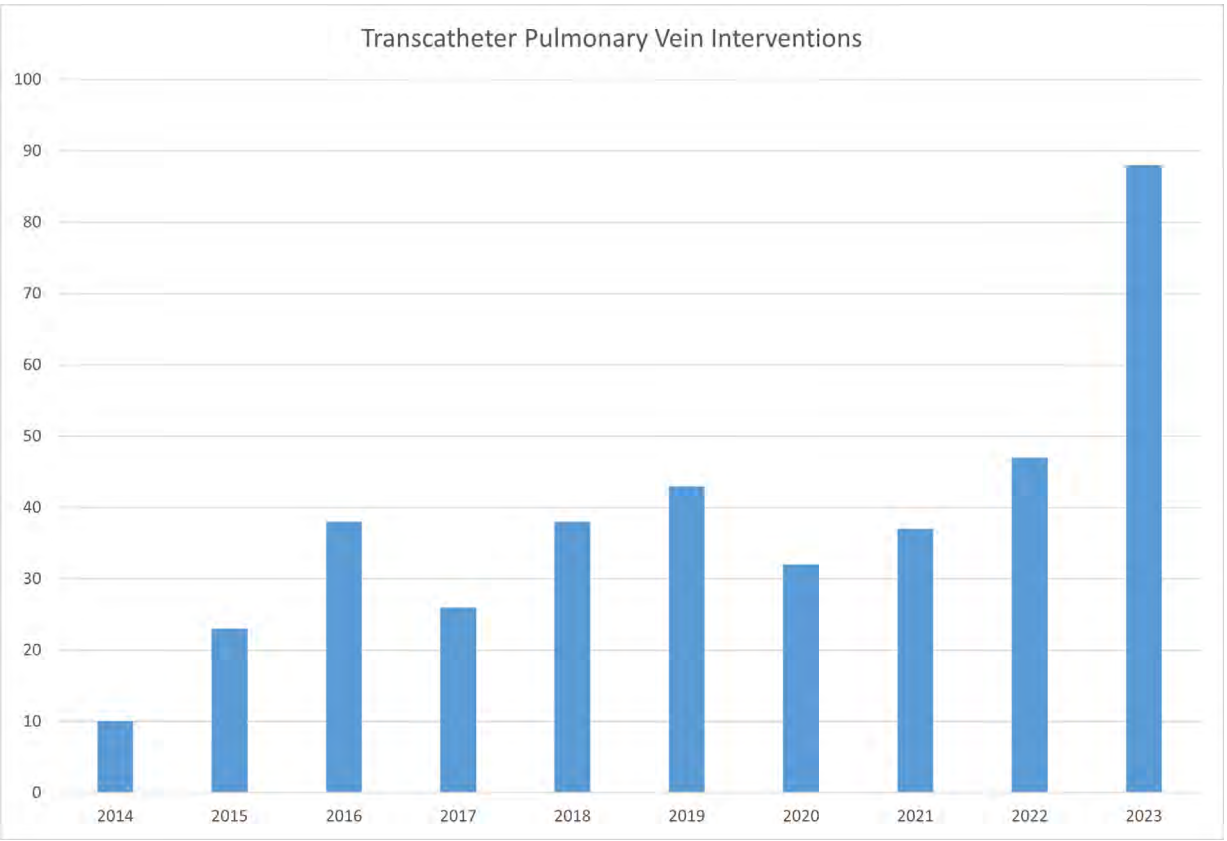
NOT PICTURED:
Kim Butler BSN, RN
Nurse Coordinator

PULMONARY VEIN STENOSIS PROGRAM





PULMONARY VEIN STENOSIS PROGRAM



2023 HIGHLIGHTS

- Hired Heather Meluskey, CPNP-AC, MSN; a full-time nurse practitioner dedicated to caring for patients with PVS
- CHOP PVS Website went live (Pulmonary Vein Stenosis | Children's Hospital of Philadelphia (chop.edu))
- Opened the first CHOP outpatient clinic dedicated to patients with PVS
- Performed 30 PVS related second opinions (8 international)
- Members of the PVS team gave 13 invited presentations (1 international, 8 national, 3 regional, 1 local)
- Constantine D. Mavroudis MD, MSc, MTR awarded the Thoracic Surgical Foundation Robert Replogle Traveling Fellowship to study innovative pulmonary vein surgical methods

SAVE THE DATE!
CHOP PVS SYMPOSIUM: APRIL 4-5, 2025

ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM

INTRODUCTION

The electrophysiology laboratory at CHOP is one of the few state of the art EP labs in the world that is fully equipped with the latest technology to perform catheter ablation of the most complex arrhythmia disorders. With a variety of advanced 3D ultra-high resolution mapping systems available (CARTO® 3 System Version 7 and the CARTO PRIME® Mapping Module, EnSite X EP system, RHYTHMIADx™) and ablation energy sources (radiofrequency, irrigated radiofrequency and cryoablation) and intra-cardiac echocardiography in our EP lab, we are able to select technology that is best suited for an individual patient. We are one of the few pediatric centers in the world to have a dedicated pediatric CIED lead extraction program and have laser technology for lead extraction. We have a robust program for pediatric patients with and at-risk for inherited arrhythmias and sudden cardiac death and provide a thorough evaluation including investigation of the patient's or deceased's medical records, autopsy reports, and genetic testing. In partnership with surgeons, our program offers patients with cardiac channelopathies and life-threatening arrhythmias, cervical sympathectomy procedures which can be lifesaving in some patients.

ELECTROPHYSIOLOGY TEAM

Maully Shah, MBBS, FACC, FHRS, CEPS, CCDS
Medical Director

V. Ramesh Iyer, MD, CEPS, CCDS

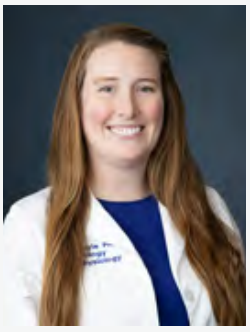
Christopher Janson, MD, CEPS, CCDS

Chandra Srinivasan, MD, CEPS, CCDS

Victoria Vetter, MD, MPH

Scott Weinreb, MD
EP Fellow

Kate Spivak, PA-C



Bridget Boyle, PA-C

ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM

ELECTROPHYSIOLOGY TEAM (CONTINUED)

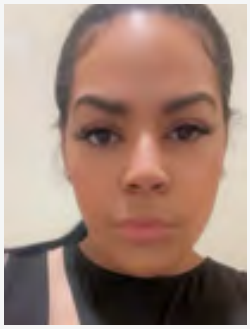
Emily Brown, RN, BSN

Dana Sleeman, RN, BSN

Tammy Sweeten
EP Specialist

Maureen Murphy
EP Lab Technician

Marva Prince
Program Coordinator



Tamira Lewis
Office Administrator

PROGRAM HIGHLIGHTS

The EP program is one of the highest volume interventional electrophysiology programs in the world performing complex catheter ablation procedures with a focus on minimizing radiation exposure in a state of the art Electrophysiology cath lab. The EP service continues to perform innovative device procedures which include implantation of Transcatheter Leadless pacemakers. We now perform transcatheter "physiologic" pacing at the site of the Bundle of His or the left bundle branch in select patients that need permanent pacing in order to preserve ventricular function and reverse pacemaker mediated cardiomyopathy. The EP program has arrhythmia and device clinics at the main hospital as well as satellite clinics in Lancaster, PA, Exton, PA and in Voorhees, N.J. In addition, Dr. Shah travels to Danville, PA to perform catheter ablation procedures at the Geisinger Medical Center. We also conduct combined EP-Cardiomyopathy clinics at the Main Hospital.

ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM

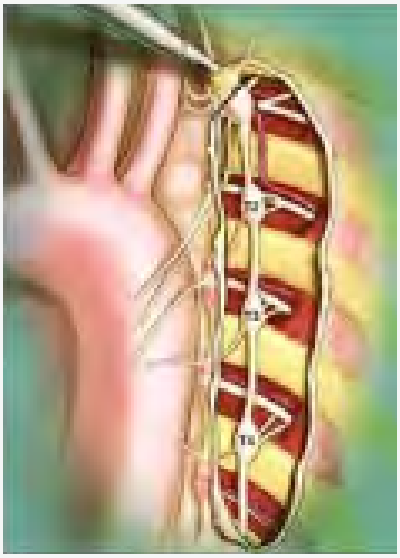
PROGRAM HIGHLIGHTS (CONTINUED)

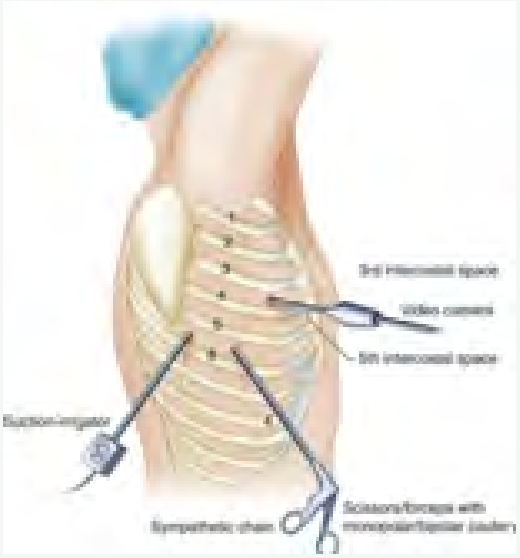
In addition to having a primary electrophysiology in-patient service on the CCU, we provide consultation for arrhythmia management throughout the hospital including the CICU, PICU, NICU, ER and other in-patient units. The EP physicians provide reporting of all in -patient and ER EKGs as well as all CHOP main ambulatory monitors (Holters, event recorders, mobile cardiac telemetry).

Our program evaluates and treats patients with inherited channelopathies (*LQTS, CPVT, ARVC, Brugada Syndrome* to name a few) and unexplained *sudden death* which includes a comprehensive evaluation of patient, family history, EKG, signal average EKG, exercise stress testing, genetic testing, echocardiography, cardiac MRI, ambulatory mobile cardiac telemetry monitoring, and implantation of loop recorders).

SURGICAL TREATMENT FOR CATECHOLAMINE SENSITIVE LIFE THREATENING ARRHYTHMIAS

The EP physicians work with Dr. Pablo Laje from general pediatric surgery who specializes in Cardiac Sympathetic Denervation procedures to treat life threatening ventricular arrhythmias. Most patients can have this procedure performed with a thoracoscopic approach (3 small key hole incisions) and are discharged the same day. This procedure often replaces the need for life long ICD therapy and is considered a life saving procedure in select cases.



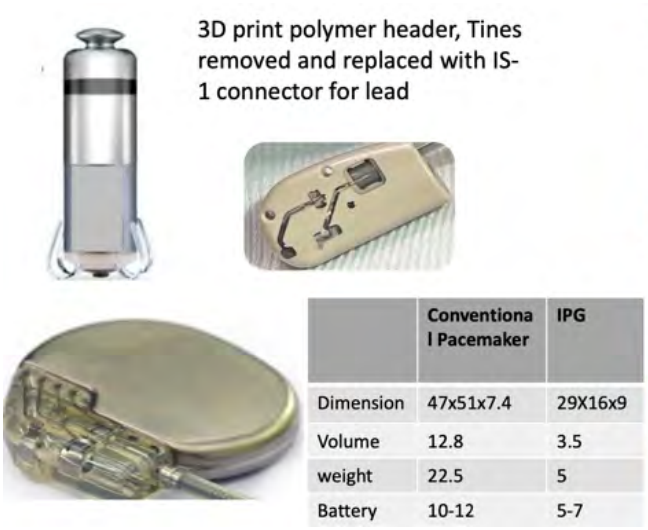


Pablo Laje, MD

ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM

NEW PACEMAKER TECHNOLOGY

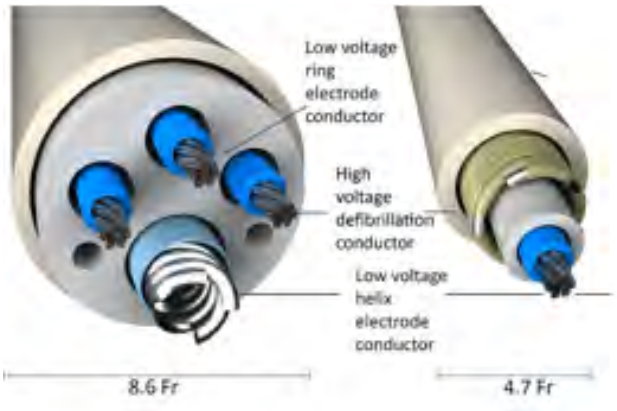
CHOP is one of the few centers implanting the transcatheter leadless pacemaker as well as the modified leadless (IPG) pacemakers in babies with heart block. The transcatheter leadless pacemaker obviates the need for a surgical pocket and a pacing lead. The IPG pacemaker is 50% the size of a regular pacemaker and our surgeons are able to implant this pacemaker through a 2.5 cm incision.



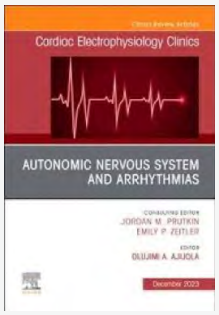
	Conventional Pacemaker	IPG
Dimension	47x51x7.4	29X16x9
Volume	12.8	3.5
weight	22.5	5
Battery	10-12	5-7

NEW ICD LEAD TECHNOLOGY

Dr. Shah is the CHOP PI for the new small diameter implantable cardioverter defibrillator (ICD) lead which is undergoing clinical trials. We are the only Children's Hospital in the world participating in this clinical trial. This lead is approximately half the diameter of a standard ICD lead and is projected to have a lower fracture rate than a standard ICD lead. We have successfully implanted this lead in two teenagers with dilated cardiomyopathy and heart block for primary prevention of sudden cardiac death.



ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM



NEW ELECTROPHYSIOLOGY BOOK

Dr. Maully Shah is the co-editor of a newly published book entitled "Advances in Cardiac Implantable Electronic Devices and Congenital Heart Disease" published by Elsevier Inc.

EP QA/QI PROJECT

The genetic testing and follow up program is spearheaded by Dr. Victoria Vetter and Kate Spivak with the following goals:

- Increase completion of cardiac genetics tests for CHOP electrophysiology patients
- Evaluate different genetic testing approaches and develop best practices in an effort to improve patient care and satisfaction

RESEARCH HIGHLIGHTS

Our electrophysiologists are leaders in multicenter collaborative as well as large clinical database research. Dr. Chandra Srinivasan is the principle investigator on the NCDR IMPACT Research project: "Outcomes of Catheter Ablation for Atrial Tachyarrhythmias in Congenital Heart Disease" and multicenter study :" Non-traditional ICD Systems in Children and Patients with Congenital Heart Disease" Dr. Maully Shah is the site Principal Investigator for the International LEADR study (https://clinicaltrials.gov/ct2/show/NCT04863664), which is a prospective multicenter clinical trial to investigate a new 4.5 French defibrillation lead. We are the only pediatric EP study site in the world. Our section has presented abstracts at all major national meetings (ACC, AHA, HRS).

Below, is a summary of completed studies with current and anticipated publications:

1. Transcatheter Leadless Pacing in Children
2. Arrhythmogenic Right Ventricular Pacing in the young
3. Comparison of Cryo Vs. Radiofrequency Ablation in Children: An Analysis Of The NCDR®IMPACT Registry
4. Utility of Ivabradine for Postoperative Junctional Ectopic Tachycardia- Multicenter study
5. Contemporary Outcomes in Neonates with Isolated Congenital Complete Heart Block
6. Management and outcome of "lone" atrial fibrillation in children and young adults- Multicenter study submitted for NIH funding
7. Risk stratification of sudden cardiac death in Pediatric Hypertrophic Cardiomyopathy- Multicenter study
8. Electrocardiographic signatures for single ventricle failure
9. Cardiac Resynchronization Therapy in Single Ventricle patients
10. Implant characteristics and outcomes of Leadless Pacemakers in Children-Multicenter study
12. Conduction System Pacing in children- Multicenter study

ELECTROPHYSIOLOGY AND HEART RHYTHM PROGRAM

13. MRI in pediatric and congenital heart disease patients with CIEDs and epicardial or abandoned leads Multi center study
14. Accuracy and Diagnostic Performance Of The Apple Watch™ Cardiac Features In Pediatric Patient.
15. Catheter Ablation of Ventricular Tachycardia Before Transcatheter Pulmonary Valve Replacement in Repaired Tetralogy of Fallot

EP EPIC CUPID CHAMPIONS

Dr. Chandra Srinivasan – Holter / Mobile Telemetry
Tammy Sweeten – EP cath lab
Devices: Kate Spivak, Emily Brown, Marva Prince

STATISTICS

Electrophysiology Outpatient Clinic Visits	1436
Device Outpatient clinic visits	406
Telemedicine visits	650 (2020- present)
EP laboratory procedures (ablations, other EP studies)	225
Device implants (Transvenous and epicardial devices)	94
Remote Device Transmissions	3164
EKG	55,993
Holters	5635
Transtelephonic/MCOT monitoring	919

ROLES IN NATIONAL AND INTERNATIONAL PROFESSIONAL & SCIENTIFIC SOCIETIES

- Dr. Shah is associate editor of the Journal of the American College of Cardiology (EP), and serves on the American College of Cardiology's IMPACT research and publications committee, Heart Rhythm Society's Scientific Clinical Documents and Guidelines committee and on the International Board of Heart Rhythm Examiners' (IBHRE) continuous competency certification and test writing committees. Dr. Shah is on the writing committee for the Heart Rhythm Society's Arrhythmias in the Athlete Scientific Guidelines Document. Dr. Shah is a member of the CDC funded Philadelphia County Sudden Death in the Young Advanced Review Team. Dr. Shah served on the WCPCCS2023 organizing committee for the electrophysiology track
- Dr. Christopher Janson is the associate program director for the CHOP cardiology fellowship program. He is a member of the PACES research committee, as well as the PACES QI committee
- Dr. Chandra Srinivasan serves on the PACES QI committee.
- Dr. Ramesh Iyer's focus is on health care policy.
- Dr. Victoria Vetter is the Director of Youth Heart Watch at CHOP and affiliate of Project Adam.
- Kate Spivak was selected for the Heart Rhythm Society's LEAP program (Leadership and Education for Allied Health Professionals) - an exclusive group of leaders in the field who will build on their leadership and development skills, expound on personal influences, and explore strategies for goal development and advancement.

YOUTH HEART WATCH

Youth Heart Watch (YHW), an affiliate of Project ADAM®, is committed to preventing sudden cardiac death in the young through education, research, and advocacy. This is accomplished by the implementation of automatic external defibrillators (AEDs) and CPR training in schools and ECG screening programs in the community. In 2023, Youth Heart Watch (YHW) designated nineteen schools as Heart Safe and is currently working with almost three hundred additional schools to implement the program, as well as several youth athletic groups, churches, and recreation centers. YHW has identified ten schools from the School District of Philadelphia to begin the Heart Safe School program and serve as a model for the other 210 schools within the District. Nearly 1,000 community members have received CPR and AED training in the last year thanks to Youth Heart Watch, including school staff, students, coaches, and parents. We continue to partner with the Philadelphia Parks and Recreation Department and the Philadelphia School District in these efforts.

Youth Heart Watch was awarded $35,000 from the CHOP Excel Grant, funding through CHOP's Community Impact team. The grant supports four Heart Health Screening Study community events that will provide free ECGs and health education to children and families. Events are scheduled to take place over the 2024 calendar. The YHW program was also provided $33,000 from the Blake Gives Back Foundation to support screenings and purchase AEDs for donations. Pennsylvania Senate Bill 375 that would require school buildings and athletics to have AEDs, trained staff, response plans, and practice sudden cardiac arrest drills was introduced in the PA Senate 2023. Dr. Vetter and her team have joined the NFL and American Heart Association as part of the PA Heart Smart Sports Coalition to support these legislative efforts. University of Pennsylvania students working with Dr. Vetter over the summer collected data on school AED needs to provide information to the state and inform the budget for the bill. Dr. Vetter presented this information to legislators and Governor Shapiro at a press conference and advocacy day in September. Additional data on athletic spaces is being conducted and voting on the bill is expected to occur this spring.

FACULTY/STAFF

Victoria Vetter, MD, FAAP, FACC

Lindsey Flanagan, MPH

Youth Heart Watch continues to contribute to the education and training of other cardiac emergency professionals. Youth Heart Watch hosted the 2023 Project ADAM National Meeting at CHOP in May. There were 150 attendees from across the country including Project ADAM members, medical and community partners, Pennsylvania Legislators, and industry sponsors. The meeting brought together like-minded individuals to discuss national and local policy, partnering with medical and community groups, programmatic strategies for working with schools and the community, and future plans for Project ADAM and local affiliates.

Once again, YHW hosted students from the University of Pennsylvania through the Penn Undergraduate Research Mentorship summer program and provided them experience in developing research projects that were presented at poster sessions at the University of Pennsylvania in the Fall of 2023. Four students from the 2022 summer presented their research at the 2023 World Congress of Pediatric Cardiology and Cardiac Surgery in both oral abstract and poster sessions.

YOUTH

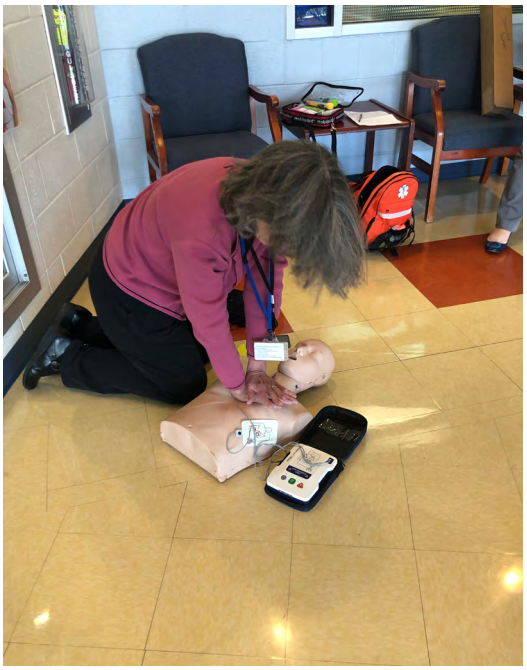
HEART WATCH

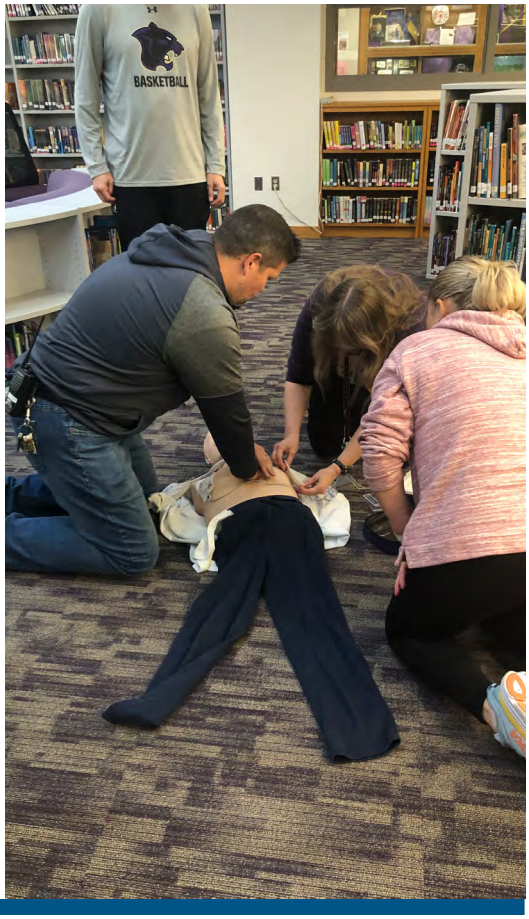
Lindsey Flanagan, the Youth Heart Watch Program Coordinator has led many programmatic efforts in SCD prevention and cardiac emergency response. Lindsey was recognized as one of the Citizen CPR Foundation's 40 Under 40 at the Cardiac Arrest Survival Summit in San Diego, CA.

Dr. Vetter was awarded the Lifetime Achievement Award/PACES (Pediatric and Congenital Electrophysiology Society) of the Heart Rhythm Society at the annual PACES/HRS meeting in May 2023. Over the 2023 year, she has presented, nationally and regionally, regarding YHW/sudden cardiac death topics at the Parent Heart Watch National Heart to Heart meeting in January, the Project ADAM National meeting in May, the World Congress of Pediatric Cardiology in August, the Scientific Sessions of the American Heart Association in November, the Beatrice Nicoletti CHOP Resuscitation Science Center and Pediatric Global Resuscitation Alliance Conference in November, and the NJ Public Health Department Annual Rural Health meeting in November.

YOUTH

HEART WATCH





VETTER, VL 2023 PUBLICATIONS

1. Longitudinal echocardiographic parameters before and after pacemaker placement in congenital complete heart block.
   Weinreb SJ, Ampah SB, Okunowo O, Griffis H, Vetter VL.
   Heart Rhythm. 2023 Nov 18:S1547-5271(23)02919-3. doi: 10.1016/j.hrthm.2023.11.015. Online ahead of print.
   PMID: 37981292
2. Electrocardiographic Findings in Genotype-Positive and Non-sarcomeric Children with Definite Hypertrophic Cardiomyopathy and Subclinical Variant Carriers.
   Anvekar P, Stephens P Jr, Calderon-Anyosa RJC, Kauffman HL, Burstein DS, Ritter AL, Ahrens-Nicklas RC, Vetter VL, Banerjee A.
   Pediatr Cardiol. 2023 Sep 19. doi: 10.1007/s00246-023-03281-z. Online ahead of print.
   PMID: 37725123
3. Risk Stratification in Pediatric Wolff-Parkinson-White: Practice Variation Among Pediatric Cardiologists and Electrophysiologists.
   Christmyer Z, Pisupati M, Shah MJ, Srinivasan C, Vetter VL, Iyer VR, Triguba M, Janson CM.
   Pediatr Cardiol. 2023 Aug 6. doi: 10.1007/s00246-023-03247-1. Online ahead of print.
   PMID: 37544951
4. A Pilot Randomized Clinical Trial of Intranasal Oxytocin to Promote Weight Loss in Individuals With Hypothalamic Obesity.
   McCormack SE, Wang Z, Wade KL, Dedio A, Cilenti N, Crowley J, Plessow F, Bamba V, Roizen JD, Jiang Y, Stylli J, Ramakrishnan A, Platt ML, Shekdar K, Fisher MJ, Vetter VL, Hocking M, Xiao R, Lawson EA.
   J Endocr Soc. 2023 Mar 17;7(5):bvad037. doi: 10.1210/jendso/bvad037. eCollection 2023 Mar 6.
   PMID: 37153702 **Free PMC article**.
5. Assessing Effective Practices and Barriers to Creating School and Community Partnerships for a Sudden Cardiac Death Prevention Program: A National Project ADAM® study.
   Malloy-Walton L, Gopineti L, Thompson AJ, Vetter VL, Batlivala SP.
   Acad Pediatr. 2023 May-Jun;23(4):808-813. doi: 10.1016/j.acap.2022.09.023. Epub 2022 Oct 8.
   PMID: 36220618

ECHOCARDIOGRAPHY LABORATORY

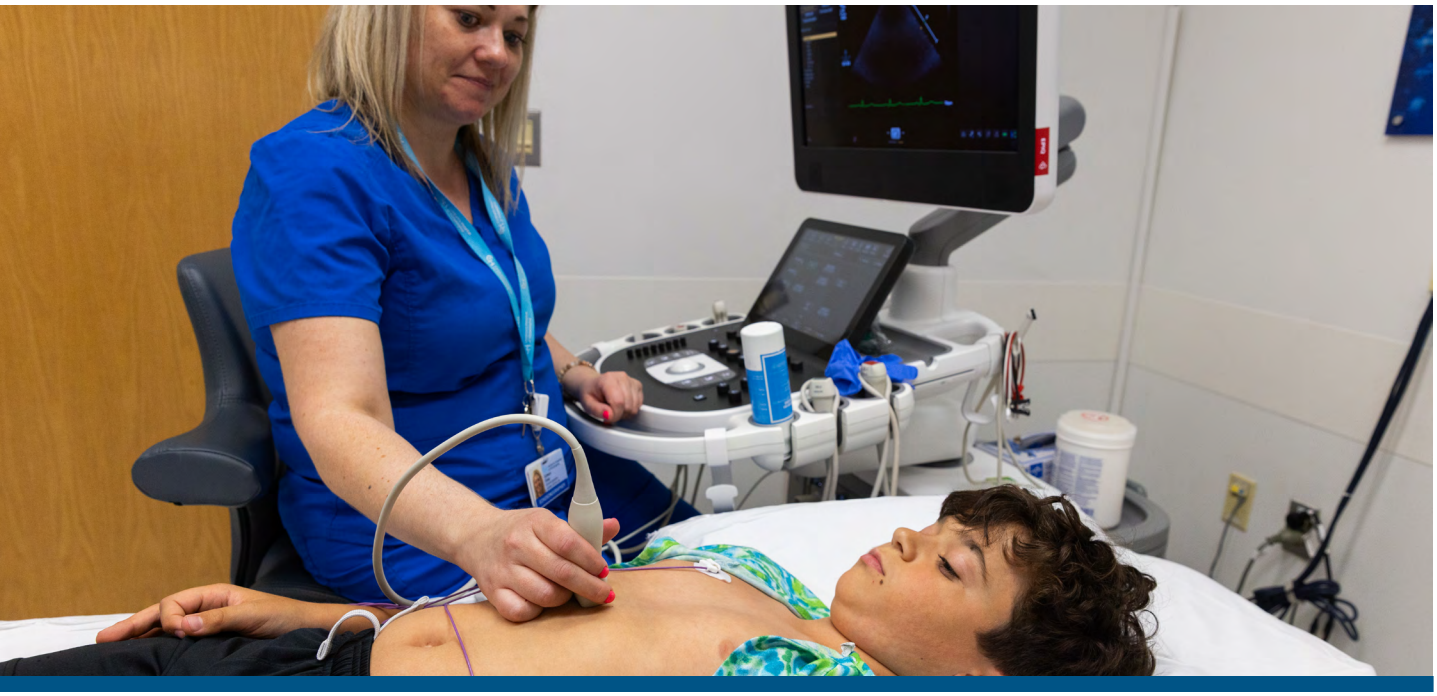
INTRODUCTION

The Cardiac Echo Lab at the Children's Hospital of Philadelphia continues to be one of the largest pediatric echo labs in the United States. As an enterprise, the Cardiac Echo Lab performs over 40,000 exams per year providing services for the Cardiac Center as well many other Divisions under the Departments of Pediatrics and Surgery including: Oncology, Pulmonology, Neurology, Nephrology, Orthopedic Surgery, General Surgery. At the main campus, the echo lab supports both inpatient and outpatient services, providing transthoracic, transesophageal and sedated echo services. The Cardiac Echo Lab also supports echo services across the region as well as in the state of New Jersey.

In January 2022, the Cardiac Echo lab expanded its footprint to provide 24/7 coverage of echo services at the newly opened CHOP King of Prussia Hospital as well as acquiring neonatal echo services within the Main Line Health system (Bryn Mawr, Lankenau, Paoli and Riddle). In October 2022, CHOP also broke ground with an additional specialty care center at the Main Line Bryn Mawr campus and formally announced its partnership to the region. New pediatric echo service affiliations were also created at Princeton Medical Center and St. Mary's Medical Center in Langhorne.

In March of 2023, the Cardiac Echo lab made a historical change to operations and separated the inpatient and outpatient services at the Main Campus and moved all outpatient operations to the Buerger Center for Advanced Pediatric Care. This move marked an official and unprecedented separation of the main echo lab operations with a number changes made to internal workflows to support this change in operation. One major change was the addition of an associate Medical Director to ensure consistent leadership across the inpatient and outpatient echo labs.

In totality, the Cardiac Echo Enterprise provides service in 14 specialty care centers and 11 affiliated nurseries that send echocardiograms into the central reading system. The Cardiac Echo lab also provides collaborative services for the Hospital of the University of Pennsylvania, supporting inpatient neonatal services as well as outpatient needs for the Philadelphia Adult Congenital Heart Center. The Cardiac Echo Lab is robust with research efforts, many studies originate and are conducted through the Echo Lab though the lab also provides services through the Cardiac Core for the Center for Human Phenomic Science (CHPS).



ECHOCARDIOGRAPHY LABORATORY

KEY PERSONNEL

Michael Quartermain, MD
Medical Director

Laura Mercer-Rosa, MD, MSCE
Associate Medical Director
Echo Lab Core Director:
- Center for Human Phenomic Science (CHPS)
- Echo Lab Research

Shobha Natarajan, MD
Echo Lab Core Director: Quality Improvement

Lindsay Rogers, MD, Med
Echo Lab Core Director: Education

Christine Pascua, B.Sc, RCS, RCCS, FASE
Program Director

Technical Manager, KOPH:
- Mike Convery, RDCS, MBA

Technical Supervisors:
- Valerie Capone, RDCS
- Devon Ash, RDCS
- Melissa Wasserman, RDCS, RCCS

Interim Technical Supervisors:
- Penelope Hazin, RDCS
- Stephanie Kren, RDCS

Lead Sonographers
- CHPS Research: Anysia Fedec, RDCS
- Advanced Modality Imaging: Yan Wang, RDCS
- Quality Improvement: Jenna DiFrancesco, RDCS
- Education: Karen Miller, RDCS
- Lancaster Satellite: Tiffany Cantler, RDCS
- Allentown Satellite: Maria Pero, RCS

ECHOCARDIOGRAPHY LABORATORY

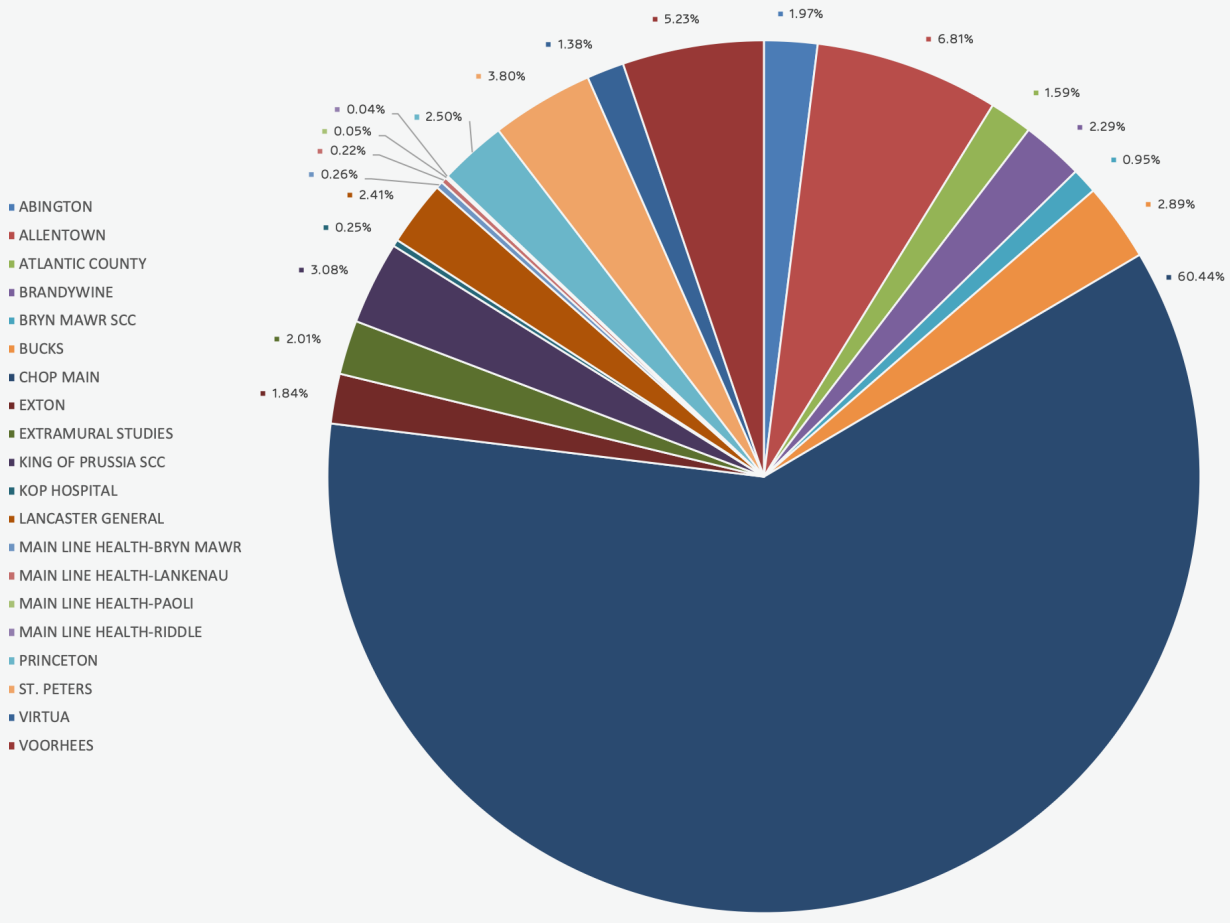
CLINICAL PROGRAMS AND ACTIVITIES

Echocardiograms performed by the echo team provide comprehensive assessment of cardiac anatomy and function to identify cardiac abnormalities, evaluate heart muscle function and surgical repairs.

The Cardiac Echo Lab is also proficient and highly skilled in providing state of the art services in advanced imaging modalities like three-dimensional and strain imaging. Requests for advanced imaging have increased over the past year and intra-operative imaging has become routine in all surgical interventions to improve patient outcomes. Three-dimensional imaging within the catheterization laboratory has also increased this past year and has been an important tool used for novel device programs.

Additionally, advanced vascular evaluation is offered through the Cardiac Echo Lab and includes carotid intima imaging, comprehensive blood pressure assessment, arterial pressure assessment and evaluation of arterial stiffness.

CARDIAC ECHO LAB VOLUME FOR FISCAL YEAR 2023 (January 2022-December 2023)



Main: 24,451 Satellites: 14,863 Extramural Studies: 812 KOPH/MLH: 329 Overall Total: 40,455

ECHOCARDIOGRAPHY LABORATORY

RESEARCH ACTIVITIES/HIGHLIGHTS

The Cardiac Echo Lab Research Unit has made significant progress in 2022 both in terms of prospective research studies and in the development of collaborations with other divisions in the Department of Pediatrics. Of note, the lab has transitioned to have 20 Philips Epiq systems, with all of the systems being fully outfitted with state-of-the-art technology like heart model, 3D automated RV volume and automated strain for all the chambers of the heart. Real time strain measurements for the assessment of ventricular function, have directly impacted the Lab's research endeavors and testing the reproducibility of these parameters is part of research protocols. It is part of the Research Unit's mission to support and foster retrospective and prospective studies led by the faculty and sonographers with the ultimate goal to use echocardiography as a tool to inform and improve the outcome of patients with congenital and acquired heart disease. The Research Unit has successfully implemented a Core Lab to augment our collaborative efforts while assuring optimal data quality. We initiated a multicenter collaboration for the NIH-funded ICU-RESUS study, names ICU-RESUS-Echo. Nice institutions have signed sub-contracts with CHOP and are have transferred de-identified echocardiograms to our lab for analysis. Data analysis is ongoing. These data will be used for a future multi-center grant submission in collaboration with the Division of Critical Care Medicine. In addition, we are the Core Lab for a Friedreich Ataxia study in collaboration with Dr. Kimberly Lin and pulmonary hypertension studies in collaboration with Dr. Catherine Avitabile, to name a few.

In 2022, the CHOP Echo Lab was well represented at the Scientific Sessions of the American Society of Echocardiography (ASE). Speakers included Melissa Wasserman, Lindsay Rogers, Laura Mercer-Rosa, and Meryl Cohen. Michael Quartermain presented the annual ASE Year in Review presentation. Several posters were presented, including those by Shobha Natarajan and Meryl Cohen (multi-center collaborative), Ani Banerjee, Laura Mercer-Rosa (in collaborations with fellows Marc Delaney and Andrea Jones, sonographers, Monique Gardner, Shivani Bhatt, Mark Friedberg and Sushma Reddy).
An important metric for the Cardiac Echo Lab Research Unit is the number of publications and grants by the faculty. Several faculty members and Cardiac Echo Lab sonographers remain engaged and collaborative in research projects. A list of publications (not exhaustive) is at the bottom of this report. We also provide a summary of studies with ongoing data collection/analysis with anticipated publications for 2022/2023. Please note that this report does not include prospective studies that are conducted in the Cardiac Echo Lab which are funded through CHPS, now under Laura Mercer-Rosa's leadership. The Cardiac Echo Lab CHPS Core supports a multitude of studies for both transthoracic echo and vascular imaging and assessment. Below is a summary of ongoing research studies and publications by Echo Lab investigators reflecting a collaborative nature among Echo Lab physicians, fellows and sonographers.

Kate Avitabile:

1. Ongoing collaborations with the pediatric surgery group (H. Hedrick) to study the congenital diaphragmatic hernia population
2. Ongoing funding by United therapeutics (with Laura Mercer-Rosa): prospective "Omics" study + RV strain under IRB review in CDH+ TOF + normal controls
3. K23 active enrollment
4. BPD-PH patients discharged on PH drugs-published.

Publications in 2022:

1. Hopper RK, Abman SH, Elia EG, Avitabile CM, Yung D, Mullen MP, Austin ED, Bates A, Handler SS, Feinstein JA, Ivy DD, Kinsella JP, Mandl KD, Raj JU, Sleeper LA; Pediatric Pulmonary Hypertension Network Investigators. Pulmonary Hypertension in Children with Down Syndrome: Results from the PediatricPulmonary Hypertension Network Registry. J Pediatr. 2023 Jan;252:131-140.e3.doi: 10.1016/j.jpeds.2022.08.027. Epub 2022 Aug 24. PMID: 36027975.

2. Avitabile CM, McBride MG, Zhang X, Ampah S, Goldstein BH, Alsaied T, Wittekind SG, Whitehead KK, Zemel BS, Paridon SM. Peak Work Rate Increases With Lower Extremity-Focused Exercise Training in Adolescents With Fontan Circulation. J Am Heart Assoc. 2022 Dec 20;11(24):e027464. doi:10.1161/JAHA.122.027464. Epub 2022 Dec 14. PMID: 36515264; PMCID: PMC9798796.

3. Avitabile CM, McBride MG, Harris MA, Whitehead KK, Fogel MA, Paridon SM, Zemel BS. Skeletal muscle deficits are associated with worse exercise performance in pediatric pulmonary hypertension. Front Pediatr. 2022 Oct 5;10:1025420. doi: 10.3389/fped.2022.1025420. PMID: 36275051; PMCID: PMC9579321.

4. Avitabile CM, Zhang X, Ampah SB, Wang Y, Ash D, Nilan K, Mercer-Rosa L, Fierro JL, Frank DB, Gibbs KA. Factors associated with discontinuation of pulmonary vasodilator therapy in children with bronchopulmonary dysplasia associated pulmonary hypertension. J Perinatol. 2022 Sep;42(9):1246-1254. doi:10.1038/s41372-022-01421-6. Epub 2022 Jun 8. PMID: 35676536.

5. De Bie FR, Avitabile CM, Joyeux L, Hedrick HL, Russo FM, Basurto D, Deprest J, Rintoul NE. Neonatal and fetal therapy of congenital diaphragmatic hernia-related pulmonary hypertension. Arch Dis Child Fetal Neonatal Ed. 2022 Sep;107(5):458-466. doi: 10.1136/archdischild-2021-322617. Epub 2021 Dec 24. PMID: 34952853.

6. Avitabile CM, Edelson JB, Goldberg DJ, Rossano JW. Commentary: Liver Disease Score: A New Tool for the Evaluation of Fontan Associated Liver Disease. Semin Thorac Cardiovasc Surg. 2022 Summer;34(2):653-654. doi:10.1053/j.semtcvs.2021.09.020. Epub 2021 Dec 3. PMID: 34871671.

7. Gardner MM, Faerber J, Glatz AC, Preminger TJ, Avitabile CM, Shankar S, Shustak RJ, Weber DR, Schachtner S, Ravishankar C, Goldberg DJ. Relationship Between Serum Brain-Type Natriuretic Peptide and Biomarkers of Growth in Infants With Shunt-Dependent Single Cardiac Ventricle. Am J Cardiol. 2022 May 15;171:146-150. doi: 10.1016/j.amjcard.2022.01.052. Epub 2022 Mar 11. PMID:35287945.

8. Handler SS, Varghese NP, Rosenzweig EB, Yung D, Krishnan U, Whalen E, Bates A, Avitabile CM, Jackson EO, Hirsch R, Fineman J, Abman SH; Pediatric Pulmonary Hypertension Network (PPHNet). Building a dedicated pediatric pulmonary hypertension program: A consensus statement from the pediatric pulmonary hypertension network. Pulm Circ. 2022 Feb 15;12(1):e12031. doi:10.1002/pul2.12031. PMID: 35506071; PMCID: PMC9052968.

9. O'Byrne ML, Faerber JA, Katcoff H, Huang J, Edelson JB, Finkelstein DM, Lemley BA, Janson CM, Avitabile CM, Glatz AC, Goldberg DJ. Prevalent pharmacotherapy of US Fontan survivors: A study utilizing data from the MarketScan Commercial and Medicaid claims databases. Am Heart J. 2022 Jan;243:158-166. doi: 10.1016/j.ahj.2021.09.012. Epub 2021 Sep 25. PMID:34582777; PMCID: PMC8819625.

10. Abman SH, Mullen MP, Sleeper LA, Austin ED, Rosenzweig EB, Kinsella JP, Ivy D, Hopper RK, Raj JU, Fineman J, Keller RL, Bates A, Krishnan US, Avitabile CM, Davidson A, Natter MD, Mandl KD; Pediatric Pulmonary Hypertension Network. Characterisation of paediatric pulmonary hypertensive vascular disease from the PPHNet Registry. Eur Respir J. 2021 Dec 31;59(1):2003337. doi:10.1183/13993003.03337-2020. PMID: 34140292.

Other ongoing Echo-related research work by Kate Avitabile with sonographer involvement (Yan Wang and Devon Ash's efforts are funded by Grant 2021262 from the Doris Duke Charitable Foundation through the COVID-19 Fund to Retain Clinical Scientists collaborative grant program)

1. DeBie FR, **Avitabile CM**, Flohr S, Land S, Mathew L, **Wang Y**, **Ash D**, Rintoul NE, Hedrick HL. Treprostinil in neonates with congenital diaphragmatic hernia-related pulmonary hypertension. Provisionally accepted pending revision, *J Peds*
2. **Avitabile CM**, Flohr S, Mathew L, **Wang Y**, **Ash D**, Frank DB, Tingo JE, Rintoul NE, Hedrick HL. Quantitative measures of right ventricular size and function by echocardiogram correlate with cardiac catheterization hemodynamics in congenital diaphragmatic hernia. *Under review, J Peds.*
3. **Avitabile CM**, Florh S, Mathew L, **Wang Y**, **Ash D**, Rintoul NE, Hedrick HL. Echocardiographic changes in infants with severe congenital diaphragmatic hernia after fetoscopic endoluminal tracheal occlusion (FETO). *Manuscript in progress.*
4. **Avitabile CM**, Florh S, Mathew L, **Wang Y**, **Ash D**, Rintoul NE, Hedrick HL. Impact of ventricular dysfunction on early mortality in congenital diaphragmatic hernia. *Manuscript in progress.*

Anirban Banerjee:

1. Yubbu P, Kauffman H, Calderon-Anyosa R, Montero AE, Sato T, Matsubara D, Banerjee A. Peak apical recoil rate is a simplified index of left ventricular untwist: validation and application for assessment of diastolic function in children. Int J Cardiovasc Imaging. 2022 Mar 15. PMID: 35290534.
2. Matsubara D, Chang J, Kauffman HL, Wang Y, Nadaraj S, Patel C, Paridon SM, Fogel MA, Quartermain MD, Banerjee A. Longitudinal Assessment of Cardiac Outcomes of Multisystem Inflammatory Syndrome in Children Associated With COVID-19 Infections. J Am Heart Assoc. 2022 Feb;11(3):e023251. PMID: 35043684; PMCID: PMC9238494.

Matthew Jolley:

1. Frontier Valve Program: Creating tools for the planning of transcatheter valve interventions
2. R01(PI): Focused on modeling and shape analysis tools for TV and RV applied to HLHS cohort
3. R43 (Co-Investigator): Development of modeling toolkit for self-expanding transcatheter pulmonary valves for TOF (Harmony)
4. PHN Scholars: CAVC modeling tools from 3DE.
5. EP Modeling: Cardiac Center Grant (Janson-PI) to develop tools to put 3DE into CARTO

Publications in 2022:

1. Williams TR, Cianciulli AR, Wang Y, Lasso A, Pinter C, Pouch AM, Biko DM, Nuri M, Quartermain MD, Rogers LS, Chen JM, Jolley MA. Truncal Valve Repair: 3-Dimensional Imaging and Modeling to Enhance Preoperative Surgical Planning. Circ Cardiovasc Imaging. 2022 Dec;15(12):e014424. doi:10.1161/CIRCIMAGING.122.014424. Epub 2022 Sep 12. PMID: 36093770; PMCID:PMC9772078.

2. Wu W, Ching S, Maas SA, Lasso A, Sabin P, Weiss JA, Jolley MA. A Computational Framework for Atrioventricular Valve Modeling Using Open-Source Software. J Biomech Eng. 2022 Oct 1;144(10):101012. doi: 10.1115/1.4054485. PMID: 35510823; PMCID: PMC9254695.

3. Lasso A, Herz C, Nam H, Cianciulli A, Pieper S, Drouin S, Pinter C, St-Onge S, Vigil C, Ching S, Sunderland K, Fichtinger G, Kikinis R, Jolley MA. SlicerHeart: An open-source computing platform for cardiac image analysis and modeling. Front Cardiovasc Med. 2022 Sep 6;9:886549. doi: 10.3389/fcvm.2022.886549. PMID: 36148054; PMCID: PMC9485637.

4. Nam HH, Herz C, Lasso A, Cianciulli A, Flynn M, Huang J, Wang Z, Paniagua B, Vicory J, Kabir S, Simpson J, Harrild D, Marx G, Cohen MS, Glatz AC, Jolley MA. Visualization and Quantification of the Unrepaired Complete Atrioventricular Canal Valve Using Open-Source Software. J Am Soc Echocardiogr. 2022 Sep;35(9):985-996.e11. doi:10.1016/j.echo.2022.04.015. Epub 2022 May 7. PMID:35537615; PMCID: PMC9452462.

5. Vicory J, Herz C, Allemang D, Nam HH, Cianciulli A, Vigil C, Han Y, Lasso A, Jolley MA, Paniagua B. Statistical shape analysis of the tricuspid valve in hypoplastic left heart sydrome. Stat Atlases Comput Models Heart. 2022 Sep;13131:132-140. doi: 10.1007/978-3-030-93722-5_15. Epub 2022 Jan 1. PMID:35088061; PMCID: PMC8788948.

6. Ross CJ, Trimble EJ, Johnson EL, Baumwart R, Jolley MA, Mir A, Burkhart HM, Lee CH. A pilot investigation of the tricuspid valve annulus in newborns with hypoplastic left heart syndrome. JTCVS Open. 2022 Jun;10:324-339. doi:10.1016/j.xjon.2022.02.015. Epub 2022 Feb 24. PMID: 35937182; PMCID: PMC9354836.

7. Ghosh RM, Jolley MA, Mascio CE, Chen JM, Fuller S, Rome JJ, Silvestro E, Whitehead KK. Clinical 3D modeling to guide pediatric cardiothoracic surgery and intervention using 3D printed anatomic models, computer aided design and virtual reality. 3D Print Med. 2022 Apr 21;8(1):11. doi: 10.1186/s41205-022-00137-9. PMID: 35445896; PMCID: PMC9027072.

8. Nam HH, Dinh PV, Lasso A, Herz C, Huang J, Posada A, Aly AH, Pouch AM, Kabir S, Simpson J, Glatz AC, Harrild DM, Marx G, Fichtinger G, Cohen MS, Jolley MA. Dynamic Annular Modeling of the Unrepaired Complete Atrioventricular Canal Annulus. Ann Thorac Surg. 2022 Feb;113(2):654-662. doi:10.1016/j.athoracsur.2020.12.013. Epub 2020 Dec 24. PMID: 33359720; PMCID:PMC8219815.

9. Jolley MA, Ghelani SJ, Adar A, Harrild DM. Three-Dimensional Mitral Valve Morphology and Age-Related Trends in Children and Young Adults with Structurally Normal Hearts Using Transthoracic Echocardiography. J Am Soc Echocardiogr. 2017 Jun;30(6):561-571. doi: 10.1016/j.echo.2017.01.018. Epub 2017 Apr 6. PMID:28391001.

Laura Mercer-Rosa:

1. Prospective cohort of TOF with ongoing analyses: 1) Pre-operative serum biomarkers of myocardial fibrosis predict early post-operative RV dysfunction after TOF repair (Andrea Jones); 2) Right atrial strain reflects diminished diastolic function early after TOF repair; 3) Longitudinal RV remodeling after TOF repair using RV strain (Andrea Jones)
2. Cardiac Center grant: RV remodeling in patients with TOF combining RV strain, biomarkers and diffuse myocardial fibrosis by CMR- enrolling
3. Collaborations: Prospective RV/LV function study in Pediatric Acute respiratory Distress Syndrome (PARDS)- Himebauch- Grants JIPGP/ K23
4. Stress Echo in TOF and Fontans (Shivani Bhatt's work): ongoing analysis of right atrial strain in TOF, and RV strain in Fontans at peak exercise
5. Liquid biopsy of single ventricles- collaboration with Sushma Reddy (Stanford)-funded
6. FA cohort- assessment of LV function (implementing Echolab Core Lab- Kim Lin)
7. ICU-RESUS Study- implemented Echo Core Lab (Robert Sutton, Adam Himebauch)
8. United Therapeutics Grant with Kate Avitabile, funded (detailed above)

Publications in 2022:

1. Chilcote D, Mercer-Rosa L, Wang Y, Kawut SM, Berg RA, Yehya N, Himebauch AS. Alveolar dead space fraction is not associated with early RV systolic dysfunction in pediatric ARDS. Pediatr Pulmonol. 2023 Feb;58(2):559-565. doi:10.1002/ppul.26237. Epub 2022 Dec 1. PMID: 36349816; PMCID: PMC9870940.

2. Avitabile CM et al (above)

3. Mercer-Rosa L, Fogel MA, Wei ZA, Trusty PM, Tree M, Tang E, Restrepo M, Whitehead KK, Cassedy A, Paridon SM, Yoganathan A, Marino BS. Fontan Geometry and Hemodynamics Are Associated With Quality of Life in Adolescents and Young Adults. Ann Thorac Surg. 2022 Sep;114(3):841-847. doi:10.1016/j.athoracsur.2022.01.017. Epub 2022 Feb 1. PMID: 35120878; PMCID:PMC9528566.

4. DiLorenzo MP, DeCost G, Mai AD, Hughes N, Goldmuntz E, Jones A, Fogel MA, Mercer-Rosa L. Comparison of serum biomarkers of myocardial fibrosis with cardiac magnetic resonance in patients operated for tetralogy of Fallot. Int J Cardiol. 2022 Jul 1;358:27-33. doi: 10.1016/j.ijcard.2022.04.064. Epub 2022 Apr 26. PMID: 35487317.

5. Savla JJ, Putt ME, Huang J, Parry S, Moldenhauer JS, Reilly S, Youman O, Rychik J, Mercer-Rosa L, Gaynor JW, Kawut SM. Impact of Maternal-Fetal Environment on Mortality in Children With Single Ventricle Heart Disease. J Am Heart Assoc. 2022 Jan 18;11(2):e020299. doi: 10.1161/JAHA.120.020299. Epub 2022 Jan 11. PMID: 35014861; PMCID: PMC9238520.

6. Srinivasan R, Faerber JA, DeCost G, Zhang X, DiLorenzo M, Goldmuntz E, Fogel M, Mercer-Rosa L. Right Ventricular Strain Is Associated With Increased Length of Stay After Tetralogy of Fallot Repair. J Cardiovasc Imaging. 2022 Jan;30(1):50-58. doi: 10.4250/jcvi.2021.0069. PMID: 35086170; PMCID: PMC8792718.

Michael Quartermain:

1. Prospective study of contrast echocardiography
2. Prospective study of point of care ultrasound for imaging of ECMO cannula positioning (Neonatology)

Publications in 2022:

1. Chaszczewski KJ, Linder JR, Campbell MJ, Convery M, Wang Y, Smith CL, Kozyak BW, Quartermain MD. Novel Utilization of Ultrasound Enhancing Agents in Complex Congenital Heart Disease Following Superior Cavopulmonary Connection. J Am Soc Echocardiogr. 2023 Jan 13:S0894-7317(23)00016-0. doi:10.1016/j.echo.2023.01.007. Epub ahead of print. PMID: 36642236.

2. Williams TR, Cianciulli AR, Wang Y, Lasso A, Pinter C, Pouch AM, Biko DM, Nuri M, Quartermain MD, Rogers LS, Chen JM, Jolley MA. Truncal Valve Repair: 3-Dimensional Imaging and Modeling to Enhance Preoperative Surgical Planning. Circ Cardiovasc Imaging. 2022 Dec;15(12):e014424. doi:10.1161/CIRCIMAGING.122.014424. Epub 2022 Sep 12. PMID: 36093770; PMCID: PMC9772078.

3. Matsubara D et al (above)

Meryl Cohen:

Publications in 2022:

1. Campbell MJ, White BR, Rychik J, Linder J, Faerber JA, Tian Z, Cohen MS. Fetal Doppler Echocardiographic Assessment Predicts Severe Postnatal Obstruction in Total Anomalous Pulmonary Venous Connection. J Am Soc Echocardiogr. 2022 Nov;35(11):1168-1175. doi: 10.1016/j.echo.2022.07.007. Epub 2022 Jul 19. PMID: 35863543; PMCID: PMC9643594.

2. Cohen MS. Imaging of Left Ventricular Hypoplasia. World J Pediatr Congenit Heart Surg. 2022 Sep;13(5):620-623. doi: 10.1177/21501351221114767. PMID: 36053101.

3. Nam HH et al (above)

4. Metcalf MK, Ghosh RM, Harris MA, Savla JJ, Cohen MS. Sinus venosus defect of the pulmonary vein-type: An easily missed diagnosis. Echocardiography. 2022 Mar;39(3):543-547. doi: 10.1111/echo.15310. Epub 2022 Feb 15. PMID: 35170076.

5. Nam HH et al (above)

EDUCATIONAL ACTIVITIES

The echocardiography lab continues to provide education to sonographers, nurse practitioners, fellows in cardiology, critical care, emergency medicine, cardiac anesthesia, and cardiac critical care as well as residents and students. There are many ongoing and some new efforts within the educational core of the echo lab for 2022. These are outlined below.

Curriculum Development

In collaboration with Karen Miller, sonographer education lead, the education core completes ongoing assessments of experiences of first-year fellows on their first and second echo rotations. Feedback is given during these assessments to measure sonographer support as well as imaging guidance for Fellows.

We continued the RR2 review sessions on Monday, Wednesday and Friday (9-10am) as well as the first-year fellows lectures. In this session, the echo faculty review 1-2 studies with group of fellows and sonographers in main lab conference area. This session has been well attended and receives positive reviews from fellows.

We continued our TEE educational sessions. This conference is run by our 4th year fellows (overseen by Mike Quartermain and Lindsay Rogers) and occurs every few months to review interesting TEE cases, improving our own practice variation.

As new educational lead sonographer, Karen Miller has given several didactic sessions to both sonographers and fellows on echo related topics. In addition, Karen has given echo education sessions to cardiac nurse practitioners and even started education sessions with CICU front-line providers to improve echo order quality.

Finally, Karen has led the effort to organize a sonographer lecture series, with didactic sessions for sonographers given by sonographers and echo faculty. In addition, she obtained approval for sonographers to receive continuing educational credit for these lectures.

ECHOCARDIOGRAPHY LABORATORY

QUALITY IMPROVEMENT INITIATIVES

The CHOP echo lab has a well-developed quality improvement program, currently with 5 active QI imaging projects. The las has set the expectation for both echo attendings and sonographers to be a part of at least 1 Echo Lab QI project and attend quarterly QA reviews. These projects range from standardizing imaging and reporting protocols to reviews of potential diagnostic errors. The most developed program is our pre-operative echo to surgical discrepancy review. All diagnostic discrepancies identified between echo and surgical inspection, are reviewed by the group quarterly. This allows for development of educational activities to improve our imaging capabilities and decrease errors. This work has led to utilization of additional imaging modalities such as epicardial echo imaging. This program is also now part of a multi-institutional study.

In addition to clinical activities, Quality Improvement initiatives have also been impactful to lab operations. Through the ongoing project "Improving Efficiency and Quality of Performing and Reporting on Outpatient Echocardiograms for Routine Visits of Patients with Repaired Congenital Heart Disease", the Echo lab has been successful in implementing standardized imaging and reporting protocols that have been useful in decreasing overall imaging time and improving the patient experience.

QI Projects, Invited Lectures, Abstracts and Publications

Team Lead: Focused Outpatient Echocardiograms in Repaired Congenital Heart Disease

Team Lead: Standardizing Sonographer Workflow in the Outpatient Echo Lab

Team Lead, QI Initiative-Echocardiograms for Patients after Norwood operation in the interstage period

Team Lead, QI Initiative - Inpatient Echocardiograms for Patients with Kawasaki Disease

Director For the Biweekly Neonatal Review: a multi-disciplinary patient review of all postoperative neonates to engage staff in team learning

"Have QI Metrics Made Your Lab Better?" The American Society of Echocardiography, 30th Annual Scientific Sessions, Portland, OR

Chaszczewski KJ, Quartermain MD, and Natarajan SS: Implementing a Quality Improvement Tool to Systematically Identify Discrepancies between Pre-operative Echocardiographic Findings and Intraoperative Inspection in Pediatric Patients Undergoing Repair for Congenital Heart Defects. American Society of Echocardiography Annual Scientific Sessions August 2020

Natarajan SS, Chaszczewski K, Ansah D, Balasubramanian S, Beattie M, Bhat, AH, Brewer C, Campbell MJ, Carney M, Churchill TL, Dhanantwari P, Jone P, Kong G, Kwon EN, Lipinski J, Madan N, Nelson J, Olsen R, Parthiban A, Prospero C, Rajagopal H, Sachdeva R, Sanandajifar H, Sanchez Mejia A, Srivastava S, Stern K, Taylor C, Tierney S, Cohen MS: Rationale and Design of the First Multicenter Pediatric Echocardiography Quality Improvement Collaborative: Decreasing Pre-operative Imaging Discrepancies in Patients prior Congenital Heart Defect Surgery. The American Society of Echocardiography Scientific Sessions 2022.

ECHOCARDIOGRAPHY LABORATORY

White BR, Ho DY, Rogers LS, Natarajan SS: A Standardized Imaging Protocol Improves Quality and Reduces Practice Variability Echocardiography 36(8): 1515-1523, July 2019.

White BR, Chaszczewski KJ, Lemley B, Natarajan SS, Rogers LS: Sustained improvement in fellows' echocardiographic completeness through the coronavirus pandemic with a standardised imaging protocol. Cardiol Young Feb 2022

GOALS AND OUTLOOK FOR FISCAL YEAR 2024

After a successful separation of the Main Cardiac echo lab, the Cardiac Echo lab is gearing up for the EPIC CUPID go live slated for March of 2024. This implementation will impact the sonographer workflow and allow for more system integration in the future. In addition, the Cardiac Echo lab will be unveiling and implementing updates Syngo reporting templates this fiscal year that will better align with sonographer and physician reporting. From a research standpoint, we will continue to accept international research fellows to work on year-long research projects and will seek funding to help support their effort. This international collaboration is essential to the mission of the Echolab to train individuals that will contribute novel research findings to the echocardiography community at large.

With these major changes, the Cardiac Echo Lab will continue to push forward with ongoing workflow optimization and innovation.

The Cardiac Echo Lab continues to grow resources at rapid pace in order to support increases in services and providers in both the inpatient and outpatient sectors of the division.

CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

INTRODUCTION

The Cardiovascular Exercise Physiology Laboratory at the Children's Hospital of Philadelphia continues to be one of the most productive clinical pediatric exercise physiology laboratories in the United States. The laboratory serves the exercise physiology testing needs of the Cardiac Center at the Children's Hospital of Philadelphia as well as other Divisions of the Department of Pediatrics including: Pulmonology, Allergy, Oncology, Gastroenterology, Neurology, and Adolescent Medicine. The laboratory also provides both in-patient and out-patient cardiovascular rehabilitation services in conjunction with the Physical Therapy Department for the Cardiac Center and other Divisions of the Department of Pediatrics.

CLINICAL PROGRAMS AND ACTIVITIES

The Cardiovascular Exercise Physiology Laboratory provides comprehensive assessment of exercise performance, risk assessment, and symptoms for a wide range of patients including:

1. Diagnosed congenital or acquired heart disease.
2. Patients with undiagnosed exercise-related symptoms.
3. Patients with known or suspected pulmonary disease affecting exercise performance.
4. Oncology patients who have received or will receive cardio-toxic drugs.
5. Children with undiagnosed musculoskeletal disorders
6. Children with diagnosed or undiagnosed metabolic disorders resulting in exercise related symptoms
7. Children and adolescents with symptoms or concerns about performance in competitive sports.

Testing routinely includes measurements of heart rate, heart rhythm, and blood pressure. Physical working capacity measured by cycle ergometry. Expired gasses using metabolic carts directly measure aerobic capacity. Comprehensive resting and exercise pulmonary functions are routinely obtained. Special protocols using nuclear imaging, stress echocardiography, and pharmacological stress protocols are used when indicated.

Stephen Paridon, MD
Medical Director

KEY PERSONNEL

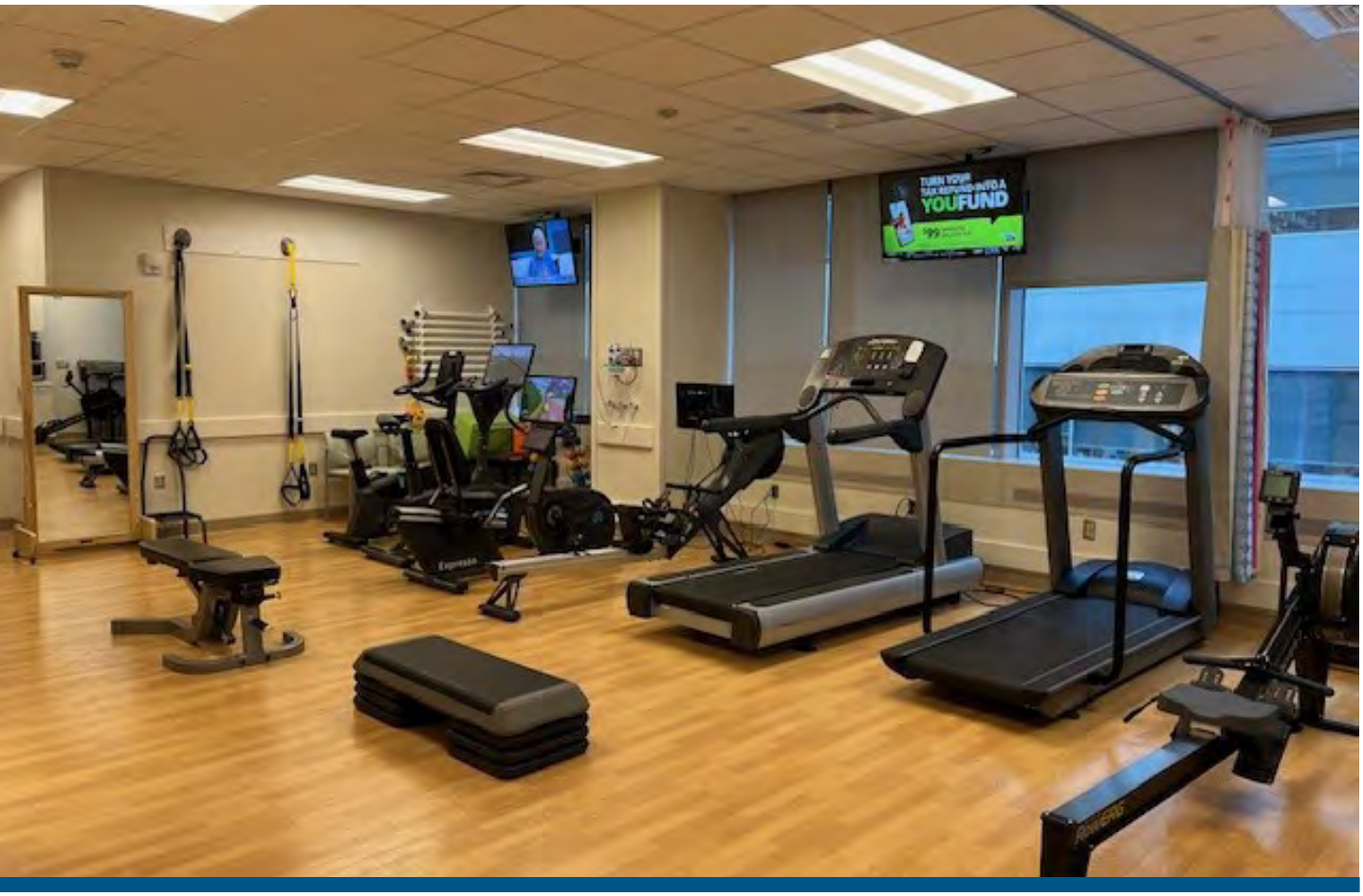
Attending Physicians:
Julie Brothers, MD
Paul Stephens, Jr., MD
Alexa Hogarty, MD
Matthew Elias, MD
Jonathan Edelson, MD
Emmanuel Favilla, MD
Imran Massood, MD
(4th Year Fellow)

Laboratory Director:
Michael G. McBride, PhD

Laboratory Exercise Physiologists:
Elizabeth Ford, M.Ed
Shannon O'Malley, MS
Andrea Linton, MS
Christine Giovinazzo, BS
Declan McDonald, MS

CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

In addition to exercise testing, the laboratory maintains an active inpatient cardiovascular rehabilitation program. This program is run in conjunction with the Children's Hospital of Philadelphia Physical Therapy Program and serves the needs of both in-patients and out-patients. These patients include many of the sickest children in the institution including children awaiting heart or lung transplantation. Many of these children are on multiple intravenous inotropic medications or have received implantable ventricular assist devices. This Phase I program monitors heart rate, rhythm, blood pressure, and arterial oxygen saturation throughout each hourly exercise session. Non-cardiac in-patients with chronic pulmonary disease are also frequently served by this program. Selected out-patients also use this program. These are frequently children who are too ill or have complicating medical conditions that prohibit enrollment in community based rehabilitation. This is currently the only active pediatric rehabilitation program of its kind in the country.



CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

EXERCISE LABORATORY VOLUME FOR FISCAL YEAR 2022:

Exercise Testing:

A total of 2402 exercise tests were performed in fiscal year 2023. (see Fig. 1). This number includes the testing done at the Main lab, King of Prussia, and six-minute walks. This is an 8% increase in volume over FY 2022. Individually, these represent an increase of 6% (EST Main), 29% (KOP), and 23% (6MWT), respectively.

Cardiovascular Rehabilitation:

: A total of 236 rehabilitation sessions were performed in fiscal year 2023. This is a 7% increase compared to fiscal year 2022 (see Fig. 1).

Ambulatory Blood Pressure (ABP):

This is a program offered for children and adolescents with suspected disease resulting in systemic hypertension or hypotension. To align with services provided in Nephrology, FY13 transitioned AMBP testing to Nephrology as Cardiology's primary referral base and AMBP was discontinued in June 2023. Therefore, there was a 38% decrease in diagnostic testing using this modality during FY23.

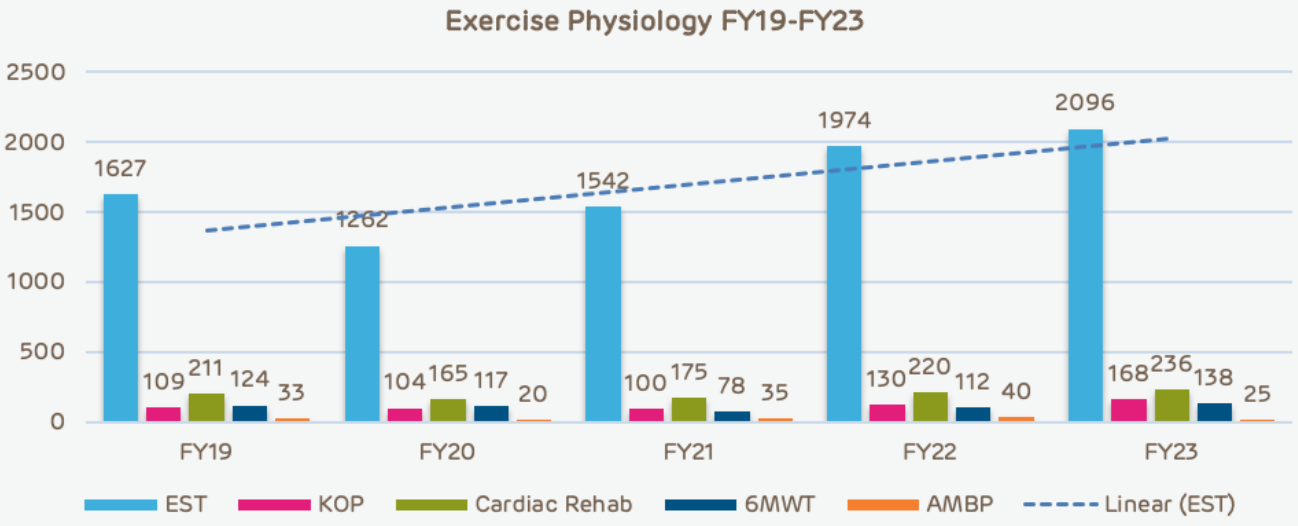


Figure 1.

CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

RESEARCH ACTIVITIES

The laboratory continues to be productive in research related to cardiovascular exercise physiology. Listed below are the publications and presentations from the laboratory for fiscal year 2023.

Peer Review Publications:

1. Fogel M, Donnelly E, Goldmuntz E, Harris M, Biko D, Partington S, Paridon S, Ferrari V, Whitehead K, Merer-Rosa L. Contraction fraction and maldistribution of lung flow is associated with exercise performance in tetralogy of Fallot: A substudy the single center cardiac magnetic resonance outcomes registry – tetralogy of Fallot. *J Am Coll Cardiol* 81 (8 Suppl) 1544, 2023.
2. Goldberg D, Hu C, Lubert A.....**McBride M, Paridon M**. The Fontan udenafil exercise longitudinal trial: Subgroup analysis. *Ped Cardiol* 44:1691-1701, 2023.
3. Goldberg C, Trachtenberg F Gaynor JW, Mahle W..... **Paridon S.** Longitudinal follow-up of children with HLHS and association between Norwood shunt type and long-term outcomes: The SVR III Study. Circulation 148: 1330-1339, 2023.
4. Huang J, Wittekind S, Opotowsky A.....**Paridon S.** Pediatric cardiology fellowship standards for training in exercise medicine and curriculum outline. *Ped Cardiol* 44: 540-548, 2023.

Abstracts:

1. Fogel M, Reddy K, Mahmood A, ... **Paridon S, McBride M.** Cardiac MRI ventricular function and hemodynamic multivariable model predictors of exercise performance in tetralogy of Fallot using machine learning and multivariate modelling. *Circulation* 148: A15272, 2023.
2. **Linton A**, Drant S. Health coaching for children with congenital heart disease: Tips from a pilot program in a tertiary children's hospital. Presented: *American College of Lifestyle Medicine Annual Conference. Denver Oct 29-Nov 1, Denver, CO 2023.*

Invited Lectures:

1. **Brothers J**. "Congenital Coronary Artery Anomalies/Bridges: Is there Finally Data?" *World Congress of Pediatric Cardiology and Cardiac Surgery*, Aug. 26, 2023.
2. **McBride M.** "Exercise Presciption: Risk to Me or Risk to the Patient?" *World Congress of Pediatric Cardiology and Cardiac Surgery,* Aug. 29, 2023.
3. **Paridon M**. "Pediatric Stress Testing: Under Appreciated or Less Than Adequate? *World Congress of Pediatric Cardiology and Cardiac Surgery*, Aug. 30, 2023.
4. **Paridon M.** "Hidden Gems: The Treadmill" *World Congress of Pediatric Cardiology and Cardiac Surgery*, Aug. 30, 2023.

CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

Educational Activities:

The Exercise Laboratory continues to be an integrated part of the regular cardiology fellowship non-invasive rotation. The yearly didactic lecture series on exercise physiology for the Cardiology and Pulmonary fellows continues.

The laboratory continues to be an extremely popular site for external training for undergraduate students from exercise physiology at regional universities and visiting physicians from national and international medical centers.

Several of the Exercise Physiology Lab staff serve as adjunct faculty in area colleges providing didactic lectures and laboratory experiences to facilitate undergraduate learning. These area colleges include the University of the Sciences, Eastern University, and Westchester university.

GOALS AND OUTLOOK FOR FISCAL YEAR 2024

Clinical Program

Exercise Testing

Early trends for clinical volume for FY 2024 are encouraging as the historical trends continue to rise over the past several years. FY 2020 was the first year in the last 15 years that the number of exercise tests performed in the Laboratory decreased from the previous fiscal year (COVID). However, with precautions in place, the Main Lab was able to nicely rebound to volumes that approach 95% of the previous fiscal year (FY2019). Our focus this coming year is to expand services into the New Jersey area as a large population of patients requiring exercise testing come from this region. The second major goal is to increase the volume of encounters (testing and remote sessions) referred by the newer programs in preventive medicine. The last major goal is to improve the reporting structure with the launch of CUPID within EPIC. Target launch is in late March 2024 and will facilitate a streamlined approach to report turnover and more efficient means of communicating results to providers.

Exercise Counseling

Under the umbrella of the Preventative Cardiovascular Program, staff in the exercise lab routinely attend and provide exercise counselling for patients attending the multi-disciplinary clinics **(Lipid-Heart, Hypertension, FORWARD/ Frontier, Lifestyle Medicine)**. These clinics are generally held 2 times per month. Our goal is to increase the frequency of visits and utilize telemedicine as a means if tracking patient's wellness and physical activity patterns. **During fiscal year 2023, a cumulative increase of 49% relative to FY22 was observed as shown below (Fig 2).**

Led by Stacey Drant, MD, Lifestyle Medicine is a new addition to the Preventive Cardiology umbrella. Primarily aimed to service patients with connective tissue disorders, Lifestyle Medicine aims to help families identify and make changes that will improve their overall health and wellbeing. Areas of focus include nutrition, physical activity, sleep, stress, social connections, and risky behaviors.

CARDIOVASCULAR EXERCISE PHYSIOLOGY LABORATORY

LIFESTYLE MEDICINE TEAM:

- Stacey Drant, MD (Cardiology)
- Susan Beck, MD (Pulmonary Sleep Medicine)
- Nicholas Seivert, PhD (Psychology)
- Danielle Campbell, MS, RD, LDN (Clinical Nutrition)
- Andrea Linton, MS (Exercise and Health Coach)
- Emma Dickinson (Program Manager)

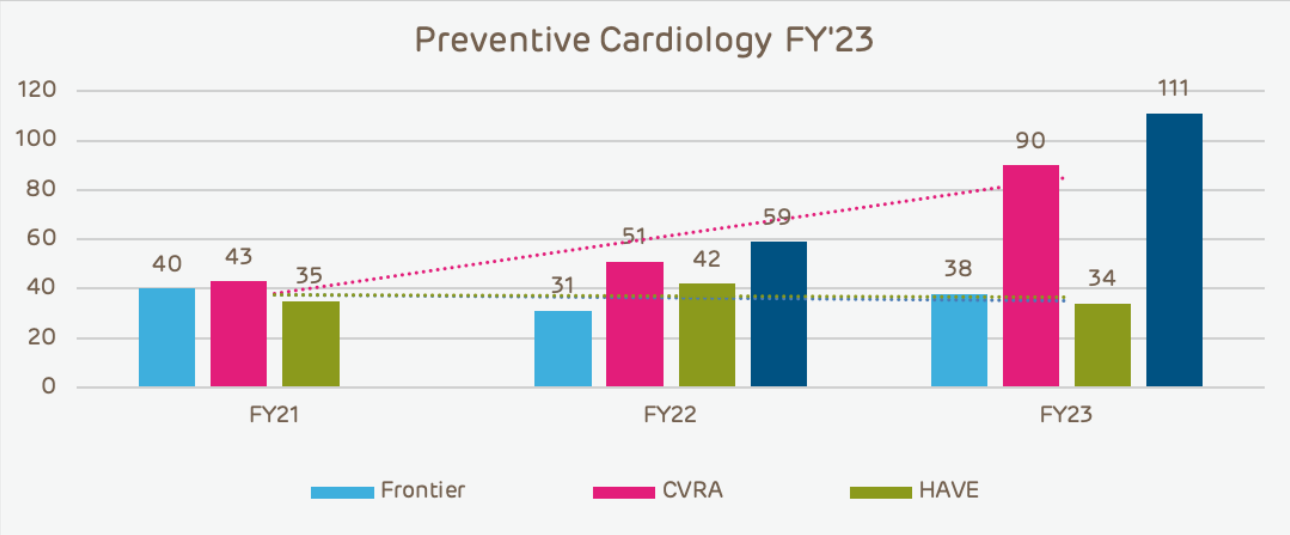


Fig. 2 Patient counseling visits among different Preventive Cardiology subgroups

Remote Physical Activity Monitoring

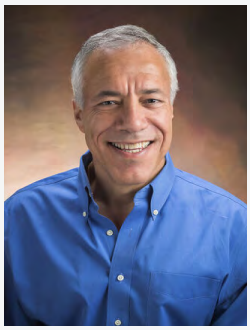
As part of the Cardiac Center Health Initiative, we have partnered with the Open Health Network in developing the MyHeartCHOP app to provide remote monitoring in two pilot research studies led by Shana McCormick MD and Kimberly Lin, MD. These studies are designed to assess the effect of home exercise through the use of Fit Bit monitoring and specific individualized exercise regimens in adolescents and young adult with Friedreich's Ataxia and Hypertrophic Cardiomyopathy. As well, two additional programs aimed at providing remote physical activity and telemedicine training session were launched during this fiscal year. These include patients diagnosed with Hypertrophic Cardiomyopathy and those who underwent Orthotopic Heart Transplantation. This research and recruitment is currently active.

CARDIAC MAGNETIC RESONANCE IMAGING

INTRODUCTION AND CLINICAL ACTIVITIES

The Cardiac Magnetic Resonance (CMR) program at CHOP is a state-of-the-art nationally and internationally recognized clinical and research program bringing the highest quality CMR services to patients with congenital and acquired cardiac disease, both pediatric and adult. In calendar year 2023, the program performed 1,322 CMRs, a 2.4% increase over the previous year, despite limitations in cardiac anesthesia and MRI technologist manpower as well as scanner availability. Our program has grown nearly every year with the exception for scanner availability and COVID-19 (see graph below). CMRs are offered every day, Monday through Friday as well as one weekend day per month. On Wednesdays, we have 2 full scanners being utilized the entire day. Our primary MRI scanner is a 1.5 Tesla Avanto-FIT system that has been upgraded to the latest hardware and software. Dr. Mark Fogel leads a team of six CMR physicians, 7 highly trained CMR technologists and two radiology nurses who provide the primary services.

CARDIAC MRI TEAM



Mark Fogel, MD
Director of Cardiac MR

Matthew Harris, MD

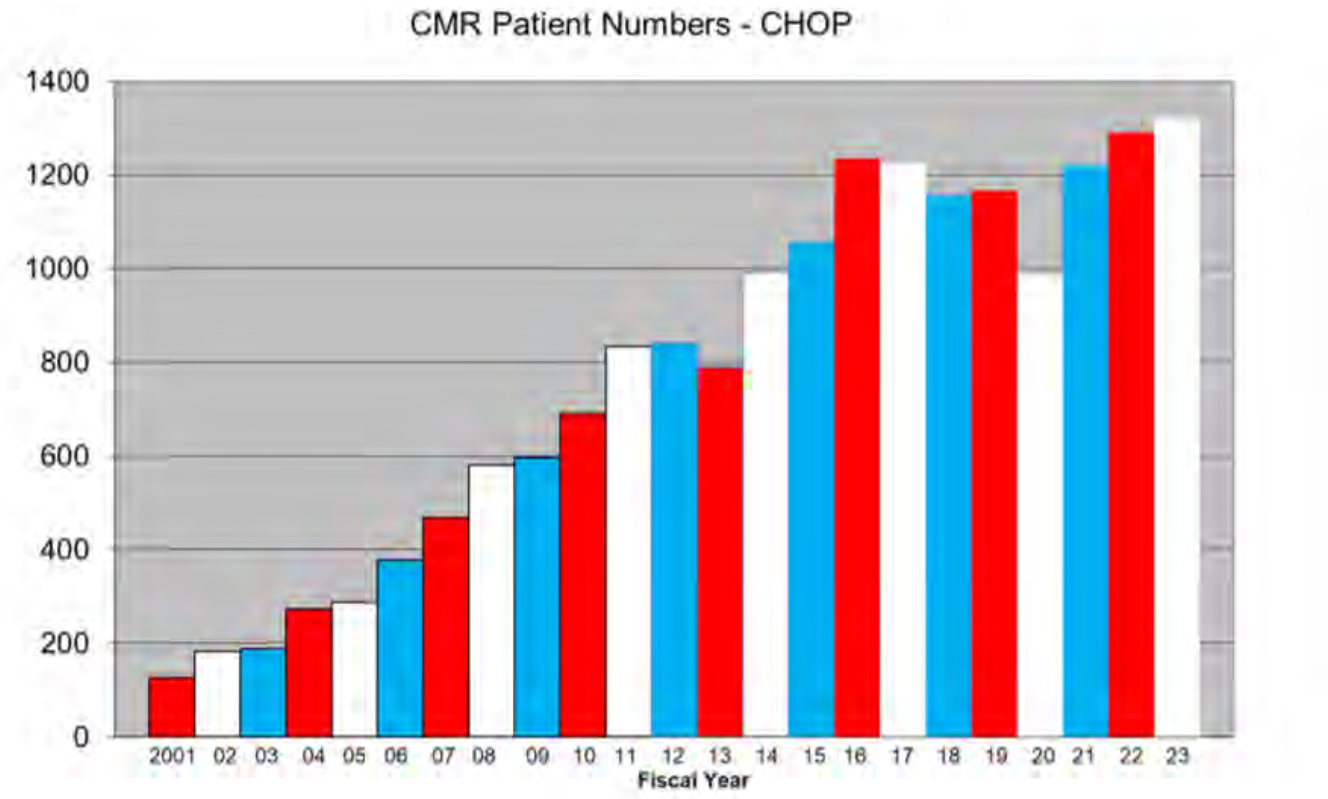
Kevin Whitehead, MD

Sarah Partington, MD

David Biko, MD, MBA

Danish Vaiyani, MD

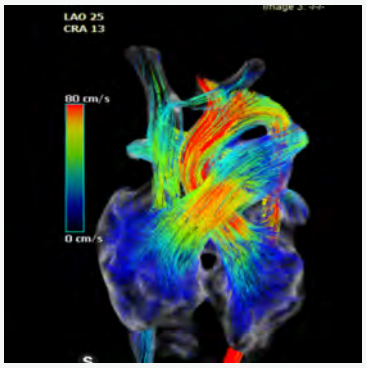
CARDIAC MAGNETIC RESONANCE IMAGING



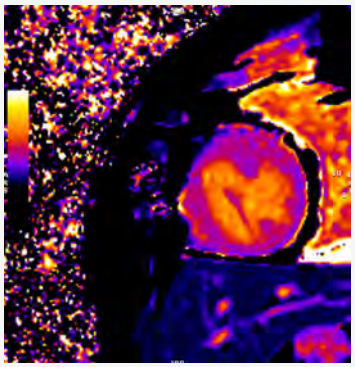
The section provides the highest quality and most advanced techniques for CMR imaging of anatomy, heart function, blood flow and tissue characterization (heart scarring, infarction, edema and myocardial iron) from fetus through and including adulthood. The program brings imaging quality and clinical care that only a few centers worldwide can perform with advanced imaging techniques only a few provide. Studies such as "XMR," a combination of CMR and cardiac catheterization, are routinely done 2-3 times per week. CMR sometimes replaces cardiac catheterization in these situations. Stress CMR, such as using the drug adenosine or with a supine MRI-compatible bicycle, is used to assess heart blood perfusion or wall motion abnormalities. Recently, we have replaced adenosine with regadenoson, a much safer and effect alternative for pharmacologic stress. 3D printing and virtual reality to aid in interventional procedures such as surgery or cardiac catheterization are based in CMR and occur 1-2 times per week. Feed and swaddle CMR is offered for those infants less 6 months of age or younger without the need for anesthesia. Ferumoxytol, a CMR contrast agent available in only a few centers, is utilized 1-2 times per day to get ultra high quality of small structures such as coronary arteries, newborn pulmonary arteries, small pulmonary veins or to view the beating heart of a patient in four dimensions

CARDIAC MAGNETIC RESONANCE IMAGING

Coronary Arteries in a 2 week old 6 Pound Infant



4D Flow Imaging in a Patient with Pulmonary Hypertension



Heart Scarring in a Single Ventricle Patient after Fontan

RESEARCH

Our research mission is to support and foster retrospective and prospective studies led by faculty, fellows and CMR technologists with the ultimate goal to use CMR as a tool to inform and improve the outcome of patients with congenital and acquired heart disease. Besides improving outcome, two major thrusts are understanding the functional, hemodynamics and tissue characteristics that underpin congenital and acquired heart disease and the effects of surgical / catheter intervention along with advancing new techniques in CMR. The program collaborates with investigators at Siemens Medical Solutions, the National Institutes of Health, University of California – Los Angeles and the University of Pennsylvania to develop and test new and novel ways to image heart anatomy, function and blood flow.

The CMR team heads one National Institutes of Health grant (R01 Mark Fogel) using CMR to understand and heart and liver scarring in single ventricles before and after Fontan. The section is involved with 7 other grants also involving CMR including the role of heart function and scarring in Friedrich's Ataxia and heart and liver scarring in teenagers with Fontans to name a few. The program is part of the CMR FORCE registry (Fontan Outcomes Registry Using CMR Examinations), the largest Fontan registry in the world and Dr Fogel serves as a founding member of the Executive Board. A large tetralogy of Fallot single center CMR registry was assembled by Dr Fogel to determine CMR predictors of clinical outcomes including global heart function, strain and hemodynamics of from which 5 abstracts have been presented at national and international meetings and the first paper has been submitted. The team published 16 manuscripts this year in prestigious journals such as Circulation: Cardiovascular Imaging, the American Journal of Cardiology, Radiology: Artificial Intelligence, Annals of Thoracic Surgery and the American Journal of Cardiology to name a few. There are 4 papers submitted and being reviewed. Two chapters in major imaging textbooks were submitted for publication. Twenty one (21) abstracts were presented or accepted for presentation at national and international meetings such as the American Heart Association, the American College of Cardiology and The Society for Cardiovascular Magnetic Resonance. Staff have delivered over 16 lectures at national and international meetings.

CARDIAC MAGNETIC RESONANCE IMAGING

SELECTED RESEARCH PUBLICATIONS

(see Cardiac Center Research Section for full Publication List):

- Vaiyani D, Elias MD, Biko DM, Whitehead KK, Harris MA, Partington SL, Fogel MA. Patients with Post-COVID-19 Vaccination Myocarditis Have More Favorable Strain in Cardiac Magnetic Resonance Than Those With Viral Pediatr Cardiol. 2023;44(5):1108-1117.
- Fogel MA, Donnelly E, Crandell I, Hanlon A, Whitehead KK, Harris M, Partington S, Biko D, Flynn T, Nicolson S, Gaynor JW, Licht D, Vossough A. Cerebral Blood Flow, Brain Injury And Aortic-Pulmonary Collateral Flow After The Fontan Operation. Am J Cardiol. 2023;208:164-170.
- Biko DM, Fogel MA. Fetal Cardiac MRI: Doppler US-gated Cine Imaging in Complex Congenital Heart Disease. Radiol Cardiothorac Imaging. 2023;5(1):e220314
- Jones AL, White BR, Ghosh RM, Mondal A, Ampah S, Ho DY, Whitehead K, Harris MA, Biko DM, Partington S, Fuller S, Cohen MS, Fogel MA. Cardiac Magnetic Resonance Predictors for Successful Primary Biventricular Repair of Unbalanced Complete Common Atrioventricular Canal. Cardiology in the Young. 2024;34(2):387-394
- Yao T, St. Clair N, Miller GF, Dorfman AL, Fogel MA Ghelani S, Krishnamurthy R, Lam CZ, Quail M, Robinson JD, Schidlow D, Slesnick TC, Weigand J, Steeden JD, Rathod RH, Muthurangu V. A Deep Learning Pipeline for Assessing Ventricular Volumes from a Cardiac Magnetic Resonance Image Registry of Single Ventricle Patients. (in press – Radiology: Artificial Intelligence)

CARDIAC CARE UNIT

CARDIAC CARE UNIT (CCU)

The Cardiac Care Unit includes 40 inpatient beds on two vertically integrated care areas on the 5th and 6th floors. This highly specialized unit provides intermediate-level pediatric cardiac care with a high nurse to patient ratio and includes active telemetry. The Cardiac Care Unit can treat acutely ill or convalescing patients on vasoactive or antiarrhythmic infusions, patients with pulmonary hypertension initiating or receiving pulmonary vasodilators, patients with acute and chronic heart failure, patients on non-invasive positive pressure ventilation, and patients with complex lymphatic issues. We also provide care for stable patients with ventricular assist devices, either awaiting transplant or as a bridge to home.

LEADERSHIP AND PERSONNEL

Under the leadership of Nurse Managers **Natalie Bernard, RN, BSN, MHL** and **Arnetta Woodson, RN, BSN**, and Medical Directors **David Goldberg, MD** and **Susan Schachtner, MD** the Cardiac Care Unit manages more than 1500 inpatient encounters per year. In our care model, front-line patient coverage is provided by an integrated team of Advanced Practice Providers (APPs) and pediatric residents with attending coverage by rotating subspecialists. Our current front-line team (team lead Diana Holbein) includes 15 full-time APPs and two pediatric residents who rotate through the service each month. The attending physician team includes 14 general cardiologists, seven heart failure/transplant cardiologists, four pulmonary hypertension cardiologists, and five electrophysiologists. Each attending physician provides inpatient care for 6-13 weeks/year. The 5th and 6th floor units have a combined total of approximately 150 nurses, 25 senior nurses' aides, 12 telemetry technicians, and 12 inpatient clerks all working together to support our patients and families.

Susan Schachtner, MD
Medical Director

David Goldberg, MD
Medical Director

Natalie Bernard, RN, BSN
Nurse Manager

Arnetta Woodson, RN, BSN
Nurse Manager

Cardiac inpatients are distributed across **four subspecialty cardiac services** providing in-depth, specialized care across a wide array of diagnoses. These subspecialty cardiac services include **general medical/post-surgical, heart failure/transplant, electrophysiology, and pulmonary hypertension**. A strong partnership exists between nursing, medical provider teams and multidisciplinary support services. All members of the Cardiac Care Unit have a strong commitment to patient, and family-centered care including family-centered bedside morning work rounds.

CARDIAC CARE UNIT

RESEARCH AND QUALITY IMPROVEMENT

The Cardiac Care Units and Cardiac Center continue to actively participate in the Pediatric Acute Care Cardiology Collaborative (PAC3), a national learning network created with the aim of improving care for all acute care pediatric cardiac inpatients. The collaborative has a number of active projects focused on supporting evidenced-based, high-quality care in the cardiac inpatient setting. Current work is focused on ensuring adequate medical and medical-technology teaching, reducing the number of patients who require tube-based feeding supplementation at discharge, and ensuring timely discharge once a patient is ready to leave the hospital through the Hearts to Home collaborative. This project was awarded innovation funding under the direction of our Quality Improvement physician lead, **Emmanuelle Favilla, MD** along with **APP lead Sarah Bakke**.

EDUCATION

Education on the Cardiac Care Unit includes both training of cardiology residents and fellows and working with families to ensure comfort with their child's care needs prior to hospital discharge.

The Cardiology inpatient service provides pediatric residents with daily bedside teaching, multiple didactic lectures each week, and frequent emergency response simulations. Our **Director of Trainee Education, Rachel Shustak, MD**, works closely with the Pediatric Residency program to ensure excellence in cardiac training for these future intensivists, emergency physicians, neurologists, neonatologists and, of course, future pediatric cardiologists. Under Dr. Shustak's direction, the Cardiology service has developed a revised curriculum to ensure education goals are achieved.

In addition to the pediatric residents, the Cardiology inpatient service provides a critical opportunity for learning for each of the six first year pediatric cardiology fellows. The fellows join the cardiac service for two months during their first year during which they learn management of inpatient cardiac patients from all subspecialists, they learn to coordinate multidisciplinary care teams, and they learn to lead/direct inpatient rounds. They are given more responsibility as the year progresses, always under the supervision of the cardiology attendings.

The **Cardiac Center Education Room**, staffed by a select group of experienced Cardiac Care Unit nurses, continues to teach multiple aspects of home-based complex cardiac care to parents and families. Topics include ventricular assist device care, home central line care, feeding tube placement and safety, non-standard formula preparation, medication administration, and cardio-pulmonary resuscitation. Parents and families value the education provided during the Education Room classes and the training provides for earlier, safe discharge of complex cardiac patients. Nearly 3000 classes were taught in the Education Room over the past calendar year.

CARDIAC CENTER COLLABORATION

Although the Cardiac Care Unit has its own physical space, we work in close collaboration with all areas of the Cardiac Center to provide safe and seamless care from hospital admission through discharge. Over the last few years, we have developed both a local "watcher" program and a Cardiac Critical Assessment Team (CAT), designed to assist with early identification and prevention of hemodynamic instability and to facilitate rapid access to care escalation when required. These programs provide for increased situational awareness across the center.

Although we are an inpatient unit, we work closely with a team of nurses through the **Cardiac Care Managers Program** and the **Stutman Discharge Program**. These teams provide post-discharge outpatient follow-up for our cardiac families within 24-48 hours of leaving the hospital and are adept at answering questions, reviewing medications, and providing reinforcement of care and education provided while a patient was hospitalized. These programs have been instrumental at increasing family comfort at discharge and decreasing the number of hospital readmissions.

CARDIAC PREPARATION & RECOVERY UNIT

The Cardiac Prep and Recovery Unit (CPRU) follows ASPAN guidelines for recovery of patients receiving and recovering from sedation and cardiac anesthesia. This translates to 1:1 and 2:1 as indicated by the phase of recovery. Nurses and the Nurse Practitioners in the CPRU are highly engaged. They have creatively and proactively supported organizational and Cardiac Center efforts during high census, expanding the footprint to support ongoing patient care needs. The team has led several harm-prevention and quality improvement initiatives including the CPRU Flat-Time Project for catheterization patients. This project directly impacts the patient family experience. After a slight pause, the project is slated to move into phase 3 this upcoming spring. Another project is underway to improve employee and patient safety. The team has partnered with IS to develop reports that identify patients with behavioral health needs prior to admission. The team then partners with the families and develops and individualized plan which is communicated upon admission during a Tier 0 huddle. The team onboarded several new staff members this past summer and fall to prepare for the projected increased volumes. Leaders continue to expand the cross-training program to promote professional development and growth for nurses. The team continues to have high engagement and Press Ganey scores.

CPRU LEADERSHIP

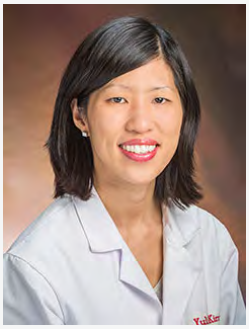
Donna Calfin, RN, MHL, CPN

The CPRU annual yoga retreat takes place in the town of Malden-on-Hudson in NY. Two yoga sessions per day, wellness activities vary each year, teambuilding, swimming (aka cold plunging), hot tub soaking, hiking, brunch, and wellness swag.

ADULT CONGENITAL HEART PROGRAM

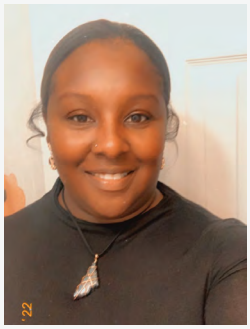
The Philadelphia Adult Congenital Heart Center is a joint program of Children's Hospital of Philadelphia and Penn Medicine. With improved life expectancy due to advances and innovations in surgical and medical care, over 95% of babies born with congenital heart disease will reach adulthood. The mission of the Philadelphia Adult Congenital Heart Center is to provide comprehensive, collaborative, patient-centered care to adults affected by congenital heart disease and is dedicated to ensuring that our patients thrive into young adulthood and beyond.

KEY LEADERS & STAFF



Yuli Kim, MD
Medical Director

Stephanie Fuller, MD, MS
Surgical Director



Dawanna Pratt
Program Manager

FACULTY

Cardiology
- Sara Partington, MD
- Emily Ruckdeschel, MD
- Sumeet Vaikunth, MD, MEd
- Allison Tsao, MD

Cardiac Surgery
- Muhammad Nuri, MD
- Constantine Mavroudis, MD

Nurse Practitioners
- Lynda Tobin, CRNP
- Kirby Bate, CRNP

Nursing
- Robert Karvell, RN
- Christian Reda, RN
- Madison Angstadt, RN
- Tyesha Cusack, RN

Social Work
- Teresa Salinas

New Recruits
- Allison Tsao, MD

Allison L. Tsao, MD has joined the Division of Cardiovascular Medicine in the Sections of Interventional Cardiology and Adult Congenital Heart Disease. She comes to us from the Boston VA where she was a structural interventional cardiologist and Instructor of Medicine at Harvard Medical School. She completed her medical school and residency in Internal Medicine at Johns Hopkins where she was Assistant Chief of Service of the Osler Medicine Residency. She then completed her fellowships in Cardiovascular Medicine and Interventional Cardiology at Brigham and Women's Hospital and then went on to complete a second fellowship in ACHD at Boston Children's Hospital. Dr. Tsao's clinical interests involve structural and congenital heart disease with her translational research efforts focused on large animal model design for novel cardiovascular device development.

ADULT CONGENITAL HEART PROGRAM

CLINICAL & PROGRAMMATIC HIGHLIGHTS 2023

CHOP and Penn Medicine were sponsors of the annual Adult Congenital Heart Association congenital heart walk and were interviewed by adult congenital heart disease patient and Fox News reporter Chris O'Connell for this piece.

- Doctors in Philly helping patients with Congenital Heart Disease lead active lives (fox29.com)

Former CHOP patient Patrick Brett, who was a patient in the Philadelphia Adult Congenital Heart Center, underwent dual heart liver transplant by Dr. Fuller and Penn transplant surgeons for complications related to his congenital heart defect. He just celebrated his 2 year post transplant anniversary in 2023.

- Heart and liver transplant helps Pa. baseball coach make it home - 6abc Philadelphia
- How this diehard Philadelphia sports fan got a 2nd chance (audacy.com)

PROGRAM STATISTICS

January to December 2023

- **3851** total patient visits
- **929** new patient visits
- **2,275** echocardiograms
- **75** surgeries
- **167** cardiac catheterizations
- **45** electrophysiology procedures
- **440** CMR Studies (18 and older)

RESEARCH HIGHLIGHTS

- Multicenter study describing the largest cohort of Fontan patients with hepatocellular carcinoma published in December 2023.
- Kim YY et al. European Heart Journal (2023) 00, 1–4. https://doi.org/10.1093/eurheartj/ehad788
- STS oral presentation which demonstrates a business case for developing a robust congenital heart disease program with surgical services in an adult hospital.
- Fuller S et al. Using the STS Database to Assess the Positive Financial Impact of an Adult Congenital Heart Surgery Program on a Tertiary Hospital. STS 2024: The 60th Annual Meeting of the Society of Thoracic Surgeons. San Antonio, TX.
- Investigators from the Philadelphia Adult Congenital Heart Center were involved in a large multicenter study examining transplant outcomes in adults with Fontan circulation.
- Lewis MJ et al. Morbidity and Mortality in Adult Fontan Patients After Heart or Combined Heart-Liver Transplantation. J Am Coll Cardiol. 2023 Jun, 81 (22) 2161–2171.
- Lewis MJ et al. Clinical Outcomes of Adult Fontan-Associated Liver Disease and Combined Heart-Liver Transplantation, J Am Coll Cardiol. 2023 Jun, 81 (22) 2149–2160

NEW DEVELOPMENTS COMING IN 2024

- ACHD fellowship sponsored by former CHOP cardiologist and Philadelphia Adult Congenital Heart Center physician, Dr. Dick Donner. Dick and Gail Donner have generously funded a 2-year advanced fellowship for Rebecca Moore, MD- a 3rd year CHOP cardiology fellow- to stay and continue training as an ACHD fellow 2024-2026.
- Dr. Fuller will be the Vice Chair of the updated ACC/AHA Guidelines on the Management of Adults with Congenital Heart Disease
- The PHN-sponsored study ACHD-MINDS, examining neurocognitive outcomes in congenital heart disease, is complete and will be published later this year with Dr. Fuller as CHOP PI.

CONNECTIVE TISSUE PROGRAM

INTRODUCTION

The combined Cardiology and Genetics Connective Tissue Disease Program is a recognized Center of Excellence for the diagnosis and treatment for pediatric and young adult patients with underlying disorders of connective tissue that place them at risk for development of aneurysms of the aorta and other vessels. Cardiovascular connective tissue disorders are rare diseases that are often inherited and involve multiple family members however any child can be the first in their family to be affected. The most common of these disorders is Marfan syndrome that affects 1 in 5,000 people and there are many other similar disorders that are even more uncommon. Our Cardiologist Dr. Drant and Geneticist Dr. Kallish have extensive experience in diagnosing and caring for even the rarest of these disorders. Because we evaluate patients together during the same visit, patients and their families receive our opinion before the end of the visit. Imaging of the heart and aorta using an echocardiogram is often performed immediately prior to the visit allowing those results to be incorporated into the evaluation Genetic counseling is provided and genetic testing to confirm a diagnosis is initiated if needed. Our program uses a personalized approach to create a treatment plan that is individual to each patient. The program receives local and regional referrals and will coordinate with local providers as needed for those who reside outside of the Philadelphia area.

Cardiovascular connective tissue disorders can affect any portion of the vascular system in the body and CHOP is one of only a few programs in the country with a pediatric vascular surgeon. Dr. Alexander Fairman has joined our team to provide expertise in evaluation and management of arterial complications outside of the chest. He also provides care at the Hospital of the University of Pennsylvania thus continues to provide continuity of care for patients as they reach adulthood and transition care from CHOP.

Another unique aspect of our program has been incorporation of a Lifestyle Medicine Program. This program is made available to school age children and teens with connective tissue disorders. Through the program, families learn about the impact of lifestyle choices encompassing diet, physical activity, sleep, social connectedness, and emotional wellbeing on their cardiovascular health. Our trained pediatric health coach then provides guidance and support to empower them to make changes. Lifestyle choices then become an important adjunct to their overall health and emotional wellbeing and the program has been very well received.

Our program has an extended multidisciplinary team of providers for referral to evaluate and treat many of the extracardiac problems associated with the cardiovascular connective tissue disorders.

CONNECTIVE TISSUE PROGRAM

FACULTY

Stacey Drant, MD
Pediatric Cardiology (Director)

Staci Kallish, DO
Medical Genetics

REFERRAL SPECIALISTS

Allergy:
- Dr. Rahul Datta
- Dr. Ashley Kazatsky
- Dr. Soma Jyonouchi

Cardiothoracic Surgery
- Dr. Jonathan Chen
- Dr. Mohamad Nuri
- Dr. Stephanie Fuller
- Dr. Katsuhide Maeda
- Dr. Constantine Mavroudis

Craniofacial/Plastic Surgery
- Dr. Oksana Jackson

Dietician
- Danielle Campbell, RD

ENT
- Dr. Karen Zur

Gastroenterology/EoE Center
- Dr. Terri Brown-Whitehorn
- Dr. Jonathan Spergel
- Dr. Antonella Cianferoni
- Dr. Laura Gober

Neurology

Ophthalmology
- Dr. William Anninger

Orthopedics
- Dr. John Flynn
- Dr. Michael Nance

Pain management
- Dr. F. Wickham Kraemer

Physical Medicine/Rehabilitation
- Dr. Sarah (Sally) Evans

Psychology
- Nicholas Seivert

Pulmonology
- Dr. Oscar (Hank) Meyer

Vascular Surgery
- Dr. Alex Fairman, MD (CHOP and Hospital of University of Pennsylvania)

PROGRAMMATIC HIGHLIGHTS

1. CHOP sponsored the annual Walk for Victory in June 2023 held at Fairmont Park with Dr. Drant serving as Chairperson. We continue to serve as a Referral Center for the National Marfan and Related Disorders Foundation that serves as a vital resource for families affected by these rare disorders to identify centers of excellence to care for their children. Because of the success of the event it has become an annual event in Philadelphia.

2. CHOP joined the Collaborative for Longitudinal Aortic Research In The Young (CLARITY). This registry serves as the sole venue for the sharing of patient information to enable much needed research of these rare diseases and provide evidence-based treatments for children and adults with these debilitating and deadly disorders. The first abstract was presented at the World Congress of Pediatric Cardiology in August 2023 and a manuscript has been submitted for publication.

CONNECTIVE TISSUE PROGRAM

PUBLICATIONS: ABSTRACTS

1. Beecroft T, Espahbodi N, Milewicz D et al. Cardiovascular Outcomes and Survival in Patients with Early Onset Marfan Syndrome. World Congress of Pediatric Cardiology, Washington DC 2023

2. Drant S, Linton A. Health Coaching for Children with Congenital Heart Disease: Tips from a Pilot Program in a Tertiary Children's Hospital. Lifestyle Medicine Conference 2023, Denver Colorado

PATIENT STORIES

AS is a 15 y.o. patient with the vascular form of Ehlers Danlos Syndrome that leads to arterial complications within any artery in the body and there is currently no known prevention. In addition to traditional care they chose to participate in the Lifestyle Medicine Program. Since jointing the program and working with our health coach they have improved their sleep, decreased time spent playing video games, became better organized and joined the school Golf Team where they are now #1 on the Varsity Golf Team. His mother thanked us for "giving me my son back".

CORONARY ANOMALY MANAGEMENT PROGRAM (CAMP)

OVERVIEW

The Coronary Anomaly Management Program is a clinic for children, adolescents, and young adults with coronary artery anomalies. Most patients we see in clinic are those with anomalous aortic origin of the right (R-AAOCA) or left coronary artery (L-AAOCA), but we also see those with rare coronary anomalies as well, such as single coronary arteries and myocardial bridges. Our team consists of Drs. Brothers, Paridon, Harris, Callahan, Maeda, Partington, Shah, and our Nurse Practitioner, Giordana (Jordy) Martino. Christine Williams is our Program Coordinator. Dr Brothers and Paridon see patients generally once/month. The clinic sees patients monthly and together, Drs. Brothers and Paridon saw 20 new patients and 36 follow-up patients. The team serves as a resource for second opinions from other doctors as well as directly to patients/families. Together, the CAMP team has provided approximately 60 expert opinions and record reviews this year. The team in 2023 will be working toward finalizing the treatment and management algorithm for AAOCA patients and looks forward to publishing their experiences to date. Dr Brothers co-founded the Coronary Anomaly Forum that met nearly monthly and included cardiologists and surgeons across North America with interest in coronary anomalies to discuss interesting and unique cases. Dr. Brothers spoke at the Fouad Mobassaleh Symposium on Sudden Cardiac Death in the Young at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery on "Congenital coronary artery anomalies/ bridges: Is there finally data?" Drs. Brothers and Paridon have continued to be involved with a PCORI grant with the coronary anomaly population. There have been several abstracts presented from these data and manuscripts are in process. Dr. Brothers was a co-author of a manuscript accepted in Annals of Thoracic Surgery, entitled, "Expert Review: Anomalous Aortic Origin of a Coronary Artery." She is also a member of the International Coronary Artery Anomalies Collaborative, which is a group of international pediatric cardiologists, cardiothoracic surgeons, radiologists, and morphologists with the first aim to standardize nomenclature surrounding AAOCA; a first manuscript is in progress. Patients continue to be enrolled in the CHSS Anomalous Coronary Artery Registry.

One patient's story exemplifies what the journey can be like for patients with AAOCA. Patient EH presented to CAMP clinic in 2019 at age 6 years for a second opinion. He had been followed at an outside institution since infancy when a murmur was heard and an echocardiogram was performed which showed a small mid-muscular VSD, which subsequently closed, a possible bicuspid aortic valve, and a suspicion for a R-AAOCA. He also had a mild-moderate amount of isolated monomorphic ventricular ectopy. EH underwent a sedated cardiac MRI, which confirmed the R-AAOCA and did not show a bicuspid aortic valve but a normal trileaflet valve. He underwent an exercise stress test which showed frequent monomorphic ventricular ectopy that suppressed early in exercise; there was no complex ectopy. There were no ischemic changes or symptoms. EH was subsequently followed at his primary institution and continued playing high level soccer. He then experienced an episode of severe chest pain after playing soccer for a few hours. He was brought to their local ED where there was evidence of a troponin leak. Because of this, he was seen by his primary cardiologist, who referred him back to CHOP. After review of his data and discussion with our CAMP team, we agreed that given his symptoms and laboratory abnormalities, he should undergo surgical repair. Dr Maeda performed a reimplantation of the anomalous coronary artery. EH followed with his primary cardiologist and did very well post-operatively. He returned to CHOP 3 months post-operatively for a CTA and stress echocardiogram with stress test. All of these studies were reassuring and he was cleared for slow progression back to sports.

CORONARY ANOMALY MANAGEMENT PROGRAM (CAMP)

CAMP TEAM


Julie Brothers, MD, FAAP


Stephen Paridon, MD


Matthew Harris, MD


Ryan Callahan, MD


Katsuhide Maeda, MD, PhD


Jordy Martino, MSN, CRNP

PULMONARY HYPERTENSION

OVERVIEW

The Pulmonary Hypertension (PH) Program at the Children's Hospital of Philadelphia is one of the largest PH centers in the country. They provide care for all forms of PH including idiopathic pulmonary arterial hypertension (PAH), congenital heart disease-related PAH, left heart disease PH, developmental lung disease PH, chronic thromboembolic PH, and others. They work closely with the Pulmonary Hypoplasia/Congenital Diaphragmatic Hernia and Chronic Lung Disease programs to provide care to an expanding population. The PH program saw over 500 unique patients and over 1500 encounters in 2022.

The PH program is a top referral center from across the country and overseas. They are experts in the delivery of life-saving PH-directed continuous prostacyclin and oral drug therapies. Additionally, they work closely with the Interventional Cardiology and Cardiothoracic Surgery teams to provide the most up-to-date surgical and catheter-based shunts, mechanical support, and lung transplantation to prevent right heart failure and improve quality of life.

FACULTY

Alex Davidson, MD, FACC
Medical Director

Catherine Avitabile, MD

David Frank, MD, PhD

Jennifer Tingo, MD

Andrea Jones, MD

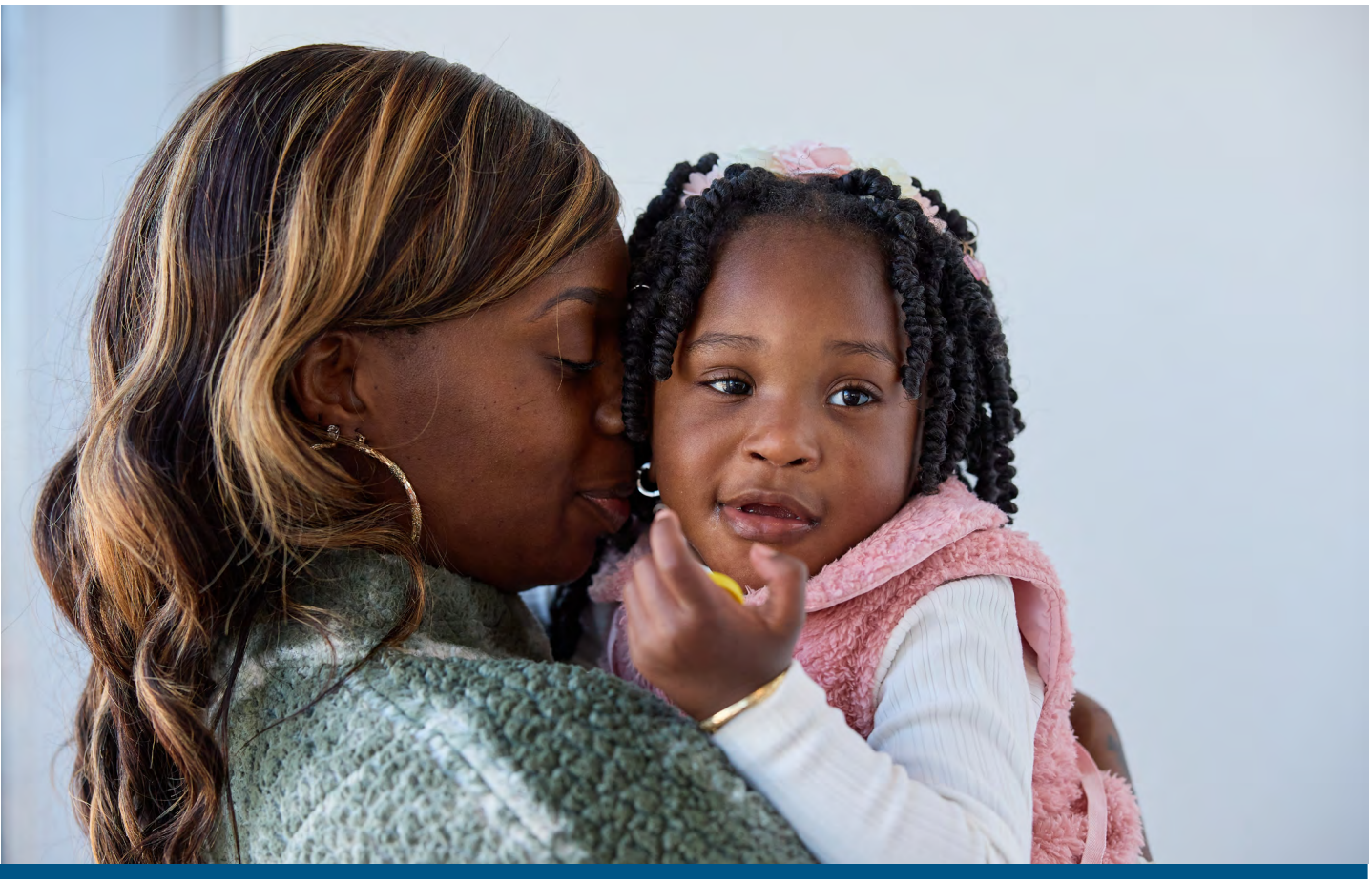
NOT PICTURED:
Stephen Walker, CRNP (retired)
CRNP Kerri Cram, CRNP
Kim Butler, RN, Nurse Coordinator

PULMONARY HYPERTENSION

RESEARCH HIGHLIGHTS

Dr. Avitabile is one of the country's leading experts on the use of actigraphy to promote physical activity, improve exercise tolerance, and reduce skeletal muscle deficits in children with PH. Her research funded through the NIH/NHLBI K23 Mentored Patient Oriented Research Career Development Award is a driving force to establish home-based exercise training program for children with PH and to identify novel markers of exercise tolerance to be used in clinical trials. She is CHOP site-PI for the North American Pediatric PH Network. She is also the site PI and co-investigator for the NIH/NHLBI UG3 multicenter randomized clinical trial testing upfront mono- versus dual-therapy for pediatric PH and the CHOP site-PI for clinical trials investigating the use of the oral prostacyclin, selexipag, and new mechanism-directed PAH therapy, sotatercept.

Dr. Frank is an NIH-funded physician scientist studying pulmonary vascular development and disease driven pulmonary vascular defects. He is a Parker B. Francis Fellow, a Doris Duke Charitable Foundation Clinician Scientist, and Young Physician Scientist Awardee from the American Society for Clinical Investigation. He has nearly 50 publications. Through the Cardiac Center Innovation grant, his team has recently developed a large animal model to study pulmonary vein stenosis, opening the door to more clinically relevant discovery for therapies. Dr. Avitabile and Dr. Frank are currently Finalists for the CHOP Frontier program for their Comprehensive Pulmonary Vascular Disease Frontier program.



PREVENTIVE CARDIOVASCULAR PROGRAM

FACULTY

Julie Brothers, MD, FAAP
Co-Medical Director

Shobha Natarajan, MD
Co-Medical Director

The Preventive Cardiovascular Program includes the Lipid Heart Clinic, Cardiovascular Risk Assessment Clinic (CVRA) Clinic, and Hypertension Clinic. The Program has continued to grow in 2023, offering patient visits both in person and via telemedicine (PA and NJ patients) at CHOP Main and most satellites. The Program is led by Drs. Julie Brothers and Shobha Natarajan with Emma Dickinson as the Program Coordinator. The different clinics are highlighted below.

LIPID HEART CLINIC

Lipid Heart Clinic (LHC) has continued to see patients in PA at Buerger, Brandywine Valley, King of Prussia, Bryn Mawr, Lancaster, Allentown and in NJ at Voorhees. Our providers include at Buerger: Drs. Brothers, Bamba, Barsky, Prout, Shustak, and Ms. Martino; King of Prussia: Dr. Shustak; Brandywine Valley and Bryn Mawr: Dr. Brothers; Lancaster: Dr. Elias; Allentown: Dr. Palermo; Exton and Lancaster: Dr. Lizano; and Voorhees: Dr. Lee. For calendar year 2023, the numbers presented are those seen at Buerger, Brandywine Valley, and Voorhees (Brothers, Shustak, Bamba, Prout, Lee, and Barsky). The LHC team saw 1,031 patients with 390 new in person visits, 286 follow up in person visits, 118 new telemedicine and 237 follow-up telemedicine visits for a total of ~1/3 of visits as telemedicine (355, 34.4%). There was a 3% no show rate, 5% 48-hour cancellation rate and 4% 24-hour cancellation rate. Since the COVID-19 pandemic, our clinic has offered telemedicine, and we have continued this for PA and NJ residents and plan to continue in the future. We remain involved with a Quality Improvement project for LHC, looking at parent/patient satisfaction, no show and cancellation rates, and change in non-HDL-cholesterol with telemedicine compared to in person visits. Ms. Giordana (Jordy) Martino, along with Dr. Tamar Preminger, presented a poster at the SEARCH National Telehealth Research Symposium in November on this project. We are working on a manuscript to detail our ongoing experience. We are utilizing a Qlik Sense dashboard so we can continue to track our progress. Dr. Brothers was the site PI on 1 pharmaceutical trial for treatment of homozygous familial hypercholesterolemia which completed enrollment in 2023. Dr. Shustak has continued enrolling with her study "Evaluating the Use of Motivational Text Message and Loss-Frame Financial Incentives to Increase Step Counts in Obese Adolescents with Dyslipidemia."

PREVENTIVE CARDIOVASCULAR PROGRAM

The team has continued to be involved with research publications as well as speaking locally, regionally and nationally about pediatric dyslipidemia. Dr. Brothers published in Circulation a manuscript entitled "Evinacumab for pediatric patients with homozygous familial hypercholesterolemia" and has one submitted to JAMA Cardiology entitled, "Diagnosis, treatment, and cardiovascular outcomes in homozygous familial hypercholesterolemia: a sex-specific analysis." Dr Brothers has also been a part of several posters/abstracts regarding the use of evinacumab in patients with homozygous familial hypercholesterolemia. Drs. Shustak and Brothers co-authored a book chapter with Dr. Stephen Daniels and was published in "Clinical Lipidology, 3rd edition" in April 2023. Dr. Shustak spoke at the American Society of Nephrology Conference, entitled "Controversies in treating dyslipidemia in youth with chronic CKD." She and Ms. Martino spoke about lipid screening on the CHOP Primary Care Perspectives Podcast, link: https://open.chop.edu/courses/?search=&filter-categories=primary-care-perspectives-podcast. Dr. Brothers gave a Grand Rounds talk for Jersey Shore Medical Center on Pediatric Dyslipidemia; she also spoke at NYU School of Medicine and Center City Pediatrics on screening and management of pediatric dyslipidemia.

A pair of siblings are a good example of the type of lipid patients we commonly see: those with heterozygous familial hypercholesterolemia (HeFH). These two brothers, HA and RA, presented to the Lipid Heart Clinic when they were very young. HA, the older brother, was seen first at age 3 years and RA was subsequently also seen at age 3 years. They had their lipid panels checked at age 2 years due to a family history of HeFH in their mom and several members of mom's family. At age 3 years, HA's LDL-C was 270 mg/dL, with otherwise normal lipid values, including lipoprotein (a); RA's LDL-C at age 3 years was 177 mg/dL, also with a normal lipoprotein (a). Family history was significant for mom, age 33, with untreated total cholesterol values of 480 mg/dL and had been on a statin since age 16 years, currently on statin + zetia + PCSK9 inhibitor. She had an elevated coronary calcium score. The boys maternal grandfather died at 41 from a heart attack. Their maternal uncle, in his 30s, had HeFH and multiple coronary stents. There were several 3rd degree relatives with early, fatal heart attacks. Based on this family history, we discussed the likelihood of starting the boys on a statin medication around age 8 years with an LDL-c cutpoint of > 160 mg/dL. HA was initially started on atorvastatin 10 mg and increased to 20 mg for LDL-c of > 160 mg/dL. At the most recent visit, his LDL-c was at 150 mg/dL, with a mildly low HDL-c despite being active in several sports, and normal triglycerides. We discussed changing to rosuvastatin 10 mg nightly at the next visit to goal LDL-c < 130 mg/dL, given mom's history. RA was started on atorvastatin 10 mg nightly and has had a wonderful response with most recent LDL-c of 116 mg/dL with mildly low HDL-c, despite being on several sports teams, and normal triglycerides. We opted to not make any further changes to his medication.

CARDIOVASCULAR RISK ASSESSMENT CLINIC

The Cardiovascular Risk Assessment Clinic (CVRA) has continued to see patients approximately two times per month. We saw 31 patients total, with 26 new and 4 follow-up. The physicians in this clinic for 2023 were Drs. Brothers, Shustak and Palermo. Ms. Giordana (Jordy) Martino has been seeing patients and is an integral part of the clinic. Shannon O'Malley has served as our exercise specialist and Danielle Campbell as our dietitian. We have had many referrals from LHC as well as from our colleagues in the Healthy Weight Program, with several as pre-bariatric surgery patients. The latter will serve as a patient population we will see one year after surgery to assess their vascular and metabolic changes after weight loss surgery.

PREVENTIVE CARDIOVASCULAR PROGRAM

One patient exemplifies how our Preventive Cardiology clinics work together. An 11-year-old young lady, EB, was referred to CVRA clinic by her primary care pediatrician due to severe obesity, mild hypertriglyceridemia, pre-diabetes, and concern for elevated systolic blood pressure. Her family history was not remarkable for any early coronary or peripheral vascular disease, congenital heart disease, or sudden cardiac death. Her father had hypercholesterolemia and hypertension and both of her grandfathers had hypertension. She was asymptomatic. At the CVRA clinic visit, her systolic blood pressure was at the 95th% for age, height and gender, and her BMI was at the 133% of the 95th percentile. She underwent ECG and echocardiography, both of which were normal. We performed vascular testing, including carotid IMT and pulse wave velocity, and these were normal. She met with our dietitian and exercise specialist, who followed her as an outpatient as well. Given her elevated systolic blood pressure and the concern by her primary, we placed a 24-hour ambulatory blood pressure monitor. This showed mildly elevated systolic blood pressure. Because of this, we referred her to the Hypertension Clinic, where she was seen by Dr. Meyers and was found to have systolic hypertension. She was started on amlodipine 5 mg daily and at the next visit, losartan 25 mg daily was added for additional blood pressure control. She was recently seen and now has good blood pressure control. From a lipid perspective, she is to repeat her lipids and will be seen in Lipid Heart Clinic if abnormalities persist.

HYPERTENSION CLINIC

The hypertension clinic (former HAVE clinic) focuses on patients with systemic hypertension related to complex medical conditions including but not restricted to heart defects and transplant, chronic kidney disease and transplant, vasculitis and sickle cell disease. The clinic also sees patients with high blood pressure, or a diagnosis of hypertension related to cardiovascular risk factors including diabetes and obesity. It is a multidisciplinary clinic staffed by cardiologists (Drs. Natarajan, Palermo and Shustak with our nurse practitioner, Jordy Martino) and nephrologists (Drs. Meyers and Kogon) along with our nutritionist (Danielle Campbell); and exercise physiologist (Shannon O'Malley) who provide important guidance on healthy eating habits and regular exercise. The Hypertension clinic has about 2 morning clinics per month at the Buerger Center. The clinic evaluated 63 patients in 2022 with 24 cancellations and 16 patients who did not arrive in clinic. The team is involved with several research studies, including those sponsored by PCORI, the NIH, and the AHA. There is also a Quality Improvement project, "BP Under Three", with support from the Magic Mila Foundation. Recent publications include:

- Kaplinski M, et al. "Clinical Innovation: A Multidisciplinary Program for the Diagnosis and Treatment of Systemic Hypertension in Children and Adolescents". Clin Pediatr 59(3): 228-235, Mar 2020.
- Min J, et al. " Association of neighborhood-level social determinants and food environments with pediatric hypertension care". Health Place 65(19): 102383, Aug 2020.
- Min J, et al. "The Impact of Early Recognition and Treatment of Systemic Hypertension on Reducing Blood Pressure: The Hypertension and Vascular Evaluation Program". Clin Pediatr 59(11): 970-977, Oct 2020.
- Chang JC, et al. "Echocardiographic strain analysis reflects impaired ventricular function in youth with pediatric-onset systemic lupus erythematosus". Echocardiography 37: 2082-2090, Dec 2020.
- Kaplinski M, et al. "Left ventricular measurements and strain in pediatric patients evaluated for systemic hypertension and the effect of adequate anti-hypertensive treatment". Pediatric Cardiology Page: doi: 10.1007, Aug 2021.
- Kaplinski M, et al. "Left Ventricular Measurements and Strain in Pediatric Patients Evaluated for Systemic Hypertension and the Effect of Adequate Anti-hypertensive Treatment". Pediatr Cardiol, Jan 2022.

PREVENTIVE CARDIOVASCULAR PROGRAM

Ms. Martino, our nurse practitioner, is leading a study looking at long-term outcomes after coarctation repair. Dr. Meyers has also co-authored several other publications related to systemic hypertension.

A patient story that exemplifies the Hypertension clinic is pt AM. He is a sweet 8-year-old boy with Williams syndrome which was diagnosed at three months of age when he was evaluated by cardiology for a murmur. He had repair of supravalvar aortic stenosis at The Children's Hospital of Philadelphia by Dr. Spray at 17 months of age. Since that time, he has been followed for his small aorta, renal artery stenosis and mid aortic syndrome. Andrew has had comprehensive testing in the Hypertension clinic and does have significantly thickened carotid artery walls. His pulse wave velocity is normal and although he has no significant LV hypertrophy or residual supravalvar aortic stenosis on his echocardiograms or cardiac magnetic resonance imaging, he does have a diffusely small thoracic and abdominal aorta. Through our multidisciplinary clinic, he has been able to see the nutritionist and exercise physiologist who have made sure that he has a healthy weight and is quite active. Even though Andrew has systemic hypertension, Dr. Meyers and the Hypertension clinic team has been able to medically manage him on antihypertensive medication. We have collaborated with our interventional radiology team and have pursued second opinions from other centers of excellence for renal artery stenosis to ensure that Andrew continues to have the best care. AM is thriving and his family is very grateful for the care that they have received at CHOP's Hypertension clinic.

In the future, we hope to expand to satellite clinics so that more patients can have access to this valuable multi-disciplinary clinic which works to reduce the risks of adverse events related to hypertension as patients grow into adulthood.

INTERSTAGE PROGRAM

LEADERSHIP

Therese M. Gigia, MD
Director

Alyson Stagg, CRNP
Program Coordinator

TEAM

Monique Gardner, MD
Cardiac Critical Care

David Hehir, MD
Cardiac Critical Care

Shobha Natarajan, MD
Cardiology

Tamar Preminger, MD
Cardiology

Chitra Ravishankar, MD
Cardiology

Jonathan Rome, MD
Cardiology

Rachel Shustak, MD
Cardiology

Amita Szwast, MD
Cardiology

INTERSTAGE PROGRAM

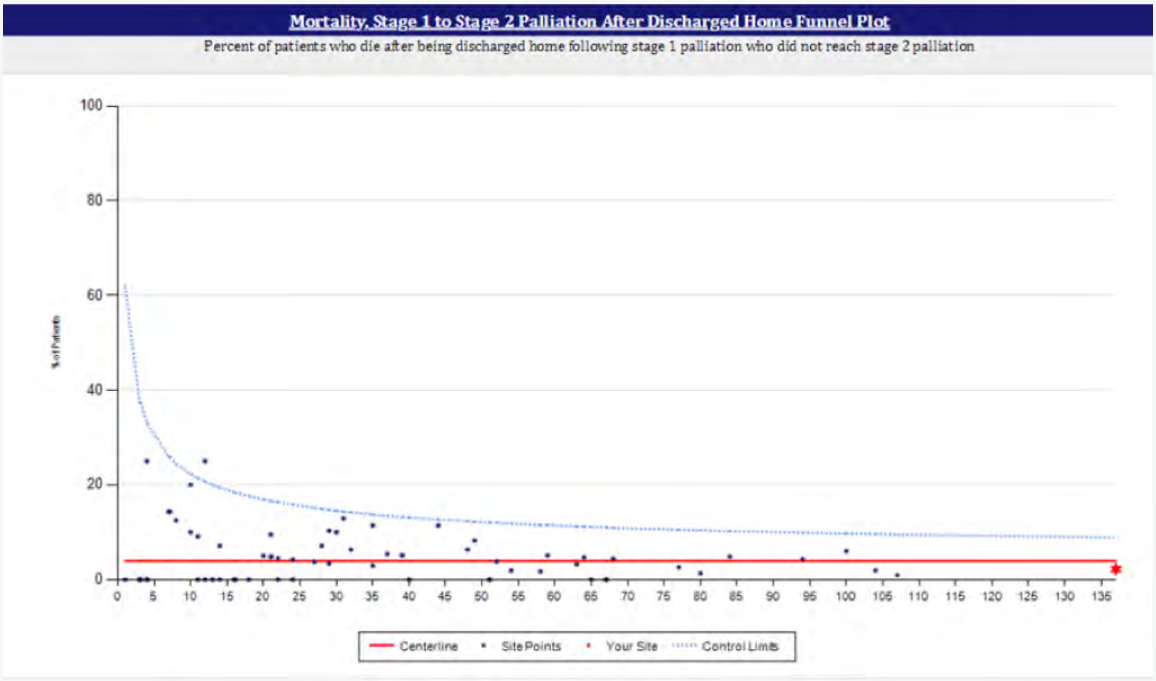
INTRODUCTION

CHOP's Infant Single Ventricle Monitoring Program (ISVMP) is one of the nation's highest volume programs with one of the lowest interstage mortalities.

ISVMP was established in the fourth quarter of 2010 to decrease morbidity and mortality during the fragile "interstage" period between discharge after neonatal single- ventricle intervention and second-stage operation at about 4 to 6 months of age. In 2014, at the request of the Cardiac Center, we broadened our enrollment to include all shunt or PDA stent-dependent infants with both single and two-ventricle heart disease. With additional nurse pratitioner support we plan on including all fragile interstage neonates being discharged to home, for example those with pulmonary artery-banded single ventricle heart disease, aortic stenosis with small LV, etc. and to expand our program to beyond the stage I interstage. We also plan on expanding our tube weaning project, an initiative to aid NG tube-dependent infants back to feeding normally.

For hypoplastic left heart syndrome (HLHS) the "interstage mortality" at the time of ISVMP inception was about 15% nationally. With the institution of the ISVMP at CHOP our interstage mortality for HLHS decreased from 14 % to 4.8% in 2015. Our current "all interstage" mortality is 1% with HLHS interstage mortality at 2%. We have made great strides in the areas of nutrition and communication in HLHS and remain one of the highest volume members and highest performers nationally in the National Pediatric Cardiology Quality Improvement Collaborative (NPC-QIC). We are also active participants in the joint collaborative of NPC-QIC and the Fontan Outcomes Network (FON) extending home oversite from fetal life through Fontan.

NPC-QIC All-Site Funnel Plot:



*Indicates CHOP's cumulative data from NPC-QIC

INTERSTAGE PROGRAM

STATISTICS

Volume: average 70 patients per year over last 5 years. ~25 Stage I; remainder BTS or PDA stents in other critical heart disease.

PROGRAMMATIC HIGHLIGHTS

- Since the inception of program, we have enrolled 900 patients
- All Interstage death rate 1%, HLHS interstage death rate 2%
- Monthly telemedicine visits are our standard of care often with digital stethoscopes. 593 telemedicine visits to date since 2019, 255 with Eko digital stethoscopes.
- Care Companion Module in EPIC MyCHOP allows families to enter home data directly into the EMR
- Discharge consult on all patients
- Continued enrollment and active participation in NPC-QIC. Active participants in the collaboration of NPC-QIC and the Fontan Outcomes network (FON)

2023 RESEARCH HIGHLIGHTS

- Shustak RJ, Faerber JA, Stagg A, Hehir DA, Natarajan SS, Preminger TJ, Szwast A, Rome JJ, Giglia TM, Ravishankar C, Mercer-Rosa L, Gardner MM. Association of Home Monitoring and Unanticipated Interstage Readmissions in Infants With Hypoplastic Left Heart Syndrome. J Am Heart Assoc. 2023 Apr 18;12(8):e025686. doi: 10.1161/JAHA.122.025686. Epub 2023 Apr 17. PMID: 37066818; PMCID: PMC10227247.
- Shustak RJ, Huang J, Tam V, Stagg A, Giglia TM, Ravishankar C, Mercer-Rosa L, Guevara JP, Gardner MM. Neighborhood Social Vulnerability and Interstage Weight Gain: Evaluating the Role of a Home Monitoring Program. J Am Heart Assoc. 2023 Sep 19;12(18):e030029. doi: 10.1161/JAHA.123.030029. Epub 2023 Sep 13. PMID: 37702068; PMCID: PMC10547291.
- Stagg A, Giglia TM, Gardner MM, Offit BF, Fuller KM, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Laskin BL, Preminger TJ. Initial Experience with Telemedicine for Interstage Monitoring in Infants with Palliated Congenital Heart Disease. Pediatr Cardiol. 2023 Jan;44(1):196-203. doi: 10.1007/s00246-022-02993-y. Epub 2022 Sep 1. PMID: 36050411; PMCID: PMC9436461.
- Stagg A, Giglia TM, Gardner MM, Shustak RJ, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Preminger TJ. Feasibility of Digital Stethoscopes in Telecardiology Visits for Interstage Monitoring in Infants with Palliated Congenital Heart Disease. Pediatr Cardiol. 2023 Dec;44(8):1702-1709. doi: 10.1007/s00246-023-03198-7. Epub 2023 Jun 7. PMID: 37285041; PMCID: PMC10246546.
- Shustak, R, Faerber, J, Stagg, A, Ravishankar, C, Mercer-Rosa, L, Giglia, T, Gardner, M. (2023) Home Monitoring and Unanticipated Interstage Readmissions: Evaluating the Impact of Neighborhood Social Vulnerability. AHA November 12, 2023
- Shustak, R, Purcell, L, Mai, A, Stagg, A, Preminger, T, Natarajan, S, Ravishankar, C, Gardner, M, Giglia, T. (2023) COVID-19 Infection and the Interstage Period. World Congress
- AHA Young Investigator finalist (Shustak) on Neighborhood Social Vulnerability and Interstage Weight Gain
- Ongoing research includes: COVID-19 and interstage care, BNP in interstage monitoring, disparities in interstage care

CARDIAC ANTICOAGULATION & THROMBOSIS PROGRAM

INTRODUCTION

Children with congenital and acquired heart disease are prone to blood clots that may be life-threatening. **The Cardiac Anticoagulation and Thrombosis Program** is a one-of-a-kind, multidisciplinary program managed jointly by cardiology and hematology and supported by nursing and clinical pharmacy to reduce the incidence and complications of thrombosis in cardiac inpatients and to improve outpatient anticoagulation treatment and monitoring.

In July 2013 the Divisions of Cardiology (Dr. Giglia) and Hematology (Dr. Raffini) were awarded a competitive 2-year internal grant (Chair's Initiative) to pilot the program. To our knowledge, our team is the only dedicated, multidisciplinary cardiac thrombosis team in the US, and is now comprised of 2 nurse practitioners, 3 cardiologists, 7 hematologists, and 2 PharmDs. Recently a dedicated CT surgeon joined the team. Our advanced practice providers perform an initial consult on all patients in the cardiac center with clots or in need of anticoagulation and follow them through to discharge. This includes follow-up visits as needed and a discharge visit with plan that goes into the official discharge summary. Half the year is staffed by a cardiology attending and the other half of the year by a hematology attending. Our outpatient team consists of the nurse practitioners and the cardiology program director who in addition to managing medication adjustments remotely see outpatients in a dedicated, weekly outpatient clinic. The entire thrombosis team meets weekly with the individual cardiac center inpatient teams to review inpatients as well as outpatients with questions or of particular concern.

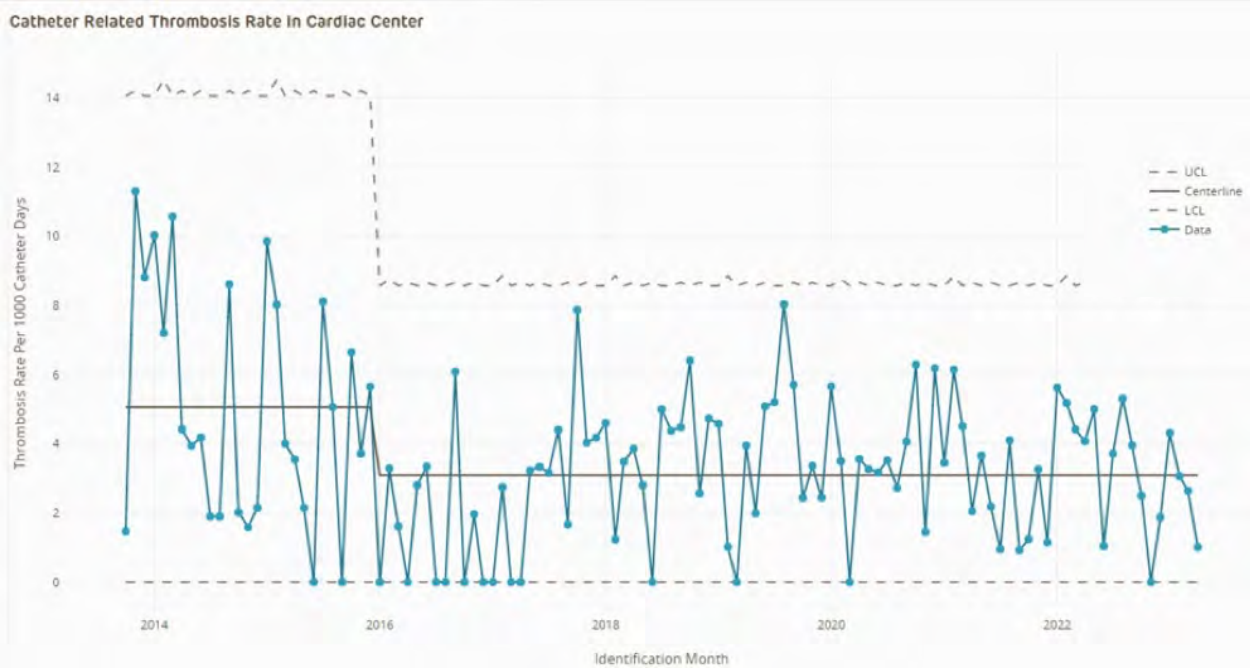
STATS

The inpatient team sees 5-6 new consults and 3-8 follow-up visits per week. 260 outpatients on warfarin, enoxaparin or direct oral anticoagulants are currently followed by the outpatient team.

PROGRAMATIC HIGHLIGHTS

- Established a robust REDCap database with QlikView application to track all inpatients with thrombosis and those needing prophylactic anticoagulation
- Established an EPIC flowsheet for tracking outpatient labs and dosages which is maintained by the NPs and is available to all caregivers
- Consulted on nearly 1200 inpatients with thrombosis or on prophylactic anticoagulation since the program inception and currently manage over 260 outpatients on warfarin, enoxaparin, or direct oral anticoagulants
- Built and utilize CICU/CCU Pathway for the Management of Acute Catheter-related Venous Thromboembolism which standardized care https://www.chop.edu/clinical-pathway/venous-thromboembolism-catheter-related-cicu-ccu-clinical-pathway.
- Decreased inpatient thrombosis rate (venous clots per 1000 line days) from 5.06 in October 2013 to 3.09 in March 2023 with a centerline shift and sustained improvement.

CARDIAC ANTICOAGULATION & THROMBOSIS PROGRAM



RESEARCH HIGHLIGHTS

- We currently are working on a predictive model for first hospital-acquired thrombosis in infants in the Cardiac Center and hope to pilot thromboprophylaxis in identified high-risk infants before launching a multicenter trial.
- Oral Presentation and Silver Medal winner at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery, Washington, DC September 2023.
  - Novel Multidisciplinary Program Correlates with Reduction in Thrombosis Rate in Inpatients with Pediatric Congenital and Acquired Heart Disease
    Therese M. Giglia, MD; Rachel A. Keashen, CRNP; Whitney Petrosa, MSN, CPNP-AC Jacquelyn Sager, MSN, CRNP; Bhavya S. Doshi, MD; Nina R. Griffonetti; Michele P. Lambert, MD, MSTR; Jarrett Linder, MD, MS; Xianqun Luan; Karen Murphy, RN, BSN; Shobha S. Natarajan, MD; Matthew J. O'Connor, MD; Chitra Ravishankar, MD; Benjamin J. Samelson-Jones, MD, PhD; Kelly L. Veneziale, RN, BSN; Jamie Weller, MD; Hilary B. Whitworth, MD, MSCE; Kyle Winser; Char Witmer, MD, MSCE; Leslie J. Raffini, MD, MSCE
- 3 manuscripts in preparation

CARDIAC ANTICOAGULATION & THROMBOSIS PROGRAM

TEAM

Susan Maeder-Chieffo, CRNP
Advanced Practice Provider

Jacquelyn Oswald Sager, CRNP
Advanced Practice Provider

Therese Giglia MD
Cardiologist, Program Director

Matthew O'Connor, MD
Cardiologist

Chitra Ravishankar, MD
Cardiologist

Leslie Raffini, MD
Lead Hematologist

Bhavya Doshi, MD
Hematologist

Michele Lambert, MD
Hematologist

Ben Samelson-Jones, MD
Hematologist

Hilary Whitworth, MD
Lead Hematologist

Char Witmer, MD
Hematologist

Mohammed Nuri, MD
CT Surgery

NOT PICTURED:

Marilyn Blumenstein, CRNP
Advanced Practice Provider

Abraham Haimed, MD
Hematologist

Hailey Collier, PharmD
Clinical Pharmacy

Alyssa Hager, PharmD
Clinical Pharmacy

E. Zach Ramsey, PharmD
Clinical Pharmacy

Andrew Sweigart, PharmD
Clinical Pharmacy

CARDIAC KIDS DEVELOPMENTAL FOLLOW-UP PROGRAM

OVERVIEW

The Cardiac Kids Developmental Follow-up Program (CKDP) aims to optimize the neurodevelopmental and behavioral outcomes of children with congenital heart disease through equitable clinical care, patient and family education, multidisciplinary collaboration, community outreach, training, and research contributions. The Cardiac Center at The Children's Hospital of Philadelphia has been a pioneer in the important area of developmental care for children with congenital heart disease since the launch of the NeuroCardiac Care Program in 2009. Routine evaluations and early intervention services have been shown to improve neurodevelopmental outcomes in high-risk populations. We know that experiences of our patients can impact their growth and development, even years after cardiac surgery. For that reason, we remain committed to providing a developmental follow-up program to help identify areas of need, and to help our patients and their families access resources within CHOP and the larger community to address any developmental challenges they may face.

OUR TEAM

Alisa A. Burnham, MD
Co-Director

Lyla Hampton, PhD, ABBP-CN
Co-Director

Amanda J. Shillingford, MD
Cardiology Liason

Kate Wallis, MD, MPH
Developmental Pediatrician

Laura Mazza, RN, MSN, CRNP-PC
Developmental Pediatrican

Colleen Driscoll, PhD
Pediatric Psychologist

CARDIAC KIDS DEVELOPMENTAL FOLLOW-UP PROGRAM

EVALUATION: BIRTH – 5 YEARS

The collaborative and multidisciplinary approach of the CKDP allows for care of patients and their families from infancy to school age. Comprehensive evaluation is provided starting at 3 months of age with our pediatrician and occupational, physical, and speech-language therapists. Our psychologists also evaluate developmental and behavioral functioning from early childhood to 5 years of age. Social work, nutrition and education consultations are available as well. Once children reach school-age and graduate from the CKDP program, there are opportunities for ongoing follow-up with our neuropsychologist to navigate cognitive or behavioral concerns that may present through school age to adolescence. Our ability to collaborate with multiple providers, as well as ancillary support allows us to provide comprehensive care within the patient's visit and reduce burden of multiple appointments and referrals. The goal is that eligible patients have CKDP appointments scheduled prior to their hospital discharge. In addition, all clinicians can refer their eligible patients to the CKDP by placing a consult in EPIC. Eligibility for CKDP includes any child with CHD who underwent a catheter or surgical based intervention or has CHD with a prolonged hospital admission prior to 6 months of age. Patient-specific questions can also be routed to the CKDP Program Manager, Lauren Zimmerman, RN and Office Administrator, Cheyenne Andino. The CKDP works closely with the financial clearance team and families typically opt to bill their insurance for the visits.

EVALUATION: SCHOOL-AGE

CKDP expanded in 2018 to address the developmental needs of school-age children with a history of congenital or acquired cardiac conditions. In 2023, our program expanded again as we welcomed Laura Mazza, CRNP, a nurse practitioner in developmental and behavioral pediatrics as a member of the clinical team.

Laura now works with developmental and behavioral pediatrician, Dr. Kate Wallis, and the rest of the CKDP team in caring for school-age children with congenital heart disease (CHD) and co-occurring developmental disabilities. These include learning disabilities, intellectual disabilities, autism, and Attention-Deficit/Hyperactivity Disorder (ADHD). The elevated risks for these conditions among children with CHD makes ongoing long-term monitoring of and access to medical and educational services for these conditions critical as a child advances through elementary school and beyond. As a team, we provide initial assessments and ongoing care for patients, which can include developmental testing, medication management, and educational or therapeutic recommendations.

Children with congenital heart disease (CHD) have an increased risk of ADHD approximately 3-4 times that of the general population. There is also an increased risk of learning issues, including specific learning disabilities in math or reading, and of autism spectrum disorder. Many of these conditions do not present until a child reaches school-age, when they may become more evident in a classroom setting or when learning, behavioral, and social demands increase.

CARDIAC KIDS DEVELOPMENTAL FOLLOW-UP PROGRAM

In the past year, we have completed 82 visits for school-age children. We have performed assessments for 10 new patients and completed 72 follow-up visits (by telemedicine or in person), addressing concerns related to ADHD, learning disabilities, autism, and anxiety. Assessments generally consist of review of medical history and of any prior assessments completed by another provider or the child's school, physical examination, review of behavioral rating scales completed by parents and teachers, and in-person testing (either by members of our team or by neuropsychologist, Dr. Lyla Hampton). We have consulted closely with each patient's primary cardiologist to tailor treatment recommendations, including for medications to treat ADHD, anxiety, sleep issues, and other behavioral challenges when needed.

Addressing these conditions in school-age children can profoundly impact their educational, personal, and social development; the functioning of their families; their self-esteem; and their self-understanding and ability to advocate for themselves over time. It continues to be a pleasure to work with the incredible families and school-age children we serve. We are excited to continue to grow our program over the next year, and to meet more amazing children.

PROGRAM DEVELOPMENT

Through support from the Division of Cardiology we have added an Education Coordinator, Roberta Rossman, to the CKDP. Roberta has a background in Social Work, Special Education, and is a Teacher of the Deaf and Hard of Hearing. She comes to us with a variety of experiences including working in educational settings, early intervention, and at CHOP.
Roberta's role acts as a bridge, connecting families, medical providers and community and school-based services. She helps families understand, navigate, and collaborate with these resources. She also creates opportunities to inform educational providers about possible implications and accommodations a child may need. Future goals include developing materials for families and schools related to educational information and highlighting the impact of congenital heart disease on development, making CKDP reports increasingly school friendly, and creating general and individualized health care plans for families to share with their childcare centers and schools.

Colleen Driscoll, PhD is a pediatric psychologist who joined the CKDP team in May 2023. Her role focuses on early childhood and she works with patients and families across settings in the Cardiac Center. In the CKDP, she completes evaluations of children's developmental and behavioral functioning. She also meets with patients and families in the inpatient (CICU, CCU) and outpatient settings to address concerns with mood, development, and behaviors and to support adaptive family coping.

CARDIAC KIDS DEVELOPMENTAL FOLLOW-UP PROGRAM

RESEARCH CONTRIBUTIONS

The CKDP participates in the Cardiac Neurodevelopmental Outcome Collaborative (CNOC) clinical registry, which is incorporated into the Cardiac Networks United organization and allows for integration of developmental outcome data with other participating clinical registries such as PC4 and PAC3. CHOP CKDP participated in a multicenter CNOC study published in 2023 investigating the factors that impact adherence to the 2012 American Association Guidelines for toddler age neurodevelopmental follow-up after cardiac surgery. (1) Results demonstrated that the average return rate was 29% (range 8-54%), and that a primary driver impacting return for follow-up was if follow-up was scheduled for families prior to hospital discharge. (2) Dr. Luma Essaid collaborated with the CKDP for her oral abstract presented at the 8th World Congress of Pediatric Cardiology and Cardiac Surgery which was a single center review of factors impacting neurodevelopmental follow-up at CHOP. Follow-up through the CKDP was higher than the national average, but still just over 50% of the eligible patients participated, highlighting the importance of our ongoing efforts to expand awareness and improve access to all CHD patients. (3) Standardized developmental testing is performed at many of these follow-up visits, and the CKDP team invites ongoing research collaboration.

1. Marino BS, Lipkin PH, Newburger JW, et al; American Heart Association Congenital Heart Defects Committee, Council on Cardiovascular Disease in the Young, Council on Cardiovascular Nursing, and Stroke Council. Neurodevelopmental outcomes in children with congenital heart disease: evaluation and management: a scientific statement from the American Heart Association. Circulation. 2012;126(9):1143–1172
2. Ortinau CM, Wypij D, Ilardi D, et al. Factors Associated With Attendance for Cardiac Neurodevelopmental Evaluation. Pediatrics. 2023;152(3)
3. Luma Essaid MD, Kelly Haque MD, Amanda Shillingford MD , et al. “Factors Associated with Attendance for Cardiac Neurodevelopmental Evaluation”. [Abstract] 8th World Congress of Pediatric Cardiology and Cardiac Surgery, August 2023, Washington DC

CARDIAC

CONSULT SERVICE

The consult service is the face of cardiology outside the cardiac center. The service provides cardiology consultations in the NICU, PICU, PCU, all medical and surgical floors and the ED. The patient population includes those with complex CHD and co-morbidities such as prematurity and multiple congenital anomalies with known genetic syndromes and those not specified. In addition, this team manages patients with acquired heart disease such as KD, MISC and rare conditions such as conjoined twins in collaboration with other medical and surgical specialties.

Chitra Ravishankar, MD
Section Chief

Section Chief:
Dr. Chitra Ravishankar

APNs:
Kelley Miller, MSN, CRNP,
Sara Mylett, MSN, CRNP
Jacquelyn Sager, MSN, CRNP
Deborah Torowicz, MSN, CRNP

Team members
Dr. Julie Brothers
Dr. Marie Carillo
Dr. Aaron Dorfman
Dr. Karl Degenhardt
Dr. Stacey Drant
Dr. Matthew Elias
Dr. Alexa Hogarty
Dr. Ramiro Lizano
Dr. Meghan Metcalf
Dr. Tamar Preminger
Dr. Amy Schultz
Dr. Paul Stephens *(lifetime member)*

Dr. James Starc will be joining the team this year.

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

LEADERSHIP

Andrew Costarino, MD, MSCE
Division Chief
Cardiac Critical Care Medicine

David Hehir, MD, MS
Associate Chief, Quality Impovement
Cardiac Critical Care Medicine
Safety Officer, The Cardiac Center

Maryam Naim, MD, MSCE
Associate Chief, Research
Cardiac Critical Care Medicine

Venkat Shankar, MBBS, MBA
Associate Chief, Clinical Operations
Cardiac Critical Care Medicine
Medical Director, Cardiac Intensive Care Unit

Aaron Dewitt, MD
Medical Director, Advanced Cardiac Therapeutics (ACT) Intensive Care Unit

Marissa Brunetti, MD
Program Director, Extracorporeal Life Support Advanced Fellowship

Jodi Chen, MD
Program Director, Cardiac Critical Care Medicine Fellowship

Rebecca Cardoso, MHA
Administrative Director

LIST OF CURRENT FACULTY

- Pilar Anton-Martin, MD, PhD
- Geoffrey Bird, MD, MSIS, FAAP
- Marissa Brunetti, MD
- Jodi Chen, MD, MS
- Andrew Costarino Jr., MD, MSCE
- Aaron Dewitt, MD
- Thomas Dietzman, MD
- J. Wesley Diddle, MD
- Monique Gardner, MD
- Michael Goldsmith, MD
- David Hehir, MD, MS
- Elizabeth Herrup, MD
- Benjamin Kozyak, MD
- Felina Mille, MD
- Maryam Naim, MD, MSCE
- J. "Nick" Pratap, MB BChir, MRCPCH, FRCA
- Amy Romer, MD
- Venkat Shankar, MBBS, MBA
- Jamie Weller, MD
- Renee Willett, MD
- Mahsun Yuerek, MD

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

NEW RECRUITS

Dr. George Spyropoulos will join the division in August 2024

CURRENT FELLOWS (2023-2024)

- Saad Feroz, MD
- Daniel Torres Arias, MD

OVERVIEW

The Division of Cardiac Critical Care Medicine is responsible for managing and treating critically ill newborns, infants, and children with critical congenital and acquired heart diseases round the clock. In addition, adults with congenital heart diseases requiring intensive care are managed by the members of the division as well. The goals of the division are to 1) provide world-class clinical care to achieve best clinical outcomes using an inter-disciplinary collaborative care model, 2) advance the field of cardiac critical care medicine through continued clinical and basic science research and quality improvement efforts, and 3) identify, create, and train the next generation of pediatric cardiac intensivists using innovative pedagogical approach.

The Division has continued to thrive under the leadership of Andrew Costarino, MD, with continued growth and successful faculty recruitments. The division now has 21 full time faculty members. This year, Pilar Anton-Martin, MD, PhD joined the division as an Assistant Professor. She obtained her degree in medicine and PhD from Universidad Alcala de Henares School of Medicine in Madrid, Spain. Dr Anton-Martin trained at Great Ormond Street in London, United Kingdom, Phoenix Children's Hospital, and at University of Texas Southwestern Medical Center. Most recently, she was a faculty member at Le Bonheur Children's Hospital in Memphis, Tennessee prior to joining the division. J. Wesley Diddle, MD joined the division as an Associate Professor. He was previously a faculty member at Children's National Hospital in Washington, DC. Dr. Diddle his degree in medicine from the University of Tennessee Health Sciences Center, Memphis. He completed residency in pediatrics at Seattle Children's Hospital, followed by a fellowship in pediatric cardiology at Boston Children's Hospital/ Harvard Medical School, followed by a second fellowship in pediatric critical care medicine at Children's Hospital of Pittsburgh.

The Division also has continued to evolve and enhance the clinical care model to meet the continued clinical growth of the cardiac center and the resultant demands for critical care services. The Cardiac Intensive Care Unit (CICU) expanded its bed capacity to 36 beds in March 2023 and further to 38 beds in January 2024 by utilizing surge beds. To meet the increased census and acuity, there was a thoughtful addition of a fourth physician team during the daytime and a second team for the late evenings. This was well received by the patients, their families, nursing, and other clinical services. The CICU has seen continued growth in average daily census, which has increased to 32.96. Additionally, the creation of a dedicated team that manages all children with heart failure and advanced cardiac therapies (ACT-ICU) has led to improved efficiencies and outcomes.

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

Despite the challenging and physically and emotionally demanding work, the division faculty members have been able to manage optimal work-life balance and have been exemplary citizens of the Cardiac Center and CHOP, participating in many committees and workstreams across the institution. The division was among the top performing programs across the institution in the 2023 Physician Wellness Survey, with low burnout, and high wellness, professional fulfillment, and resilience scores. This is reflected in the continued successful recruitment of world-class faculty, continued 100% retention of the current excellent faculty, and the stellar reputation among peer institutions across the nation. The faculty members of the division have promoted exemplary interdisciplinary work culture in the CICU, and consequently, there has been a continued excellent growth and maturation of the advanced practice provider (APP) team and bedside nursing team.

The Advanced Cardiac Therapeutics (ACT) ICU completed its first full calendar year under the medical directorship of Dr. Aaron Dewitt. Many notable achievements were made to standardize and improve the care for this population of patients. Under the leadership of Dr. Benjamin Kozyak, associate director of ACT-ICU, a novel intravenous drug, cangrelor was brought on the formulary. The addition and use of this short acting anti-platelet agent, along with a few other interventions, has led to a lower stroke rate in the young patients on ventricular assist devices. Monique Gardner, MD, an accomplished biomarkers researcher, started the ACT ICU Biobank, which will allow a better understanding of the body's biomolecular response in heart failure and the effect of advanced heart failure treatments on these. Jess Eichner, CRNP, Lead APP for ACT ICU, has lent her experience and expertise to the fellows and APPs caring for these complex patients and has been instrumental in creating order sets to standardize practice. She has been a relentless advocate for providing systematic psychosocial support to patients and family members who are coping with stressful hospitalizations that can last over a year.

The Division in addition continues to foster excellence in education with an advanced fellowship program, led by Dr. Jodi Chen, designed to meet the ever-growing needs of our field. One of the highlights this year was a multi-institutional collaboration to develop entrustable professional activities and define the clinical practice of cardiac intensivists. Under the leadership of Dr. Marissa Brunetti, an innovative and novel Extracorporeal Life Support advanced fellowship was created, which the division will co-lead. The division continues to provide essential training to Pediatric Critical Care Medicine, Pediatric Cardiology, Neonatal-Perinatal and Cardiac Anesthesiology fellows, as well as fellows from other hospitals. Additional educational initiatives include a medical student elective through the University of Pennsylvania School of Medicine, a resident elective, an annual "boot camp" for advanced categorical fellows, regular simulation training sessions for inpatient providers, and an observership with Global Pediatric Education. The division faculty members have actively participated in nursing education, simulation programs, ultrasound workshops and communication workshops locally, regionally, and nationally.

Dr. Felina Mille and Dr. Amy Romer from the Division co-directed two "senior fellow cardiac critical care bootcamps" in spring and fall of 2023. These extremely successful bootcamps were attended by over 35 senior level clinical physician trainee fellows in cardiology and critical care medicine from 13 institutions across the East coast and drew faculty from 7 leading institutions. Based on the exceptional evaluations and continued high demand for this educational offering, the division plans to host this every year, with plan to increase the number of participants and institutions across the East coast.

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

QUALITY & SAFETY PROGRAM

CICU Faculty are leading a number of quality and safety efforts across the Cardiac Center. Dr. Diddle joined our faculty as Director of Quality Improvement for the division, with an interest in improving outcomes following cardiac arrest. Dr. Brunetti continues to lead our infection prevention efforts, as well as our simulation and E-CPR process improvement work. We continue to see sustained improvement in CLABSI metrics under Dr. Brunetti's leadership. Drs. Diddle, Gardner, and Goldsmith have led a robust effort to improve outcomes related to cardiac arrest through the work of the CAPER group, through implementation of tools to predict and prevent patient deterioration, standardizing debriefing processes, and performing code reviews. In addition, team members have led ongoing improvement in emergency response outside the CICU through work in the Cardiac Watcher and Critical Assessment Team (CAT) programs.

In collaboration with the Cardiac Center Operations team and QI/Safety Core, CICU faculty are playing important roles in projects to improve care and decrease length of stay. Dr. Romer is leading efforts to reduce intubation times and improve extubation success, and Dr. Herrup is leading projects to improve early mobility and revise our sedation guidelines to reduce sedative exposure. Dr. Dietzman continues to lead efforts related to improving post-operative processes of care through the multi-center target-based care initiative and our local efforts to track and reduce important post-operative residual lesions.
This effort has resulted in significant academic productivity in the Quality and Safety area, with a number of publications, as well as national and international presentations delivered by our faculty. In the spring, a team from the CICU, including Drs. Dietzman and Hehir, attended the International Forum on Quality and Safety in Healthcare Copenhagen 2023 and presented our work on the Daily Rounding Checklist and the impact of the CAT program on reducing emergency transfers to the CICU.

RESEARCH HIGHLIGHTS / RESEARCH AWARDS

In 2023 the Division of Cardiac Critical Care Medicine showed significant growth in research with presentations at national and international meetings, publications, awards and grants. Faculty from the Division Cardiac Critical Care Medicine are actively involved in collaborative research with other divisions within the institution and in multicenter collaborative research with ongoing projects with the Pediatric Cardiac Critical Care Consortium, Pediatric Cardiac Intensive Care Society, Extracorporeal Life Support Organization and the Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease.

There were numerous publications from the NIH funded multicenter ICU-RESUS study in which Wes Diddle, David Hehir and Maryam Naim were co-investigators.

SELECT PUBLICATIONS FROM ICU RESUS (FULL LIST IN CARDIAC CENTER RESEARCH PUBLICATIONS):

1. Berg RA, Morgan RW, Reeder RW, Ahmed T, Bell MJ, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, **Diddle JW**, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, **Hehir DA**, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Mourani PM, Nadkarni VM, **Naim MY**, Notterman D, Palmer CA, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tabbutt S, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Sutton RM. Diastolic Blood Pressure Threshold During Pediatric Cardiopulmonary Resuscitation and Survival Outcomes: A Multicenter Validation Study. Crit Care Med. 2023 Jan 1;51(1):91-102.

2. Morgan RW, Berg RA, Reeder RW, Carpenter TC, Franzon D, Frazier AH, Graham K, Meert KL, Nadkarni VM, **Naim MY**, Tilford B, Wolfe HA, Yates AR, Sutton RM; ICU-RESUS and the Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups. The physiologic response to epinephrine and pediatric cardiopulmonary resuscitation outcomes. Crit Care. 2023 Mar 13;27(1):105.

3. Cashen K, Sutton RM, Reeder RW, Ahmed T, Bell MJ, Berg RA, Burns C, Carcillo JA, Carpenter TC, Michael Dean J, Wesley Diddle J, Federman M, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, **Hehir DA**, Horvat CM, Huard LL, Kirkpatrick NT, Maa T, Manga A, McQuillen PS, Morgan RW, Mourani PM, Nadkarni VM, **Naim MY**, Notterman D, Page K, Pollack MM, Qunibi D, Sapru A, Schneiter C, Sharron MP, Srivastava N, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Meert KL; Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network (CPCCRN) and National Heart Lung and Blood Institute ICU-RESUScitation Project Investigators Calcium use during paediatric in-hospital cardiac arrest is associated with worse outcomes. Resuscitation. 2023 Apr;185:109673.

4. Morgan RW, Reeder RW, Ahmed T, Bell MJ, Berger JT, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, **Diddle JW**, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, **Hehir DA**, Himebauch AS, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Mourani PM, Nadkarni VM, **Naim MY**, Notterman D, Page K, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tabbutt S, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Berg RA, Sutton RM: Outcomes and characteristics of cardiac arrest in children with pulmonary hypertension: A secondary analysis of the ICU-RESUS clinical trial. Resuscitation 2023 Sep;190:109897.

5. Yates AR, **Naim MY**, Reeder RW, Ahmed T, Banks RK, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, **Diddle JW,** Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, **Hehir DA**, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Morgan RW, Mourani PM, Nadkarni VM, Notterman D, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yeh J, Zuppa AF, Sutton RM, Meert KL. Early Cardiac Arrest Hemodynamics, End-Tidal Co2, and Outcome in Pediatric Extracorporeal Cardiopulmonary Resuscitation: Secondary Analysis of the ICU-RESUScitation Project Dataset (2016-2021).Pediatr Crit Care Med 2023 Dec 13. Online Ahead of Print.

6. Federman M, Sutton RM, Reeder RW, Ahmed T, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, **Diddle JW**, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, **Hehir DA**, Horvat CM, Huard LL, Kirkpatrick T, Maa T, Maitoza LA, Manga A, McQuillen PS, Meert KL, Morgan RW, Mourani PM, Nadkarni VM, Notterman D, Palmer CA, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, **Naim MY**. Survival With Favorable Neurologic Outcome and Quality of Cardiopulmonary Resuscitation Following In-Hospital Cardiac Arrest in Children With Cardiac Disease Compared With Noncardiac Disease. Pediatr Crit Care Med. 2024 Jan 1;25(1):4-14.

7. **Gardner MM, Hehir DA**, Reeder RW, Ahmed T, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, **Diddle JW**, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Harding ML, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Morgan RW, Mourani PM, Nadkarni VM, **Naim MY**, Notterman D, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Sutton RM, Topjian AA Identification of post-cardiac arrest blood pressure thresholds associated with outcomes in children: an ICU-Resuscitation study. Crit Care. 2023 Oct 7;27(1):388

INDIVIDUAL FACULTY ACCOMPLISHMENTS GRANTS, AWARDS AND SELECT PUBLICATIONS (FULL LIST IN CARDIAC CENTER RESEARCH PUBLICATIONS):

Pilar Anton-Martin:

1. **Anton-Martin P**, Zook N, Kochanski J, Ray M, Nigro JJ, Vellore S. Right Atrial Lines as Primary Access for Postoperative Pediatric Cardiac Patients. Pediatr Cardiol. 2023 Mar;44(3):702-713.

2. DeVol C, McDaniel C, Singh N, **Anton-Martin P**. Operative Treatment for Umbilical Venous Catheter-Related Staphylococcal Aureus Infectious Endocarditis with Subsequent Septic Thrombosis. Brain and Heart, 2023;1(2):1005.

Marissa Brunetti:

1. Ortmann LA, Reeder RW, Raymond TT, **Brunetti MA**, Himebauch A, Bhakta R, Kempka J, di Bari S, Lasa JJ. Epinephrine dosing strategies during pediatric extracorporeal cardiopulmonary resuscitation reveal novel impacts on survival: A multicenter study utilizing time-stamped epinephrine dosing records. Resuscitation. 2023 Jul;188:109855.

Andrew Costarino:

1. Walter JK, Feudtner C, Cetin A, **DeWitt AG**, Zhou M, Montoya-Williams D, Olsen R, Griffis H, Williams C, **Costarino A**. Parental communication satisfaction with the clinical team in the paediatric cardiac ICU. Cardiol Young. 2023 Jun 26:1-9.

Aaron Dewitt:

1. Adamson GT, Winder MM, Catton KG, **Dewitt AG, Kozyak BW**, Glenn ET, Bailly DK Current practices for refractory hylothorax following congenital heart surgery. Cardiol Young. 2023 Dec 11:1-5.

2. Simpao AF, Randazzo IR, Chittams JL, Burnham N, Gerdes M, Bernbaum JC, Walker T, Imsdahl S, **DeWitt AG**, Zackai EH, Gaynor JW, Loepke AW. Anesthesia and Sedation Exposure and Neurodevelopmental Outcomes in Infants Undergoing Congenital Cardiac Surgery: A Retrospective Cohort Study. Anesthesiology. 2023 Oct 1;139(4):393-404.

3. Yver H, Habet V, **DeWitt AG**, Thomas NJ, Yehya N. Stratifying Severity of Acute Respiratory Failure Severity in Cyanotic Congenital Heart Disease. Pediatr Cardiol. 2023 Aug;44(6):1271-1276.

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

Wes Diddle:

1. Wernovsky G, Ozturk M, **Diddle JW**, Muñoz R, d'Udekem Y, Yerebakan C. Rapid bilateral pulmonary artery banding: A developmentally based proposal for the management of neonates with hypoplastic left heart. JTCVS Open. 2023 Apr 3;14:398-406.

Monique Gardner:

Grants:

1. Cardiac Center Innovation Grant (PI) "ACT ICU Biobank"

Notable Publications (Full List in Cardiac Center Research Publications):

1. **Gardner MM**, Wang Y, Himebauch AS, Conlon TW, Graham K, Morgan RW, Feng R, Berg RA, Yehya N, Mercer-Rosa L, Topjian AA. Impaired echocardiographic left ventricular global longitudinal strain after pediatric cardiac arrest children is associated with mortality. Resuscitation. 2023 Oct;191:109936.

2. Shustak RJ, Faerber JA, Stagg A, **Hehir DA**, Natarajan SS, Preminger TJ, Szwast A, Rome JJ, Giglia TM, Ravishankar C, Mercer-Rosa L, **Gardner MM**. Association of Home Monitoring and Unanticipated Interstage Readmissions in Infants With Hypoplastic Left Heart Syndrome. J Am Heart Assoc. 2023 Apr 18;12(8):e025686.

3. Shustak RJ, Huang J, Tam V, Stagg A, Giglia TM, Ravishankar C, Mercer-Rosa L, Guevara JP, **Gardner MM**. Neighborhood Social Vulnerability and Interstage Weight Gain: Evaluating the Role of a Home Monitoring Program. J Am Heart Assoc. 2023 Sep 19;12(18):e030029.

Michael Goldsmith:

1. Desai KD, Yuan I, Padiyath A, **Goldsmith MP**, Tsui FC, Pratap JN, Nelson O, Simpao AF. A Narrative Review of Multiinstitutional Data Registries of Pediatric Congenital Heart Disease in Pediatric Cardiac Anesthesia and Critical Care Medicine. J Cardiothorac Vasc Anesth. 2023 Mar;37(3):461-470.

Ben Kozyak:

Grants:

1. Boston Children's Hospital Research Grant (Site PI) "Trial of Indication-Based Transfusion of Red Blood Cells in ECMO (TITRE)"
2. Cardiac Center Innovation Grant (PI) "Development of a Fontan Assist Device"

Notable publications (Full List in Cardiac Center Research Publications):

1. **Kozyak BW, Yuerek M**, Conlon TW. Contemporary Use of Ultrasonography in Acute Care Pediatrics. Indian J Pediatr. 2023 May;90(5):459-469.

DIVISION OF CARDIAC CRITICAL CARE MEDICINE

Maryam Naim:

Grants:

1. Cardiac Center Research Grant (PI, Cody Gathers-Mentee) "Understanding Racial, Ethnic, and Socioeconomic Disparities in Bystander CPR Provision for Pediatric Out-Of-Hospital Cardiac Arrest in Philadelphia"

2. Department of Anesthesiology and Critical Care Medicine Education Grant (PI, Cody Gathers-Mentee) "Understanding Racial, Ethnic, and Socioeconomic Disparities in Bystander CPR Provision for Pediatric Out-Of-Hospital Cardiac Arrest in Philadelphia"

3. Eisenberg Scholar Research Award (PI, Cody Gathers-Mentee) "Understanding Racial, Ethnic, and Socioeconomic Disparities in Bystander CPR Provision for Pediatric Out-Of-Hospital Cardiac Arrest in Philadelphia"

4. Frontier Program (Co-I) "Delivery Room of the Future"

Awards:

1. Outstanding Investigator Award Cardiology 2023 (Jill Hsia-Mentee) "Risk Factors for Electroencephalographic Seizures in Neonates Following Surgery with Cardiopulmonary Bypass."

Notable publications (Full List in Cardiac Center Research Publications):

1. Massey SL, Weinerman B, **Naim MY** Perioperative Neuromonitoring in Children with Congenital Heart Disease. Neurocrit Care 2023. Epub May 15

2. Hsia J, Abend NS, Gaynor JW, Chen JM, Fuller S, Maeda K, Mavroudis CD, Nuri M, Leonard J, Ampah SB, Licht DJ, Massey SL, **Naim MY**. Incidence of postoperative seizures in neonates following cardiac surgery with regional cerebral perfusion and deep hypothermic circulatory arrest. JTCVS Open. 2023 Oct 31;16:771-783.

Venkat Shankar:

1. **Shankar VR**, Lodha R. Advances in Pediatric Critical Care. Indian J Pediatr. 2023 Mar;90(3):249-250.

2. **Shankar VR**, Lodha R. Advances in Pediatric Critical Care- II. Indian J Pediatr. 2023 May;90(5):457-458.

Renee Willett:

Obtained a Masters in Clinical Informatics from Northwestern University.

Mahsun Yuerek:

1. **Yuerek M, Naim MY**. Communication breakdown, it's always the same. Resuscitation. 2023 Aug;189:109878.

2. **Yuerek M, Kozyak BW, Shankar VR**. Advances in Extracorporeal Support Technologies in Critically Ill Children. Indian J Pediatr. 2023 May;90(5):501-509.

CARDIAC CRITICAL CARE NURSING

OVERVIEW - CICU NURSING

The CICU is a 38-bed intensive care unit providing care for patients with congenital and acquired heart conditions, requiring surgical or medical intervention, often within the neonatal period. The CICU at CHOP is one of the largest in the world, supported by a highly trained interprofessional team dedicated to the healing and well-being of this specialized patient population. State of the art medical technology such as Ventricular Assist Devices (VADs), ECMO, dialysis, and heart and lung transplants are readily cared for in the CICU. This education rich and collaborative environment leads with evidence-based practice and innovation to promote the best possible patient outcomes. CICU staff includes over 180 extensively trained nurses that support 1:1 or 1:2 nurse to patient ratios. As co-managers, Amanda Seelhorst and Jamie Fitzgerald lead a dedicated team of advanced practice clinical, safety, and education nurse leaders in supporting the clinical care and unit operations.

ACCOMPLISHMENTS

- Continued to accommodate increased patient flow capacity demand through supporting an additional 6 ICU level patients in overflow beds on neighboring step-down unit.
- 96% of nurses hold a BSN or higher-level degree and 24% are certified in critical care.
- Collaborated with Patient Safety and organizational leaders to assess and address opportunities for improved safety culture with frontline staff through the implementation of Safety Stand Ups.
- Reached harm prevention milestones including over a year without a catheter associated urinary tract infection (CAUTI), over 5 years without a fall with injury, and over 4 months without an unplanned extubation or hospital acquired pressure injury (HAPI).
- Expanded coverage of vascular access nursing support across all shifts to support safety and management of central and peripheral vascular access.
- Collaborated to onboard and orient greater than 80 nurses to the CICU resulting in a significant decrease in nurse vacancy to less than 2%.
- The successful orientation and stabilization of our nursing workforce has allowed us to focus on building upon staff engagement in evidence-based practice improvement projects impacting the care of our patients and families.
- Expansion of the nursing leadership team to include 4 clinical supervisors and 6 clinical nurse experts to support staff development and engagement.

DIVISION OF CARDIAC ANESTHESIOLOGY

OVERVIEW & CLINICAL HIGHLIGHTS

The millennia-old adage "Change is the only constant" continues to hold true for yet another year of transformational change in the Division of Cardiac Anesthesiology. While achieving our mission of providing world-class clinical care, performing cutting edge clinical and basic science research, and providing exemplary training for the next generation of Pediatric Cardiac Anesthesiologists, Pediatric Anesthesiologists, and Certified Registered Nurse Anesthetists, we also integrated an unprecedented number of new team members into the group. We graduated our first class of Accreditation Council for Graduate Medical Education-certified Pediatric Cardiac Anesthesiology fellows. Our interdisciplinary care team, comprised of board-certified anesthesiologists, Cardiac Certified Registered Nurse Anesthetists (CRNAs) and Pediatric Anesthesiology and Pediatric Cardiac Anesthesiology fellows, as well as Cardiac Anesthesiology technicians, took care of more than 3,000 children with complex congenital heart disease for cardiac surgeries, catheterization laboratory procedures, including complex lymphatic procedures, as well as a variety of imaging studies. In doing so, our team takes care of some of the highest acuity patients in the hospital and treats the largest number of neonates with congenital heart disease in the nation. We were able to provide this level of care for critically ill cardiac patients undergoing cutting edge procedures and life-saving surgeries with the support of our colleagues in General Anesthesiology who helped care for the growing number of children with congenital heart disease undergoing non-cardiac surgery in the General Operating Rooms.

Our small and dedicated clinical team works in a high stress/high acuity environment and can only sustainably carry out our mission by working collaboratively with colleagues from other disciplines. Our mantra is to strive for excellence in patient care, research, education, and provider wellbeing by exhibiting Compassion, Accountability, Respect, Dedication, Inclusiveness and Integrity, Adaptability, as well as Community and Collective improvement.
We know that we are at our best when we embrace diversity in people and ideas, when we actively practice inclusion, and when we strive for equity and pride ourselves in being among the best Pediatric Cardiac Anesthesiology teams in the world.

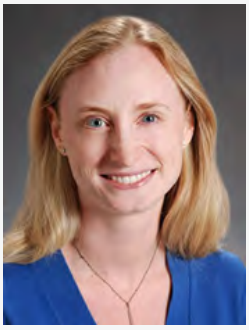
The Cardiac Anesthesiology team experienced significant growth last year. In the Spring of 2023, Dr. Murray-Torres joined the team. In the Fall and Winter of 2023, five additional faculty joined the division: Dr. Molly Deacutis, Dr. Jennifer Lynch, Dr. Manal Mirreh, Dr. Deborah Romeo, and Dr. Lindsey Weidmann. In the Fall and Winter of 2023, the division also welcomed four new Cardiac CRNAs: Peter Caruso, Hannah Kuhn, Christopher McMichael, and Lapio Tkach.

In July, Lisa Jones, CRNA was appointed to the newly created position of Chief Cardiac CRNA. Lisa has been a valued member of the division since 2006 and has served as the division's Clinical CRNA Lead since 2013.

DIVISION OF CARDIAC ANESTHESIOLOGY

LEADERSHIP

Andreas W. Loepke, MD, PhD, FAAP
Chief, Division of Cardiac Anesthesiology



Lindsey Loveland Baptist, MD, FASA
Associate Chief for Education and Professional Development
Program Director, Advanced Pediatric Cardiac Anesthesiology Fellowship

Eduardo Goenaga Diaz, MD
Associate Chief for Quality Improvement and Safety

Jayant "Nick" Pratap, MB, BChir, MRCPCH, FRCA
Director of Perioperative Informatics

Lisa Jones, CRNA
Cheif Nurse Anesthetist, Division of Cardiac Anesthesilogy

Rebecca Cardoso, MHA
Administrative Director

FACULTY

- Molly Deacutis, MD
- Eduardo Goenaga Diaz, MD
- Matthew Jolley, MD
- Andreas Loepke, MD, PhD
- Lindsey Loveland Baptist, MD
- Jennifer Lynch, MD, PhD
- John McCloskey, MD
- Manal Mirreh, MD
- Reese Murray-Torres, MD
- Susan Nicolson, MD
- Asif Padiyath, MBBS
- J. "Nick" Pratap, MB BChir
- Deborah Romeo, MD
- Lindsey Weidmann, DO, MS

CRNAS

- Therese Brady, CRNA
- Peter Caruso, CRNA
- Lisa Jones, CRNA
- Hannah Kuhn, CRNA
- Christopher McMichael, CRNA
- Deirdre McFillin, CRNA
- Jamie Sloan, CRNA
- Lapio Tkach, CRNA

PEDIATRIC CARDIAC ANESTHESIOLOGY FELLOWS (2023-2024)

- Jeremy Friedman, MD
- Lea Matthews, MD

DIVISION OF CARDIAC ANESTHESIOLOGY

QUALITY IMPROVEMENT AND PATIENT SAFETY

Under the leadership of Dr. Nick Pratap, the Quality and Safety (Q&S) team within the Division of Cardiac Anesthesiology has been very busy to improve quality of patient care and safety. Creating a more streamlined system for logging critical incidents has resulted in substantially improved timely incident reporting in our busy clinical environment. The highly streamlined approach to reporting has since been adopted by the General Anesthesiology division of our Department. Furthermore, CHOP Q&S leadership are testing out updates to the institution-wide Keeping All People Safe (KAPS) system based on our success. Unfortunately, Carolyn Srinivasan, CRNA who has been an integral part of our Division's Q&S team and KAPS reporting for many years has left to pursue an opportunity in another state.

In partnership with the Cardiac Operative & Imaging Complex (COIC) Safety team, we established an emergency alert system to rapidly summon assistance to procedural areas, when urgently needed. More widely, during 2023, the Q&S team led extensive improvements in organization and consistency of equipment and supplies, in order to ensure a safe patient care environment. The team continues to collaborate closely with CICU nursing leadership and educators in a joint forum to ensure safer, smoother transitions from the Cardiac OR to the CICU for the Division's highly complex patients. This year we have worked on issues around transport with vasoactive agents and transducers with the aims of both reducing risk and also decreasing waste. We look forward to 2024 as Dr. Eduardo Goenaga Diaz takes over leadership of the Q&S team.

EDUCATIONAL PROGRAM

The Division of Cardiac Anesthesiology supports a one-year Pediatric Cardiac Anesthesiology fellowship as well as three-month rotations in pediatric cardiac anesthesiology for the 11 Pediatric Anesthesiology fellows this year.

2023 was quite remarkable for the Pediatric Cardiac Anesthesiology fellowship, as under the leadership of Dr. Lindsey Loveland Baptist the program successfully applied for and received accreditation from the Accreditation Council for Graduate Medical Education (ACGME), following a more than two-year process that involved collaboration from the entire division and institutional educational leadership and included the submission of a substantial syllabus. CHOP's Pediatric Cardiac Anesthesiology fellowship program was approved as a training program by the ACGME for 3 positions annually, which makes it a national leader in educating the next generation of pediatric cardiac anesthesiologists and only one of 11 programs in the country that have attained accreditation. This is especially critical in the current era of extreme nation-wide shortage of physicians in this subspecialty. Accreditation will help us create a consistent, excellent program, recruit the strongest candidates, and contribute critically needed physicians.

RESEARCH HIGHLIGHTS (All research publications will be in a combined section at the end):

JOLLEY LABORATORY

Dr. Matt Jolley leads a cutting-edge research laboratory focusing on using novel 3D imaging and modeling to inform patient-specific planning of cardiac surgery and interventions in children. The Jolley lab has over 12 members including three post-doctoral fellows in computational physics, biomechanics, and image processing. In 2023, Dr. Jolley was awarded the inaugural Topolewski Endowed Chair in Pediatric Cardiology. Dr. Jolley is the Primary Investigator on an Additional Ventures Single Ventricle Research Fund Grant, project title, "Computational Modeling of the Atrioventricular Valve Repair Single Ventricle Patients with Atrioventricular Canal." He is also the Primary Investigator for a CHOP Cardiac Center Innovation Grant, project title, "Quantitative 3D Analysis to Inform Systemic Semilunar Valve (SSV) Repair in Children."

DIVISION OF CARDIAC ANESTHESIOLOGY

Dr. Jolley's publication highlights in 2023 include:

- Jolley MA, Sulentic A, Amin S, Gupta M, Ching S, Cianciulli A, Wang Y, Sabin P, Zelonis C, Daemer M, Silvestro E, Coleman K, Ford LK, Edelson JB, Ruckdeschel ES, Cohen MS, Nicolson SC, Gillespie MJ. Introduction of transcatheter edge-to-edge repair in patients with congenital heart disease at a children's hospital. Catheter Cardiovasc Interv. 2023
- Amin S, Dewey H, Lasso A, Sabin P, Han Y, Vicory J, Paniagua B, Herz C, Nam H, Cianciulli A, Flynn M, Laurence DW, Harrild D, Fichtinger G, Cohen MS, Jolley MA. Euclidean and Shape-Based Analysis of the Dynamic Mitral Annulus in Children using a Novel Open-Source Framework. J Am Soc Echocardiogr. 2023
- Barak-Corren Y, Herz C, Lasso A, Dori Y, Tang J, Smith CL, Callahan R, Rome JJ, Gillespie MJ, Jolley MA, O'Byrne ML. Calculating Relative Lung Perfusion Using Fluoroscopic Sequences and Image Analysis: The Fluoroscopic Flow Calculator. Circ Cardiovasc Interv. 2024

Wensi Wu, PhD, a postdoctoral fellow in the Jolley Lab, received a K25 Mentored Quantitative Research Career Development Award from the National Heart, Lung, and Blood Institute, with Dr. Jolley as her primary mentor. Dr. Wu's project, "Toward Patient-Specific Computational Modeling of Tricuspid Valve Repair in Hypoplastic Left Heart Syndrome (HLHS)," aims to develop machine-learning techniques to derive mechanical properties of HLHS tricuspid valves from medical images. This innovative work will enhance the computational models utilized for evaluating HLHS tricuspid valve function and enable in silico optimization of valve repair specific to individual patients before intervention.

LYNCH LABORATORY

Dr. Jennifer Lynch completed her advanced pediatric cardiac anesthesiology fellowship in July 2023, joined the division as a faculty member in August 2023, and officially started her laboratory research. Dr. Lynch's lab focuses on the use of novel biomedical optical techniques for identifying risk for neurologic injury in children with cardiac disease. The Lynch Lab for Novel Biomedical Optics currently includes Dr. Lynch, a research assistant, a graduate student, 4 medical students, and one undergraduate student. In 2023, the Lynch Lab was awarded a CHOP Cardiac Center Innovation Award. Last year, the lab published four papers and collaborated with other investigators in the Cardiac Center, Dr. William Gaynor and Dr. Constantine Mavroudis, to publish two additional papers.

NICOLSON RESEARCH

Dr. Susan Nicolson is an investigator on multiple multi-center clinical research projects and the CHOP PI on a Department of Defense sponsored randomized control trial (RCT) determining if platelets that are stored cold are as good or better than those stored at room temperature. Room temperature platelets have a shelf life of 3 days compared to chilled platelets which have a shelf life of 14 or more days. If this study shows the chilled platelets to be as good or better, it will greatly increase the pool of platelets available to transfuse both children and adults. Drs. Nicolson and Garcia-Marcinkiewicz are leading an RCT at CHOP and 7 other sites funded by the Anesthesia Patient Safety Foundation looking at the 1st attempt success rate for nasal intubation comparing direct with video laryngoscopy. Dr. Nicolson is the CHOP PI on another multi-center study championed and funded by Boston Children's Hospital looking at outcomes and health care resource utilization in children with congenital heart disease (CHD) undoing non-cardiac procedures.

CARDIAC NURSING

INTRODUCTION

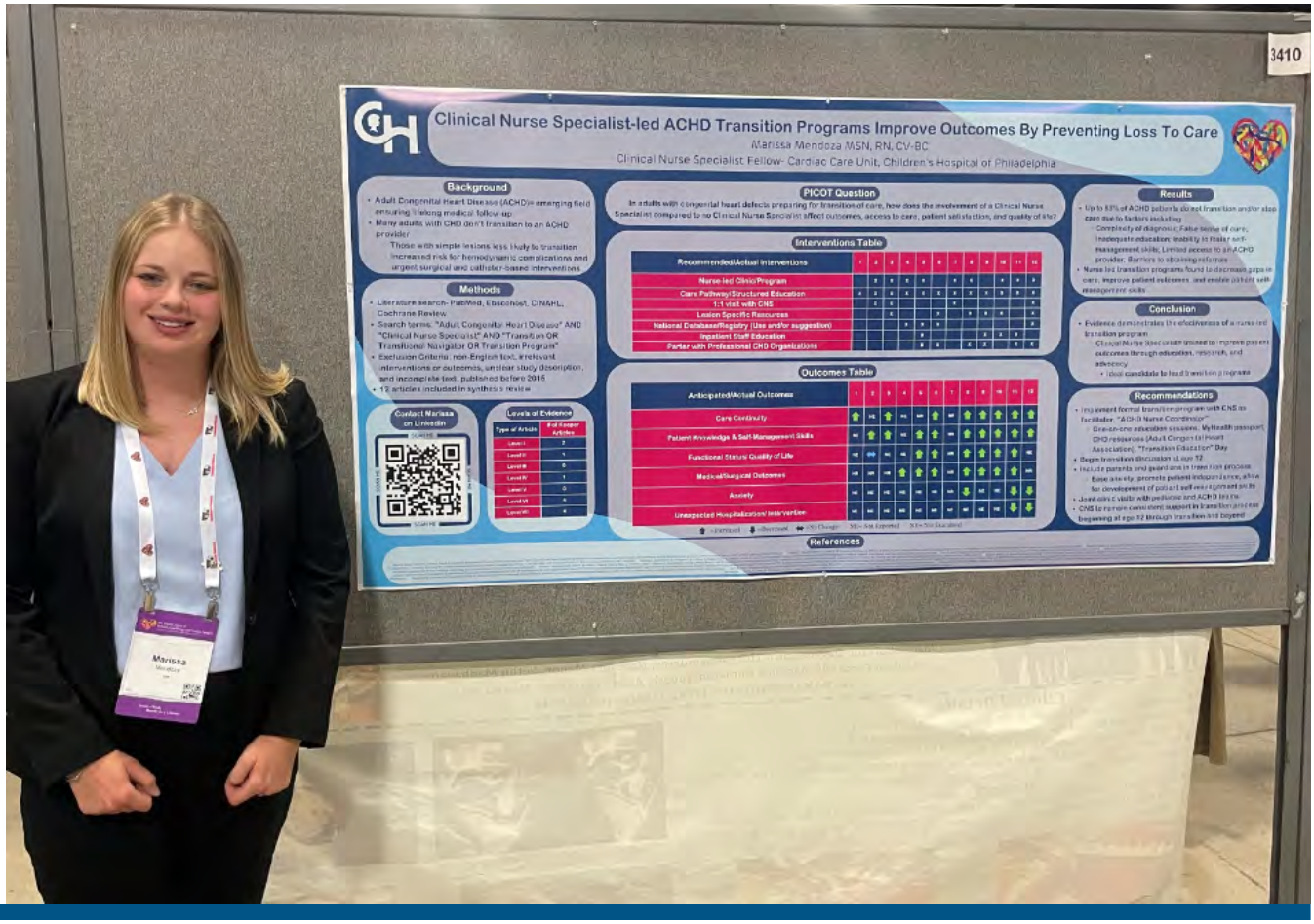
Sherri Kubis, MSN, RN, CCRN, Director of Cardiac Nursing, leads a team of over 350 nurses and 50 interdisciplinary specialists who partner with surgeons, physicians, and many others to ensure that all Cardiac Center patients and their families receive the safest, highest-quality care. This team continually strives for the highest quality of care and develops evidence-based standards of care for children with heart disease. The entire nursing leadership team consists of eight managers overseeing unit staff and operations. Additionally, a team of specially trained Safety Quality Specialists, Certified Nurse Specialists and Education Nurse Specialists support clinical practice, harm and safety prevention and educational needs for all Cardiac Center nursing and advanced practice staff. They have established highly successful onboarding programs to maintain appropriate staffing and educational levels across all specialized areas. Through strong retention and wellness efforts they have dropped the average turnover rate to an average of 10.9% across cardiac areas. Multiple Cardiac Center nurses, advanced practice providers and perfusionists had work accepted for publication or presentation at national and international forums this year as they continually work to advance evidence-based practice in the pediatric cardiac field.

Sherri Kubis, MSN, RN, CCRN
Senior Director, Cardiac Nursing Center

The Cardiac Center nursing team's recent notable achievements include:

- Implementation of a robust multi-modal educational program to support ongoing development of novice nurses. The program includes a series of advanced cardiac education with didactic, hands-on training, and high-fidelity simulation sessions. Monthly mentorship rounding is conducted with all Nurse Residents to support them in building emerging skills and independent practices.
- The cardiac nursing team has a robust internal safety program designed to help prevent common health care associated infections or preventable injuries. This program includes daily rounding by highly trained nurses who assess all patients with high-risk devices and therapies in place. This year they continued to see marked improvements in key outcomes such as hospital acquired viral infections and skin injury prevention.

Jess Fuentes RN CICU, Teresa Stegman RN, NP CICU Presenting at La Cardia in Bogota, Columbia



CARDIAC ADVANCED PRACTICE PROVIDERS

INTRODUCTION

Advanced Practice Providers (APP) provide expert care to infants, children, adolescents, and young adults with both acquired and congenital heart disease. APPs in the Cardiac Center work in many areas of the center, such as, CICU, CCU, CPRU/Cardiac Intake Center, CTOR, Consultation and Cardiology Outpatient services.

Advanced Practice Providers consist of Certified Nurse Practitioners and Physician Assistants who provide 24/7 care in our CICU and CCU and our Outpatient APPs provide both inpatient/outpatient care to our patients and families.

APP DISTRIBUTION

55 Nurse Practitioners | 21 Physician Assistants

Our APP teams continue to seek out professional opportunities and had many accomplishments. Our APP Advancement Program acknowledges the hard work and dedication that our APPs have. There are two opportunities: Clinical Expert (3 years or greater APP experience) and Master Clinician (5 years or greater experience).

LEADERSHIP

Keri Lombardi, MSN, APRN-BC, MJ, MBA
Advanced Practice Program Manager

Jarae Payne
CICU Team Lead

Erin Pinto, MSN, RN, CCRN, FNP-BC
Outpatient Team Lead

Diana Holbein, CRNP
CCU Team Lead

Christine Welch
CT Surgery Team Lead

Sharna Basu, MSN, RN, CRNP
CPRU/Intake Team Lead

CARDIAC ADVANCED

PRACTICE PROVIDERS

APP PROFESSIONAL ADVANCEMENT AWARDS

Jarae Payne selected as the Rising APP Leader for 2023

Clinical Expert

Sharna Basu
Christy Bosler
Ellen Cannon
Stephanie Braun
Lisa Gervasi
Diana Holbein
Rachel Keashen
Laura Murphy
Sara Bond
Christine Welch
Taylor Zulli
Farzana Shah
Elizabeth Trovato
Alyson Stagg
Monica Giannopoulos

Clinical Master

Katie Dodds
Jenna Heichel
Erin Pinto
Megan Yowell Scott
Jessica Eichner
Emily Schwartz

APP Welness Chapmions

Kaitlin Rubnitz
Kirsten Young
Sarah Bakke
Farzana Shah
Sophia Rubenstein
Carolyn Karpiak

The Cardiac Center APPs are involved in many initiatives across the enterprise, have presented nationally and internationally and are recognized as leaders in their field.

HUMANITARIAN AND VOLUNTEER WORK

Megan Long (Lead Coordinator), Stephen Walker, Jessica Eichner, & Jarae Payne

- KIDS Heart camp volunteer

Emily Schwartz and Jessica Eichner

- Nigeria: Cardiac Surgical mission

Teresa Stegman

- Bogota, Columbia-many presentations

Kate Spivak

- Inventor of the Neotech Bridge sold worldwide to help mothers resolve breastfeeding issues.

Louise Fromuth

- Participated in the Payton Walker athletic screening in Lancaster.

Meghan Yowell Scott:

- Outreach: Camp Heartbeat Nurse 2012-current

Emily Stevenson:

- Outreach: Camp Braveheart-Camp Twin Lakes: Rutledge, GA 2018-current

Farzana Shah

- Outreach Mission: Quito Ecuador with Novick Cardiac Alliance to provide free cardiac care for children and to initiate a cardiac program with the local staff:

QUALITY INITIATIVE WORK

Bakke, S.

- Discharge Optimization with partnership with PAC3 Hearts to Home initiative.

Spivak, K.

- EP genetics QI project. Created new flow for tracking and reporting genetic patient results.
- Transitioned cardiac devices remote monitoring to EPIC.

CARDIAC ADVANCED PRACTICE PROVIDERS

Basu, S., Gervasi, L.
- Discharge optimization post-procedure.
- Flat time QI project with flat time decreased from 6 to 4 hours for a cohort of patients.
  - Decreasing venous flat time from 4 to 2 hours if no heparin or bival used
- Reducing unnecessary blood orders in the cath lab

Youth, Jordyn
- Hospital wide sepsis QI work

Braun, Stephanie
- Weight adjust Wednesday, target-based outcomes.

Reighard, Erica
- Unplanned Extubation QI Lead

Trovato, Liz
- Co-lead: Incisional wound care after cardiac surgery
- SSI prevention champion
- QI Advisory council member

Keashen, Rachel
- Cardiac Center Quality Improvement & Safety Core/Advisory Council & Steering Committee

PROCEDURAL AREA INITIATIVES

Spivak, K. Created a new remote monitoring flow for cardiac devices resulting in a projected ~5x revenue increase, from 75K in 2022 to projected 370Kin 2023 (pending appropriate resource allocation)

DIVERSITY, EQUITY, AND INCLUSION

- Co-leads with Maryam Naim for the CICU DEI subcommittee
  - Jarae Payne
- PCICS: Diversity, Equity, and Inclusion Committee
  - Jarae Payne
- Transplant Center: DEI committee
  - Lynne Ha
- Cardiac Center DEI committee
  - Jordy Martino
  - Rachel Keashen – co-chair
- APP Multicultural Mentorship steering committee.
  - Rachel Keashen
- APP Multicultural Mentorship Program, Preceptor
  - Sharna Basu

APP CENTER

Rachel Keashen
- APP Immersion Experience-Steering Committee Member
- APP Mentorship
- APP Advancement Model-Steering Committee Member

CARDIAC ADVANCED PRACTICE PROVIDERS

APP DIRECT BILLING – OUTPATIENT

APPs who are currently direct billing:

- Voorhees: Rachel Keashen
- Lancaster: Louann Fromuth **First APP in outpatient cardiology to direct bill and have her own schedule**
- Main PHL: Monica Giannopoulos and Kaitlin Lewis
- Main PHL: Jordy Martino

PROFESSIONAL DEVELOPMENT & EDUCATION

- Cardiac Center lectures for the CICU/CCU nurses
  - Carley Boyle
  - Lynne Ha
  - Lauren Biroc – NICU
- ED cardiology lecture
  - Teresa Stegmann
- CHOP Specialty Teams
  - Jordy Martino
- CHOP Resident Lecture Series
  - Heather Meluskey
- University of Pennsylvania School of Nursing
  - Lynne Ha
  - Deb Torowicz
- Drexel University College of Nursing & Health Professions; Philadelphia, PA. (2019-2022). Clinical adjunct faculty member overseeing nurse practitioner students in pediatric acute care nurse practitioner program.
  - Diana Holbein
- Skills Day
  - Teresa Stegmann – Coordinator
  - Meghan Yowell Scott - Coordinator
- Conference Planning committee:
  - CHOP Lymphatic Conference
    - Erin Pinto
  - World Congress of Lymphology
    - Erin Pinto
- APP CICU Curriculum Course, Faculty
  - Jenna Heichel
- APP CHOP Conference Planning Committee
  - Sarah Bond
- Vital Talk, Faculty
  - Jessica Eichner

PRESENTATIONS, PUBLICATIONS &/OR POSTER

- Cardiology 2023
  - Carley Boyle-Abstract
  - Lynne Ha-Presentation

- Meluskey, Heather. AHA Scientific Session Faculty-Pulmonary Vein Conference/Case Presentation & Planning Committee for PVS symposium CHOP 2025
- World Congress 2024 &
- International-Bogota Columbia Lectures
  - Teresa Stegmann
- Bond, S., Rubnitz, K. (2023). Use of Bupivacaine Liposomal Injectable in Children ages 2-6 undergoing open heart surgery. IRB approved abstract.
- Bond, S. (2023). Surgical Resection of Pulmonary Arteriovenous Malformations (PAVMs). IRB approved abstract.
- Lombardi, K., Duran, M. Gerulsky, J., Meyers, S. & Lengetti, E. (2024). Merging Academia with Clinical Practice to Develop a Successful Advanced Practice Provider Preceptor Program. Villanova University, M. Louise Fitzpatrick College of Nursing Research Symposium.
- Martino, Jordy. (2023). SEARCH telemedicine conference
- Martino, Jordy. (2023). Telemedicine In A Pediatric Lipid Clinic: Feasibility, Acceptability, And Health Care Disparities. I also did a podcast on.Poster 8th World Congress of Pediatric Cardiology and Cardiac Surgery,Washington, DC.
- Martino, Jordy. (2023). Podcast.. Hyperlipidemia for CHOP's Primary Care Perspectives
- Payne, Jarae, Olsen, R., Gunturi, D., Ostapenko, S. Savoca, M., Sullivan, E., Gaynor, W. & Gardner, M. (2023). Rates and Trends in Treatment and Diagnosis of Necrotizing Enterocolitis in Pediatric Shunt-Dependent Congenital Heart Disease. 8th World Congress of Pediatric Cardiology and Cardiac Surgery,Washington, DC.
- Pinto, E. (2023). Building a Lymphatic Program: The Team Approach. Cardiology 2023. Puerto Rico.
- Pinto, E. (2023). Muliple manuscripts and abstracts.
- Pinto, E. (2023). International-Genoa,Italy and Copenhagen, Denmark. Lymphatics.
- Thompson, K., Lombardi, K., Huson, J., Mashburn, D., Nasser, W., Elliott, E., Newman, C. (2024). Integrating Advanced Practice Providers into Pediatric Intensive Care Units: Contrasting Approaches from four United States-Based Pediatric Hospitals. (2024). WFPICCS submission.
- Young, K. (2023). Diagnosis, Treatment, and Outcomes of Primary Bronchial Tumors in Pediatric Patients- Cardiology 2024.
- Trovato, E. (2023) Post operative skin and wound care and chest tube management and troubleshooting. Cardiac Safety Day monthly education sessions.
- Welch, C. (2023). CAPES presentation: Chest tube management and trouble shooting.
- Young, K. (2023). Diagnosis, Treatment, and Outcomes of Primary Bronchial Tumors in Pediatric Patients. Publication pending.

PROFESSIONAL MEMBERSHIP ACTIVITY

- Stephen Walker – Pulmonary Hypertension Association Task force on Subcutaneous Treprostinil for Pediatric patients. PHA task force on pharmacy prior authorizations.
- Louise Fromuth – Board Member-Anticoagulation Forum
  - Member of the cardiac Lipid program
- CICU APPs all are members of PCICS.
- Editorial Board: Pediatric Nursing Editorial Board Member. 2016-current.
  - Meghan Long

CARDIAC CENTER PARTNERSHIPS

Cardiac Center Officer Positions

- Education Officer – Jenna Heichel
- Patient and Family Officer – Jessica Eichner transitioning to Rachel Keashen

CARDIAC ADVANCED PRACTICE PROVIDERS

ACT HEART FAILURE: FRONTIER PROGRAM
- Clinical Program Manager- Farrell Weiss
- ACT Team Lead (Frontier Program) in the CICU- Jessica Eichner
- Surgical liaison for the Advanced Cardiac Therapies-Taylor Zulli

PATIENT AND FAMILY EXPERIENCE
- Jordy Martino

CICU PROCEDURAL SPECIALIST
- Meghan Yowell Scott

CARDIAC ARREST PREVENTION & EDUCATION REVIEW
- Alyssa Tani – Co-lead

CHRONIC CARE ROUNDS
- Rachel Pancoe – Facilitator

EPIC/IT
- Spivak, K. Participating in the CUPID project related to upcoming EPIC changes.
- EPIC Clinical Champion
  - Kirsten Young

CARDIAC CENTER VAD WORK GROUP
- Rachel Keashen

VOORHEES SATELLITE CARDIOLOGY OFFICE FOR PATIENTS/FAMILIES AT THE DIVISION LEVEL COUNCIL
- Rachel Keashen

PEDIATRIC IMMERSION EXPERIENCE/STEERING COMMITTEE
- Rachel Keashen

PSYCHOLOGY

Debra Lefkowitz, PsyD

Debra Lefkowitz, PsyD is the Clinical Director of Cardiology Psychology services. She specializes in providing services to patients undergoing heart transplantation or ventricular assist device (VAD) implantation and their families. Her focus is on optimizing child and family long-term health and well-being, which includes increasing VAD and transplant readiness and coping, adhering to the post-transplant medical regimen, and navigating the many transitions post-transplant, including school, adolescence, and to adult transplant care. Dr. Lefkowitz is an Associate Professor of Clinical Psychology in the University of Pennsylvania Perelman School of Medicine, and is the Pediatric Psychology Section Co-Chief in the Division of Integrated Psychology, Psychiatry, and Behavioral Sciences. In 2023, she collaborated on multiple peer-reviewed publications and gave several lectures at national and international psychology and transplant conferences on topics related to pediatric transplant psychology and ethics. Dr. Lefkowitz is currently co-leading the Transplant Center Health Equity Task Force at CHOP, and is leading an international group of transplant professionals to develop a consensus framework for best practices in the pediatric cardiothoracic transplant and VAD psychosocial evaluation.

Colleen Driscoll, Ph.D.

Colleen Driscoll, Ph.D. joined CHOP as a psychologist in the Cardiac Center in May 2023. She provides consultation and treatment services to patients and families in the inpatient and outpatient settings, with a special focus on early childhood. She also completes developmental assessments for children 5 and under in the Cardiac Kids Developmental Follow-up Program. Dr. Driscoll's clinical interests include caregiver and family coping with illness, parent-child attachment in the context of infant hospitalization, and early childhood behavioral challenges.

Dr. Driscoll participates in training and research activities. In 2023, she published 2 peer-reviewed publications related to the provision of family-centered care for children with CHD or other pediatric critical illness. She is an engaged in a number of ongoing program development and quality improvement projects in the Cardiac Center. She is also an active member of the Caregiver Wellbeing Special Interest Group of the Society of Pediatric Psychology and coordinates a podcast/video series that focuses on amplifying the voices of caregivers of children with special healthcare needs. She was also recently appointed as an Assistant Professor of Clinical Psychology at the University of Pennsylvania Perelman School of Medicine.

Nick Seivert, Ph.D.

Nick Seivert, PhD works with youth of all ages and their families with a special focus on school-age and adolescent patients. His clinical interests include child and parent adjustment to illness as well as children with comorbid medical and psychiatric disorders. Dr. Seivert provides both inpatient and outpatient services as well as consultation to patients, families, and the medical team in the Fontan Rehabilitation, Wellness, Activity and Resilience Development (FORWARD) Program and the Lifestyle Medicine Program. He is actively involved in research and quality improvement initiatives in the FORWARD Program and in 2023, presented research posters at psychology and cardiology conferences. Dr. Seivert is involved in DEI work across CHOP and in 2023, joined the newly formed Cardiac Center Diversity & Inclusion Committee. Dr. Seivert is Assistant Professor of Clinical Psychiatry at the University of Pennsylvania Perelman School of Medicine and is involved in training students across disciplines in psychological aspects of caring for pediatric cardiac patients.

CHILD LIFE SERVICES

OVERVIEW

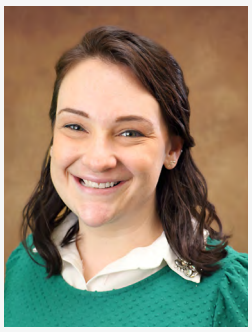
Child Life services are active parts of the Cardiac Center psychosocial team in the inpatient, outpatient and procedural areas of the Center. Individualized care and support to meet each patient and families' needs for coping is provided by Certified Child Life Specialists and a Child Activity Coordinator. Team members provide age-appropriate preparation, education, therapeutic and development play by specially trained therapists to help support clinical goals. The Child Life expanded to provide inpatient coverage to 5East in preparation for the transition of the unit population to more Cardiac Center patients. With this, the team welcomed back Child Life Specialist Sam Flick in December 2023. The current inpatient child life specialist team who also cover patients at pre-surgical appointments in the Intake Center are Elizabeth Becraft, Sammi Bachrach, Kaylee O'Brien and Sam Flick. The inpatient Child Activity Coordinator is Brittany Wickham. The child life specialist covering the CPRU, Cath Lab, Intake Center and Outpatient consults is Megan Fogerty.

Elizabeth Baecraft

Sammi Bachrach

Kaylee O'Brien

Sam Flick



Brittany Wickham

Megan Fogerty

CHILD LIFE SERVICES

HIGHLIGHTS AND ACCOMPLISHMENTS

The Child Life team has continued to provide individualized preparation, support, and play to patients and families at the bedside and in the playrooms throughout this past year. The team has continued to celebrate the individual patient milestones in partnership with the family; create unique and memorable keepsake items with the patients and families; find opportunities for connectiveness for patients and families as healthcare experiences can separate friends and families; along with time for play to meet the large variety of therapeutic and developmental needs of our patient population. The child life specialists continued to have increased involvement with procedural preparation and support, including chest tube pulls, dressing changes, surgery preparation, and cardiac catheterizations.

There were several programming highlights for 2023. Group programming opportunities in the playroom and teen activity center in the Cardiac Center have continued to be a hit in 2023. Our Child Activity Coordinator, Brittany, is hosting many groups each week, including movie nights, Lego & Robotics group with the Child Life Department's Patient Technology team, game time group and crafting groups! We hosted our second annual Heart Dance in honor of all heart warriors on Valentine's Day and appreciate the partnership with CCU and CICU nursing to have so many patients and families in the playroom participating! Another highlight for 2023 was the addition of Nettle, one of our Facility Dogs. Nettle is typically partnered with Cardiac child life specialist, Sammi Bachrach, weekly for a portion of a day. Sammi and Nettle support individual patients with their therapeutic coping goals.

CREATIVE ARTS THERAPY

OVERVIEW

Our Creative Arts Therapy Team in the Cardiac Center consists of Board-Certified Art and Music Therapists, and they are an important part of our Psychosocial Services. Our Creative Arts Therapists are masters-level, mental health professionals specifically trained to assess clinical needs and utilize creativity, counseling, and the therapeutic relationship to support emotional, social, behavioral, and physical health for patients of all ages. Creative Arts Therapists offer both verbal and non-verbal opportunities for self-expression to assist patients and families in their coping with illness, injury, potential pain or anxiety, hospitalization and overall healthcare experiences. Creative Arts Therapists offer transformative services to foster positive self-esteem, promote a sense of independence, and increase feelings of control.

Diana Hamm, MA, ATR-BC, LPC
Board Certified Art Therapist

Lydia Westle, MMT, MT-BC
Board Certified
Music Therapist

Patrick Lipawen, MA, MT-BC
Board Certified
Music Therapist

HIGHLIGHTS

Our Creative Arts Therapists provide both individual therapy and group therapy services in the Cardiac Center. They support opportunities for creative expression, family bonding, and memory making through creative arts therapy interventions like the creation of songs, music recording projects, altered book making, music-based legacy projects or art-based legacy projects made with special materials like resin. This past year we introduced a new Board-Certified Art Therapist to the team, Diana Hamm, MA, ATR-BC, LPC. Diana provides both a regular Art Therapy patient group and a bi-weekly caregiver group. Diana has also partnered with interdisciplinary staff to offer Heart 2 Heart a group that promotes staff support. Our Board-Certified Music Therapists, Patrick Lipawen, MA, MT-BC and Lydia Westle, MMT, MT-BC, continue to provide regular patient Music Therapy groups. This past year, Lydia is excited to have partnered with Nursing to introduce Heart Warrior Baby Band , a Music Therapy Group for Infants with Ventricular Assist Devices (VADS) and their Caregivers.

Our Creative Arts Therapy Team sits in the Child Life, Education, and Creative Arts Therapy Department and is proud and grateful to work closely with our department colleagues and all of our psychosocial and medical unit partners to provide compassionate, therapeutic services to our patients, families, and caregivers in the Cardiac Center.

SOCIAL WORK

OVERVIEW

The Social Work team is an integral part of the multidisciplinary care team that provides care and support to those who receive treatment in the Cardiac Center at CHOP. Families with a child diagnosed with a heart defect or disease can be emotionally, physically, and financially drained. We are here to support and guide patients and families in the best way possible based upon their individual circumstances and needs. Social Workers within the Cardiac Center are able to provide information, support and counseling to patients and their families regarding adjustment to illness, crisis management, and assistance with ongoing healthcare communication and decision-making. Social workers, whether they function within outpatient, inpatient, transplant, or other specialized cardiology arenas can guide and connect families with community resources, such as lodging, transportation assistance, behavioral health and financial resources such as Foundations or special funds for families as appropriate.

TEAM

Gino Poliziani, LSW
CICU

Melissa Greberman, LSW
CICU

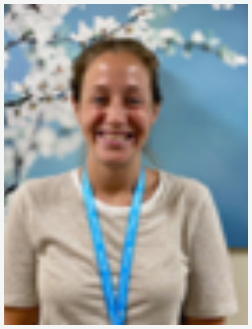
Taylor Goldberg
CCU & Lymphatics

Charisse Rhone, MSS
Transplant & Heart Failure

Lynn Callaway, MSW
Fontan Forward & Cardiac Kids

Susan White, LCSW
Outpatient Cardiology

Lucia Figueroa, LSW
Fetal Heart



Sasha Rose, LCSW
Fetal Heart

SOCIAL WORK

The following are examples of the types of assistance we offer to our families and patients:

- Scores of families require help with travel expenses to offset their cost of travel to Philadelphia from locations across the Country, ranging from New York, Texas, California, Florida, Massachusetts and South Carolina, among others. Even travel to and from CHOP for those living in the tri-State area can cause a hardship as the cost of gas, planes, trains and buses continues to rise.
- Once you arrive from your home location you need a place to stay, and securing lodging for the parents or caretakers, sometimes siblings as well, can be very challenging. Providing referrals for Ronald McDonald House, affordable hotels and other alternative housing is a frequent and demanding request.
- Additional needs such as food and meals while a family is here, maintaining the cost of home mortgages, rent or utilities, providing necessary documentation for insurance, parental leave of absence from jobs/FMLA and with educational and/or developmental programming are all areas Social Workers help provide guidance and support.
- Receiving the news that your child has a cardiac condition and may require specialized treatment, medications, surgery, and other forms of intervention is often heartbreaking. The prognosis may be more or less favorable, the prognosis and outcome may be devastating. Grief and bereavement is a natural component of the experience of our families and Social Workers, along with other members of the care team, do our best to support and empower families as they proceed through their experience of the Cardiac Center at CHOP. We hope to support every step along the way of the journey.

Social Work services are available at CHOP 24-hours seven days a week for our families' needs.

PHYSICAL AND OCCUPATIONAL THERAPY

OVERVIEW

Our team of physical and occupational therapists work together to support patient's developmental and functional needs across the Cardiac Center including inpatient on the CICU and CCU and outpatient in the Cardiac Kids Developmental Program. In 2023 the physical therapy and occupational therapy teams provided high level care to over 600 patients in the inpatient setting alone.

KEY LEADERS & STAFF

PHYSICAL THERAPY

Amanda Waples, PT, DPT, SSGBC
ACT PT Lead

Rebecca Hoffritz, PT, DPT
Floor Primary
ACT PT Treatment Team

Kristin Caputo, PT, DPT
ACT PT Co-Lead

OCCUPATIONAL THERAPY

Sarah Stevens, MS, OTR/L
Floor Primary
ACT OT Lead

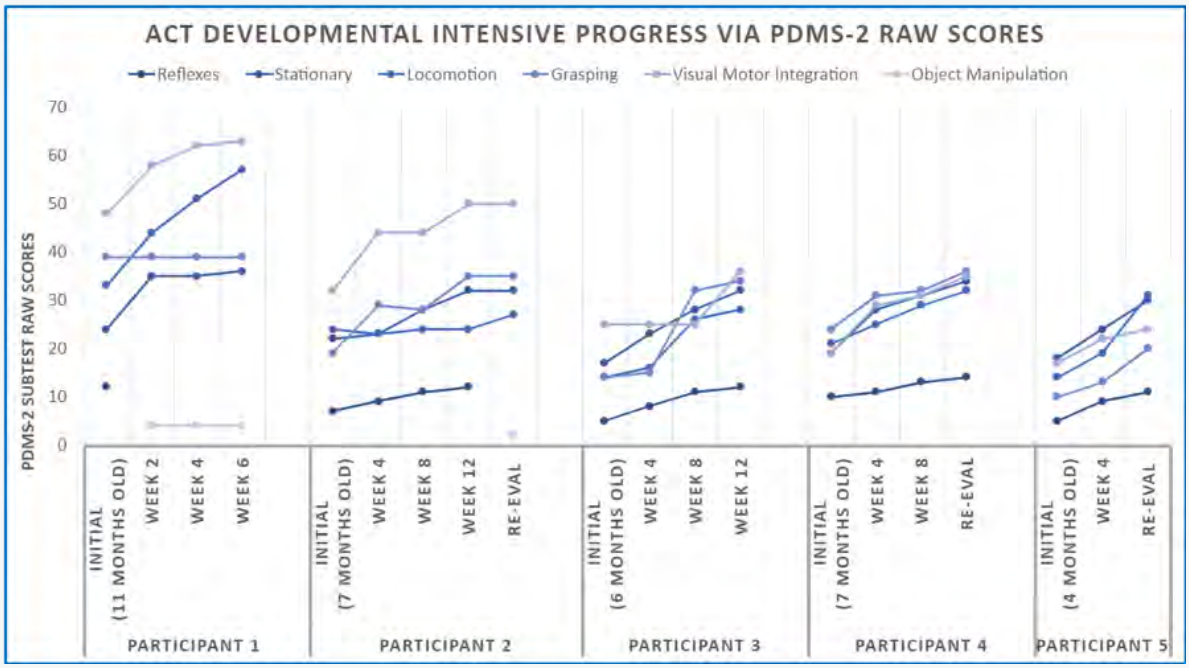
Tabatha Rudzinski, MS, OTR/L, BCP
ACT OC Treatment Team

Jennifer Brennan, COTA
ACT OT Treatment Team

PHYSICAL AND OCCUPATIONAL THERAPY

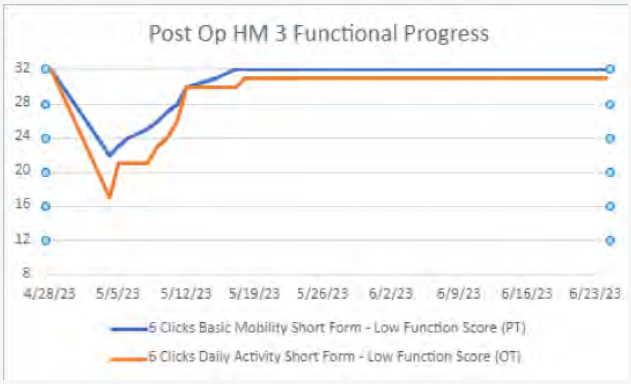
KEY PROGRAMMATIC HIGHLIGHTS

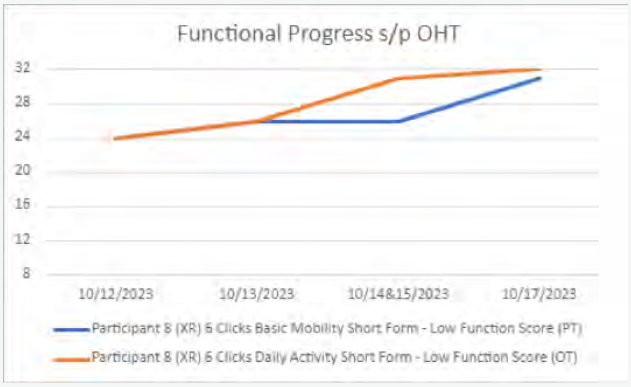
In 2023, we had 28 participants in the ACT intensive rehab program. We've seen remarkable outcomes with our ACT Intensive Rehab program in both the infant and adolescent populations. We have found children and adolescent patients who participated in the ACT intensive rehabilitation program post VAD implantation were found to have more rapid return to functional baseline post heart transplant. The infant participants have demonstrated an improved overall developmental trajectory while awaiting transplantation and return to baseline developmental skills post-operatively within sternal precautions by discharge.



The graph above demonstrates the developmental progression of our 5 initial patients in our developmental intensive program within the intensive phase of our rehab program. All patients demonstrated significant progress from a gross and fine motor skill perspective, even those who sustained neurological injury during their admission.

PHYSICAL AND OCCUPATIONAL THERAPY





The graphs above demonstrate the progress of a patient who underwent Heart Mate 3 placement and participated in our intensive rehab program post operatively. It took him approximately 2 weeks to return to his baseline functional level post operatively. He then underwent a heart transplant approximately 5 months later and returned to his functional baseline with 5 days of transplant.

ACT PATIENTS – JUST A FEW OF OUR SUCCESS STORIES FROM 2023

PHYSICAL AND OCCUPATIONAL THERAPY

We became involved in the Nursing VAD education in both the didactic and simulation portions of the class and have built and adapted our education to best support nursing carry over of activity expectations outside of therapy to maximize patient outcomes. We also worked with the Nursing Professional Development Team to create video references for nursing to support nursing beyond the completion of their mandatory VAD education.

From a general Cardiac Center perspective, our team utilized evidence-based practice and best practice recommendations, to update and further delineate sternal precautions based on patient ages to improve parental understanding of limitations post-operatively. We initiated Thursdays with Therapy with the help of the Clinical Nurse Educators to provide monthly nursing education on the role of physical and occupational therapy, neurodevelopmental education, sternal precautions, scar massage, delirium preventions, and other important education topics for nursing across the cardiac center. Thursdays with Therapy also includes speech therapy and important oral stimulation and feeding topics.

RESEARCH HIGHLIGHTS

Our ACT Rehab Leads presented on the state, national and international stages with presentations at The World Congress of Pediatric Cardiology and Cardiac Surgery, the American Academy of Pediatrics and the Pennsylvania Occupational Therapy Association. We also presented a webinar to the Cardiac Neurodevelopmental Outcomes Collaborative on our ACT Intensive Rehab Program.

ON THE HORIZON

From an ACT Rehab programmatic perspective, we are looking forward to presenting at the American Physical Therapy Association and American Occupational Therapy Association conferences as well as at the International Society of Heart and Lung Transplantation in Prague in 2024. We are planning to pilot EPIC Snapboard to allow for improved awareness of intensive therapy schedules for nursing and decrease inefficiencies that impact total therapy time for our patients. We will also be working toward formalizing our approach of postural assessment in infants with Berlins to gain a more in depth understanding of how the cannulas/pump impact them from a strength, range of motion, and motor skill acquisition perspective.

From a general PT/OT perspective, we are expanding Thursdays with Therapy to include other disciplines including Integrative Health and Lactation and exploring the modification and implementation of Critical Care Levels and ICU liberation program on the CICU. With all that we have learned from the ACT program, we are also planning to re-evaluate our standard of care for our neurodevelopmental population to determine what the most effective frequency, intensity, and duration of services for patients is. With that we are also looking toward implementing more formalized assessments for high-risk infants and are discussing considerations for opportunities to extend intensive and developmental intensive rehab services outside of the Advanced Heart Failure population.

STUTMAN FOLLOW UP PROGRAM

TEAM

Amy Schultz, MD
Medical Director

Sara Baumgarten, BA
Program Manager

Katelyn Zeoli, BSN
Nurse Manager

Hollis McLaughlin, RN, BSN
Stutman Cardiac Outreach Nurse Navigator

The Cardiac Center at CHOP launched an exciting new program in Fall 2023 with the aim to provide additional clinical and resource support to one of our most vulnerable populations: infants under 1 year of age being discharged after their initial admission or cardiac surgery. The Stutman Program began enrolling patients on November 27th, 2023. Led by Medical Director Amy Schultz, Program Manager Sara Baumgarten and Nurse Manager Katelyn Zeoli, the Stutman Program helps facilitate a seamless transition from hospital to home and aid in reducing stress and anxiety for families. In October 2023 Hollis McLaughlin, RN, BSN transitioned into the role of the Stutman Cardiac Outreach Nurse Navigator. The Stutman Cardiac Nurse Navigator contacts and follows up with families in the days after discharge and longitudinally to assess and monitor key factors that may affect how the baby and family transition to home, including nutrition and feeding, surgical incision care, durable medical equipment and supplies, psychosocial supports and accessing medical and community services. We work in close collaboration with Cardiac Nutrition dieticians, Speech therapy, Cardiac Surgery and Cardiology team members within CHOP and in the community. The Stutman Program bridges the time between discharge and the first follow up appointment so that all patients have access to the support needed to successfully transition to home and back to the care of their outpatient providers.

The Stutman Program aids patients with primary cardiology care both within and outside of the CHOP network. We hope to expand this population in the future as the program grows and evolves. The Stutman Program works alongside other outpatient support programs such as ISVMP and Cardiac Care Management to ensure all infants can receive support after discharge. The program also facilitates enhanced communication and collaboration between the Cardiac Center at CHOP and community healthcare providers.

STUTMAN FOLLOW UP PROGRAM

The program offers:

- Postoperative incision monitoring to enhance wound healing and decrease risk for wound infection
- Oral and enteral feeding support through telephone check-ins and close collaboration with Nutrition and Speech departments to assess needs and assist with scheduling Nutrition, Speech and Feeding evaluations, and follow up appointments
- Psychosocial support through telephone check ins, introduction and reinforcement of Ollie's Branch psychosocial services, assistance with navigating applying for community services and normalizing seeking support
- Assistance navigating the healthcare system and community services through patient advocacy, scheduling support, vendor support and physician communication

The Stutman Nurse Navigator is an easily accessible resource for families and physicians. When a patient is discharged from CHOP, the Nurse Navigator makes the initial post-discharge call within 24-48 hours. Families are provided with contact information for the program at the initial contact and are encouraged to reach out with questions and concerns. Additional check-in calls can be scheduled per family preference or if indicated, or the Nurse Navigator will make a pre-visit call the day before the cardiology follow up appointment to ensure all resources are in place for the appointment. Then Nurse Navigator then makes a post-visit call and will continue to check in with the families at regular intervals until the patient no longer requires the support and the family feels ready to navigate the system independently. The Nurse Navigator acts as a liaison between the family and the healthcare community. The Nurse Navigator can be found under Care Teams in the patient chart.

In the short time the Stutman Program has been operating we have been able to assist patients with early identification of wound infections, feeding intolerance and formula issues, appointment scheduling, DME vendor and private-duty nursing support and helped to facilitate transfer to CHOP from outside institutions for higher level of care. We have enrolled 30 patients in the first 2 months of operation. The program has also expanded from its initial population of post-surgical patients under 1 year of age to include patients under 1 year of age after their initial hospitalization, whether that be an SDU admission or a new postnatal diagnosis. The Nurse Navigator is uniquely positioned to reinforce the discharge education families received before discharge in an outpatient setting. The Stutman Nurse Navigator is an easily accessible resource to the patients and families during this vulnerable time. With the implementation of the Stutman Cardiac Outreach Program, the Cardiac Center looks forward to facilitating the recovery of our youngest patients and enhancing the experience of our patients and families.

To Make a Referral:
Reach out to Hollis McLaughlin RN, BSN
StutmanProgram@chop.edu
215-590-0439

CARE MANAGEMENT PROGRAM

Annique Hogan, MD
Medical Director, Care Management, Compass Care, Complex Care Blue, and CHOP Home Care

Noelle Heavey, MSN, RN, NE-BC, CPN
Nurse Manager, Care Management

Anna Simon, BSN, MTh, RN, CPN
RN Care Manager

Megan Fulmer BSN, RN
RN Care Manager

NOT PICTURED:

Michele Hillman, DNP, RN, NE-BC, CCM
Senior Director, Case and Care Management

Michele Palmer, MSN, RN, CCM
Supervisor, Care Management

The Cardiac Care Management Program constitutes a central pillar within the Centralized Care Management Department which serves over 1400 patients. Operating within the overarching framework of the Care Management Department, cardiac patients benefit from comprehensive support through various models in the Department, prominently including the Cardiac Care Management Program, Compass Care Program, and RN Care Managers who support the CHOP Care Network. The Care Management Department is committed to providing support to patients with complex medical conditions spanning multiple body systems, necessitating the expertise of numerous medical specialties at CHOP, and experiencing frequent inpatient admissions annually, yet not currently benefiting from a disease-specific care management model. Our Cardiac Care Managers, Anna Simon, and Megan Fulmer, follow a cohort of seventy-five cardiac patients, prioritizing their primary care management requirements linked to cardiac diagnoses. The RN Care Managers are dedicated to orchestrating integrated, longitudinal care planning supplemented by contingency measures, fostering seamless communication among care team members, delivering intensive transition support, advocating for patients' access to community and social services, and providing comprehensive patient and family education. Our overarching goal is to adopt a proactive stance towards addressing patients' care needs.

CARE MANAGEMENT PROGRAM

The Cardiac RN Care Managers work in close partnership with the inpatient care team, actively engaging in daily Progression of Care Rounds. They also foster collaboration with the Case Management team and the Stutman Program Nurse Navigator, facilitating the identification of referrals and thorough discussions regarding outstanding needs prior to discharge. Following a patient's discharge, our team ensures prompt contact with patients and caregivers within 48 hours and within 72 hours for weekend discharges, focusing on addressing caregivers' questions and concerns, conducting medication reconciliation, reviewing the plan of care, and ensuring all the patient's necessary supplies and equipment are in the home. The RN Care Managers serve a vital resource to the family, providing invaluable support and guidance as they navigate their child's care journey. Anna and Megan have enrolled over 200 patients in the program.

Our endeavors extend beyond the immediate medical interventions, aiming to empower patients and caregivers for future self-management to navigate the healthcare system. Emphasizing a comprehensive approach, we collaborate closely with families to address many factors influencing health outcomes. Drawing upon over 35 years of combined nursing experience, Anna and Megan represent invaluable assets to our patients and families, the Cardiac Center, and the Care Management Department. Patients can access our program through referrals from any CHOP provider, following which they undergo screening for enrollm

TRANSITION TO HOME

Emmanuelle Favilla, MD
Inpatient Team Lead

Sarah Bakke, CRNP
Advanced Practice Provider

NOT PICTURED:
Caylynn Markowitz, RN
Nursing Discharge Coordinator

Transitions from the hospital to home are a tenuous and fragile time for patients and families. As such, we have created a multi-disciplinary team, focusing on optimizing a safe transition plan for our most vulnerable families. The work that initially started in the spring of 2022 in collaboration with the Pediatric Acute Care Cardiology Collaborative, pertaining to patients' medical readiness and subsequent timely discharges within two hours, has developed into a broader aspect of work, bridging the span of care from the cardiac ICU, the Cardiac Care Unit/Infant Transitional Care Unit , and ultimately to the outpatient setting.

The inpatient team has been led by Emmanuelle Favilla, MD, Sarah Bakke, CRNP, and Caylynn Markowitz, RN, as the Advanced Practice Provider and Nursing discharge coordinators. Their work has focused on supporting families with anticipatory planning for eventual discharge, pertaining to factors from caregiver education, insurance enrollment, and creating a sustainable framework for a patient's care at home. Sarah's multidisciplinary collaboration has allowed for anticipatory planning of discharge needs even prior to admission among our complex lymphatics population. Her work has allowed for optimization of resource utilization by using intake assessments for eventual discharge needs, ranging from medication to transportation. This has in turn impacted a safe and timely transition home for patients with long journeys ahead of them.

Sarah's expertise and continued growth within the realm of informatics and quality improvement continues to open opportunities for transparency in communications by harnessing the EMR, among the intricate multidisciplinary teams that come together to ensure a safe discharge—ranging from our flow facilitators, bedside care teams, ancillary support teams, and families.

Sarah and Caylynn are spearheading efforts to integrate this work into that of the cardiac ICU, as patients' clinical status stabilizes, and preparing for transfer to the acute care units. Meeting families and providers at the bedside leading up to transfer from the intensive care unit serves as a framework for transparency in discharge expectations and needs. These are just the initial phases of multi-disciplinary collaboration aiming to provide families and patients with a supportive transition home. We are continuing to ensure partnership in both the inpatient and outpatient settings, as we look forward to continuing to optimize our patients' care during what is often the most stressful of times in their journey with congenital heart disease.

CARDIAC CENTER

OPERATIONS TEAM

In 2023, the Cardiac Center Operations Team continued to drive operational excellence through focus on throughput, utilization, efficiency, inventory management and financial stewardship. The Executive Operations Team worked closely with division leadership to ensure strategic collaboration for resource alignment and planning for the following fiscal year. Below are several key highlights from this year.

TEAM

Mark Schwartz, MBA, M.Ed.
Senior Director, Cardiac Center Administration and Service Line

Vivek Allada, MD
Director, Cardiac Center Strategic Operations

Sherri Kubis, RN, MSN
Senior Director of Cardiac Nursing

Lawrence Barnes, MBA
Senior Director Physician Practice Operations and Outreach, Pediatric Cardiology

Victoria Otarola
Senior Director, Anesthesiology and Critical Care Medicine

Rebecca Cardoso, MHA
Administrative Director, Cardiac Anesthesiology & Cardiac Critical Care Medicine

Heather Meldrum, RN, BSN
Cardiac Center Procedure, Care Coordination and Flow Manager

Jenny Osborne, RN, MSN
Clinical Operations Manager, Cardiac Center

CARDIAC CENTER

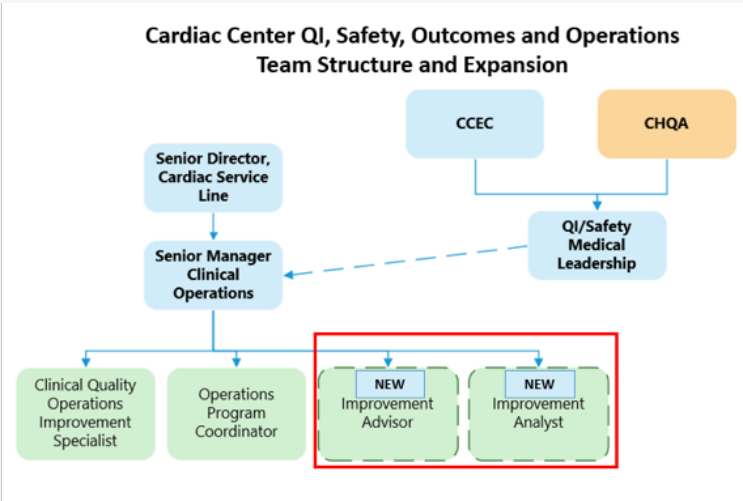
OPERATIONS TEAM

PROCEDURAL UTILIZATION

- Procedure room utilization: centerline above goal since Spring of 2023
- Block schedule optimization: above goal of 90% throughout 2023
- Procedural volume: at budget or above for CT Surg and Cath for 2023

STRATEGY AND STRUCTURE:

- Executive Operations Committee continued to collaborate across divisions to better drive operational efforts based on strategy, growth, and financial factors
- Multidisciplinary strategic workstreams from 2022 leadership retreat continued to lead planning efforts for Outpatient and Inpatient Growth and New Patient Tower transition and provided key updates at the fall 2023 leadership retreat with new initiatives launching in 2024
- 2023 saw the collaboration and expansion of the Cardiac Center QI, Safety and Outcomes Program with the planning and integration of two internal improvement team members in 2024, more optimizations to come in 2024 from this program



CARDIAC CENTER

OPERATIONS TEAM

EFFICIENCY AND THROUGHPUT

- Launch of Throughput Program: CICU and CCU workgroups charged with project creation and sustainment, goal of reducing overall length of stay (LOS)
- Cardiac Flow Facilitator Team continued to manage through high volume days, while simultaneously streamlining communication and situational awareness with the launch of their new Cardiac Command Center
- Includes 5 monitors tracking today and tomorrow's schedule and live updates on bed movement

Cardiac Command Center

FINANCIAL STEWARDSHIP AND INVENTORY MANAGEMENT

- Re-design of procedural space inventory management and supply chain policies to enhance safety and cost savings
- Cardiac OR: graft inventory analysis, surgical set standardization and development, PAR level evaluation, and team and central processing communication has resulted in over $328,000 in financial savings in 2023
- Cardiac Cath Lab: Developed 2-year strategic plan for Cath lab supplies and inventory, implementations so far have included systems for evaluating expired supplies, eliminating waste, and partnering with vendors to improve contracts resulting in over $36,000 in financial savings in 2023

NURSE NAVIGATOR/ REFERRAL

CARDIAC CENTER REFERRAL AND NURSE NAVIGATOR TEAM

The Cardiac Center's Referral Team, led by Katelyn Zeoli BSN, is dedicated to aiding referring physicians, new patients, and their families in connecting with CHOP's Cardiac Center. Shannon Paoletti joined the team this year transitioning to a Referral Nurse Navigator from her previous role of Cardiac Center Scheduler. She joins the other nurse navigators on the team: Bethany Seidel, Kristen Skrobanek, MarlaJan Wexler, and Shaylyn Leahy as well as our Access Coordinator Kelly Thomas. With this dedicated team, the program engages with referring physicians and families from all over the country. The referral process is typically initiated through direct communication channels such as phone calls and emails. This ensures that the nurse navigator team can efficiently gather essential information for triaging or clinical review by our expert physicians.

Katelyn Zeoli, BSN
Manager, Cardiac Center Referrals and Nurse Navigator Team

The program's nationwide reach is a testament to its effectiveness in addressing the diverse needs of physicians and families seeking specialized pediatric cardiology services in the Cardiac Center at CHOP. Our referral program places a strong emphasis on fostering collaborative relationships with pediatric cardiologists from various institutions in our area as well as many of the private practice cardiologists in New Jersey and across the country. The team maintains a constant line of communication and continues to build on our relationships with outside institutions such as Geisenger. Averaging approximately 200 referrals monthly, our program handles a diverse range of cases, including transfers of care, second opinions, referrals for cardiac procedures, advanced imaging, and participation in our specialty programs. This robust interaction ensures a seamless and efficient referral process, working with our dedicated scheduling team to facilitate timely access to our specialized pediatric cardiac services. The team works to ensure both physicians and families in the community have a direct line of access to connect to our flagship programs such as Jill and Mark Fishman Center for Lymphatic Imaging and Intervention, and the Topolewski Pediatric Heart Valve Center. The specialty programs that received the most direct referrals this year were the Electrophysiology and Heart Failure programs.

The referral team also collaborates with our Global Medicine Program to navigate the intricate processes involved in seeking cardiac care at CHOP from locations outside the United States. This collaborative effort is dedicated to facilitating access and navigating the challenges that may arise when families and patients from international destinations seek access to the specialized services offered at CHOP in the Cardiac Center.

Through strategic collaboration and a focus on building strong partnerships, our referral program plays a pivotal role in extending our reach and providing exceptional cardiac care to a broad spectrum of patients. The team takes pride in maintaining its role as a dependable and comprehensive resource for both referring cardiologists and families both in our community and nationwide.

SCHEDULING AND CARE COORDINATION TEAM

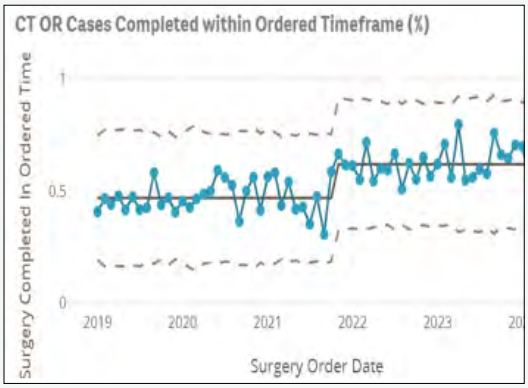
CARDIAC SCHEDULING AND CARE COORDINATION TEAM

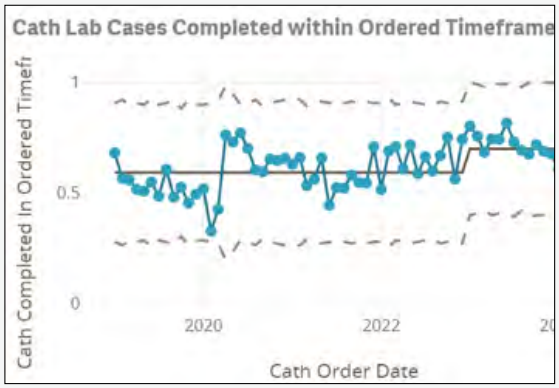
The Cardiac Center Scheduling and Care coordination team is dedicated to helping cardiac patients schedule and coordinate care that is needed. The Cardiac Scheduling Team is dedicated to helping CHOP physicians coordinate care and testing for their patients. The current team consists of a Cardiac Center Access Coordinator, Samirah Nadar and four Nurse Coordinators: Mary Kay Avington, Christine Gossard, Jennifer O'Neill and Stephanie Valadez.

Heather Meldrum
Manager

Care coordination involves review of orders, evaluation of timing and review of needs, insurance review and timing for authorization, dental clearance, collaborate pre-testing and imaging performed in the cardiac complex, while providing feedback to family and provider. Procedures that the cardiac scheduling team schedules are CT surgery, Cardiac Cath, Lymphatic, EP procedures, Cardiac MRI and Sedated ECHOs. Team collaborates with Cardiac Anesthesia to assist in scheduling other procedures if being combined with cardiac procedures also.

The goal of the scheduling team is to support patients and families with coordination of care in a timely manner while maximizing the utilization of the block schedule, increase procedural volume and decrease backlog. Improved utilization has assisted in a decrease in backlog and improved procedure scheduling within requested timeframe over the past year.





PROJECTS FOR IMPROVEMENT

The scheduling team is involved in multiple initiatives this year to help improve transparency and efficiency.

- Epic Refuel: team engaged in work groups to support epic modifications for cardiac procedures.
- Procedure pass; new epic enhancement to improve communication and transparency.
- Dental clearance: building tools to include in after visit summary at cardiology visit, and awareness of resources available.
- MRI protocolling: MRI protocoling prior to scheduling will improve MRI scanner efficiency within block time utilization.
- Surgical Conference note: scheduled encounter to improve transparency and note accessibility.

QUALITY IMPROVEMENT & SAFETY

FACULTY

Cardiac Center QI Core Team

- Shobha Natarajan, MD
- David Hehir, MD
- Katie Kennedy, Senior Enterprise Improvement Advisor
- Andrea Kennedy, Cardiac Center Data Manager
- Jenny Osborne, Cardiac Center Senior Clinical Program Operations Manager
- Susan Ferry, Cardiac Center QI Specialist
- Kyle Winser, Analytics Lead
- Robert Olsen, Data Programmer/Analyst
- Leanne Cimato, BSN, RN, Manager, Enterprise Quality Improvement
- Leigh Foppert, Improvement Advisor
- Torrin Davis, Enterprise Improvement Advisor

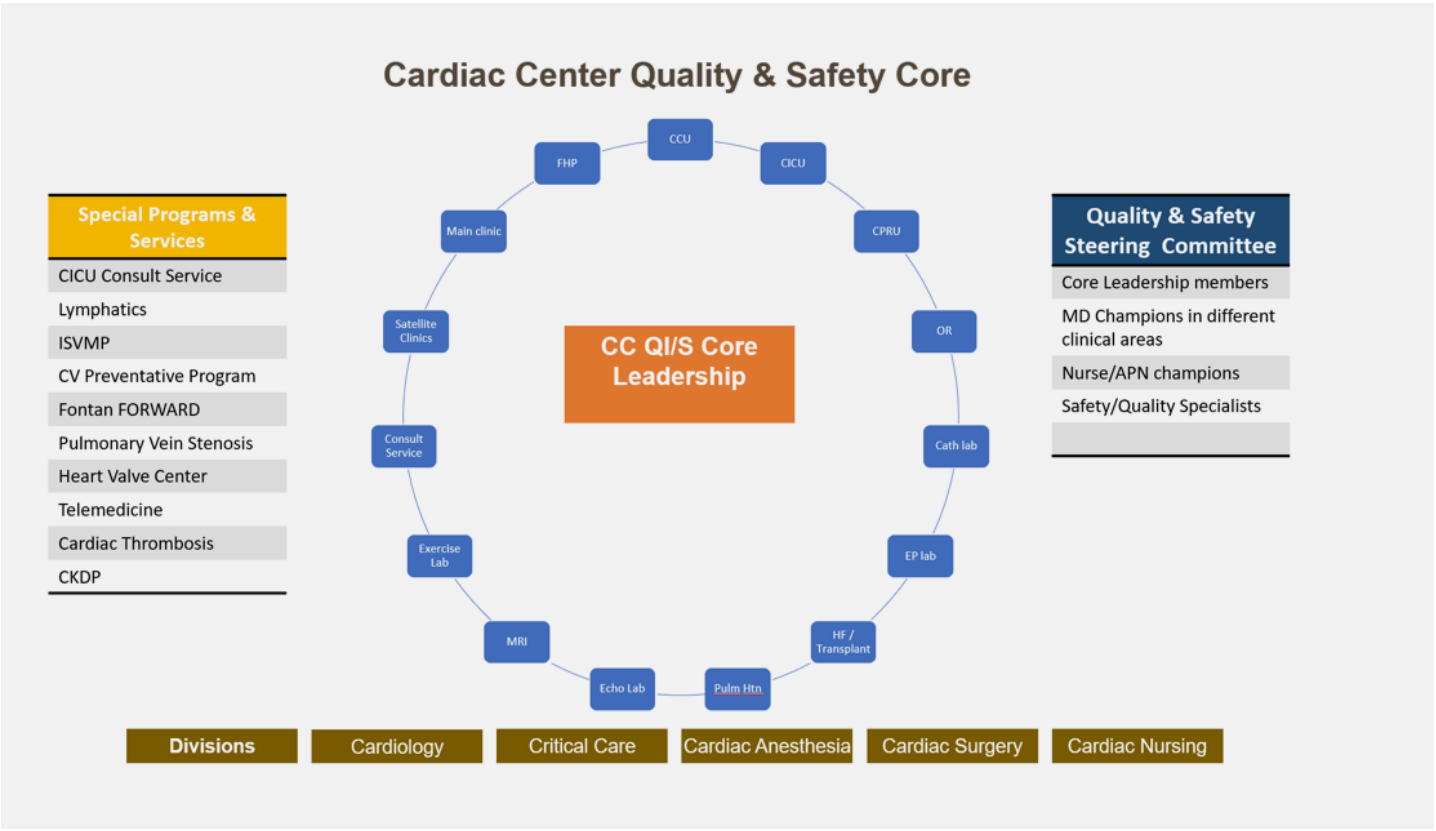
Shobha Natarajan, MD
Director, Cardiac Center QI

David Hehir, MD
Associate Director, Cardiac Center QI and Safety Officer

Led by Drs. Natarajan and Hehir, The Cardiac Center Quality Improvement (QI) and Safety Core continues its vision to engage, train, and promote leaders in improvement science and patient safety through bridging teams across the center. Expanded collaborations will facilitate multidisciplinary partnerships, engage leaders in QI and reducing harm, support a broad range of projects, and provide education and infrastructure to do the work.

QUALITY IMPROVEMENT & SAFETY

CARDIAC CENTER QI AND SAFETY CORE ORGANIZATIONAL STRUCTURE



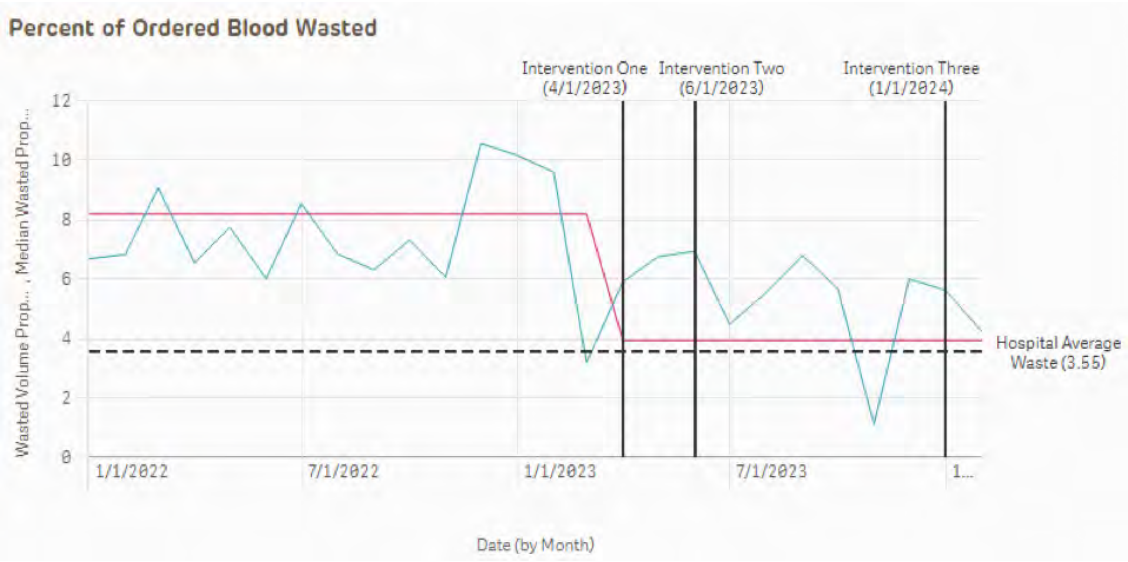
PAST YEAR ACCOMPLISHMENTS

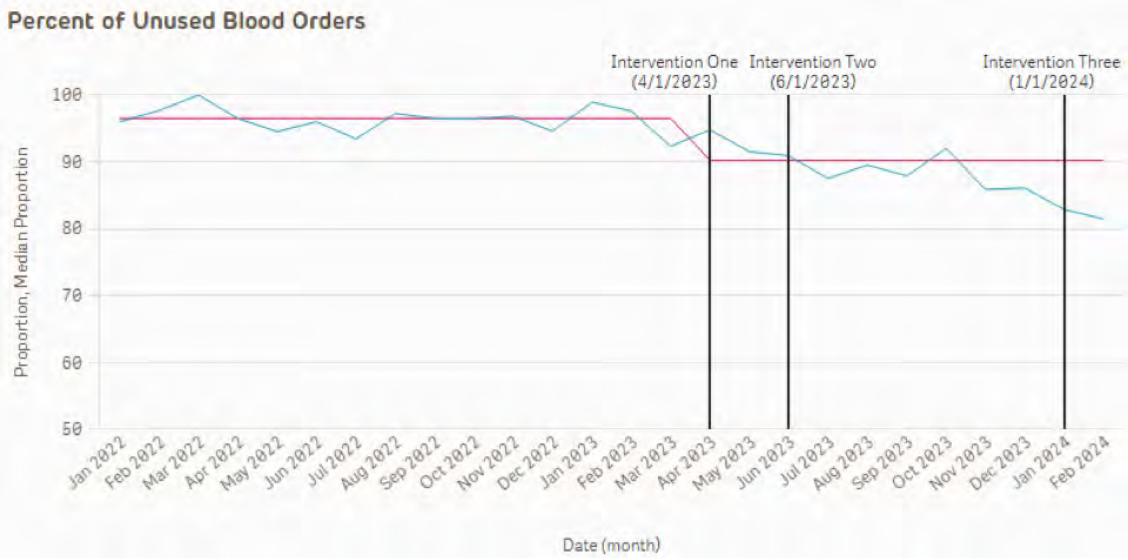
The Annual QI and Safety Forum was held in the Spring and supported the educational advancement mission of the QI and Safety Core by showcasing successful projects from the prior year. The forum also included a talk designed to help listeners envision, organize, and lay out the steps to begin a grassroots QI project. The Request for Proposals (RFP) application process to elicit support from an improvement advisor or data analyst in the Center for Healthcare Quality and Analytics (CHQA) was redesigned for easier use and year-round proposal submission.

The Cardiac Center EPIC Radar Dashboard transitioned a QI/Safety effort to an important clinical care tool within EPIC. Clinical pathway management has increased compliance with the review and revision of important cardiac clinical pathways. The Cardiac Center QI Project Tracker and Portfolio tool gained support and was launched in R Studio, providing a way to reduce siloes and increase transparency of QI and Safety project work across the center. Key performance indices, and QI and Safety outcomes tracking were enhanced by developing additional dashboards and data visualization capabilities to track quality and safety efforts. In addition, several projects were undertaken across the center:

QUALITY IMPROVEMENT & SAFETY

Reducing Blood Orders in the Cath Lab had a goals of reducing waste from pRBC units ordered for pediatric cardiac catheterization procedures and reducing the amount of unused pRBC orders for catheterization procedures by the end of December 2023. By first assuring a pathway to emergency blood procurement, the team was able to de-implement automatic blood orders for outpatients >1 year old undergoing annual post transplant right heart cardiac catheterizations, and later PDA closure, ASD closure, PH study, aortic and pulmonary valvuloplasty. Additionally, splitting pRBCs for patients less than 5 kilograms was de-implemented. The team met their primary outcome goal of reducing the percent blood waste from 8.7% to <4% and those results have been sustained. Data continues to be collected to quanitfy the savings.





QUALITY IMPROVEMENT & SAFETY

Missed Care Opportunities has the goal of reducing the number of patients with heart disease who do not follow-up with cardiology. The cohort includes patients with serious cardiac disease who have missed the 1 year mark following a recommendation to follow up within that year. A series of dashboards with heat maps were created for tracking trends for these patients which will enable the future identification of trends to be addressed.

Cardiac Arrest Improvement work is an ongoing effort aimed at improving outcomes of patients who have had or are at risk for cardiac arrest. The work operates under the CAPER team leadership. The group has education, clinical, research, and continuous quality improvement emphasis and presented reminders for clinicans at a number of safety and quality-focused meetings across the center. Recent workstreams include assuring correct firing of alerts in EPIC, increasing consistent event reporting and data collection, utilizing consistent event reviews to identify systems issues for improvement, revamping cardiac arrest prevention identification and huddles, and leveraging a hot debrief process.

Decreasing Post-operative Complications after Cardiac Surgery to Improve Patient Outcomes is an initiative with 2 arms:

> Early recognition and ultimately decreasing residual lesions after cardic surgery: Still in the early phases of improvement, we have collected baseline data from the national registries and from EPIC about residual lesions. We have chosen our cohort of surgeries to focus on first, created a driver diagram to optimize early identification and reducing residual lesions, and are now starting our interventions.
>
> Course correction for those patients who are not following the expected post-operative course: This is a project to improve outcomes and decrease CICU length of stay by identifying patients who do not follow the expected post operative course, and correct their course by medical or interventional management. We plan to improve communication between providers through the operative and post-operative periods. Thorough review of available data led to enhanced understanding of patients who fail to meet Target-based Care milestones.

INTERNATIONAL FORUM ON QUALITY AND SAFETY IN HEALTHCARE

In May 2023, the Cardiac Center was proud to send five members of our team to Copenhagen to attend the International Forum on Quality and Safety in Healthcare, 2023, which was organized by the Institute for Healthcare Improvement and the British Medical Journal. Jaqueline Morrison MD, Katy Murtaugh RN, SQS, Emily Schwartz NP, Thomas Dietzman MD, and David Hehir MD represented the Cardiac Center with posters and presentations from the prior year's work. Our team was able to present their work to an international community of healthcare providers and those involved in healthcare quality and safety. (see posters, right)

Genetics testing for Electrophoresis Patients looks to standardize testing and results posting either through identification of a third party or through our own laboratory services. Enterprise-wide work may dovetail with our electrophysiology improvement project as this is a global issue.

QUALITY IMPROVEMENT & SAFETY

INTERNATIONAL FORUM ON QUALITY AND SAFETY IN HEALTHCARE

In May 2023, the Cardiac Center was proud to send five members of our team to Copenhagen to attend the International Forum on Quality and Safety in Healthcare, 2023, which was organized by the Institute for Healthcare Improvement and the British Medical Journal. Jaqueline Morrison MD, Katy Murtaugh RN, SQS, Emily Schwartz NP, Thomas Dietzman MD, and David Hehir MD represented the Cardiac Center with posters and presentations from the prior year's work. Our team was able to present their work to an international community of healthcare providers and those involved in healthcare quality and safety. (see posters, right)

Genetics testing for Electrophoresis Patients looks to standardize testing and results posting either through identification of a third party or through our own laboratory services. Enterprise-wide work may dovetail with our electrophysiology improvement project as this is a global issue.

Other projects include Language Services Optimization in the CICU, work on the *sedation pathway*, a spread project for *progressive mobility* and additional safety projects.

THE FUTURE STATE

Collaboration with the QI and Safety teams will further embed quality improvement processes through joint work tracking clinical improvement follow ups and action items identified in multidisciplinary clinical case conferences such as the Cardiac Neonatal Review and MMI.

The Cardiac Center anticipates supporting a broader portfolio of projects in the coming year both in partnership with CHQA Improvement Advisors and Analysts and through expansion of QI and safety resources from within the Cardiac Center. Quality, Safety, and Operations leaders have added two new improvement analysts with plans to lead longer-term initiatives and transition projects from sustain and spread phases to operations. In addition to projects led by CHQA or by the Cardiac Center Administrative Operations Team, local grassroots projects will also benefit by these new roles and resources. This new structure, which will meld QI, Safety, and Operations, will allow for a more integrated approach that decreases silos to benefit patients, families, and staff across the Cardiac Center.

PATIENT/FAMILY EXPERIENCE

The Cardiac Center patient and family experience program has been led by Sara Baumgarten and Jess Eichner with support from Christa Piccininni. Over the past year, they have focused on creating a more comprehensive program with additional representation for inpatient and outpatient needs. In the upcoming year, Emmanuelle Favilla and Kiana Redd will lead the inpatient experience and Rachel Keashan will lead the outpatient experience with continued leadership from Sara.

Sara Baumgarten, BA

Jessica Eichner, MSN, BSN, CRNP

Emannuelle Favilla

Rachel Keashan

Kiana Redd

Some of the highlights of the past year include a new outpatient visit look book with visual aids appropriate for use with children of various ages to guide them through their clinic appointments. Several satellite clinic sites also now have "Moving through the visit" bingo cards for a patient focused interactive experience.

Our family council continued to grow with addition of 7 new members including a former patient, and more fathers to balance out the group! The nursing education team worked with our council to develop a beautiful video with interviews of family members on their experiences with nurses while inpatient. The video is being used in nursing education routinely now at CHOP, is being added to the Cardiac Center Library and we are exploring ways to bring this valuable resource to a wider audience.

PATIENT/FAMILY EXPERIENCE

This year we also held a volunteer event for our Family Advisory Council members, which allowed them to give back to current patients in the hospital. We were able to create over 100 Heart Month Patient Bags for inpatients, Fetal Heart moms, and patients coming in for a same day procedure. These bags consisted of GrubHub gift cards, hats, socks, activity books, travel size toiletries, and blankets.

Highlights of our Ollie's Branch partnership from May – December 2023

- Referrals - 45 (62% are from families living in PA)
- 60% of clients actively engaged in therapy
- Sessions - 168
- 90% of clients matched, a few awaiting therapists with very specific requests
- 38 licensed therapists available
- 100% of clients with follow-up responses reported their treatment was extremely helpful

Testimonial from CHOP heart parent utilizing Ollie's Branch:
"I am so grateful for this and for the therapist they recommended. She is wonderful and so instrumental in helping me navigate through my grief."

In the upcoming year, we hope to have Pump Bags for breastfeeding moms readily available, find ways to get real time feedback from both inpatients & outpatients, update the nutrition room and playroom for those patients on 5 East, and continue to build on the new Outpatient Welcome Guide.

EDUCATION

EDUCATION LEADERS

Jenna Heichel MSN, BSN, CRNP

Meryl Cohen, MD, MSEd

Christina Piccinnini

Over the past year, the Cardiac Center Education Officers, Meryl Cohen, MD and Jenna Heichel, CRNP, along with their Program Coordinator, Christa Piccininni, have worked with various team members to expand educational resources throughout the Cardiac Center. The goal is to make these resources available to all colleagues as well as easily accessible in both inpatient and outpatient settings.

We continue to expand the Cardiac Center (digital) Library resources to include additional recorded lectures, associated journal articles and even the new employee welcome video. This digital guide enables us to better collate our cardiology resources and encourage continual learning and development. The library can be accessed via the link below or QR code with single sign-on access – log in while at CHOP, from home, or on the train! Our goal is to build a comprehensive catalogue of content submitted by our Cardiac Center colleagues that our employees can use for ongoing learning. Feel free to contribute your content by contacting our medical librarian, Bri Johnson (johnsonbk@chop.edu).
https://chop.libguides.com/cardiaclibrary/home

We have coordinated an additional lecture series this past year on Transposition of the Great Arteries. Experts from across the Cardiac Center have provided brief, recorded educational lectures on specific topics regarding the evaluation and management of our TGA patients. These lectures are housed on the Cardiac Center Library; if you haven't already, please check them out!

EDUCATION

The upcoming lecture series will review pediatric heart failure and its management, including the use of ventricular assist devices and pediatric heart transplantation – stay tuned for more.

We have also scheduled a diverse group of lecturers for our Cardiac Center Grand Rounds. These presentations are designed for all colleagues across the Cardiac Center and include both internal and external speakers. Throughout 2024, Grand Rounds are held on the 3rd Tuesday at 7:30am in Hope auditorium or via Teams. For past presentations, access the Grand Rounds Archive on the Cardiac Center Library (https://chop.libguides.com/cardiaclibrary/grandrounds). In 2023, we had prominent national and international speakers including Daniel Penny from Texas Children's Hospital, Ben Eidem from Mayo Clinic and Kisaburo Sakamoto from Mt, Fuji Children's Hospital. In March we had our first DEI focused lecture given by one of our former cardiology fellows, Kiona Allen from Lurie Children's Hospital. Please don't hesitate to reach out with suggestions for future speakers.

2023

NEW! Evolving? Surgical Managements In Patients with **Asplenia** (Right Atrial Isomerism)
Dr. Kisaburo Sakamoto
Director of the Department of CV Surgery
Mt. Fuji Shizuoka Children's Hospital
Recorded November 21, 2023

Moving Forward Together In the Care of Our Patients... Lessons From Unexpected Sources
Daniel Penny, MD, PhD, MHA
Chief of Cardiology
Co-Director, The Heart Center, Texas Children's Hospital
Recorded October 16, 2023

Cardiac Arrest In the Cardiac Intensive Care Unit: Where We Are and What's Next
Christine Riley, BS, MSN, APRN
Strategic Defense
Recorded July 25, 23

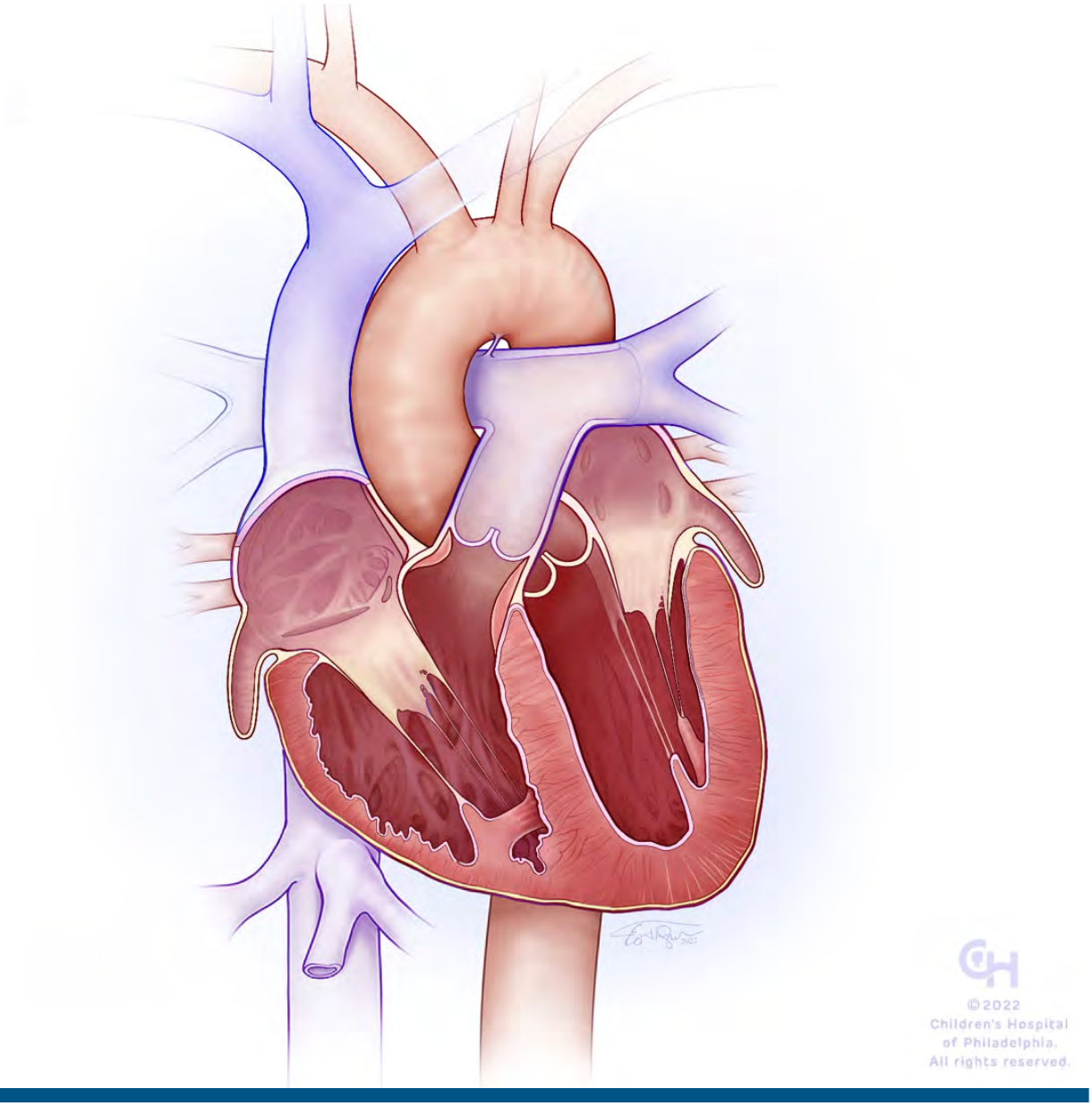
Ebstein Anomaly: Echocardiographic Imaging & Evolving Management Strategies
Benjamin W. Eidem, MD, FASE
Professor of Pediatrics & Medicine, Departments of Pediatrics & Cardiovascular Medicine, Mayo Clinic
President-Elect, American Society of Echocardiography

EDUCATION

The Cardiac Center APP Education Curriculum continues to be a success. This monthly series includes a wide variety of topics, from cardiac resynchronization therapy, to palliative care, to cardiopulmonary interactions. We are grateful to our many colleagues throughout the Cardiac Center who have taken the time to educate and support APP growth. We now proudly offer continuing education credits for all providers who attend!

Finally, we are working with the CHOP media lab, Stream Studios, to revise our current cardiac illustrations and expand the collection of images to include a wider variety of defects and procedures as well as images for acquired heart disease and ventricular assist devices. Along with the illustrations, we are updating the written descriptions available to our patients and families with inclusion of Spanish translation. This is a team effort and includes other members of the Cardiac Center including Stephanie Fuller, Amanda Shillingford, Felina Mille, Victoria Vetter, Katie Dodds, and Lindsey Loveland Baptist. Our hope is to improve the content and accessibility of educational information available to our patients and their families. We also are planning 3D images of heart disease and cardiac repairs for families to better understand what their children's procedures entail.

See an image here of the normal heart:



DATA & INFORMATION TECHNOLOGY GROUP

This past year has been exceptionally productive for the Cardiac Center Data and Information Technology group (CCDIT), where we continue to spark digital transformation, improve upon Cardiac Center technology infrastructure, and partner closely with CHOP Digital Technology Services (DTS) to provide optimal support for clinical, operational, and research missions of the Cardiac Center. Much of this work is supported by a dedicated team of:

- 5 Cardiac Center applications analysts (who oversee specialized Cardiac Systems like Syngo Echo, Sensis Cath, etc) - Brian Vanard, Nina Griffonetti, Jon Marsella, Bob Bovitt, and Jon Slowik.
- 2 Epic analysts (who optimize and build within Epic to tailor the system to Cardiac Center needs) – Karen Keough and Jason Ward
- 2 Nursing Informaticists (who bridge the gap between clinical workflow and technical builds in our technology systems) – Mary Beth Bartko and Theresa Hutchinson
- 1 DTS manager who oversees the enter above Cardiac DTS team - Chris Shultz
- A team of cardiac center clinical champions and superusers who translate technical details to clinical teams in the Cardiac Center.

Michael Goldsmith, MD
Cardiac Center
Technology & Information
Systems Leader

By far the biggest project for this team over the past year has been implementation of Epic's dedicated Cardiac module, Cupid. This 2-year, multi-phase project is an overhaul to the way cardiac diagnostics (Echocardiograms, Cardiac Catheterizations, Holter Monitors, etc.) are ordered, scheduled, documented, billed, and resulted; with a focus on moving toward digital workflows, improving ease of procedural scheduling, improved visibility and transportability of procedural results, and modernize interaction with our key Echo, Cath, and EP platforms. As part of this project, several other key systems will see upgrades including:

- Muse EKG reading software was embedded in Epic for faster access, and with discrete smartlinks for pulling EKG results into notes
- Apollo Healthview, our current repository of cardiac studies, procedures, and historic notes, was upgraded
- A new dedicated Cardiac tab has been created within Epic to house all Cardiac Diagnostic studies
- -Cardiac Applications team started first phase of backloading last 7 years of cardiac studies from Apollo into Epic (approximately 70,000 studies)
- Cardiac Surgery Case Conference will see improved workflow and integrations within Epic

DATA & INFORMATION TECHNOLOGY GROUP

This project required the tireless efforts of a team of 10+ dedicated DTS analysts, engineers, and nursing informaticists who partnered with over 30 Cardiac Center clinicians and providers to co-develop a system that best meets the need of our system. While many poured hours into this project, we highlight the work of **Mary Beth Bartko** *(pictured right)* – a nursing informaticist principle who has been fundamental to the success of Cupid and many other Cardiac Center informatics projects. Mary Beth has spent 45 years at CHOP, initially as a nurse in the Pediatric ICU (including working with Dr. Norwood in the Acute ICU caring for some of the earliest Cardiac Surgical patients at CHOP). After her time in the ICUs, she transitioned to be the Clinical Nurse Specialist for Radiology where she helped to develop sedation workflow at CHOP. She then moved to the informatics world where, for the last 15 years, she has supported the transition of various legacy systems to Epic-based systems, including in Radiology, OR, Anesthesia, and Perfusion. Mary Beth is noted for her remarkable ability to quickly connect with clinicians to understand how work gets done and who does the work. She can translate complex Electronic Medical Record (EMR) systems into understandable language for clinicians and visa-versa. She is always willing to entertain ideas and suggestions in developing EMR systems, taking her time to understand and investigate. Her unwavering positive attitude and can-do approach is universally respected and appreciated within the Cardiac Center. We are most appreciative of her leadership, wisdom and candor – she is truly invaluable to the success of our team and the development of Epic Cupid at CHOP.

Mary Beth Bartko, MSN

Additionally, below we highlight select awards and projects completed this year:

- Dr. Robert Palermo was named new Epic Clinical Champion for Ambulatory Cardiac
- Jessica (Kane) Ettore, BSN, RN, CPN was named new Epic Nursing Clinical Champion for Inpatient Cardiac
- Dr. Aaron Dorfman was elected as a member of the Epic Pediatric Cardiology Steering Board
- Cardiac DTS Applications team hired John Slowik, a systems analyst to primarily support the Echocardiography Lab
- Creation and implementation of a first-ever Cardiac Center Technology Roadmap – setting a 3-year course for technology development and implementation
- Regular Cardiac Informatics Office Hours were established as a forum for developing and improving Epic Cardiac upgrades
- Participation in CHOP-wide Technology Downtime/Ransomware Tabletop Exercise
- Creation of task-force to address Cardiac Center extended Technology Downtime/Ransomware risk
- Completed the merge of Syngo Cath with Syngo Echo to allow viewing of Echo and Cath studies on the same workstation
- New SentrySuite Exercise Lab application replaced VMAX
- More than 20 additional build projects in Epic to improve the clinical experience including:
  - Improved Cardiac ICU automatically-populating handoff report
  - Improved precharting report to save time and effort
  - New ACT-Heart Failure orderset and consult orders
  - New Cardiac Anticoagulation Team thrombosis dashboard
  - And many more

WELLNESS

The Cardiac Center Well-being Committee formed in the fall of 2021 and includes

Carol Wittlieb-Weber, MD
Cardiac Center Physician
Well-being Lead, Cardiology
Well-being Lead

Ashley Phillips, RN, BSN
Cardiac Center Nursing
Well-being Lead

Maryam Naim, MD
Cardiac ICU Well-being Lead

Lindsey Loveland Baptist, MD
Cardiac Anesthesia
Well-being Lead

Constantine Mavroudis, MD
Cardiothoracic Surgery
Well-being Lead

Sarah Bakke, CRNP
APP Well-being
Tepresentative

Christa Piccininni
Program Coordinator

Over the last year, the Well-being Committee has worked to increase visibility of provider well-being efforts in line with prioritization of provider well-being across the Cardiac Center. Resources have been focused on several Cardiac Center wide initiatives that hope to strengthen our culture of wellness. The Well-being Committee has received two Cardiac Center Academic Enrichment Awards (a total of $100,000 in grant funding) to support their work.

The 'recognition' program, led by Ashley Phillips, RN has the mission to recognize all members of the Cardiac Center on their respective (recognition) days in order to share gratitude for each individual's contribution. Currently, 26 different departments/disciplines active throughout the Cardiac Center are recognized each academic year with a small gift. Our goal is to continue to expand our recognition efforts to recognize work done both inpatient and in our outpatient offices. For 'Heart Month 2024', the Well-being Committee sponsored coloring walls across the Cardiac Center; Main Hospital, Buerger, and several of our outpatient offices in NJ and PA.

WELLNESS

Carol Wittlieb-Weber, MD, led the second annual Cardiac Center fitness initiative, Hearts on the Move. Through this initiative, 75 members of the Cardiac Center completed one of the races included in Philadelphia Marathon Weekend 2023 (34 8K, 33 half-marathon, 8 marathon) thanks to the support from the Exercise Lab team and funding from a Cardiac Center Academic Enrichment Award. The data collected from the first year of Hearts on the Move was presented as an oral abstract at the American Conference on Physician Health in the fall of 2023. The Hearts on the Move fitness initiative was recently recognized by hospital leaders as a Breakthrough Maker Moment. Given the success of this program, Hearts on the Move will return for Philadelphia Marathon Weekend 2024!






Lindsey Loveland Baptist, MD and Constantine Mavroudis, MD were awarded an Academic Enrichment Award for their initiative, "Academic Enrichment through Asynchronous Coaching: An in-app, Mobile based Approach to Burnout Mitigation using Targeted Education, Training and Data Feedback" which is in partnership with Arena Strive. We are excited to see the second phase of this initiative role out in 2024.

Maryam Naim, MD led efforts in the CICU focused on recruitment to keep pace with the growth of the CICU and evolving coverage models. The CICU successfully recruited 5 new attendings in the last academic year, an effort that will both support future growth but also, will support retention of existing faculty.

Sarah Bakke CRNP will be leading the first ever Cardiac Center Advanced Practice Provider Well-being Retreat which will be held in April 2024.

WELLNESS

The Cardiac Center Well-being Committee continues to support the Physician Women of the Cardiac Center (PWOC) group which includes over 75 female physicians from Cardiology, CICU, Cardiac Anesthesia, and Cardiothoracic Surgery including attending physicians, house physicians, and fellows in training. This year, PWOC welcomed Liz Moore, author of the New York Times bestselling book Long Bright River for a book club held in the HUB lounge. In honor of National Women Physician Day 2024, PWOC hosted Reshma Saujani CEO of Girls Who Code and author of Brave Not Perfect for a special guest lecture and discussion.

The Cardiac Center Well-being committee remains committed to continuing to serve cardiac patients and families by ensuring that their medical providers are optimally supported to provide high quality care in a healthy and sustainable way.

DATA & ANALYTICS

OVERVIEW

The Cardiac Center Product Team consists of Data Analytics and Engineering resources along with a team of Data Specialists who are all focused on the practical implementation of data solutions related to cardiac data management, collection, quality assurance, insights, and governance. The Product Team targets five key program areas:

1. Providing data solutions that meet the needs of our data consumer community.
2. Assessing, measuring, publishing, and communicating outcomes and clinical quality indicators, both internally and externally.
3. Implementation of data management best practices aimed at improving data timeliness, reliability, validity, and completeness in new and existing data collection efforts.
4. Development and maintenance of a data dictionary that serves as the identification of cardiac center data and source of truth for clinical data elements.
5. Participation in various, well-respected clinical data registries (STS, CCAS, ACC-NCDR, PC4, PAC3, CNOC, Perfusion PediPerform, Fontan Forward and CCRC) which serve as expert consensus on common data definitions and data standards.

LEADERSHIP

Andrea Kennedy
Manager Data Analytics

Kyle Winser
Analytics Lead

Kelly Veneziale
Clinical Data Specialist Lead

Data Team

- Robert Olsen, Sr. Data Analyst
- Kyle Winser, Sr. Data Analyst
- Benjamin Parrish, Data Analyst
- Nina Griffonetti, Sr. Data Engineer

Patient Reported Outcomes Program

- Eurrai Booth, Sr. Quality and Outcomes Specialist

Data Specialist Team

- Alison Hill, Clinical Data Specialist
- Brittany McClelland, Sr. Clinical Data Specialist
- Karen Murphy, Sr. Clinical Data Specialist
- Ashley Paulson, Clinical Data Specialist
- Judah Siomos, Sr. Clinical Data Specialist
- Melissa Wiggins, Sr. Clinical Data Specialist

DATA & ANALYTICS

HIGHLIGHTS/ACCOMPLISHMENTS LAST YEAR

- Supported many Quality Improvement Projects including Reducing Lost to Follow-up, Reducing Wait Times in Cardiology Visit, Reducing Blood Orders, Post-Op Lesions and Qualitative Monitoring of Neuromuscular Blockade.
- Automated new data pipeline to stream Cardiac U.S. News and World Report from source data to Enterprise Reporting Dashboards for real-time monitoring of metrics.
- Created dashboard and reporting suite of tools to monitor Cardiology Follow-up work queue to optimize scheduling for patients that would otherwise be missed.
- Revitalized the Cardiac SSI Qlikview into a modern Rstudio Dashboard which tracks SSIs for STS, NHSN, and Billing which results in fewer discrepancies across multiple data sources.
- Built dashboards to support the Cardiac Center Inpatient Throughput initiative, which aim to help positively impact opioid exposure, CICU LOS and timely transfers.
- Developed reports to support over 60 research requests.

MAJOR PROJECTS

- Developed Lipid Clinic Lab data import template which resulted in significant time savings each week.
- Improved huddle rates by approximately 300% for CICU patients newly flagging for Cardiac Arrest by developing and implementing missed-huddle-alert system.
- Created reports for the Cath Lab Blood Utilization Project which has resulted in reduced cardiac cath lab blood waste.

SUMMARY OF NEW/COMPLETED WORK

- Total New Requests - 159
- Research – 65 (41%)
- Administrative/operational – 40 (25%)
- QI – 24 (15%)
- Clinical Inquiry (non-research) – 22 (14%)
- Other – 8 (5%)

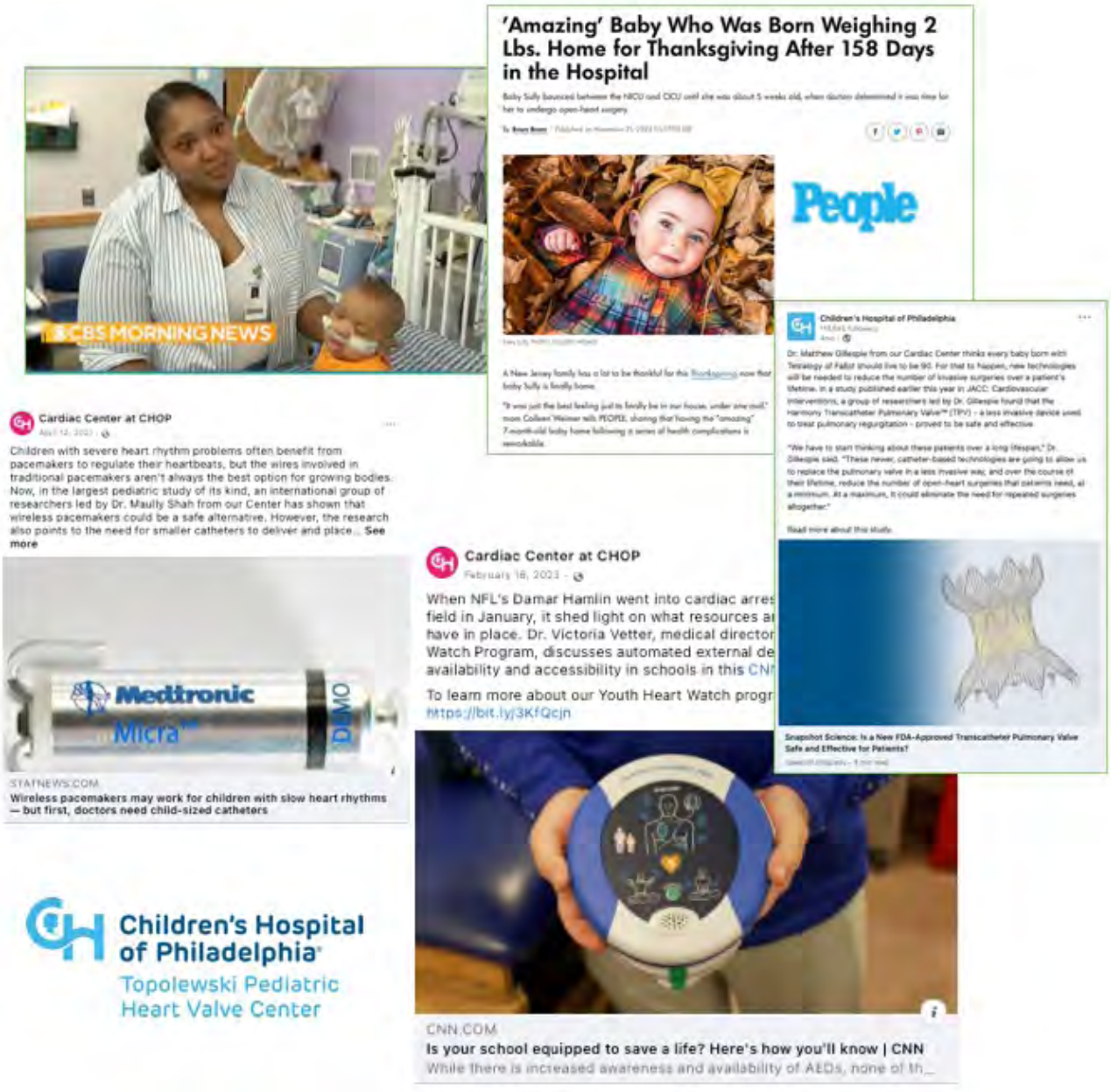
MARKETING/

PUBLIC RELATIONS

BUILDING THE BRAND | DRIVING BUSINESS | SUPPORTING EXPERIENCE

CLINICAL BREAKTHROUGHS AND PATIENT STORIES DROVE MEDIA IN 2023

- 2600+ Cardiac Center media mentions
- 2023 Heart Month Radio Media Tour with Dr. Matt O'Connor
  - 20 interviews, **reaching 11million+ people in 118 markets across the country.**
- 530+ Cardiac related social media posts shared across all of CHOP social media channels



MARKETING/

PUBLIC RELATIONS

DIGITAL UPDATES

- CHOP.edu redesign overhaul underway
- +30 eNewsletters and emails reaching 5,000 professionals and 2,000 families
- Doximity campaigns reaching +3,000 referrers

TOP STORIES OF 2023

- Cameron Knowles, patient who received the smallest pacemaker – story featured on CBS News nationally and with more than 200 airings across the country in various markets
- Heart surgery patient Sully from New Jersey featured in People magazine and front page of Asbury Park Press
- Dr. Maully Shah's leadless pacemaker research featured in STAT News
- Dr. Cody Gathers sudden cardiac arrest research presented at AHA conference and featured in multiple news outlets and via a radio spot
- Dr. Vicki Vetter interviewed by CNN about sudden cardiac arrest and AEDs in schools, and by Philadelphia Inquirer for a story about collaboration with Daniel Rumph Foundation and our Youth Heart Watch
- Press release announcement of naming of Topolewski Pediatric Heart Valve Center

TRADITIONAL MARKETING AND PROMOTION

- Naming of the Topelewski Heart Valve Center
- Fetal Heart Program Annex Opens in Bryn Mawr
- Cardiology 2023 – Puerto Rico
- Cardiac Center Video
- 8th World Congress for Pediatric Cardiology and Cardiothoracic Surgery
- Network/Regional Advertising

PHILANTHROPY

OVERVIEW OF THE FOUNDATION

The CHOP Foundation has grown significantly, both in size and fundraising capacity with successful outcomes. For the Cardiac Center, fundraising is multi-faceted and requires collaboration across the enterprise. Our teams work in close partnership with cardiac leadership, faculty, and staff to understand and advocate for the needs of the Cardiac Center related to clinical care, patient and family experience, training and education, and innovative research. Our progress is built on a foundation of trust and a mutually shared desire to advance the vision and goals of the Cardiac Center through external partnerships. In this past year, we have established a new infrastructure that integrates multiple fundraising streams. We are excited about the foundation we have built over the last year and look forward to the opportunities it will create within the Cardiac Center.

FOUNDATION TEAM DEDICATED TO THE CARDIAC CENTER

The CHOP Foundation has continued its rapid growth over the past year to accommodate the growing volume and sophistication of our donors. Multiple teams comprise the fundraising strategies that engage support for the Cardiac Center. These teams work in concert to drive revenue from multiple charitable sources, all to support the strategic goals and priorities of the Cardiac Center. Below is the integrated structure of our Foundation partners supporting the Cardiac Center.

Summary of Fundraising Performance FY 23

Total Giving	$10,950,039
Total Donors	11,925
Total Number of Gifts	11,931
Total Number of Fund Allocations	41
Average Gift Size	$1,036

PHILANTHROPY

BOARD OF VISITORS

The Cardiac Board of Visitors continues to be a committed and enthusiastic group, dedicated to ensuring philanthropic support to the Cardiac Center to advance its goals and vision. This growing, multigenerational group of donors includes parents, grandparents, and adult former pediatric patients. At the core, their goal is to advance the division through philanthropy. We are fortunate to have in this group philanthropists living and working in Philadelphia and beyond, who see how CHOP is advancing the field of pediatric cardiac care. Our members meet twice each year to learn and share holistically about what it means to advance the field by supporting research breakthroughs, clinical care, recruitment, and training the next generation of talent. They also work to support emerging priorities and initiatives in the Cardiac Center, like psychosocial support for patients and families. In FY23, our BOV donated $204,848.54 through many vehicles. For example, one member used her 70th birthday as a fundraising opportunity, while another member fundraised around Philly Spin-In by starting a team in honor of their young son. Cardiac Center is fortunate to have a deeply engaged support system in the Cardiac BOV.

PHILLY SPIN IN HIGHLIGHTS

2024 Philly Spin-In as of 2/19/24
Total Donations + Sponsorship+ Registration fee = **$594,014**

Revenue Stream	Raised	Target Goal	% Raised	FY23 YOY
Registration	$33,480	$56,500	59%	$31,325
Fundraising	$403,534	$760,000	53%	$389,913
Sponsorship	$157,000	$243,000	65%	$155,000
Match		$50,000	0%	$40,000
TOTAL	$594,014	$1,109,500	54%	$576,238

KPI	Current	Goal	% to goal	
Teams	187	235	80%	188

YOY NUMBERS

	2017	2018	2019	2020	2021	2022	2023
Teams	84	130	163	165	154	199	200
Participants	480	900	1,449	1668	1193	1660	1940
Number of Donors	2,995	5,531	6,761	7,152	6,785	8,784	8,781
Dollars Raised	$221,350.00	$424,793.75	$571,398.22	$674,169.00	$675,004.00	$824,991.00	$ 1,147,338.58
TOTAL	$4,539,044.55						

PHILANTHROPY

KEY SPIN-IN UPDATES

- In November 2023 we hosted our first ever Philly Spin-In Cardiac Center Innovation Awards Day. We invited Philly Spin-In team captains, CHOP staff and Cardiac Center donors to hear from four innovation award winners and the work they are doing in the CHOP Cardiac Center.
- As of 2.19.24 – 227 CHOP employees are registered to participate in Philly Spin-In –
- Innovation Awards Funded: 28
- Heart of Gold Award 2024
  - 122 Nominations
    - 87 coming from CHOP staff

KEY TAKEAWAYS AND DEVELOPMENTS ON THE HORIZON

Phill Spin-In continues to be an integral asset to the Cardiac Center fundraising strategy, as both a rising annual revenue stream and pillar of culture that galvanizes patient families, faculty and staff, and the community at-large. The Cardiac Center is grateful to all participants who support this signature event.

The Cardiac Center Major Gifts program continues to be a source of potential as we work to expand the capacity of the Cardiac Center through strategic priorities of 1) Patient Experience, 2) Innovation & Research, and 3) People, Training, & Talent. It will be essential to take a diversified approach to our fundraising efforts as we continue to support the Cardiac Center of the future. With our new team structure firmly in place, we intend to further build and employ the strengths of this team-based approach, focusing on building a higher volume for Annual Gifts, leveraging the Spin In for new corporate partnerships, and utilizing the strengths of our Major Gift Officer and Director of Development to engage larger populations of interested supporters, such as CHOP Cardiac Center grandparents to build a more consistent Major Gift streams.

PHILANTHROPY

PHILLY SPIN IN

On March 9th and 10th over 2,000 people rode for the big and little hearts at CHOP at our 8th annual Philly Spin-In. More than 300 teams consisting of grateful patients families, CHOP staff and corporate partners raised over $1 million dollars to support the Cardiac Center Innovation Awards. Since inception this event has raised more than $5.5 million dollars for the Cardiac Center at CHOP.

CARDIOLOGY CONFERENCE

The 27th annual **Update on Pediatric and Congenital Cardiac Disease** was held in Scottsdale, Arizona From February 13th through February 18th. Over 650 people attended from throughout the country and internationally, and there were 200 abstracts submitted. The theme of the conference was ***Actual (Not Artificial) Intelligence in Pediatric & Congenital Cardiovascular Disease What do we know and what do we need to learn?***

In addition to the wide variety of plenary sessions, break-out sessions, panel discussions, special events, abstract presentations and posters - this year, at the annual CHOP Alumni Dinner - **Jack Rome, MD** (pictured below) was the honoree and recipient of the **2024 Cardiac Center Distinguished Achievement Award** - for his years of dedicated service, contributions and mentorship. Once again, thanks to **Jack Rychik, MD, Katie Dodds, CRNP and Christina Mannices** and her team for their leadership efforts in making the conference a huge success

CARDIOVASCULAR INSTITUTE

Daniel Kelly, MD, PhD
ACT Frontier Program
Co-Investigator

CHOP CARDIOVASCULAR INSTITUTE

Pediatric cardiology and cardiac surgery at CHOP are well-known as leaders in the care of children with congenital forms of heart and vascular disease, and in the development of breakthrough therapeutics and diagnostics. The CHOP Cardiac Center was established to further integrate the pediatric cardiologic, cardiac surgery and cardiac anesthesia/critical care groups. CHOP leadership made a strategic decision to invest in the development of a comprehensive research center that spans from fundamental discoveries to their translation and clinical implementation in the Cardiac Center. To excel the development of a superb cardiovascular research enterprise at CHOP, the CHOP CVI was established in the spring of 2022 in partnership with the Penn CVI, under the common leadership provided by Dr. Daniel Kelly. An overview of the early-stage progress and long-term plans for the CHOP CVI is provided here, with emphasis on linkage to the CHOP Cardiac Center.

CHOP CVI MISSION STATEMENT

Channeling the expertise of top basic and translational scientists at Children's Hospital of Philadelphia (CHOP) and Penn, the CHOP CVI will enhance our understanding of pediatric cardiovascular disease and drive scientific discovery and medical breakthroughs that will improve pediatric cardiovascular treatment and care. One important goal of the CVI is to employ curated state-of-the-art scientific approaches, including imaging, metabolomics, and genomics to guide precision care for the individual patient (Figure 1). The objectives of the CVI are:

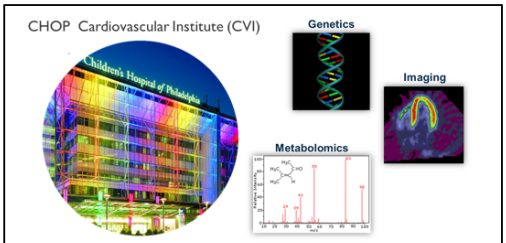


Figure 1. CHOP CVI mission: Towards precision pediatric cardiovascular care and breakthrough therapeutics.

- **Fundamental discovery** to elucidate the pathophysiology of pediatric heart and vasculature.
- **Translation** to rapidly move discovery to new paradigms in pediatric patient cardiovascular care.
- **Train the next generation** of pediatric cardiovascular scientists.

PROGRESS UPDATE KEYED TO 5-YEAR PLAN GOALS

1. **Establish CHOP CVI membership and website**. Over the past year, we opened CVI membership and launched its website (https://www.research.chop.edu/chop-cardiovascular-institute). The CHOP CVI now has 32 faculty members with basic or clinical research interests in the broad arena of pediatric cardiovascular disease. In addition to providing information about the faculty, the website displays important current news information such as awards and notable publications by the CVI members. The website also holds information for educational activities sponsored by various entities at CHOP and Penn, including the weekly Penn CVI Seminar Series. FY25 Plans: Continue to expand membership as outlined below.

2. **Faculty recruitment.** As outlined in last year's annual report, we have endeavored to recruit a mid-to-senior level scientist with research interest in the area of pediatric cardiovascular disease to establish the first CVI Scientific Program, complementing the existing Center/Programs within the Penn CVI (Figure 2). We are in the final stages of negotiating with a candidate who is a leader in the genetics of congenital heart disease. FY25 Plans: Assuming success in this recruitment, the Program Director, in partnership with Dr. Kelly and the Research Institute leadership, will proceed to recruit 2-3 additional junior faculty members over the next several years. The research space housing this evolving unit will be located on the 11th floor of the Colket building.

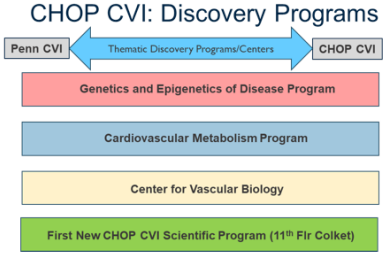


Figure 2. Plans to establish a new CHOP CVI Discovery Program in partnership with the Penn CVI.

3. **Develop and implement plans/SOP for a centralized "through the door" CVI/Cardiac Center Biobank.** We have made excellent progress in collaboration with Dr. William Gaynor and Stacy Woyciechowski using the existing infrastructure of the Birth Defect Biorepository (BDB) to formally launch the CVI/Cardiac Center Biobank (Figure 3). This launch was supported, in part, by CVI IDF funds, along with investment by the CHOP Cardiac Center. We are now enrolling patients for collection of blood samples to conduct whole genome DNA sequencing to support a variety of approved studies aimed at delineating the genetic bases of pediatric heart and vascular disease. In addition, extensive de-identified clinical information is collected and stored in a database so that outcome studies may be conducted. Notably, this effort is one of the few such pediatric cardiac biobank efforts nationwide. FY25 Plans: We will continue to develop and expand this important research resource over the next year.

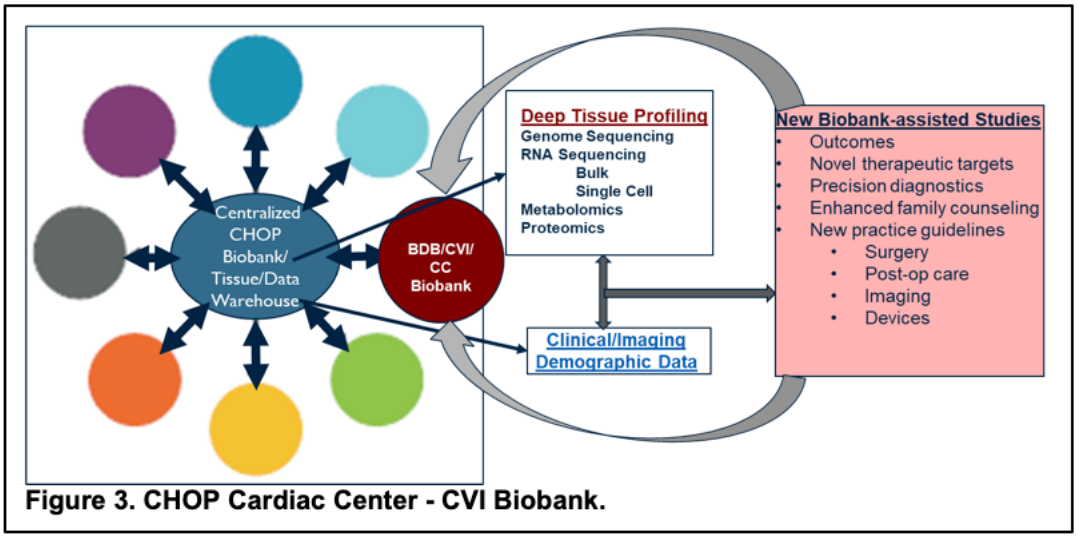


Figure 3. CHOP Cardiac Center - CVI Biobank.

4. **In partnership with the Cardiac Center leadership, establish a strategic plan for clinical research from first in humans to innovative trial design (Figure 4)**. This goal involves the recruitment of a clinical research leader jointly by the CVI and Cardiac Center. A strategic plan has been developed in partnership with the Executive Directors of the Cardiac Center (Drs. Chen and Rossano) to recruit a Clinical Research Director who would be primarily housed in the Cardiac Center but will work closely with the CVI. The roles of this new Director are to bring a visible clinical research program to CHOP, lead the clinical research faculty of the Cardiac Center, work with Dr. Kelly and the newly hired Scientific Program Director to build bridges between the CVI and Cardiac Center to enable rapid translation of discoveries to the clinics and vice versa, further catalyze usage of the emerging CVI/Cardiac Center Biobank, and to train the next generation of cardiovascular clinical scientists. We now have established a job description and a Search Committee is being assembled. Resources for this effort will be provided by the Department of Pediatrics and the Research Institute. FY25 Plans: Recruit the Clinical Research Director.

Figure 4. Bridging the CHOP CVI and Cardiac Center researchers to cross the translational divide.

5. **Penn-CHOP CVI Education/Seminar Integration.** This goal involves connecting the extensive research education and seminar series in both the Penn CVI and Cardiac Center. The website has been used to achieve this goal highlighting opportunities on each side. For example, the Penn CVI hosts both a weekly seminar series as well as a "trainee research-in-progress series" (TRIPS) that is now attended by both Penn and CHOP CVI scientists. Conversely, research activities that are sponsored by the Cardiac Center T32 in Pediatric Cardiology support a weekly event that is cross-attended. FY25 Plans: One goal for the upcoming year is to further bolster the CHOP-Penn CVI interactions by co-hosting several invited seminar speakers in the area of imaging and engineering. This will afford an opportunity to also establish collaborative links with the School of Engineering. In addition, we plan to host a Cardiac Center/CVI Research Retreat during the FY25 year.

6. **Develop fundraising strategies with Cardiac Center leadership and CHOP development group**. In conjunction with the Executive Directors of the Cardiac Center, Drs. Joe Rossano and Jonathan Chen, and the CHOP Cardiac Development group, the CVI Director now participates in regular Board of Visitor meetings which are held at least bi-annually. In addition, a variety of different fundraising events sponsored by the Cardiac Center have included Dr. Kelly. Several smaller gifts have been acquired and currently, in collaboration with Dr. William Gaynor, a larger ask (approximately $5M) is being developed to further support the biobanking effort. FY25 Plans: In the upcoming year, we hope to secure the biobank gift along with other funds that could support the recruitment of the Cardiac Center/CVI Clinical Research Director and the CHOP CVI-Engineering bridging effort.

2023 PUBLICATIONS FROM CVI MEMBERS

1. Abramov A, Xue Y, Zakharchenko A, Kurade M, Soni RK, **Levy RJ**, Ferrari G. Bioprosthetic heart valve structural degeneration associated with metabolic syndrome: Mitigation with polyoxazoline modification. *Proc Natl Acad Sci* U S A. 2023 Jan 3;120(1):e2219054120. PMID: 36574676; PMC9910464.
2. Castillero E, Fitzpatrick E, Keeney SJ, D'Angelo AM, Pressly BB, Simpson MT, Kurade M, Erwin WC, Moreno V, Camillo C, Shukla HJ, Inamdar VV, Aghali A, Grau JB, Salvati E, Nissim I, Rauova L, Oyama MA, **Stachelek SJ**, Brown C, Krieger AM, **Levy RJ**, Ferrari G. Decreased serotonin transporter activity in the mitral valve contributes to progression of degenerative mitral regurgitation. *Sci Transl Med*. 2023 Jan 4;15(677):eadc9606. PMID: 36599005; PMCID: PMC9896655.
3. **Lisanti, A.J.**, Uzark, K.C., Harrison, T.M., Peterson, J.K., Butler, S.C., Miller, T.A., Allen, K.Y., Miller, S.P., Jones, C.E on behalf of the American Heart Association Pediatric Cardiovascular Nursing Committee of the Council on Cardiovascular and Stroke Nursing; Council on Lifelong Congenital Heart Disease and Heart Health in the Young; and Council on Hypertension. Developmental care for hospitalized infants with complex congenital heart disease: A science advisory from the American Heart Association. *J Am Heart Assoc*, 2023 Feb 7;12(3):e028489
4. Conway J, Min S, Villa C, Weintraub RG, Nakano S, Godown J, Tatangelo M, Armstrong K, Richmond M, Kaufman B, Lal AK, Balaji S, Power A, Baez Hernandez N, Gardin L, Kantor PF, Parent JJ, Aziz PF, Jefferies JL, Dragulescu A, Jeewa A, Benson L, Russell MW, Whitehill R, **Rossano J**, Howard T, Mital S. The Prevalence and Association of Exercise Test Abnormalities With Sudden Cardiac Death and Transplant-Free Survival in Childhood Hypertrophic Cardiomyopathy. *Circulation*. 2023 Feb 28;147(9):718-727. PMID: 36335467
5. Nam HH, Flynn M, Lasso A, Herz C, Sabin P, Wang Y, Cianciulli A, Vigil C, Huang J, Vicory J, Paniagua B, Allemang D, Goldberg DJ, Nuri M, Cohen MS, Fichtinger G, **Jolley MA**. Modeling of the Tricuspid Valve and Right Ventricle in Hypoplastic Left Heart Syndrome With a Fontan Circulation. *Circ Cardiovasc Imaging*. 2023 Mar;16(3):e014671. PMID: 36866669; PMCID: PMC10026972.

6. Ching S, Cianciulli AR, Flynn M, Silvestro E, Sabin P, Lasso A, Ghosh RM, Gillespie MJ, **Jolley MA**. Physical Simulation of Transcatheter Edge-to-Edge Repair using Image-Derived 3D Printed Heart Models. *Ann Thorac Surg Short Rep*. 2023 Mar;1(1):40-45. PMID: 36909146; PMCID: PMC9996204.
7. Ellison M, Mangiola M, Marrari M, Bentlejewski C, Sadowski J, Zern D, Kramer CSM, Heidt S, Niemann M, Xu Q, Dipchand AI, Mahle WT, **Rossano JW**, Canter CE, Singh TP, Zuckerman WA, Hsu DT, Feingold B, Webber SA, Zeevi A. Immunologic risk stratification of pediatric heart transplant patients by combining HLA-EMMA and PIRCHE-II. *Front Immunol*. 2023 Mar 14;14:1110292. PMID: 36999035
8. Lynch A, Tatangelo M, Ahuja S, Steve Fan CP, Min S, Lafreniere-Roula M, Papaz T, Zhou V, Armstrong K, Aziz PF, Benson LN, Butts R, Dragulescu A, Gardin L, Godown J, Jeewa A, Kantor PF, Kaufman BD, Lal AK, Parent JJ, Richmond M, Russell MW, Balaji S, Stephenson EA, Villa C, Jefferies JL, Whitehill R, Conway J, Howard TS, Nakano SJ, **Rossano J**, Weintraub RG, Mital S. Risk of Sudden Death in Patients With RASopathy Hypertrophic Cardiomyopathy. *J Am Coll Cardiol*. 2023 Mar 21;81(11):1035-1045. PMID: 36922089
9. Burstein D, Kimmel S, Putt M, **Rossano J**, VanderPluym C, Ankola A, Lorts A, Maeda K, O'Connor M, Edelson J, Lin K, Buchholz H, Conway J. Cost-effectiveness of bivalirudin in pediatric ventricular assist devices. *J Heart Lung Transplant*. 2023 Mar;42(3):390-397. PMID: 36333207
10. Blinder JJ, Huang YS, **Rossano JW**, Costarino AT, Li Y. Variation in hospital costs and resource utilisation after congenital heart surgery. *Cardiol Young*. 2023 Mar;33(3):420-431. PMID: 35373722
11. Xue Y, Kossar AP, Abramov A, Frasca A, Sun M, Zyablitskaya M, Paik D, Kalfa D, Della Barbera M, Thiene G, Kozaki S, Kawashima T, Gorman JH, Gorman RC, Gillespie MJ, Carreon CK, Sanders SP, **Levy RJ**, Ferrari G. Age-related enhanced degeneration of bioprosthetic valves due to leaflet calcification, tissue crosslinking, and structural changes. *Cardiovasc Res*. 2023 Mar 17;119(1):302-315. PMID: 35020813; PMCID: PMC10022861.
12. Cao Y, Zhang X, Akerberg B, Yuan H, Sakamoto T, Xiao F, VanDusen N, Zhou P, Sweat M, Wang Y, Prondzynski M, Chen J, Zhang Y, Wang P, **Kelly DP**, Pu W: In vivo dissection of chamber selective enhancers reveals estrogen-related receptor as a regulator of ventricular cardiomyocyte identity. Circulation, 2023 Mar 14;147(11):881-896, PMID: 36705030, PMC10010668
13. Matsuura TR, Puchalska P, Crawford PA, Kelly DP: Ketones and the heart: Metabolic principles and therapeutic implications. *Circ Res*. 2023 Mar 31;132(7):882-898. PMID: 36996176, PMC10289202
14. Hahn V, Petucci C, Kim MS, Bedi K, Wang H, Mishra S, Koleini N, Yoo E, Margulies K, Arany Z, **Kelly DP**, Kass D, and Sharma K: Myocardial Metabolomics of Human Heart Failure with Preserved Ejection Fraction. Circulation, 2023 Apr 11;147(15):1147-1161. PMID: 36856044
15. Wu W, Ching S, Sabin P, Laurence DW, Maas SA, Lasso A, Weiss JA, **Jolley MA**. The effects of leaflet material properties on the simulated function of regurgitant mitral valves. *J Mech Behav Biomed Mater*. 2023 Apr 21;142:105858. PMID: 37099920.
16. Kim Y, Mastali M, Van Eyk JE, Orav EJ, Vissing CR, Day SM, Axelsson Raja A, Russell MW, Zahka K, Lever HM, Pereira AC, Murphy AM, Canter C, Bach RG, Wheeler MT, **Rossano JW**, Owens AT, Bundgaard H, Benson L, Mestroni L, Taylor MRG, Patel AR, Wilmot I, Thrush P, Soslow JH, Becker JR, Seidman CE, Ho CY; VANISH Investigators. Transforming Growth Factor-β Analysis of the VANISH Trial Cohort. *Circ Heart Fail*. 2023 Apr;16(4):e010314. PMID: 36999957
17. Yamamoto T, Maurya SK, Pruzinsky E, Batmanov K, Xiao Y, Sulon SM, Sakamoto T, Wang Y, Lai L, McDaid KS, Shewale SV, Leone TC, Koves TR, Muoio DM, Dierickx P, Lazar MA, Lewandowski ED, **Kelly DP**: RIP140 deficiency enhances cardiac fuel metabolism and protects mice from heart failure. J Clin Invest., 2023 May 1;133(9):e162309. PMID: 36927960
18. Restaino K, Zhang X, Faerber JA, **Rossano JW**, Burstein D, Wittlieb-Weber CA, Lin KY, Edelson JB, **Edwards JJ**, O'Connor MJ. Temporal trends in primary payers in pediatric heart transplant and association with long-term survival. *Pediatr Transplant*. 2023 May;27(3):e14484. PMID: 36751006

19. Kittleson MM, Wittlieb-Weber C, **Rossano JW**. When art and science collide: The 2022 guidelines for the care of heart transplant recipients. *J Heart Lung Transplant*. 2023 May;42(5):541-543. PMID: 36564336
20. Adachi I, Peng DM, Hollander SA, Simpson KE, Davies RR, Jacobs JP, VanderPluym CJ, Fynn-Thompson F, Wells DA, Law SP, Amdani S, Cantor R, Koehl D, Kirklin JK, Morales DLS, **Rossano JW**; Pedimacs Investigators. Sixth Annual Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report: The Society Of Thoracic Surgeons Pedimacs Annual Report. *Ann Thorac Surg*. 2023 May;115(5):1098-1108. PMID: 36402175
21. Ghosh RM, Whitehead KK, Harris MA, Kalb E, **Chen JM**, Partington SL, Biko DM, Faerber J, Fogel MA. Longitudinal trends of vascular flow and growth in patients undergoing Fontan operation. *Ann Thorac Surg* 2023 Jun;115(6):1486-1492.
22. Almond CS, Sleeper LA, **Rossano JW**, Bock MJ, Pahl E, Auerbach S, Lal A, Hollander SA, Miyamoto SD, Castleberry C, Lee J, Barkoff LM, Gonzales S, Klein G, Daly KP. The teammate trial: Study design and rationale tacrolimus and everolimus against tacrolimus and MMF in pediatric heart transplantation using the major adverse transplant event (MATE) score. *Am Heart J*. 2023 Jun;260:100-112. PMID: 36828201 Clinical Trial
23. Luda KN, Longo J, Goosen SK, Duimstra LR, Ma EH, Watson MJ, Oswald BM, Fu Z, Madaj Z, Kupai A, Dickson BM, DeCamp LM, Dahabieh MS, Compton SE, Teis R, Kaymak I, Lau KH, **Kelly DP**, Puchalska P, Williams KS, Krawczyk CM, Lévesque D, Boisvert FM, Sheldon RD, Rothbart SB, Crawford PA, Jones RG: Ketolysis drives CD8+ T cell effector function through effects on histone acetylation. *Immunity*, 2023;Sep12;56(9):2021-2035. PMID 37516105, PMC10528215
24. Franco A, Li J, **Kelly DP**, Hershberger RE, Marian AJ, Lewis RM, Song M, Dang X, Schmidt AD, Mathyer ME, Edwards JR, de Guzman Strong C, Dorn II GW: A human mitofusin 2 mutation can cause mitophagic cardiomyopathy. *eLife* Nov1 12e84235. PMID: 37910431
25. Vissing CR, Sxelsson RA, Day SM, Russel MW, Zahka K, Lever HM, Pereira AC, Colan SD, Margossian R, Murphy AM, Canter C, Bach RG, Wheeler MT, **Rossano JW**, Owens AT, Benson L, Mestroni L, Taylor MRG, Patel AR, Wilmot I, Thrush P, Soslow JH, Becker JR, Seidman CE, Lakdawala NK, Cirino AL, McMurray JJV, MacRae CA, Solomon SD, Bundgaard H, Orav EJ, Ho CY: Valsartan for attenuating disease evolution in early sarcomeric hypertrophic cardiomyopathy (VANISH) investigators. Cardiac remodeling in subclinical hypertrophic cardiomyopathy: the VANISH randomized clinical trial. *JAMA Cardiol*. 2023 Nov 1;8(11):1083-1088. PMID: 37672268 PMCID: PMC10483382
26. Amin S, Dewey H, Lasso A, Sabin P, Han Y, Vicory J, Paniagua B, Herz C, Nam H, Cianciulli A, Flynn M, Laurence DW, Harrild D, Fichtinger G, Cohen MS, **Jolley MA**. Euclidean and Shape-Based Analysis of the Dynamic Mitral Annulus in Children using a Novel Open-Source Framework. *J Am Soc Echocardiogr*. 2023 Nov 22; S0894-7314(23)00594-1. PMID: 37995938; NIHMSID:NIHMS1948638.
27. Ashfaq A, Lorts A, Rosenthal D, Adachi I, **Rossano J**, Davies R, Simpson KE, Maeda K, Wisotzkey B, Koehl D, Cantor RS, Jacobs JP, Peng D, Kirklin JK, Morales DLS. Survival in pediatric patients with ventricular assist devices: a special Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report. *Ann Thorac Surg*. 2023 Nov;116(5):972-979. PMID: 37573991
28. Kamsheh AM, Edelson JB, Faerber J, Mondal A, Quarshie W, **Edwards JJ**, Lin KY, O'Connor MJ, Wittlieb-Weber C, Maeda K, Goldsmith MP, **Rossano JW**. Mechanical circulatory support in pediatric myocarditis: support strategies and outcomes in a nationally representative cohort. *JHLT Open*. 2023 Nov. Vol 3, 100026.
29. Hirschhorn MD, Lawley JEM, Roof JA, Johnson APT, Stoddard WA, Stevens RM, **Rossano J**, Arabia F, Tchantchaleishvili V, Massey HT, Day SW, Throckmorton AL. Next generation development of hybrid continuous flow pediatric total artificial heart technology. *ASAIO J*. 2023 Dec 1;69(12)1090-1098. PMID: 37774695
30. Singh SK, Faridmoayer E, Vitale N, Woodard E, Xue Y, Abramov A, **Levy RJ**, Ferrari G. Valved Conduits for Right Ventricular Outflow Tract Reconstruction: A Review of Current Technologies and Future Directions. *Pediatr Cardiol*. 2023 Dec 2. Epub ahead of print. PMID: 38041710.

31. **Lisanti, A.J.**, Vittner, D., Peterson, J., Van Bergen, A., Miller, T., Gordon, E., Negrin, K., Desai, H., Willette, S., Jones, M., Caprarola, S., Jones, A., Helman, S., Smith, J., Anton, C., Bear, L., Russell, S., Mieczkowki, D., Hamilton, B., McCoy, M., Feldman, Y., Steltzer, M., Savoca, M., Spatz, D., & Butler, S. Developmental care pathway for hospitalized infants with congenital heart disease, on behalf of the Cardiac Newborn Neuroprotective Network, a special interest group of the Cardiac Neurodevelopmental Outcome Collaborative. *Cardiol Young*. 2023 Dec;33(12)2521-2538.
32. Webber SA, Chin H, Wilkinson JD, Armstrong BC, Canter CE, Dipchand AI, Dodd DA, Feingold B, Lamour JM, Mahle WT, Singh TP, Zuckerman WA, **Rossano JW**, Morrison Y, Diop H, Demetris AJ, Bentlejewski C, Mohanakumar T, Odim J, Zeevi A; COTOTC-09 Investigators. Impact of donor specific anti-HLA antibody on cardiac hemodynamics and graft function 3 years after pediatric heart transplantation: first results from the COTOC-09 multi-institutional study. *Am J Transplant*. 2023 Dec;23(12):1893-1907. PMID: 37579817.
33. Peng DM, Davies RR, Simpson KE, Sugh SB, Morales DLS, Jacobs JP, Butto A, Joong A, Conway J, Schindler K, Griffiths ER, Koehl D, Kirklin JK, **Rossano JW**, Adachi I; Pedimacs Investigators. Seventh annual Society of Thoracic Surgeons Pedimacs Report. *Ann Thorac Surg* 2023 Dec 18:S0003-4975(23)01297-3 PMID: 38123046
34. Sakamoto T and **Kelly DP**: Cardiac Maturation. *J Mol Cell Cardiol*, 2023, Dec 30:187:38-50. PMID: 38160640

2023 AWARDS AND HONORS OF CVI MEMBERS

- **Jonathan Chen** was elected to the American Surgical Association.
- **Amy Lisanti** was awarded FAHA in the American Heart Association.
- **Matthew Jolley** was awarded the CHOP Cardiac Center Innovation Award.
- The CHOP Cardiology NHLBI Research Training Program (T32 HL007015) has been successfully renewed, directed by **Robert J. Levy and Joseph Rossano**.
- **Andrey Zakharchenko** was awarded the 2nd Century Early Faculty Independence Award from the American Heart Association (AHA).
- **William Peranteau** and Kiran Musunuru were awarded a $26.5 Million U19 grant from the NIH National Institute of Neurological Disorders and Stroke (NINDS) entitled “Postnatal and Prenatal Therapeutic Base Editing for Metabolic Diseases”.
- **Wensi Wu** was awarded a K25 Mentored Quantitative Research Career Development Award from the NIH National Heart, Lung, and Blood Institute (NHLBI) titled “Toward Patient-Specific Computational Modeling of Tricuspid Valve Repair in Hypoplastic Left Heart Syndrome (HLHS).
- **Robert Levy’s** collaborative NIH research program on serotonin receptor signaling and its relationship with mitral regurgitation (R01HL131872) has received supplemental grant support from the NHLBI funded CAROL Act Program.
- **Brian R. White** was awarded a $200,000 award from the Margaret Q. Landenberger Research Foundation for his project "Functional neuroimaging biomarkers of neurologic injury and recovery in a mouse model of phenylketonuria with corrective gene-editing."
- **Michael O’Byrne** and **Halley Ruppel** (Nurse investigator at PENN/CHOP) received funding for an R01 through NHLBI to perform a multicenter prospective observational study evaluating the accuracy of pulse oximetry in patients undergoing catheterization across different skin tones to evaluate whether the technology is less accurate in patients with darker skin.
- **Daniel Kelly** received the Peter Harris Distinguished Scientist Award of the International Society of Heart Research.

ON THE HORIZON

The CHOP CVI has made tremendous progress in its launching over the past year. As detailed above, we have a number of key objectives for the upcoming year including:

- Recruitment of a Scientific Program Director followed by the building of the first research laboratory team on the 11th floor of the Colket building.
- With the initiation of the Cardiac Center/CVI Biobank, we now have the opportunity to significantly increase enrollment and to engage CHOP cardiovascular researchers in activities that use this precious resource for defining the genetic basis of pediatric heart and vascular disease as well as important outcomes studies.
- We hope to recruit the Cardiac Center/CVI Clinical Research Director over the next year.
- We will continue to connect the mentoring and didactic activities of the CHOP and Penn Cardiovascular Institutes.
- We will continue to build thematic collaborative bridges between CHOP CVI investigators interested in imaging and engineering with scientists in the Penn School of Engineering. We will also strive to co-recruit promising Engineering young faculty with interests in cardiovascular diseases.

CARDIOLOGY

RESEARCH LABORATORY

INTRODUCTION

The Topolewski Pediatric Heart Valve Center includes Dr. Levy's basic science laboratory, that continues to examine the mechanism and potential targets for both the therapy of native valve disease progression and prevention of bioprosthetic valve calcification and structural degeneration. Dr. Levy's group published 13 papers this past year related to heart valve disease and related cardiovascular research subjects. Dr. Levy's heart valve research is supported by two NIH R01 programs, one concerted with serotonin mechanisms involved in the progression of heart valve disease, and a recently renewed R01 that focuses on bioprosthetic heart valve structural degeneration. In addition, Dr. Levy, founding director of the Cardiac Centers NHLBI T32 Research Training Program, has just successfully renewed this program for years 26-30, that will commence July 1, 2024. Dr. Levy is also the Program Director for the Pennsylvania Pediatric Medical Device Consortium (PPDC), now in its 11th year. The PPDC is transitioning this year from FDA support to becoming a component of Penn Health Tech.

LEADERSHIP AND KEY STAFF MEMBERS

Robert J. Levy, MD

Robert J. Levy, MD

- Section Head for Research in the Division of Cardiology, and William J. Rashkind
- Endowed Chair in Pediatric Cardiology at CHOP, Professor of Pediatrics and
- Professor of Systems Pharmacology, Perelman School of Medicine, University of Pennsylvania (PSOM)
- PI on 3 NIH grants, and 1 FDA grant
- 13 publications 2022-2023

Ivan Alferiev, PhD

- Research Associate Professor of Pediatrics, CHOP and PSOM
- Co-investigator on 4 NIH grant programs with Dr. Michael Chorny, and 1 with Dr. Robert Levy
- 8 publications 2022-2023

Michael Chorny, PhD

- Research Professor, of Pediatrics, CHOP and PSOM
- PI on 4 NIH grants
- 6 publications 2022-2023

Ilia Fishbein, MD, PhD

- Research Associate Professor of Pediatrics, CHOP and PSOM
- Co-I on 2 NIH grants
- 7 publications 2022-2023

Stanley J. Stachelek, PhD

- Research Associate Professor of Pediatrics, CHOP and PSOM
- Co-I in 2 NIH grants
- 4 publications 2022-2023

Andrey Zakharchenko, PhD

- Instructor, Pediatrics, CHOP and PSOM
- PI, AHA Early Career Development Grant
- 4 publications 2022-2023

CARDIOLOGY

RESEARCH LABORATORY

KEY HIGHLIGHTS/ACCOMPLISHMENTS

- Dr. Robert Levy renewed his bioprosthetic heart valve NIH grant program for an additional 5 years, beginning April, 2024.
- Dr. Robert Levy, as founding program director, successfully renewed the Cardiac Center's NHLBI Research Training Grant for years 26-30, as of July 1, 2024.
- A CAROL ACT supplement was awarded by NHLBI (2023-24) to Dr. Robert Levy for advanced research to be added to his NHLBI R01 program concerned with serotonin mechanisms leading to the progression of heart valve disease. The CAROL ACT was passed by the US Congress in 2022 in memory of Carol Mann, the wife of US Representative Andy Mann from Kentucky. Mrs. Mann died because of valvular heart disease, and the CAROL ACT provides additional funds for research in this field.
- CHOP'S Cardiology 2024 meeting in Scottsdale, Arizona featured the 1st annual Robert J. Levy Lecture in Cardiovascular Basic and Translational Sciences. The lecture was delivered by Dr. Robert J. Levy, and the title of the talk was The Role of the Serotonin Transporter in the Progression of Heart Valve Disease.
- Dr. Andrey Zakharchenko was awarded an American Heart Association Early Career Development Award. Dr. Zakharchenko was a CHOP Cardiology T32 NHLBI Research Trainee, mentored by Dr. Robert Levy, and has now been appointed an Instructor in Cardiology, Department of Pediatrics, at CHOP and PSOM. The focus of his research is non-calcific structural degeneration of bioprosthetic heart valves.
- Dr. Levy's research group produced 13 peer reviewed publications, that are cited below.

PUBLICATIONS 2022-2023

1. Abramov A, Xue Y, Zakharchenko A, Kurade M, Soni RK, Levy RJ and Ferrari G. Bioprosthetic heart valve structural degeneration associated with metabolic syndrome: Mitigation with polyoxazoline modification. *Proc Natl Acad Sci* U S A. 2023;120:e2219054120.
2. Alferiev IS, Chorny M, Wilensky RL, Levy RJ and Fishbein I. Stent-Based Gene Delivery for Coronary Disease. *Methods Mol Biol*. 2022;2573:217-233.
3. Alferiev IS, Fishbein I, Levy RJ and Chorny M. Robust Chemical Strategy for Stably Labeling Polyester-Based Nanoparticles with BODIPY Fluorophores. *ACS Appl Polym Mater*. 2022;4:1196-1206.
4. Alferiev IS, Hooshdaran B, Pressly BB, Zoltick PW, Stachelek SJ, Chorny M, Levy RJ and Fishbein I. Intraprocedural endothelial cell seeding of arterial stents via biotin/avidin targeting mitigates in-stent restenosis. *Sci Rep*. 2022;12:19212.
5. Alferiev IS, Zhang K, Folchman-Wagner Z, Adamo RF, Guerrero DT, Fishbein I, Soberman D, Levy RJ and Chorny M. Nanocarrier Design for Dual-Targeted Therapy of In-Stent Restenosis. *Pharmaceutics*. Published online. PMD 2024 pending;16.
6. Castillero E, Fitzpatrick E, Keeney SJ, D'Angelo AM, Pressly BB, Simpson MT, Kurade M, Erwin WC, Moreno V, Camillo C, Shukla HJ, Inamdar VV, Aghali A, Grau JB, Salvati E, Nissim I, Rauova L, Oyama MA, Stachelek SJ, Brown C, Krieger AM, Levy RJ and Ferrari G. Decreased serotonin transporter activity in the mitral valve contributes to progression of degenerative mitral regurgitation. *Sci Transl Med*. 2023;15:eadc9606.
7. Fishbein I, Inamdar VV, Alferiev IS, Bratinov G, Zviman MM, Yekhilevsky A, Nagaswami C, Gardiner KL, Levy RJ and Stachelek SJ. Hypercholesterolemia exacerbates in-stent restenosis in rabbits: Studies of the mitigating effect of stent surface modification with a CD47-derived peptide. *Atherosclerosis*. 2023;390:117432.
8. Hooshdaran B, Pressly BB, Alferiev IS, Smith JD, Zoltick PW, Tschabrunn CM, Wilensky RL, Gorman RC, Levy RJ and Fishbein I. Stent-based delivery of AAV2 vectors encoding oxidation-resistant apoA1. *Sci Rep*. 2022;12:5464.
9. Pressly BB, Hooshdaran B, Alferiev IS, Chorny M, Levy RJ and Fishbein I. Adeno-Associated Viral Vector Immobilization and Local Delivery from Bare Metal Surfaces. *Methods Mol Biol*. 2022;2394:601-616.

10. Singh SK, Faridmoayer E, Vitale N, Woodard E, Xue Y, Abramov A, Levy RJ and Ferrari G. Valved Conduits for Right Ventricular Outflow Tract Reconstruction: A Review of Current Technologies and Future Directions. *Pediatr Cardiol*. 2023.
11. Xue Y, Kossar AP, Abramov A, Frasca A, Sun M, Zyablitskaya M, Paik D, Kalfa D, Della Barbera M, Thiene G, Kozaki S, Kawashima T, Gorman JH, Gorman RC, Gillespie MJ, Carreon CK, Sanders SP, Levy RJ and Ferrari G. Age-related enhanced degeneration of bioprosthetic valves due to leaflet calcification, tissue crosslinking, and structural changes. *Cardiovasc Res*. 2023;119:302-315.
12. Zakharchenko A, Rock CA, Thomas TE, Keeney S, Hall EJ, Takano H, Krieger AM, Ferrari G and Levy RJ. Inhibition of advanced glycation end product formation and serum protein infiltration in bioprosthetic heart valve leaflets: Investigations of anti-glycation agents and anticalcification interactions with ethanol pretreatment. *Biomaterials*. 2022;289:121782.
13. Zakharchenko A, Xue Y, Keeney S, Rock CA, Alferiev IS, Stachelek SJ, Takano H, Thomas T, Nagaswami C, Krieger AM, Chorny M, Ferrari G and Levy RJ. Poly-2-methyl-2-oxazoline-modified bioprosthetic heart valve leaflets have enhanced biocompatibility and resist structural degeneration. *Proc Natl Acad Sci U S A*. 2022;119.

CLINICAL RESEARCH HIGHLIGHTS

INTRODUCTION

In 2023, CHOP Cardiac Center clinical researchers continued to be immensely productive, receiving prestigious grants and wards, presenting at national and international scientific meetings, and publishing high-impact manuscripts.

Michael L. O'Byrne, MD, M.S.C.E

THE CARDIAC CENTER CLINICAL RESEARCH CORE

Under the direction of Michael O'Byrne MD MSCE, Amy Roberts, and Jing Huang PhD, the Research Core supports much of the clinical research efforts in the CHOP Cardiac Center. In 2023, the Research Core received 44 distinct research projects to provide data science, statistical and epidemiological support to investigators in all of the divisions and sections of the Cardiac Center resulting in 19 published manuscripts. The Research Core also serves as the Scientific Review Committee for protocols and reviews of applications for the intramural Cardiac Center Grant Program. It also helps to connect researchers with interested high school, undergraduate, medical students, and residents interested in working as research assistants in the Cardiac Center.

NOTABLE AWARD AND GRANT RECIPIENTS

- In addition to ongoing federal, foundation, and industry support for clinical research, CHOP Center Researchers have obtained a number of research grants supporting clinical research.
- Michael O'Byrne was awarded an NHLBI R01 grant supporting a multicenter prospective cohort study to evaluate systematic errors in estimation of oxygen saturation by pulse oximetry in patients with darker skin. He is the M-PI project with Halley Ruppel, a nurse investigator at CHOP and The University of Pennsylvania School of Nursing.
- Matthew Jolley received an Additional Ventures Single Ventricle Research Fund Award, supporting a project using computational modeling of the atrioventricular valve in common atrioventricular canal defects. This is in addition to a previous Additional Ventures award using novel techniques to evaluate the tricuspid valve in hypoplastic left heart syndrome.
- Doctors Jack Rychik and Limeng Pei also received an Additional Ventures Single Ventricle Research Fund Award. Their project aims to develop a mechanistic understanding of Fontan-associated liver disease.
- Cardiology fellow, Helen Stanley (and her mentor Brian White), were awarded a Matthew's Hearts of Hope Award supporting her research studying total anomalous pulmonary venous return.

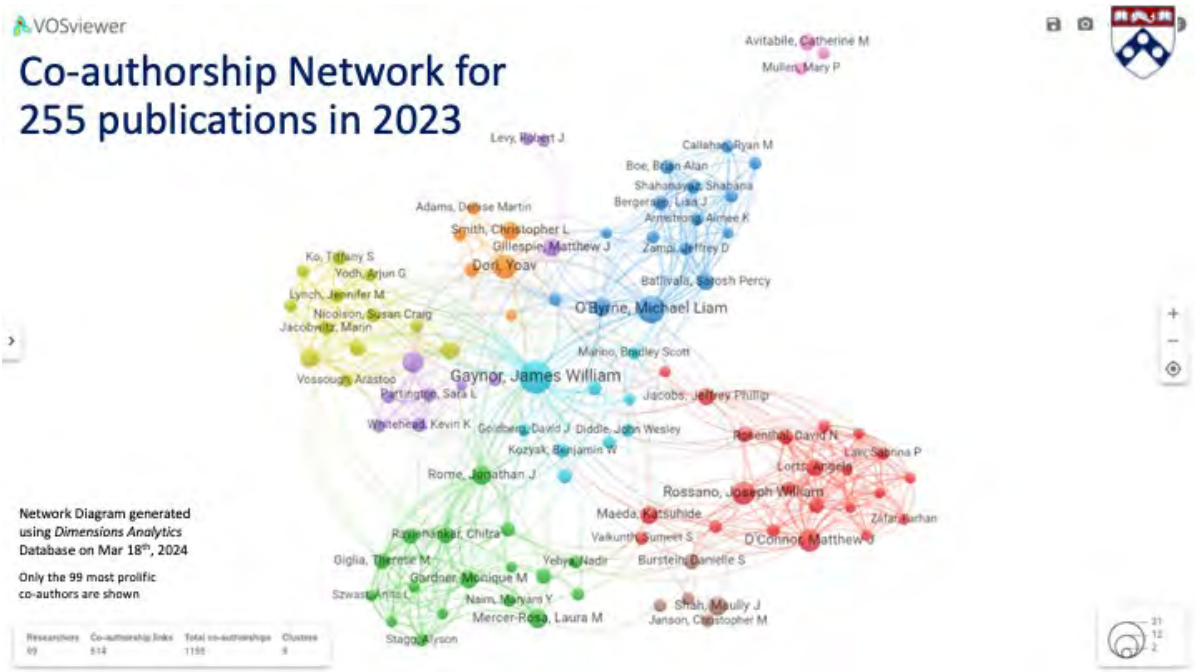
PRESENTATIONS AT SCIENTIFIC MEETINGS

CHOP clinical researchers continue to represent the institution at national and international meetings. Many were prominently featured at the American Heart Association Scientific Sessions along with numerous subspecialty meetings. At the American Heart Association Scientific Sessions (11/2023) in Philadelphia CHOP Cardiac Center faculty and trainees were prominently involved. In total cardiac center faculty, presented nine invited lectures along with 33 abstracts from CHOP Cardiac Center authors (11 of which were supported by the CCRC), including 5 oral abstracts and 2 rapid-fire abstract presentations, as well as 9 invited presentations.

CLINICAL RESEARCH HIGHLIGHTS

PUBLICATIONS IN MEDICAL JOURNALS

CHOP Cardiac Center faculty authored over 223 manuscripts in 2023. Of these, 94 were published in high impact journals (Impact Factor >6). These included clinical trials of pharmacological agents, reports leveraging national databases and multi-institutional collaboratives to identify opportunities to improve quality of care, and invited commentaries and national guidelines.



BIBLIOMETRIC ANALYSIS

BIBLIOMETRIC ANALYSIS OF PUBLICATIONS BY THE FACULTY AND STAFF OF THE CARDIAC CENTER AT THE CHILDREN'S HOSPITAL OF PHILADELPHIA, 2023

Prepared by: Neetu Rajpal., PhD.;
Manuel de la Cruz Gutierrez, PhD., MLS.;
Elizabeth Sunny Blake, MLIS.
University of Pennsylvania, Biomedical Holman Biotech Commons

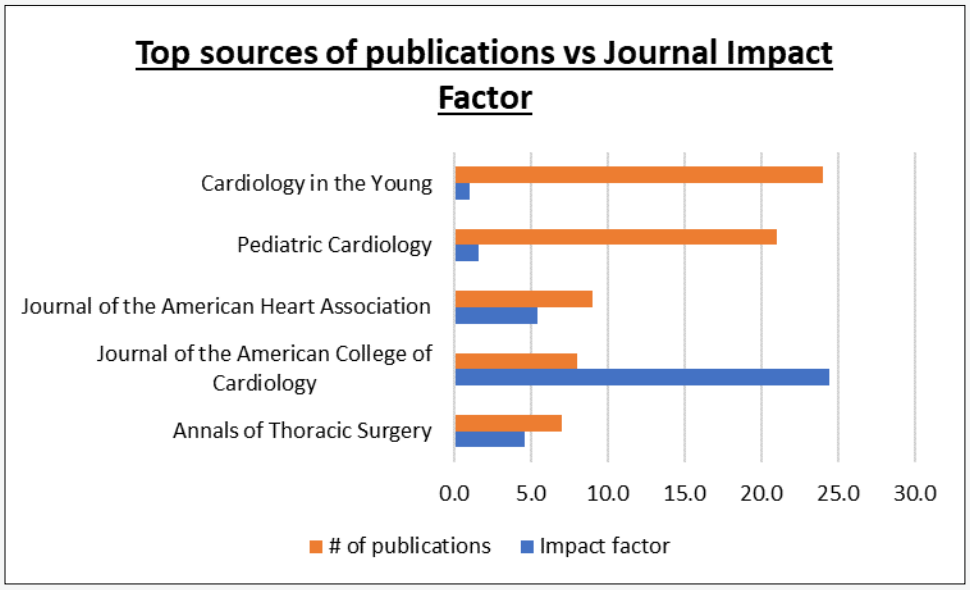
Bibliometric Indicators 2023 (Cardiac Center-wide)	Value
Number of articles (Scopus)	255
Number of citations (WoS) Number of articles citing these works	318 279
Av. Citations (per cited article: articles received at least 1 citation) Av. Citations (overall)	3.2 1.6
Median citations (Articles with citations)	2
Portfolio h-index	8
# "Highly Cited" papers (top 1% for the field of Clinical Medicine in WoS) See appendix A for bibliography of "highly cited" papers	1
# "Cited >=8" papers (Journal Impact Factor >6) See appendix B for bibliography of "Cited >=8" papers.	11

BIBLIOMETRIC ANALYSIS

SUMMARY METRICS FOR CHOP CARDIAC CENTER (FROM SCOPUS)

Cardiology in the young: 24
Pediatric Cardiology: 21
J. of the American Heart Association: 9
J. of the American College of Cardiology: 8
Annals of Thoracic Surgery: 7

Articles: 255
Cited in 2023: 417
H-index: 9
Authors searched within the CHOP Cardiac Center: 228

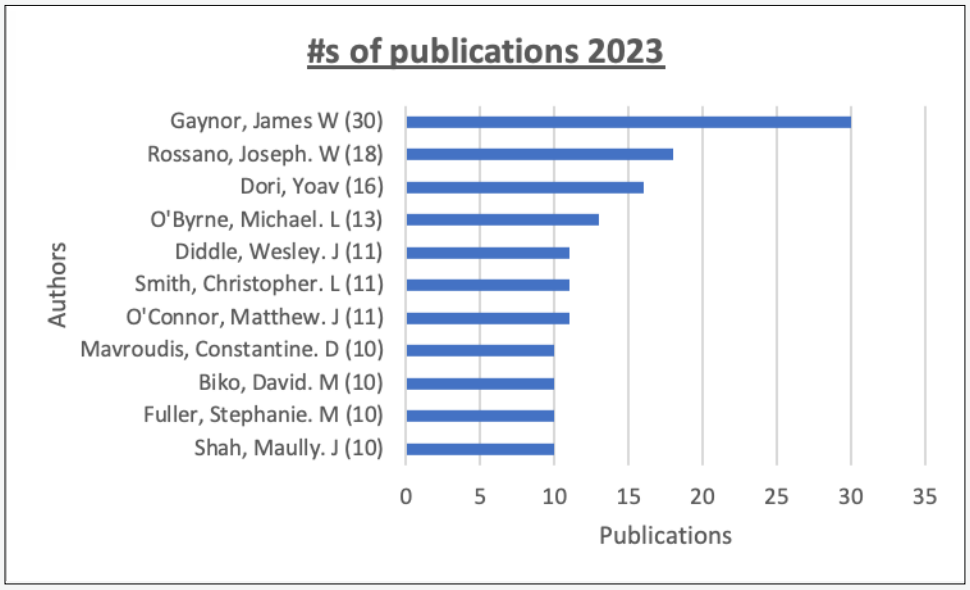


BIBLIOMETRIC ANALYSIS

AUTHOR IMPACT -CARDIAC CENTER-WIDE (FROM SCOPUS)

Number of publications, top authors in 2023 (Source: Scopus)
(limited to 10 or more publications)

Gaynor, James: 30
Rossano, Joseph: 18
Dori, Yoav: 16
O'Byrne, Michael: 13
Diddle, Wesley: 11
Smith, Christopher: 11
O'Connor, Matthew: 11
Mavroudis, Constantine: 10
Biko, David: 10
Fuller, Stephanie: 10
Shah, Maully: 10

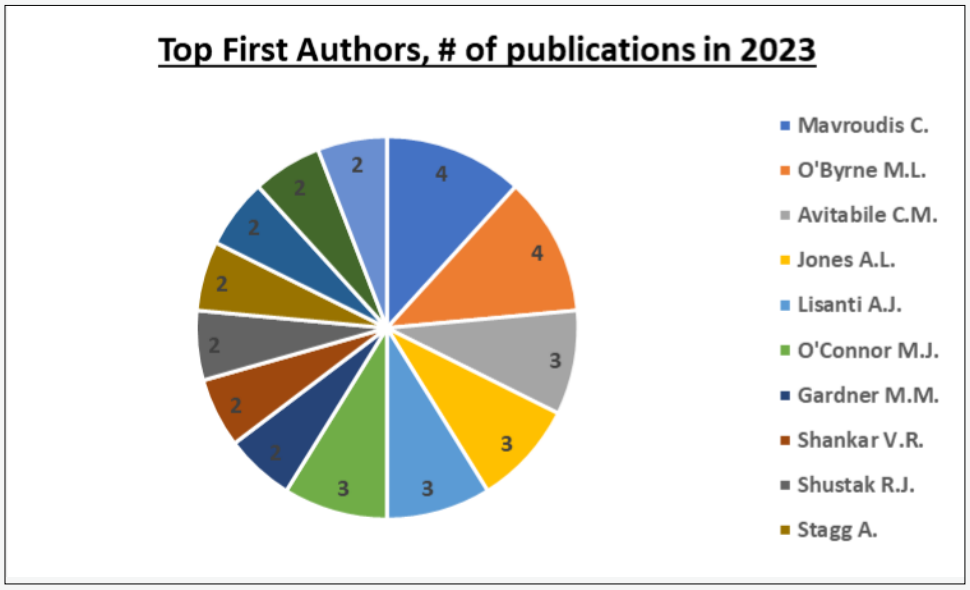


BIBLIOMETRIC ANALYSIS

TOP FIRST AUTHORS IN 2023 PUBLISHED FROM THE CHOP CARDIAC CENTER

	# of publications in 2023
Mavroudis C.	4
O'Byrne M.L.	4
Avitabile C.M.	3
Jones A.L.	3
Lisanti A.J.	3
O'Connor M.J.	3
Gardner M.M.	2
Shankar V.R.	2
Shustak R.J.	2
Stagg A.	2
Vaikunth S.	2
Weiss P.F.	2
White B.R.	2

(limited to 2 or more publications)

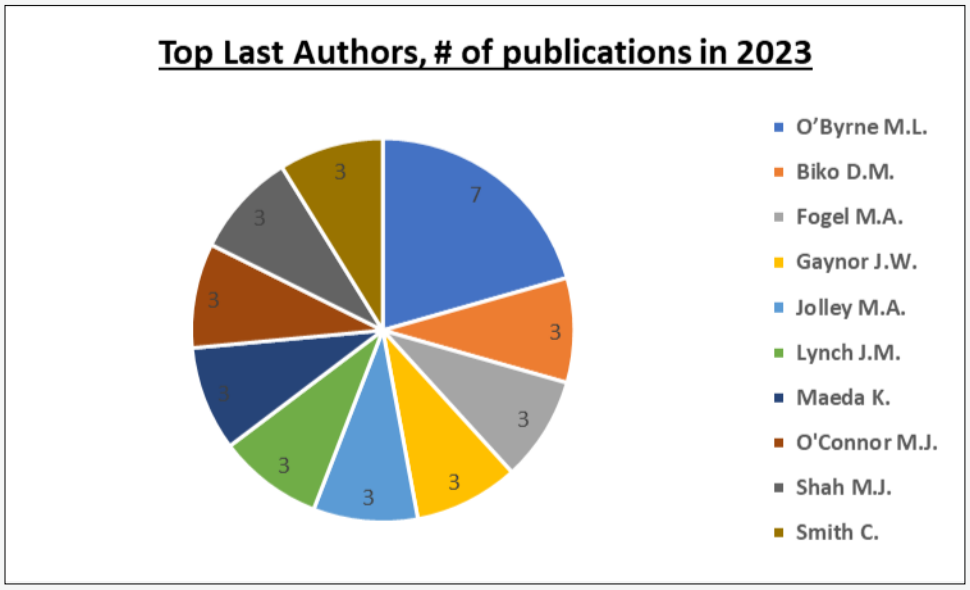


BIBLIOMETRIC ANALYSIS

TOP LAST AUTHORS PUBLISHED IN 2023 FROM THE CHOP CARDIAC CENTER

	# of publications in 2023
O'Byrne M.L.	7
Biko D.M.	3
Fogel M.A.	3
Gaynor J.W.	3
Jolley M.A.	3
Lynch J.M.	3
Maeda K.	3
O'Connor M.J.	3
Shah M.J.	3
Smith C.	3

(limited to 2 or more publications)



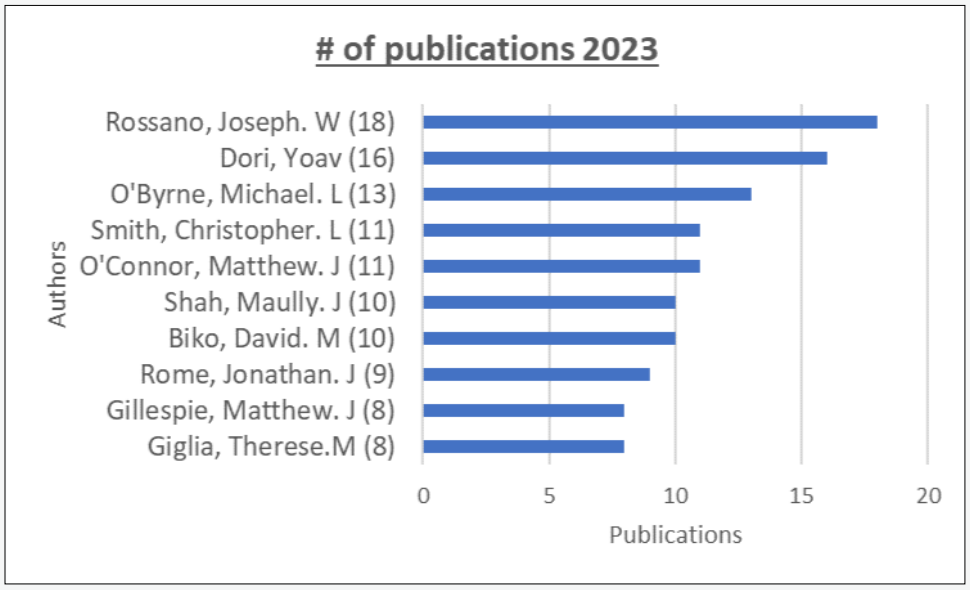
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF CARDIOLOGY

Top 5 Sources:
Pediatric Cardiology: 19
Cardiology in the Young: 11
J. of Heart and Lung Transplantation: 6
J. of Pediatrics: 6
J. of the American College of Cardiology: 6

Articles: 170
Cited in 2023: 284
H-index: 8
Authors searched within the Division of Cardiology: 89
(Outpatient: 23, Echo: 21, Pulmonary Hypertension: 5, Heart Failure/Tx: 9, ACHD: 5, MRI: 5, Cath: 8, Exercise: 3, EP: 5, Research: 5)



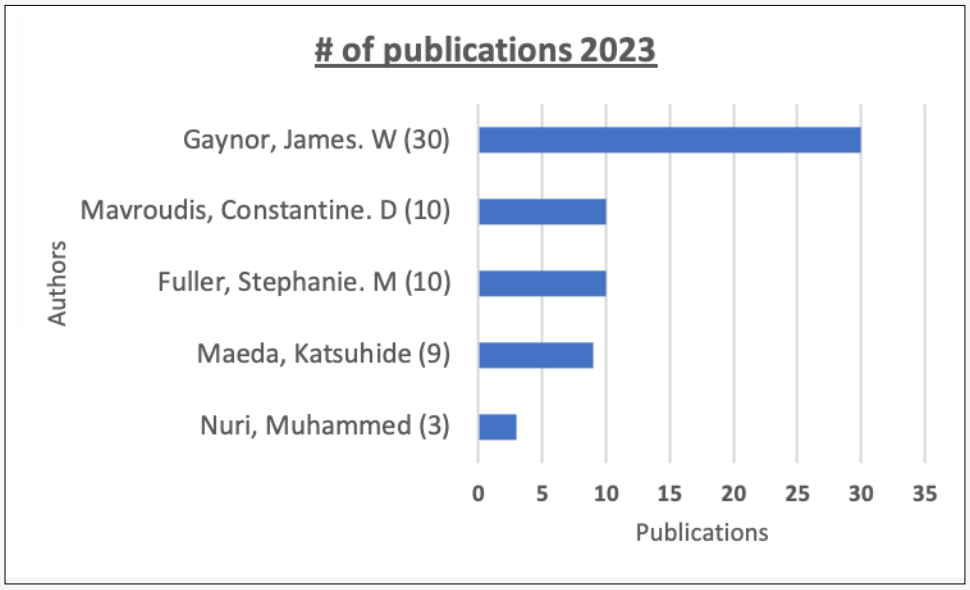
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF SURGERY

Top 5 Sources:
Cardiology in the Young: 9
Annals of Thoracic Surgery: 4
World Journal for Pediatric and Congenital Heart Surgery: 4
Frontiers in Pediatrics: 3
Journal of the American College of Cardiology: 3

Articles: 57
Cited in 2023: 73
H-index: 4
Authors searched within the Division of Surgery: 6



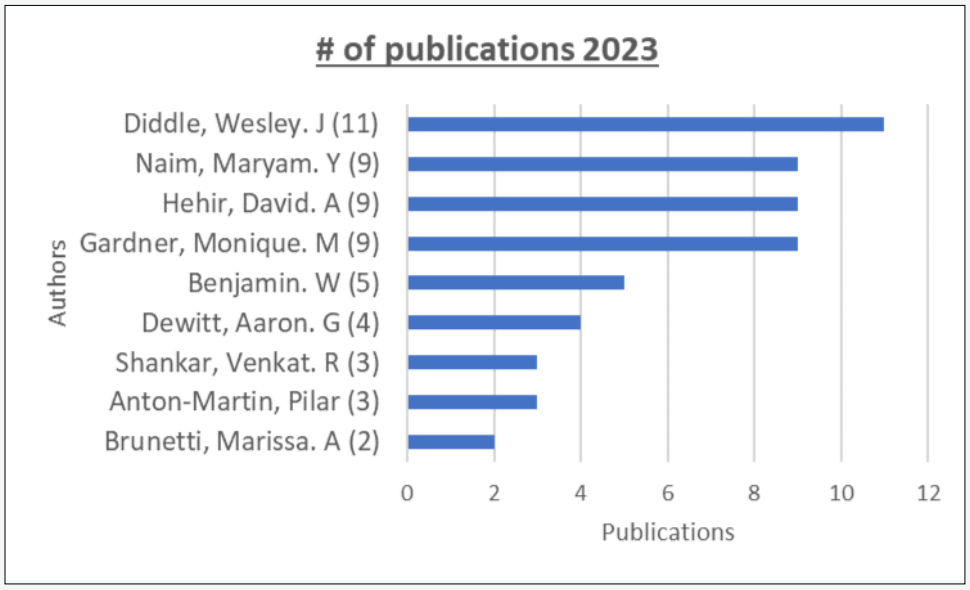
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF CRITICAL CARE MEDICINE

Top 5 Sources:
Cardiology in the Young: 7
Resuscitation: 7
Indian Journal of Pediatrics: 5
Pediatric Cardiology: 5
Critical Care: 2

Articles: 41
Cited in 2023: 65
H-index: 4
Authors searched within the Division of Surgery: 22



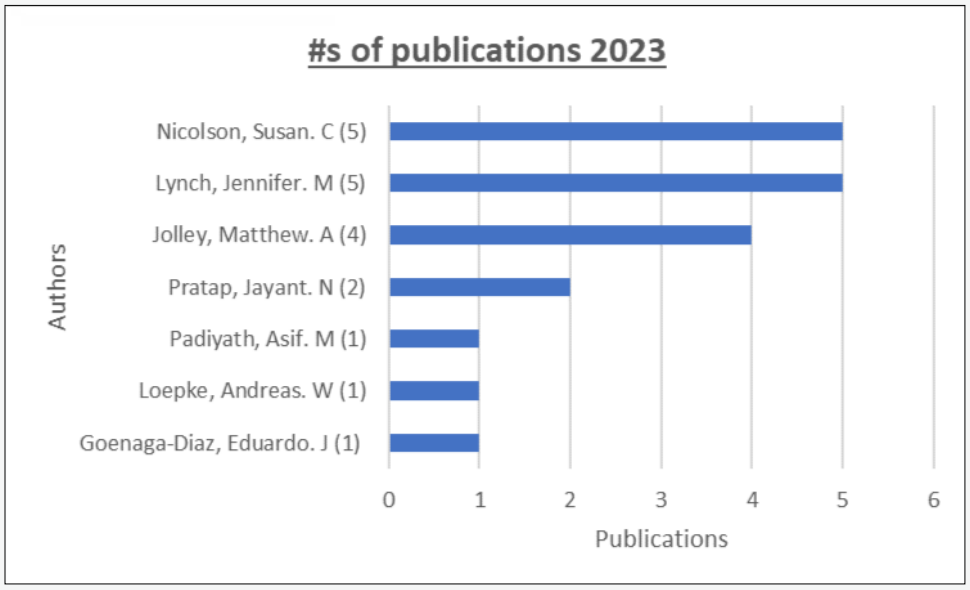
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF ANESTHESIOLOGY

Top 5 Sources:
American Journal of Cardiology: 1
Anesthesia and Analgesia: 1
Anesthesiology: 1
Anesthesiology Clinics: 1
Applied Mathematics and Mechanics (English Edition): 1

Articles: 15
Cited in 2023: 16
H-index: 2
Authors searched within the Division of Surgery: 15



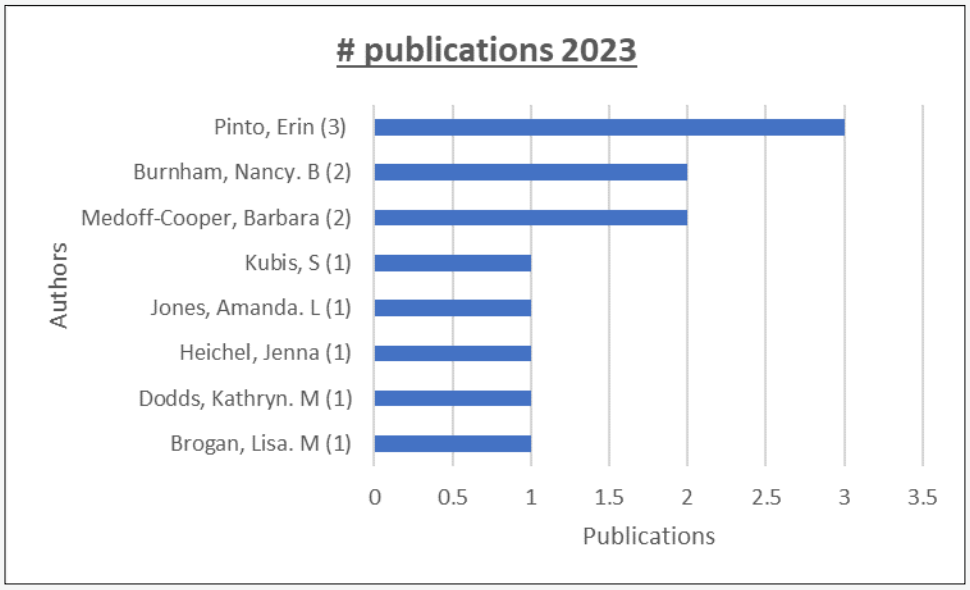
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF NURSING AND NUTRITION

Top 5 Sources:
Cardiology in the Young: 4
Journal of the American Heart Association: 3
Pediatric Cardiology: 3
Anesthesiology: 1
Clinical and Translational Science: 1

Articles: 22
Cited in 2023: 33
H-index: 3
Authors searched within the Division of Nursing &Nutrition: 66
(Nursing: 62, Nutrition (CICU): 2, Nutrition (CCU): 2)



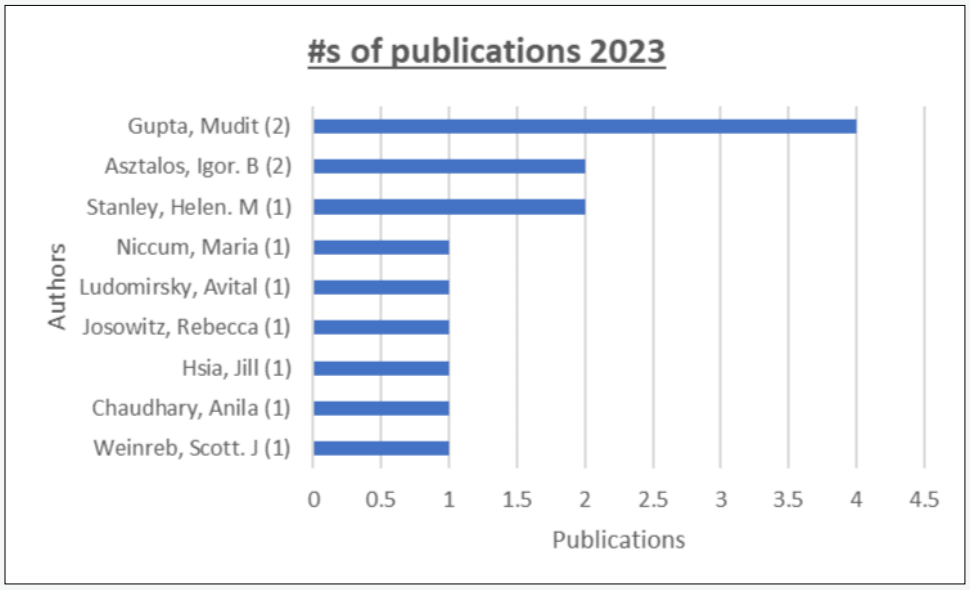
BIBLIOMETRIC ANALYSIS

SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

FELLOWS

Top 5 Sources:
Cardiology in the Young: 3
JACC: Case Reports: 2
Pediatric Cardiology: 2
American Journal of Medical Genetics, Part A: 1
ERJ Open Research: 1

Articles: 14
Cited in 2023: 4
H-index: 1
Authors searched within the Fellows: 30



BIBLIOMETRIC ANALYSIS

APPENDIX A

BIBLIOGRAPHY OF "HIGHLY CITED" PAPERS

1) The Society of Thoracic Surgeons Congenital Heart Surgery Database: 2022 Update on Outcomes and Research
Kumar, SR; Gaynor, JW; Nelson, JS; Kumar, S Ram; Gaynor, J William; Jones, Leigh Ann; Krohn, Carole; Mayer, John E; Nathan, Meena; O'Brien, James E; Pizarro, Christian; Wellnitz, Chasity; Nelson, Jennifer S; DOI: 10.1016/j.athoracsur.2022.12.040; The Annals of thoracic surgery., 2023, Vol.115(4), p.807-819

APPENDIX B

BIBLIOGRAPHY OF "CITED>=8 TIMES" PAPERS WITH JOURNAL IMPACT FACTOR >6

1) Age-related enhanced degeneration of bioprosthetic valves due to leaflet calcification, tissue crosslinking, and structural changes.
Xue Y.; Kossar A.P.; Abramov A.; Frasca A.; Sun M.; Zyablitskaya M.; Paik D.; Kalfa D.; Barbera M.D.; Thiene G.; Kozaki S.; Kawashima T.; Gorman J.H., III; Gorman R.C.; Gillespie M.J.; Carreon C.K.; Sanders S.P.; Levy R.J.; Ferrari G. ; DOI: 10.1093/cvr/cvac002; Cardiovascular Research., 2023, Vol.119(1), p.302 – 3151.
2) Diastolic Blood Pressure Threshold during Pediatric Cardiopulmonary Resuscitation and Survival Outcomes: A Multicenter Validation Study.
Berg R.A.; Morgan R.W.; Reeder R.W.; Ahmed T.; Bell M.J.; Bishop R.; Bochkoris M.; Burns C.; Carcillo J.A.; Carpenter T.C.; Dean J.M.; Diddle J.W.; Federman M.; Fernandez R.; Fink E.L.; Franzon D.; Frazier A.H.; Friess S.H.; Graham K.; Hall M.; Hehir D.A.; Horvat C.M.; Huard L.L.; Maa T.; Manga A.; McQuillen P.S.; Meert K.L.; Mourani P.M.; Nadkarni V.M.; Naim M.Y.; Notterman D.; Palmer C.A.; Pollack M.M.; Sapru A.; Schneiter C.; Sharron M.P.; Srivastava N.; Tabbutt S.; Tilford B.; Viteri S.; Wessel D.; Wolfe H.A.; Yates A.R.; Zuppa A.F.; Sutton R.M.; DOI: 10.1097/CCM.0000000000005715; Critical Care Medicine., Vol.51(1), p.91-102.
3) Risk of Sudden Death in Patients With RASopathy Hypertrophic Cardiomyopathy.
Lynch A.; Tatangelo M.; Ahuja S.; Steve Fan C.-P.; Min S.; Lafreniere-Roula M.; Papaz T.; Zhou V.; Armstrong K.; Aziz P.F.; Benson L.N.; Butts R.; Dragulescu A.; Gardin L.; Godown J.; Jeewa A.; Kantor P.F.; Kaufman B.D.; Lal A.K.; Parent J.J.; Richmond M.; Russell M.W.; Balaji S.; Stephenson E.A.; Villa C.; Jefferies J.L.; Whitehill R.; Conway J.; Howard T.S.; Nakano S.J.; Rossano J.; Weintraub R.G.; Mital S.; DOI: 10.1016/j.jacc.2023.01.012; Journal of the American College of Cardiology., Vol.81(11), p.1035-1045.
4) Emerging Insights Into the Pathophysiology of Multisystem Inflammatory Syndrome Associated With COVID-19 in Children.
Lin J.; Harahsheh A.S.; Raghuveer G.; Jain S.; Choueiter N.F.; Garrido-Garcia L.M.; Dahdah N.; Portman M.A.; Misra N.; Khoury M.; Fabi M.; Elias M.D.; Dionne A.; Lee S.; Tierney E.S.S.; Ballweg J.A.; Manlhiot C.; McCrindle B.W.; DOI: 10.1016/j.cjca.2023.01.002; Canadian Journal of Cardiology., Vol. 39(6), p. 793-802.
5) The Prevalence and Association of Exercise Test Abnormalities with Sudden Cardiac Death and Transplant-Free Survival in Childhood Hypertrophic Cardiomyopathy.
Conway J.; Min S.; Villa C.; Weintraub R.G.; Nakano S.; Godown J.; Tatangelo M.; Armstrong K.; Richmond M.; Kaufman B.; Lal A.K.; Balaji S.; Power A.; Baez Hernandez N.; Gardin L.; Kantor P.F.; Parent J.J.; Aziz P.F.; Jefferies J.L.; Dragulescu A.; Jeewa A.; Benson L.; Russell M.W.; Whitehill R.; Rossano J.; Howard T.; Mital S.; DOI: 10.1161/CIRCULATIONAHA.122.062699; Circulation., Vol.147(9) , p.718-727.

6) Conduction System Pacing Versus Conventional Cardiac Resynchronization Therapy in Congenital Heart Disease. Moore J.P.; de Groot N.M.S.; O'Connor M.; Cortez D.; Su J.; Burrows A.; Shannon K.M.; O'Leary E.T.; Shah M.; Khairy P.; Atallah J.; Wong T.; Lloyd M.S.; Taverne Y.J.H.J.; Dubin A.M.; Nielsen J.C.; Evertz R.; Czosek R.J.; Madhavan M.; Chang P.M.; Aydin A.; Cano Ó.; DOI: 10.1016/j.jacep.2022.10.012; JACC: Clinical Electrophysiology., Vol.9(3), p.385-393.
7) Evaluating the Accuracy of Pulse Oximetry in Children According to Race. Ruppel H.; Makeneni S.; Faerber J.A.; Lane-Fall M.B.; Foglia E.E.; O'Byrne M.L.; Bonafide C.P.; DOI: 10.1001/jamapediatrics.2023.0071; JAMA Pediatrics., Vol.177(5), p.540-543.
8) The physiologic response to epinephrine and pediatric cardiopulmonary resuscitation outcomes. Morgan R.W.; Berg R.A.; Reeder R.W.; Carpenter T.C.; Franzon D.; Frazier A.H.; Graham K.; Meert K.L.; Nadkarni V.M.; Naim M.Y.; Tilford B.; Wolfe H.A.; Yates A.R.; Sutton R.M.; Ahmed T.; Bell M.J.; Bishop R.; Bochkoris M.; Burns C.; Carcillo J.A.; Dean J.M.; Diddle J.W.; Federman M.; Fernandez R.; Fink E.L.; Friess S.H.; Hall M.; Hehir D.A.; Horvat C.M.; Huard L.L.; Maa T.; Manga A.; McQuillen P.S.; Mourani P.M.; Notterman D.; Pollack M.M.; Sapru A.; Schneiter C.; Sharron M.P.; Srivastava N.; Tabbutt S.; Viteri S.; Wessel D.; Zuppa A.F.; DOI: 10.1186/s13054-023-04399-5; Critical Care., Vol.27(1).
9) Examination of Adverse Reactions After COVID-19 Vaccination Among Patients With a History of Multisystem Inflammatory Syndrome in Children. Elias M.D.; Truong D.T.; Oster M.E.; Trachtenberg F.L.; Mu X.; Jone P.-N.; Mitchell E.C.; Dummer K.B.; Sexson Tejtel S.K.; Osakwe O.; Thacker D.; Su J.A.; Bradford T.T.; Burns K.M.; Campbell M.J.; Connors T.J.; D'Addese L.; Forsha D.; Frosch O.H.; Giglia T.M.; Goodell L.R.; Handler S.S.; Hasbani K.; Hebson C.; Krishnan A.; Lang S.M.; McCrindle B.W.; McHugh K.E.; Morgan L.M.; Payne R.M.; Sabati A.; Sagiv E.; Sanil Y.; Serrano F.; Newburger J.W.; Dionne A.; DOI: 10.1001/jamanetworkopen.2022.48987; JAMA network open., Vol. 6(1), e2248987.
10) Lymphatic disorders caused by mosaic, activating KRAS variants respond to MEK inhibition Sheppard S.E.; March M.E.; Seiler C.; Matsuoka L.S.; Kim S.E.; Kao C.; Rubin A.I.; Battig M.R.; Khalek N.; Schindewolf E.; O'Connor N.; Pinto E.; Priestley J.R.C.; Sanders V.R.; Niazi R.; Ganguly A.; Hou C.; Slater D.; Frieden I.J.; Huynh T.; Shieh J.T.; Krantz I.D.; Guerrero J.C.; Surrey L.F.; Biko D.M.; Laje P.; Castelo-Soccio L.; Nakano T.A.; Snyder K.; Smith C.L.; Li D.; Dori Y.; Hakonarson H.; DOI: 10.1172/jci.insight.155888; JCI Insight, Vol. 8(9).
11) Guidelines and Recommendations for Performance of the Fetal Echocardiogram: An Update from the American Society of Echocardiography Moon-Grady A.J.; Donofrio M.T.; Gelehrter S.; Hornberger L.; Kreeger J.; Lee W.; Michelfelder E.; Morris S.A.; Peyvandi S.; Pinto N.M.; Pruetz J.; Sethi N.; Simpson J.; Srivastava S.; Tian Z.; DOI: 10.1016/j.echo.2023.04.014; Journal of the American Society of Echocardiography; Vol. 36(7), p.679 – 723.

PUBLICATIONS

CHILDREN'S HOSPITAL OF PHILADELPHIA CARDIAC CENTER PUBLICATIONS 2023

Adachi I, Peng DM, Hollander SA, Simpson KE, Davies RR, Jacobs JP, VanderPluym CJ, Fynn- Thompson F, Wells DA, Law SP, Amdani S, Cantor R, Koehl D, Kirklin JK, Morales DLS, Rossano JW; Pedimacs Investigators. **Sixth annual pediatric interagency registry for mechanical circulatory support (Pedimacs) report: The Society of Thoracic Surgeons Pedimacs annual report**. *Ann Thorac Surg.* 2022, Nov. 115(5): 1098-1108. doi: 10.1016/j.athoracsur.2022.10.042. PMID: 36402175

Adamson GT, Winder MM, Catton KG, Dewitt AG, Kozyak BW, Glenn ET, Bailly DK. **Current practices for refractory chylothorax following congenital heart surgery.** *Cardiol Young*. 2023, Dec. 11:1-5. doi: 10.1017/S1047951123003918. Epub ahead of print. PMID: 38073584

Alaiwi SA, Roston TM, Marstrand P, Claggett BL, Parikh VN, Helms AS, Ingles J, Lampert R, Lakdawala NK, Michels M, Owens AT, Rossano JW, Saberi S, Abrams DJ, Ashley EA, Semsarian C, Stendahl JC, Ware JS, Miller E, Ryan TD, Russell MW, Day SM, Olivotto I, Vissing CR, Ho CY. **Left Ventricular Systolic Dysfunction in Patients Diagnosed With Hypertrophic Cardiomyopathy During Childhood: Insights From the SHaRe Registry (Sarcomeric Human Cardiomyopathy).** *Circulation.* 2023, May. 148(5): 394-404. doi:10.1161/CIRCULATIONAHA.122.062517. PMID: 37226762

Almond CS, Sleeper LA, Rossano JW, Bock MJ, Pahl E, Auerbach S, Lal A, Hollander SA, Miyamoto SD, Castleberry C, Lee J, Barkoff LM, Gonzales S, Klein G, Daly KP. **The TEAMMATE Trial: Study Design and Rationale Tacrolimus and Everolimus against TACROLIMUS and MMF in Pediatric Heart Transplantation Using the Major Adverse Transplant Event (MATE) Score.** *Am Heart J*. 2023, Feb. 260:100-112. doi: 10.1016/j.ahj.2023.02.002? PMID: 36828201

Amdani S, Auerbach SR, Bansal N, Chen S, Conway J, Da Silva JP, Deshpande SR, Hoover J, Lin K, Miyamoto S, Puri K, Price J, Spinner J, White R, Rossano JW, Bearl DW, Cousino MK, Catlin P, Hidalgo NC, Godown J, Kantor P, Masarone D, Peng DM, Rea KE, Schumacher K, Shaddy R, Shea E, Tapia HV, Valikodath N, Zafar F, Hsu D. **Research gaps in pediatric heart failure: defining the gaps and then closing them over the next decade.** *J Card Fail.* 2023, Dec. 6:S1071-9164(23)00911-9. doi: 10.1016/j.cardfail.2023.08.026. Epub ahead of print. PMID: 38065308

Amin S, Dewey H, Lasso A, Sabin P, Han Y, Vicory J, Paniagua B, Herz C, Nam H, Cianciulli A, Flynn M, Laurence DW, Harrild D, Fichtinger G, Cohen MS, Jolley MA. **Euclidean and Shape-Based Analysis of the Dynamic Mitral Annulus in Children Using a Novel Open- Source Framework**. *J Am Soc Echocardiogr*. 2023, Nov. S0894-7317(23)00594-1. doi: 10.1016/j.echo.2023.11.011. PMID: 37995938

Andersen KN, Yao S, White BR, Jacobwitz M, Breimann J, Jahnavi J, Schmidt A, Baker WB, Ko TS, Gaynor JW, Vossough A, Xiao R, Licht DJ, Shih EK. **Cerebral microhemorrhages in children with congenital heart disease: Prevalence, risk factors, and impact on neurodevelopmental outcomes**. *medRxiv* [Preprint]. 2023, Dec. 6:2023.12.05.23299539. doi: 10.1101/2023.12.05.23299539. PMID: 38105980; PMCID: PMC10723520

Anvekar P, Stephens P Jr, Calderon-Anyosa RJC, Kauffman HL, Burstein DS, Ritter AL, Ahrens-Nicklas RC, Vetter VL, Banerjee A. **Electrocardiographic Findings in Genotype- Positive and Non-sarcomeric Children with Definite Hypertrophic Cardiomyopathy and Subclinical Variant Carriers**. *Pediatr Cardiol*. 2023, Sep. doi: 10.1007/s00246-023-03281-z. E PMID: 37725123

Ashfaq A, Lorts A, Rosenthal D, Adachi I, Rossano J, Davies R, Simpson KE, Maeda K, Wisotzkey B, Koehl D, Cantor RS, Jacobs JP, Peng D, Kirklin JK, Morales DLS. **Survival in Pediatric Patients with Ventricular Assist Devices: A Special PEDIMACS Report**. *Ann Thorac Surg*. 2023, Aug. 116(5): 972-979. doi: 10.1016/j.athoracsur.2023.07.039. PMID: 37573991

PUBLICATIONS

Avitabile CM, Hopper RK, Handler SS, Bates A. **Editorial: Advances in the care of the pediatric pulmonary hypertension patient: from the neonate to the adolescent-young adult patient**. *Front Pediatr.* 2023, May. 11:1220070. doi: 10.3389/fped.2023.1220070. PMID: 37303755; PMCID: PMC10248507

Avitabile CM, Yung D, Handler S, Hopper RK, Fineman J, Freire G, Varghese N, Mullen MP, Krishnan US, Austin E, Silveira L, Ivy DD. **Measurement of Physical Activity by Actigraphy in Infants and Young Children with Pulmonary Arterial Hypertension**. *J Pediatr*. 2023, Jul. 262:113639. doi: 10.1016/j.jpeds.2023.113639. PMID: 37517653

Backer CL, Overman DM, Dearani JA, Romano JC, Tweddell JS, Kumar SR, Marino BS, Bacha EA, Jaquiss RDB, Zaidi AN, Gurvitz M, Costello JM, Pierick TA, Ravekes WJ, Reagor JA, St Louis JD, Spaeth J, Mahle WT, Shin AY, Lopez KN, Karamlou T, Welke KF, Bryant R, Husain SA, Chen JM, Kaza A, Wells WJ, Glatz AC, Cohen MI, McElhinney DB, Parra DA, Pasquali SK. **Recommendations for centers performing pediatric heart surgery in the United States**. *J Thorac Cardiovasc Surg*. 2023, Sep. 166(6): 1782-1820. doi: 10.1016/j.jtcvs.2023.09.001. PMID: 37777958

Backer CL, Overman DM, Dearani JA, Romano JC, Tweddell JS, Kumar SR, Marino BS, Bacha EA, Jaquiss RDB, Zaidi AN, Gurvitz M, Costello JM, Pierick TA, Ravekes WJ, Reagor JA, St Louis JD, Spaeth J, Mahle WT, Shin AY, Lopez KN, Karamlou T, Welke KF, Bryant R, Husain SA, Chen JM, Kaza A, Wells WJ, Glatz AC, Cohen MI, McElhinney DB, Parra DA, Pasquali SK. **Recommendations for Centers Performing Pediatric Heart Surgery in the United States**. *Ann Thorac Surg*. 2023, Sep. 116(5): 871-907. doi: 10.1016/j.athoracsur.2023.08.016.
PMID: 37777933

*Balsara SL, Burnstein D, Ittenbach RF, Kaplinski M, Gardner MM, Ravishankar C, Rossano J, Goldberg DJ, Mahle M, O'Connor ML, Mascio CE, Gaynor WJ, Preminger TJ. **Combined ventricular dysfunction and atrioventricular valve regurgitation after the Norwood procedure are associated with attrition prior to superior cavopulmonary connection.** *JTCVS*. 2023, Dec. ISSN 2666-2736. 10.1016/j.xjon.2023.09.042.

Bansal N, D'Souza N, Wisotzkey BL, Albers E, Shih R, Exil V, McQueen M, Hillenburg JP, Azeka E, Law S, Peng DM, O'Connor M, Gajarski R, Vanderpluym C, Lorts A, Barnes A, Sojka M, Bano M, Keating M, Rosenthal DN, Conway J, Schroeder K, Nandi D. **Successful implementation of telehealth visits in the paediatric heart failure and heart transplant population**. *Cardiol Young.* 2023, Jul. 31:1-4. doi: 10.1017/S1047951123001312. PMID: 37518866

#*Barak-Corren Y, Herz C, Lasso A, Dori Y, Tang J, Smith CL, Callahan R, Rome JJ, Gillespie MJ, Jolley MA, O'Byrne ML. **Calculating Relative Lung Perfusion Using Fluoroscopic Sequences and Image Analysis: The Fluoroscopic Flow Calculator.** *Circ Cardiovasc Interv.* 2023, Dec. e013204. doi: 10.1161/CIRCINTERVENTIONS.123.013204. Epub ahead of print. PMID: 38152881 #shared senior authorship (MAJ and MLO)

Barreto JA, Gauvreau K, Porras D, Esch JJ, Maschietto N, Quinn B, Bergersen L, Stein M, Callahan R. **Predictors of Serious Adverse Events and High-Level Cardiorespiratory Support in Patients Undergoing Transcatheter Pulmonary Vein Interventions**. *Pediatr Cardiol.* 2023, Mar. 44: 806-815. doi: 10.1007/s00246-023-03129-6. PMID: 36869157

Barry OM, Gudausky TM, Balzer DT, Bocks ML, Boe BA, Callahan R, El-Said H, Farias MJ, Foerster S, Goldstein BH, Holzer RJ, Janssen D, Levy P, O'Byrne ML, Rahman G, Sathanandam S, Shahanavaz S, Whiteside W, Turner ME. **Safety and Short-Term Outcomes for Infants < 2.5 kg Undergoing PDA Device Closure: A C3PO Registry Study**. *Pediatr Cardiol*. 2023, Mar. doi: 10.1007/s00246-023-03147-4. PMID: 36995404

Bauer C, Dori Y, Scala M, Tulzer A, Tulzer G. **Current diagnostic and therapeutic strategies for the management of lymphatic insufficiency in patients with hypoplastic left heart syndrome. Front Pediatr**. 2023, Feb. 11:1058567. doi: 10.3389/fped.2023.1058567. PMID: 36911024; PMCID: PMC9999027

PUBLICATIONS

Bauer C, Scala M, Rome JJ, Tulzer G, Yoav D. **Lymphatic Imaging and Intervention in Congenital Heart Disease.** *J of the Soc for Cardio Angio & Interv*. 2023, Sep. doi: 10.1016/j.jscai.2023.101174

Behere SP, Janson CM. **Smart wearables in pediatric heart health.** *J Pediatr*. 2022 Sep 24:S0022-3476(22)00718-1. doi: 10.1016/j.jpeds.2022.08.009. PMID: 36162539

Benson EJ, Aronowitz DI, Forti RM, Lafontant A, Ranieri NR, Starr JP, Melchior RW, Lewis A, Jahnavi J, Breimann J, Yun B, Laurent GH, Lynch JM, White BR, Gaynor JW, Licht DJ, Yodh AG, Kilbaugh TJ, Mavroudis CD, Baker WB, Ko TS. **Diffuse Optical Monitoring of Cerebral Hemodynamics and Oxygen Metabolism during and after Cardiopulmonary Bypass: Hematocrit Correction and Neurological Vulnerability**. *Metabolites*. 2023 Nov. 13(11):1153. doi: 10.3390/metabo13111153. PMID: 37999249; PMCID: PMC10672802

Berg RA, Morgan RW, Reeder RW, Ahmed T, Bell MJ, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, Diddle JW, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Hehir DA, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Mourani PM, Nadkarni VM, Naim MY, Notterman D, Palmer CA, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tabbutt S, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Sutton RM. **Diastolic Blood Pressure Threshold During Pediatric Cardiopulmonary Resuscitation and Survival Outcomes: A Multicenter Validation Study**. *Crit Care Med*. 2023, Jan. 51(1):91-102. doi: 10.1097/CCM.0000000000005715. PMID: 36519983

Biko DM, Fogel MA. **Fetal Cardiac MRI: Doppler US-gated Cine Imaging in Complex Congenital Heart Disease**. *Radiol Cardiothorac Imaging*. 2023, Feb. 5(1):e220314. doi: 10.1148/ryct.220314. PMID: 36860832; PMCID: PMC9969212

Boucek K, Alzubi A, Zafar F, O'Connor MJ, Mehegan M, Mokshagundam D, Davies RR, Adachi I, Lorts A, Rosenthal DN. **Taking ACTION: A Prognostic Tool for Pediatric Ventricular Assist Device Mortality.** *ASAIO J*. 2023, Jun. 69(6):602-609. doi: 10.1097/MAT.0000000000001899. PMID: 37261722

Brucia RC, Taggart NW, Sagiv E, Kohli U, Tisma-Dupanovic S, Sutton NJ, McDaniel GM, Rossano JW, Dwyer AC, Marshall AC. **Applying practice analysis to develop a new test content outline for the pediatric cardiology certification examination.** *Pediatr Cardiol.* 2022 Dec. 44(5):1057-1067. doi: 10.1007/s00246-022-03070-0. PMID: 36508019

Brunetti MA, Griffis HM, O'Byrne ML, Glatz AC, Huang J, Schumacher KR, Bailly DK, Domnina Y, Lasa JJ, Moga MA, Zaccagni H, Simsic JM, Gaynor JW. **Racial and Ethnic Variation in ECMO Utilization and Outcomes in Pediatric Cardiac ICU Patients**. *JACC: Advances*. 2023, Nov. 2(9). Doi:10.1016/j.jacadv.2023.100634 **

Chen S, Shezad MF, Lorts A, McCormick AD, Mao CY, Simpson KE, O'Connor MJ, Barnes A, Lubert AM, Castleberry C, Schmidt J, Schroeder K, Joong A, Bearl DW, Lal AK, Mokshagundam D, Conway J, Cedars A, Schumacher KR. **Outcomes after initial heart failure consultation in Fontan patients**. *Cardiol Young*. 2023 Nov. 28:1-8. doi: 10.1017/S1047951123003852. PMID: 38014551

Collaco JM, Abman SH, Austin ED, Avitabile CM, Bates A, Fineman JR, Freire GA, Handler SS, Ivy DD, Krishnan US, Mullen MP, Varghese NP, Yung D, Nies MK, Everett AD, Zimmerman KO, Simmons W, Chakraborty H, Yenokyan G, Newell-Sturdivant A, Christensen E, Eyzaguirre LM, Hanley DF, Rosenzweig EB, Romer LH. **Kids Mod PAH trial: A multicenter trial comparing mono- versus duo-therapy for initial treatment of pediatric pulmonary hypertension**. *Pulm Circ*. 2023 Oct. 13(4):e12305. doi: 10.1002/pul2.12305. PMID: 37915400; PMCID: PMC10617301

PUBLICATIONS

Carvalho JS, Axt-Fliedner R, Chaoui R, Copel JA, Cuneo BF, Goff D, Gordin Kopylov L, Hecher K, Lee W, Moon-Grady AJ, Mousa HA, Munoz H, Paladini D, Prefumo F, Quarello E, Rychik J, Tutschek B, Wiechec M, Yagel S. **ISUOG Practice Guidelines (updated): fetal cardiac screening**. *Ultrasound Obstet Gynecol*. 2023, Jun. 61(6):788-803. doi: 10.1002/uog.26224. PMID: 37267096

Cashen K, Sutton RM, Reeder RW, Ahmed T, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Wesley Diddle J, Federman M, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Hehir DA, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Morgan RW, Mourani PM, Nadkarni VM, Naim MY, Notterman D, Palmer CA, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Viteri S, Wolfe HA, Yates AR, Zuppa AF, Meert KL; Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatrics Critical Care Research Network (CPCCRN); National Heart Lung and Blood Institute ICU-RESUScitation Project Investigators. **Association of CPR Simulation Program Characteristics with Simulated and Actual Performance during Paediatric In-Hospital Cardiac Arrest**. *Resuscitation*. 2023, Oct. 191:109939. doi: 10.1016/j.resuscitation.2023.109939. 2023, Aug 23. PMID: 37625580; PMCID: PMC10528057

Castillero E, Fitzpatrick E, Keeney SJ, D'Angelo AM, Pressly BB, Simpson MT, Kurade M, Erwin WC, Moreno V, Camillo C, Shukla HJ, Inamdar VV, Aghali A, Grau JB, Salvati E, Nissim I, Rauova L, Oyama MA, Stachelek SJ, Brown C, Krieger AM, Levy RJ, Ferrari G. **Decreased serotonin transporter activity in the mitral valve contributes to progression of degenerative mitral regurgitation**. *Sci Transl Med*. 2023, Jan. 15(677):eadc9606. doi: 10.1126/scitranslmed.adc9606. PMID: 36599005

*Chaszczewski KJ, *Linder JR, *Campbell MJ, Convery M, Wang Y, Smith CL, Kozyak BW, Quartermain MD. **Novel Utilization of Ultrasound Enhancing Agents in Complex Congenital Heart Disease Following Superior Cavopulmonary Connection**. *J Am Soc Echocardiogr*. 2023, Jan. 36(5): 516-522. doi: 10.1016/j.echo.2023.01.007. PMID: 36642236

Christmyer Z, Pisupati M, Shah MJ, Srinivasan C, Vetter VL, Iyer VR, Triguba M, Janson CM. **Risk Stratification in Pediatric Wolff-Parkinson-White: Practice Variation Among Pediatric Cardiologists and Electrophysiologists**. *Pediatr Cardiol*. 2023, Aug 6. doi: 10.1007/s00246-023-03247-1. PMID: 37544951

Ching S, Cianciulli AR, Flynn M, Silvestro E, Sabin P, Lasso A, Ghosh RM, Gillespie MJ, Jolley MA. **Physical Simulation of Transcatheter Edge-to-Edge Repair using Image- Derived 3D Printed Heart Models**. *Ann Thorac Surg Short Rep*. 2023, Mar. 1(1): 40-45. PMID: 36909146

Chowers G, Abebe-Campino G, Golan H, Vivante A, Greenberger S, Soudack M, Barkai G, Fox-Fisher I, Li D, March M, Battig MR, Hakonarson H, Adams D, Dori Y, Dagan A. **Insights Image for "Treatment of Severe Kaposiform Lymphangiomatosis Positive for NRAS Mutation by MEK-inhibition"**. *Pediatr Res.* 2023, Aug. 94(6): 2117. doi: 10.1038/s41390-023- 02755-3. PMID: 37550488

Collia D, Pedrizzetti G, Sato T, Matsubara D, Zovatto L, Gei M, Banerjee A, Pedrizzetti G. **Interplay between geometry, fluid dynamics, and structure in the ventricles of the human heart.** *Phys Rev Appl*. 2023 Jan. 19(1): 014006. 10.1103/PhysRevApplied.19.014006. (No PMID)

Conway J, Min S, Villa C, Weintraub RG, Nakano S, Godown J, Tatangelo M, Armstrong K, Richmond M, Kaufman B, Lal AK, Balaji S, Power A, Baez Hernandez N, Gardin L, Kantor PF, Parent JJ, Aziz PF, Jefferies JL, Dragulescu A, Jeewa A, Benson L, Russell MW, Whitehill R, Rossano J, Howard T, Mital S. **The prevalence and association of exercise test abnormalities with sudden cardiac death and transplant-free survival in childhood hypertrophic Cardiomyopathy**. *Circulation*. 2022 Nov 6. 147(9):718-727 doi:10.1161/CIRCULATIONAHA.122.062699. PMID: 36335467

PUBLICATIONS

Conway J, Amdani S, Morales DLS, Lorts A, Rosenthal DN, Jacobs JP, Rossano J, Koehl D, Kirklin JK MD, Auerbach SR. **Widening Care Gap in VAD Therapy**. *J Heart Lung Transplant.* 2023, Aug. 42(12): 1710-1724. doi: 10.1016/j.healun.2023.08.009. PMID: 37591455

Coyan GN, Gillespie MJ, Ewing SG, Maeda K. **Successful Dilation of a Novel Expandable Polytetrafluoroethylene Pulmonary Artery Band Negating need for Further Surgery**. *JTCVS Techniques*. 2023, Sep. doi: 10.1016/j.xjtc.2023.08.029

Cuneo BF, Buyon JP, Sammaritano L, Jaeggi E, Arya B, Behrendt N, Carvalho J, Cohen J, Cumbermack K, DeVore G, Doan T, Donofrio MT, Freud L, Galan HL, Groper MRF, Haxel C, Hornberger LK, Howley LW, Izmirly P, Killen SS, Kaplinski M, Krishnan A, Lavasseur S, Lindblade C, Matta J, Makhoul M, Miller J, Morris S, Paul E, Perrone E, Phoon C, Pinto N, Rychik J, Satou G, Saxena A, Sklansky M, Stranic J, Strasburger JF, Srivastava S, Srinivasan S, Tacy T, Tworetzky W, Uzun O, Yagel S, Zaretsky MV, Moon-Grady AJ. **Knowledge is Power: Regarding SMFM Consult Series #64: Systemic Lupus Erythematosus in Pregnancy**. *Am J Obstet Gynecol*. 2023 Jun. 229(4): 361-363. doi: 10.1016/j.ajog.2023.06.040. PMID: 37394327

De Bie FR, Avitabile CM, Flohr S, Land S, Mathew L, Wang Y, Ash D, Rintoul NE, Hedrick HL. **Treprostinil in Neonates with Congenital Diaphragmatic Hernia-Related Pulmonary Hypertension**. *J Pediatr*. 2023, Apr. 113420. doi: 10.1016/j.jpeds.2023.113420. PMID: 37059388

de Jong IEM, Hunt ML, Chen D, Du Y, Llewellyn J, Gupta K, Li D, Erxleben D, Rivas F, Hall AR, Furth EE, Naji A, Liu C, Dhand A, Burdick JA, Davey MG, Flake AW, Porte RJ, Russo PA, Gaynor JW, Wells RG. **A Fetal Wound Healing Program after Intrauterine Bile Duct Injury may contribute to Biliary Atresia**. *J Hepatol*. 2023, Aug. 79(6):1396-1407. doi: 10.1016/j.jhep.2023.08.010. PMID: 37611641

Detterich J, Taylor MD, Slesnick TC, DiLorenzo M, Hlavacek A, Lam CZ, Sachdeva S, Lang SM, Campbell MJ, Gerardin J, Whitehead KK, Rathod RH, Cartoski M, Menon S, Trachtenberg F, Gongwer R, Newburger J, Goldberg C, Dorfman AL; the Pediatric Heart Network Investigators. **Cardiac Magnetic Resonance Imaging to Determine Single Ventricle Function in a Pediatric Population is Feasible in a Large Trial Setting: Experience from the Single Ventricle Reconstruction Trial Longitudinal Follow up**. *Pediatr Cardiol*. 2023 Jul. 44(7): 1454-1461. doi: 10.1007/s00246-023-03216-8. PMID: 37405456

Dori Y, Mazurek J, Birati E, Smith C. **Ascites in Animals With Right Heart Failure: Correlation With Lymphatic Dysfunction.** *J Am Heart Assoc.* 2023, Apr. 12(7):e026984. doi: 10.1161/JAHA.122.026984. PMID: 36974748

Dreher M, Min J, Mavroudis C, Ryba D, Ostapenko S, Melchior R, Rosenthal T, Nuri M, Blinder J. **Indexed oxygen delivery during pediatric cardiopulmonary bypass is a modifiable risk factor for postoperative acute kidney injury**. *J Extra Corpor Technol*. 2023, Sep. 55(3):112-120. doi: 10.1051/ject/2023029. 2023 Sep. PMID: 37682209; PMCID: PMC10487348

Edelson JB, Zhang X, Goldstone AB, Rossano JW, O'Connor MJ, Gaynor JW, Edwards JJ, Wittlieb-Weber C, Maeda K. **Reduced incidence of cardiac rejection in multi-organ transplants: A propensity matched study**. *Clin Transplant*. 2023 May. 37(9): e15019. doi: 10.1111/ctr.15019. PMID: 37212365 **

Edelson JB, Zak V, Goldberg D, Fleming G, Mackie AS, Patel JK, Files M, Downing T, Richmond M, Acheampong B, Cartoski M, Detterich J, McCrindle B, McHugh K, Hansen JE, Wagner J, Maria MD, Weingarten A, Nowlen T, Yoon JK, Kim GB, Williams R, Whitehill R, Kirkpatrick E, Yin S, Ermis P, Lubert AM, Stylianou M, Freemon D, Hu C, Garuba OD, Frommelt P, Goldstein BH, Paridon S, Garg R; Pediatric Heart Network Investigators. **The Effect of Udenafil on Heart Rate and Blood Pressure in Adolescents with the Fontan Circulation**. *Am J Cardiol*. 2023, Oct. 210:183-187. doi: 10.1016/j.amjcard.2023.09.115. PMID: 37918818

PUBLICATIONS

Elias MD, Truong DT, Oster ME, Trachtenberg FL, Mu X, Jone PN, Mitchell EC, Dummer KB, Sexson Tejtel SK, Osakwe O, Thacker D, Su JA, Bradford TT, Burns KM, Campbell MJ, Connors TJ, D'Addese L, Forsha D, Frosch OH, Giglia TM, Goodell LR, Handler SS, Hasbani K, Hebson C, Krishnan A, Lang SM, McCrindle BW, McHugh KE, Morgan LM, Payne RM, Sabati A, Sagiv E, Sanil Y, Serrano F, Newburger JW, Dionne A; Pediatric heart network MUSIC study investigators. **Examination of adverse reactions after COVID-19 vaccination among patients with a History of multisystem inflammatory syndrome in children**. *JAMA Netw Open*. 2023, Jan. 6(1):e2248987. doi: 10.1001/jamanetworkopen.2022.48987. PMID: 36595296

Ellison M, Mangiola M, Marrari M, Bentlejewski C, Sadowski J, Zern D, Kramer CSM, Heidt S, Niemann M, Xu Q, Dipchand AI, Mahle WT, Rossano JW, Canter CE, Singh TP, Zuckerman WA, Hsu DT, Feingold B, Webber SA, Zeevi A. **Immunologic risk stratification of pediatric heart transplant patients by combining HLA-EMMA and PIRCHE-II**. *Front Immunol*. 2023, Mar. 14:1110292. doi: 10.3389/fimmu.2023.1110292. PMID: 36999035; PMCID: PMC10043167

Federman M, Sutton RM, Reeder RW, Ahmed T, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, Diddle JW, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Hehir DA, Horvat CM, Huard LL, Kirkpatrick T, Maa T, Maitoza LA, Manga A, McQuillen PS, Meert KL, Morgan RW, Mourani PM, Nadkarni VM, Notterman D, Palmer CA, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Naim MY. **Survival with Favorable Neurologic Outcome and Quality of Cardiopulmonary Resuscitation Following In-Hospital Cardiac Arrest in Children with Cardiac Disease Compared With Noncardiac Disease.** *Pediatr Crit Care Med*. 2023 Sep. 25(1): 4-14. doi: 10.1097/PCC.0000000000003368. PMID: 37678381

Ferry SM, Jalloul M, Larsen EP, Montenegro LM, Brogan LM, Mecca P, Karff C, Kaplan SL, Rigby VA. I**mproving On-Time Starts for Pediatric Cardiac MRI**. *J Am Coll Radiol*. 2023 Oct 14:S1546-1440(23)00769-X. doi: 10.1016/j.jacr.2023.10.007. PMID: 37844654

Fogel MA, Donnelly E, Crandell I, Hanlon A, Whitehead KK, Harris M, Partington S, Biko D, Flynn T, Nicolson S, Gaynor JW, Licht D, Vossough A. **Cerebral Blood Flow, Brain Injury, and Aortic-Pulmonary Collateral Flow After the Fontan Operation.** *Am J Cardiol*. 2023, Oct. 208:164-170. doi: 10.1016/j.amjcard.2023.08.023. PMID: 37844519

Forti RM, Hobson LJ, Benson EJ, Ko TS, Ranieri NR, Laurent G, Weeks KM, Widmann NJ, Morton S, Davis AM, Sueishi T, Lin Y, Wulwick KS, Fagan F, Shin SS, Kao S, Licht DJ, White BR, Kilbaugh TJ, Yodh AG, Baker WB. **Non-invasive Diffuse Optical Monitoring of Cerebral Physiology in an Adult Swine-model of Impact Traumatic Brain Injury.** *Biomed Opt Exp*. 2023, Jun. 14(6) 2432-2448. doi: 10.1364/BOE.486363

Fraga MV, Dysart KC, Stoller JZ, Huber M, Fedec A, Mercer-Rosa L, Kirpalani H. **Echocardiographic Assessment of Pulmonary Arterial Hypertension Following Inhaled Nitric Oxide in Infants with Severe Bronchopulmonary Dysplasia.** *Neonatology*. 2023, Aug. 120(5): 633-641. doi: 10.1159/000531586. PMID: 37573771

Freud LR, Galloway S, Crowley TB, Moldenhauer J, Swillen A, Breckpot J, Borrell A, Vora NL, Cuneo B, Hoffman H, Gilbert L, Nowakowska B, Geremek M, Kutkowska-Kaźmierczak A, Vermeesch JR, Devriendt K, Busa T, Sigaudy S, Vigneswaran T, Simpson JM, Dungan J, Gotteiner N, Gloning KP, Digilio MC, Unolt M, Putotto C, Marino B, Repetto G, Fadic M, Garcia-Minaur S, Buil AA, Thomas MA, Fruitman D, Beecroft T, Hui PW, Oskarsdottir S, Bradshaw R, Criebaum A, Norton ME, Lee T, Geiger M, Dunnington L, Isaac J, Wilkins-Haug L, Hunter L, Izzi C, Toscano M, Ghi T, McGlynn J, Grati FR, Emanuel BS, Gaiser K, Gaynor JW, Goldmuntz E, McGinn DE, Schindewolf E, Tran O, Zackai EH, Yan Q, Bassett A, Wapner R, McDonald-McGinn DM. **Prenatal versus Postnatal Diagnosis of 22q11.2 Deletion Syndrome: Cardiac and Non-Cardiac Outcomes through 1 Year of Age.** *Am J Obstet Gynecol*. 2023, Sep. S0002-9378(23)00611-7. doi: 10.1016/j.ajog.2023.09.005. PMID: 37717890

PUBLICATIONS

Fuller SM. **Thinking outside the Heart**. *Ann Thorac Surg*. 2023, May. 115(5):1205. doi: 10.1016/j.athoracsur.2023.02.039. 2023 Feb 24. PMID: 36841496

Gakenheimer-Smith L, Ou Z, Kuang J, Moore JP, Burrows A, Kovach J, Dechert B, Beach CM, Ayers M, Tan RB, Mostafavifar M, Mah DY, Conner TM, Turpin S, Avasarala K, Shah MJ, Webster G, Posey J, Etheridge SP, Binka E, Niu M, Asaki SY, Lambert LM, Pilcher TA. **Multicenter retrospective evaluation of magnetic resonance imaging in pediatric and congenital heart disease patients with cardiac implantable electronic devices**. *Heart Rhythm*. 2023, Aug. 20(12):1752-1758. doi: 10.1016/j.hrthm.2023.08.034. PMID: 37648183

Gardner MM, Hehir DA, Reeder RW, Ahmed T, Bell MJ, Berg RA, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, Diddle JW, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Harding ML, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Morgan RW, Mourani PM, Nadkarni VM, Naim MY, Notterman D, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Sutton RM, Topjian AA. **Identification of Post-Cardiac Arrest Blood Pressure Thresholds Associated with Outcomes in Children: an ICU-Resuscitation Study. Crit Care**. 2023, Oct. 27(1):388. doi:10.1186/s13054-023-04662-9. PMID: 37805481; PMCID: PMC10559632

Gardner MM, Wang Y, Himebauch AS, Conlon TW, Graham K, Morgan RW, Feng R, Berg RA, Yehya N, Mercer-Rosa L, Topjian AA. **Impaired echocardiographic left ventricular global longitudinal strain after pediatric cardiac arrest children is associated with mortality**. *Resuscitation*. 2023, Aug. 191:109936. doi: 10.1016/j.resuscitation.2023.109936. PMID: 37574003

*Gartenberg AJ; Krishnamurthy G, Srinivasan A, Escobar FA, Brownell JN, Mamula P, O'Byrne ML, Dori Y, Smith CL. **Intrahepatic and Periduodenal Embolization for Protein- Losing Enteropathy Patients with Congenital Heart Disease**. *J Am Coll Cardiol*. 2023, Jun. 81(25. 2476-2478. 10.1016/j.jacc.2023.04.033

*Gartenberg AJ, Okunowo O, Dori Y, Smith CL, Gaynor JW, Mascio CE, Rome JJ, Gillespie MJ, Glatz AC, O'Byrne ML. **Association of Interstage Monitoring Era and Likelihood of Hemodynamic Compromise at Intervention for Recoarctation Following the Norwood Operation**. *J Am Heart Assoc*. 2023 Jul. 12(14): e029112. doi: 10.1161/JAHA.122.029112. PMID: 37421284 **

Gaynor JW, Graham EM, Bhandari D, Fenchel M, Bradman A, Klepczynski B, Collier H, Ittenbach RF, Reese CM, Blount BC. **Peri-operative Exposure to Volatile Organic Compounds in Neonates Undergoing Cardiac Surgery.** *J Thorac Cardiovasc Surg*. 2023, Aug. S0022-5223(23)00658-X. doi: 10.1016/j.jtcvs.2023.07.049. PMID: 37558202

Geoffrion TR, Aronowitz DI, Mangeot C, Ittenbach RF, Lodge AJ, Fuller SM, Chen JM, Gaynor JW. **Contemporary Outcomes for Functional Single Ventricle with Total Anomalous Pulmonary Venous Connection**. *J Thorac Cardiovasc Surg*. 2023, Sep. S0022-5223(23)00872-3. doi: 10.1016/j.jtcvs.2023.09.046. PMID: 37778502

Goldberg DJ, Hu C, Lubert AM, Rathod RH, Penny DJ, Petit CJ, Schumacher KR, Ginde S, Williams RV, Yoon JK, Kim GB, Nowlen TT, DiMaria MV, Frischhertz BP, Wagner JB, McHugh KE, McCrindle BW, Cartoski MJ, Detterich JA, Yetman AT, John AS, Richmond ME, Yung D, Payne RM, Mackie AS, Davis CK, Shahanavaz S, Hill KD, Almaguer M, Zak V, McBride MG, Goldstein BH, Pearson GD, Paridon SM; **Pediatric Heart Network Investigators. The Fontan Udenafil Exercise Longitudinal Trial: Subgroup Analysis**. *Pediatr Cardiol*. 2023, Dec. 44(8):1691-1701. doi: 10.1007/s00246-023-03204-y. PMID: 37382636

PUBLICATIONS

Goldberg CS, Trachtenberg F, William Gaynor J, Mahle WT, Ravishankar C, Schwartz SM, Cnota JF, Ohye RG, Gongwer R, Taylor M, Paridon S, Frommelt PC, Afton K, Atz AM, Burns KM, Detterich JA, Hill KD, Cabrera AG, Lewis AB, Pizarro C, Shah A, Sharma B, Newburger JW; Pediatric Heart Network Investigators. **Longitudinal Follow-Up of Children with HLHS and Association between Norwood Shunt Type and Long-Term Outcomes: The SVR III Study**. *Circulation*. 2023, Oct. 148(17):1330-1339. doi:10.1161/CIRCULATIONAHA.123.065192. 2023 Oct 5. PMID: 37795623; PMCID: PMC10589429

Grasty MA, Mavroudis CD, DeWitt AG, Kozyak BW, Mamula P, MacFarland SP, Nuri MAK, Rogers LS, Rome JJ, Gaynor JW, Goldberg DJ. **Hereditary Haemorrhagic Telangiectasia and SMAD4 Mutation in a Patient with Complex Single Ventricle Heart Disease**. *Cardiol Young*. 2023, Oct. 33(12):2667-2669. doi:10.1017/S104795112300344X. PMID: 37807723

Grenier JM, Borst AJ, Sheppard SE, Snyder KM, Li D, Surrey LF, Al-Ibraheemi A, Weber DR, Treat JR, Smith CL, Laje P, Dori Y, Adams DM, Acord M, Srinivasan AS. **Pathogenic variants in PIK3CA are associated with clinical phenotypes of kaposiform lymphangiomatosis, generalized lymphatic anomaly, and central conducting lymphatic anomaly.** *Pediatr Blood Cancer*. 2023, May. e30419. doi: 10.1002/pbc.30419. PMID: 37194624

Griffin EL, Nees SN, Morton SU, Wynn J, Patel N, Jobanputra V, Robinson S, Kochav SM, Tao A, Andrews C, Cross N, Geva J, Lanzilotta K, Ritter A, Taillie E, Thompson A, Meyer C, Akers R, King EC, Cnota JF, Kim RW, Porter GA Jr, Brueckner M, Seidman CE, Shen Y, Gelb BD, Goldmuntz E, Newburger JW, Roberts AE, Chung WK. **Evidence-Based Assessment of Congenital Heart Disease Genes to Enable Returning Results in a Genomic Study.** *Circ Genom Precis Med*. 2023, Feb. 16(2): e003791. doi: 10.1161/CIRCGEN.122.003791. PMID: 36803080

Grossi AA, Potena L, Rossano JW, Breathett K. **Socioeconomic Deprivation and Heart Transplantation: A Call for Progress in the U.S. and Europe**. *J Heart Lung Transplant*. 2023, Oct. 24:S1053-2498(23)02080-6. doi:10.1016/j.healun.2023.10.016. PMID: 37884164

Gusseva M, Thatte N, Castellanos DA, Hammer PE, Ghelani SJ, Callahan R, Hussain T, Chabiniok R. B**iomechanical Model to Aid Surgical Planning in Complex Congenital Heart Diseases**. *Functional Imaging and Modelling of the Heart*. 616-625. doi: org/10.1007/978-3-031-35302-4_63

Han Y, Vicory J, Gerig G, Sabin P, Dewey H, Amin S, Sulentic A, Hertz C, Jolley M, Paniagua B, Fishbaugh J. **Hierarchical Geodesic Polynomial Model for Multilevel Analysis of Longitudinal Shape**. *Inf Process Med Imaging*. 2023 Jun. 13939:810-821. doi: 10.1007/978-3- 031-34048-2_62. 2023 Jun 8. PMID: 37416485; PMCID: PMC10323213

Harahsheh AS, Portman MA, Khoury M, Elias MD, Lee S, Lin J, McCrindle BW. **Management of Multisystem Inflammatory Syndrome in Children: Decision-Making Regarding a New Condition in the Absence of Clinical Trial Data**. *Can J Cardiol.* 2022, Nov. 39(6): 803-814. doi: 10.1016/j.cjca.2022.11.011. PMID: 36455760; PMCID: PMC9705008

Harahsheh AS, Shah S, Dallaire F, Manlhiot C, Khoury M, Lee S, Fabi M, Mauriello D, Selamet Tierney ES, Sabati AA, Dionne A, Dahdah N, Choueiter N, Thacker D, Giglia TM, Truong DT, Jain S, Portman M, Orr WB, Harris TH, Szmuszkovicz JR, Farid P, McCrindle BW; International Kawasaki Disease Registry (IKDR). **Kawasaki Disease in the Time of COVID-19 and MIS-C - The International Kawasaki Disease Registry**. *Can J Cardiol*. 2023, Jun. S0828-282X (23)00451-8. doi: 10.1016/j.cjca.2023.06.001. PMID: 37290536; PMCID: PMC10245460

Hasan BS, Barry OM, Ali F, Armstrong AK, Batlivala SP, Crystal MA, Divekar A, Gudausky T, Holzer R, Kreutzer J, Nicholson G, O'Byrne ML, Quinn BP, Boe BA. **Evaluating Procedural Performance: A Composite Outcome for Aortic and Pulmonary Valvuloplasty in Congenital Cardiac Catheterization**. *JSCAI*. 2023, Oct. doi:10.1016/j.jscai.2023.101119

PUBLICATIONS

Hickson MR, Winters M, Thomas NH, Gardner MM, Kirschen MP, Nadkarni V, Berg R, Slomine BS, Pinto NP, Topjian A. **Long-term function, quality of life and healthcare utilization among survivors of pediatric out-of-hospital cardiac arrest.** *Resuscitation*. 2023, Mar. 187:109768. doi: 10.1016/j.resuscitation.2023.109768. PMID: 36933881

Hiremath G, Batlivala S, Callahan R, Thatte N, Rockegeller T, Nawaytou H, Reddy SV, Hussain T, Radomir C, Butts R, Vettukattil J, Aregullin EO, Aldweib N, Burkhoff D, Brenner MI. **Clinical Applications of Pressure-Volume Assessment in Congenital Heart Disease**. *JSCAI*. 2023, May. 2(3) 10599. doi: 10.1016/j.jscai.2023.100599

Hirschhorn MD, Lawley JEM, Roof AJ, Johnson APT, Stoddard WA, Stevens RM, Rossano J, Arabia F, Tchantchaleishvili V, Massey HT, Day SW, Throckmorton AL. **Next Generation Development of Hybrid Continuous Flow Pediatric Total Artificial Heart Technology: Design-Build-Test**. *ASAIO J*. 2023 Sep. 69(12): 1090-1098. doi: 10.1097/MAT.0000000000002043. PMID: 37774695

Holzer R, Batlivala SP, Boe B, Goldstein B, Gudausky T, Hasan B, O'Byrne M, Quinn B, Sathanadam S, Shahanavaz S, Trucco SM, Zampi JD, Bergersen L. **The Need for Surgery after Vascular or Cardiac Trauma, or Technical Adverse Events in the Congenital Cardiac Catheterization Laboratory**. *Pediatr Cardiol*. 2023 Feb. 44(4): 795-805. doi: 10.1007/s00246- 023-03126-9. PMID: 36806971

Holzer RJ, Bergersen L, Thomson J, Aboulhosn J, Aggarwal V, Akagi T, Alwi M, Armstrong AK, Bacha E, Benson L, Bökenkamp R, Carminati M, Dalvi B, DiNardo J, Fagan T, Fetterly K, Ing FF, Kenny D, Kim D, Kish E, O'Byrne M, O'Donnell C, Pan X, Paolillo J, Pedra C, Peirone A, Singh HS, Søndergaard L, Hijazi ZM. **PICS/AEPC/APPCS/CSANZ/SCAI/SOLACI: Expert Consensus Statement on Cardiac Catheterization for Pediatric Patients and Adults with Congenital Heart Disease.** *JACC Cardiovasc Interv*. 2023, Dec. S1936-8798(23)01493-0. doi: 10.1016/j.jcin.2023.11.001. PMID: 38099915

Houlihan TH, Combs J, Smith E, Coulter E, Figueroa L, Falkensammer C, Savla J, Goldmuntz E, Degenhardt K, Szwast A, Shillingford A, Rychik J. **Parental Impressions and Perspectives of Efficacy in Prenatal Counseling for Single Ventricle Congenital Heart Disease**. *Pediatr Cardiol*. 2023, Dec. doi: 10.1007/s00246-023-03355-y. PMID: 38112807

Hunt M, de Jong IEM, Wells RG, Shah AA, Russo P, Mahle M, Gardner MM, Fuller S, Chen J, Gaynor JW. **Conjugated hyperbilirubinemia is associated with increased morbidity and mortality after neonatal heart surgery**. *Cardiol Young*. 2023, Dec.18:1-8. doi: 10.1017/S1047951123004158. PMID: 38105562

Ittenbach RF, Gaynor JW, Dorich JM, Burnham NB, Huang G, Harvey MT, Corsmo JJ. **uConsent: Addressing the Gap in Measuring Understanding of Informed Consent in Clinical Research**. *Clin Transl Sci*. 2023, Oct.16 (12): 2530-2542. doi:10.1111/cts.13645. PMID: 37828723

Jacobs JP, Bleiweis MS, Cohen MS, Lopez L, Peek GJ, Franklin RCG, Tchervenkov CI. **Defining the Spectrum of Hypoplastic Left Heart Syndrome (HLHS)**. *World J Pediatr Congenit Heart Surg*. 2023, Nov. 14(6):741-745. doi: 10.1177/21501351231189277. PMID: 37933696

Jacobs JP, Nelson JS, Fuller S, Antonoff MB, Karamlou T, Molena D, Preventza O, Blackmon S, Romano J. **COMMENTARY: Gender Differences in Payments to Cardiothoracic Surgeons are Unacceptable**. *Eur J Cardiothorac Surg*. 2023, Mar. 14(6): 741-745. doi: 10.1093/ejcts/ezad080. PMID: 36912682

Jacobwitz M, Irving SY, Moriarty H, Yost J, Vossough A, Licht DJ, Lynch JM. **Predictors of the inability to achieve full oral feeding in postoperative infants with CHD**. *Cardiol Young*. 2023, Aug. 23:1-7. doi: 10.1017/S104795112300313X. PMID: 37608743

PUBLICATIONS

Jang MY, Patel PN, Pereira AC, Willcox JAL, Haghighi A, Tai AC, Ito K, Morton SU, Gorham JM, McKean DM, DePalma SR, Bernstein D, Brueckner M, Chung WK, Giardini A, Goldmuntz E, Kaltman JR, Kim R, Newburger JW, Shen Y, Srivastava D, Tristani-Firouzi M, Gelb BD, Porter GA Jr, Seidman CE, Seidman JG. **Contribution of Previously Unrecognized RNA Splice-Altering Variants to Congenital Heart Disease**. *Circ Genom Precis Med*. 2023, Jun. 16(3):224-231. doi: 10.1161/CIRCGEN.122.003924. PMID: 37165897

Janson CM, Shah MJ, Kennedy KF, Iyer VR, Behere S, Sweeten TL, O'Byrne ML. **Association of weight with ablation outcomes in pediatric Wolff-Parkinson-White: Analysis of the NCDR IMPACT registry**. *JACC Clin Electrophysiol*. 2023 Jan. 9(1):73-84. doi: 10.1016/j.jacep.2022.08.023. 2022 Nov 30. PMID: 36697203

Josowitz R, Linn R, Rychik J. **The Placenta in Congenital Heart Disease: Form, Function and Outcomes**. *Neoreviews*. 2023, Sep. 24(9):e569-e582. doi: 10.1542/neo.24-9-e569. PMID: 37653088

*Jones AL, Faerber J, Huang J, Ampah S, Wang Y, DeCost G, Gardner M, Naim MY, Reddy S, Goldmuntz E, Mercer-Rosa L. **Biomarkers, Socioeconomic Factors, and Right Ventricular Function After Surgical Repair for Tetralogy of Fallot**. *Pediatr Cardiol*. 2023, Feb. 44(6): 1232-1241. doi: 10.1007/s00246-023-03108-x. PMID: 36797379 **

*Jones AL, Campbell MJ, Abernathy B, Neubert S, Hager A, Collier H, Ramsey EZ, Simon A, Schachtner S, Natarajan S. **Improvement in Palivizumab Administration Prior to Discharge for Hospitalized Infants with Hemodynamically Significant Congenital Heart Disease: A Quality Improvement Initiative**. *Pediatr Cardiol*. 2023, May. doi: 10.1007/s00246-023-03163-4. PMID: 37145121

*Jones AL, White BR, Ghosh RM, Mondal A, Ampah S, Ho DY, Whitehead K, Harris MA, Biko DM, Partington S, Fuller S, Cohen MS, Fogel MA. **Cardiac magnetic resonance predictors for successful primary biventricular repair of unbalanced complete common atrioventricular canal**. *Cardiol Young*. 2023 Jul. 18:1-8. doi: 10.1017/S1047951123001786. PMID: 37462049 **

Josowitz R, Linn R, Rychik J. **The Placenta in Congenital Heart Disease: Form, Function and Outcomes**. *Neoreviews*. 2023, Sep. 24(9):e569-e582. doi: 10.1542/neo.24-9-e569. PMID: 37653088

*Kamsheh AM, O'Connor MJ, Rossano JW. **Management of circulatory failure after Fontan surgery**. *Front Pediatr*. 2022 Nov 8; 10:1020984. doi: 10.3389/fped.2022.1020984. PMID: 36425396; PMCID: PMC9679629

*Kamsheh AM, Meyers KE, Palermo RA, Wu L, Burstein DS, Edelson JB, Lin KY, Maeda K, Rossano JW, Wittlieb-Weber CA, O'Connor MJ. **Hypertension: An Important but Reversible Cause of Systolic Dysfunction in a Cohort of Pediatric Patients**. Pediatr Cardiol. 2023, Oct. doi: 10.1007/s00246-023-03313-8. PMID: 37884820

Keelan J, Pasumarti N, Crook S, Decost G, Wang Y, Crystal MA, Shah A, Bacha E, Mercer- Rosa L, DiLorenzo M. **Right Ventricular Strain in Patients with Ductal Dependent Tetralogy of Fallot**. *J Am Soc Echocardiogr*. 2023, Mar. 36(6): 654-665. doi: 10.1016/j.echo.2023.03.006. PMID: 36933850

Keisling J, Bedoukian E, Burstein DS, Gaynor JW, Gray C, Krantz I, Izumi K, Leonard J, Lin KY, Medne L, Seymour C, Skraban C, Ritter A, Ahrens-Nicklas RC. **Diagnostic Yield of Exome Sequencing in Pediatric Cardiomyopathy**. *J Pediatr*. 2023 Nov. 265:113808. doi: 10.1016/j.jpeds.2023.113808. PMID: 37923198

Kerstein JS, Valencia E, Collins S, Ferraro AM, Harrild DM, Gauvreau K, Callahan R, Mullen MP. **Transcatheter Ductus Arteriosus Stenting for Acute Pediatric Pulmonary Arterial Hypertension is Associated with Improved Right Ventricular Echocardiography Strain**. *Pediatr Cardiol*. 2023, Jul. doi: 10.1007/s00246-023-03233-7. PMID: 37442851

Khoury M, Harahsheh AS, Raghuveer G, Dahdah N, Lee S, Fabi M, Selamet Tierney ES, Portman MA, Choueiter NF, Elias M, Thacker D, Dallaire F, Orr WB, Harris TH, Norozi K, Truong DT, Khare M, Szmuszkovicz JR, Pagano JJ, Manlhiot C, Farid P, McCrindle BW; International Kawasaki Disease Registry. **Obesity and Outcomes of Kawasaki Disease and COVID-19-Related Multisystem Inflammatory Syndrome in Children.** *JAMA Netw Open*. 2023, Dec. 6(12):e2346829. doi: 10.1001/jamanetworkopen.2023.46829. PMID: 38064213; PMCID: PMC10709775

Kim Y, Mastali M, Van Eyk JE, Orav EJ, Vissing CR, Day SM, Axelsson Raja A, Russell MW, Zahka K, Lever HM, Pereira AC, Murphy AM, Canter C, Bach RG, Wheeler MT, Rossano JW, Owens AT, Bundgaard H, Benson L, Mestroni L, Taylor MRG, Patel AR, Wilmot I, Thrush P, Soslow JH, Becker JR, Seidman CE, Ho CY; VANISH Investigators. **Transforming Growth Factor-β Analysis of the VANISH Trial Cohort**. *Circ Heart Fail*. 2023, Mar. 16(4): e010314. doi: 10.1161/CIRCHEARTFAILURE.122.010314. PMID: 36999957

Kirmani S, Woodard PK, Shi L, Hamza TH, Canter CE, Colan SD, Pahl E, Towbin JA, Webber SA, Rossano JW, Everitt MD, Molina KM, Kantor PF, Jefferies JL, Feingold B, Addonizio LJ, Ware SM, Chung WK, Ballweg JA, Lee TM, Bansal N, Razoky H, Czachor J, Lunze FI, Marcus E, Commean P, Wilkinson JD, Lipshultz SE. **Cardiac Imaging and Biomarkers for Assessing Myocardial Fibrosis in Children with Hypertrophic Cardiomyopathy**. *Am Heart J*. 2023, Jun. 265:153-162. doi: 10.1016/j.ahj.2023.06.005. PMID: 37315879

Kittleson MM, Wittlieb-Weber C, Rossano JW. **When art and science collide: The 2022 guidelines for the care of heart transplant recipients**. *J Heart Lung Transplant*. 2022, Dec. 42(5): 541-543. doi: 10.1016/j.healun.2022.10.008. PMID: 36564336

Kozyak BW, Yuerek M, Conlon TW. **Contemporary Use of Ultrasonography in Acute Care Pediatrics.** *Indian J Pediatr*. 2023, Mar. 90(5): 459-469. doi: 10.1007/s12098-023-04475-2. PMID: 36897471

Kristensen R, Omann C, Gaynor JW, Rode L, Ekelund CK, Hjortdal VE. **Increased nuchal translucency in children with congenital heart defects and normal karyotype-is there a correlation with mortality?** *Front Pediatr*. 2023, Feb. 11:1104179. doi: 10.3389/fped.2023.1104179. PMID: 36873643; PMCID: PMC9981958

Kristensen R, Kelly B, Kim E, Dori Y, Hjortdal VE. **Lymphatic Abnormalities on Magnetic Resonance Imaging in Single-Ventricle Congenital Heart Defects before Glenn Operation**. *J Am Heart Assoc*. 2023, Jun. 12(12):e029376. doi: 10.1161/JAHA.123.029376. 2023 Jun 15. PMID: 37318013

Kwiatkowski DM, Shezad M, Barnes AP, Ploutz MS, Law SP, Zafar F, Morales DLS, O'Connor MJ; ACTION Network Investigators. **Impact of Weight on Ventricular Assist Device Outcomes in Dilated Cardiomyopathy Patients in Pediatric Centers: An ACTION Registry Study**. *ASAIO J*. 2023, May. 69(5):496-503. doi: 10.1097/MAT.0000000000001861. PMID: 37071761

Lai KC, Richardson T, Berman D, DeMauro SB, King BC, Lagatta J, Lee HC, Lewis T, Noori S, O'Byrne ML, Patel RM, Slaughter JL, Lakshmanan A. **Current Trends in Invasive Closure of Patent Ductus Arteriosus in very Low Birth Weight Infants in US Children's Hospitals, 2016-2021**. *J Pediatr*. 2023 Aug 31:113712. doi: 10.1016/j.jpeds.2023.113712. PMID: 37659587

Laje P, Smood B, Smith C, Pinto E, Krishnamurthy G, Taha D, Dori Y, Maeda K. **Surgical Creation of Lymphocutaneous Fistulas for the Management of Infants with Central Lymphatic Obstruction**. *Pediatr Surg Int*. 2023 Aug 31; 39(1):257. doi: 10.1007/s00383-023- 05532-9. PMID: 37653245

PUBLICATIONS

Laje P, Dori Y, Smith C, Pinto E, Taha D, Maeda K. **Surgical Management of Central Lymphatic Conduction Disorders: A Review**. *J Pediatr Surg*. 2023 Oct 21:S0022- 3468(23)00649-8. doi: 10.1016/j.jpedsurg.2023.10.039. PMID: 37953163

Laurent GH, Ko TS, Mensah-Brown KG, Mavroudis CD, Jacobwitz M, Ranieri N, Nicolson SC, Gaynor JW, Baker WB, Licht DJ, Massey SL, Lynch JM. **Electroencephalography as a tool to predict cerebral oxygen metabolism during deep-hypothermic circulatory arrest in neonates with critical congenital heart disease**. *JTCVS Open*. 2023, Aug. 12:1-9. doi:10.1016/j.xjon.2023.08.004.

Lawrence KM, Burstein DS, Ahrens-Nicklas R, Gaynor JW, Nuri MA. **Noonan Syndrome Associated with Hypoplastic Left Heart Syndrome**. *Cardiol Young*. 2023, Apr. 33(4):652-654. doi: 10.1017/S1047951122002529. PMID: 35989466

*Lemley BA, Wu L, Roberts AL, Shinohara RT, Quarshie WO, Qureshi AM, Smith CL, Dori Y, Gillespie MJ, Rome JJ, Glatz AC, Amaral S, O'Byrne ML. **Trends in Ductus Arteriosus Stent Versus Blalock-Taussig-Thomas Shunt Use and Comparison of Cost, Length of Stay, and Short-Term Outcomes in Neonates With Ductal-Dependent Pulmonary Blood Flow: An Observational Study Using the Pediatric Health Information Systems Database**. *J Am Heart Assoc*. 2023, Dec. 12(23):e030575. doi: 10.1161/JAHA.123.030575. Online ahead of print. PMID: 38038172 **

Lewis MJ, Hsieh A, Qiao L, Tan R, Kazzi B, Channing A, Griffin E, Jobanputra V, Su J, Shahryar C, Kochilas L, Gaynor W, Lee T, Goldmuntz E, Russell M, Mital S, Tristani M, Brueckner M, Newburger J, Shen Y, Chung WK. **Association of Predicted Damaging De Novo Variants on Ventricular Function in Individuals With Congenital Heart Disease**. *Circ Genom Precis Med*. 2023, Mar.16 (2): e003900. doi: 10.1161/CIRCGEN.122.003900. PMID: 36866680

Lewis MJ, Reardon LC, Aboulhosn J, Haeffele C, Chen S, Kim Y, Fuller S, Forbess L, Alshawabkeh L, Urey MA, Book WM, Rodriguez F 3rd, Menachem JN, Clark DE, Valente AM, Carazo M, Egbe A, Connolly HM, Krieger EV, Angiulo J, Cedars A, Ko J, Jacobsen RM, Earing MG, Cramer JW, Ermis P, Broda C, Nugaeva N, Ross H, Awerbach JD, Krasuski RA, Rosenbaum M. **Clinical Outcomes of Adult Fontan-Associated Liver Disease and Combined Heart-Liver Transplantation**. *J Am Coll Cardiol*. 2023, Jun. 81(22):2149-2160. doi: 10.1016/j.jacc.2023.03.421. PMID: 37257950

Lewis MJ, Reardon LC, Aboulhosn J, Haeffele C, Chen S, Kim Y, Fuller S, Forbess L, Alshawabkeh L, Urey MA, Book WM, Rodriguez F 3rd, Menachem JN, Clark DE, Valente AM, Carazo M, Egbe A, Connolly HM, Krieger EV, Angiulo J, Cedars A, Ko J, Jacobsen RM, Earing MG, Cramer JW, Ermis P, Broda C, Nugaeva N, Ross H, Awerbach JD, Krasuski RA, Rosenbaum M. **Morbidity and Mortality in Adult Fontan Patients After Heart or Combined Heart-Liver Transplantation**. *J Am Coll Cardiol*. 2023, Jun. 81(22):2161-2171. doi: 10.1016/j.jacc.2023.03.422. PMID: 37257951

Li D, Sheppard SE, March ME, Battig MR, Surrey LF, Srinivasan AS, Matsuoka LS, Tian L, Wang F, Seiler C, Dayneka J, Borst AJ, Matos MC, Paulissen SM, Krishnamurthy G, Nriagu B, Sikder T, Casey M, Williams L, Rangu S, O'Connor N, Thomas A, Pinto E, Hou C, Nguyen K, Pellegrino da Silva R, Chehimi SN, Kao C, Biroc L, Britt AD, Queenan M, Reid JR, Napoli JA, Low DM, Vatsky S, Treat J, Smith CL, Cahill AM, Snyder KM, Adams DM, Dori Y, Hakonarson H. **Genomic profiling informs diagnoses and treatment in vascular anomalies**. *Nat Med*. 2023 Jun. 29(6):1530-1539. doi: 10.1038/s41591-023-02364-x. 2023 Jun. PMID: 37264205

Licht DJ, Jacobwitz M, Lynch JM, Ko T, Boorady T, Devarajan M, Heye KN, Mensah-Brown K, Newland JJ, Schmidt A, Schwab P, Winters M, Nicolson SC, Montenegro LM, Fuller S, Mascio C, Gaynor JW, Yodh AG, Gebb J, Vossough A, Choi GH, Putt ME. **Impaired Maternal-Fetal Environment and Risk for Preoperative Focal White Matter Injury in Neonates With Complex Congenital Heart Disease**. *J Am Heart Assoc*. 2023, Mar. 12(7): e025516. doi: 10.1161/JAHA.122.025516. PMID: 36974759

PUBLICATIONS

Lin J, Harahsheh AS, Raghuveer G, Jain S, Choueiter NF, Garrido-Garcia LM, Dahdah N, Portman MA, Misra N, Khoury M, Fabi M, Elias MD, Dionne A, Lee S, Tierney ESS, Ballweg JA, Manlhiot C, McCrindle BW. **Emerging Insights Into the Pathophysiology of Multisystem Inflammatory Syndrome Associated With COVID-19 in Children**. *Can J Cardiol*. 2023, Jan. 39(6): 793-802. doi: 10.1016/j.cjca.2023.01.002. PMID: 36626979; PMCID: PMC9824951

Lin SM, Frank DB. **SOX17 at the Intersection of Sex, Transcription, and Metabolism in Pulmonary Hypertension**. *Am J Respir Crit Care Med*. 2023, Apr. 207(8):971-972. doi: 10.1164/rccm.202302-0284ED. PMID: 36927296; PMCID: PMC10112455

Lisanti AJ, Golfenshtein N, Min J, Medoff-Cooper B. **Early growth trajectory is associated with psychological stress in parents of infants with congenital heart disease, but moderated by quality of partner relationship**. *J Pediatr Nurs*. 2023, Jan. 69:93-100. doi: 10.1016/j.pedn.2022.12.016. PMID: 36696826

Lisanti AJ, Uzark KC, Harrison TM, Peterson JK, Butler SC, Miller TA, Allen KY, Miller SP, Jones CE; **Developmental Care for Hospitalized Infants with Complex Congenital Heart Disease: A science advisory from the American Heart Association**. *J Am Heart Assoc*. 2023, Feb. 12(3):e028489. doi: 10.1161/JAHA.122.028489. PMID: 36648070

Lopez KN, Morris SA, Krishnan A, Jacobs MB, Bhat AH, Chelliah A, Chiu JS, Cuneo BF, Freire G, Hornberger LK, Howley L, Husain N, Ikemba C, Kavanaugh-McHugh A, Kutty S, Lee C, McBrien A, Michelfelder EC, Pinto NM, Schwartz R, Stern KWD, Taylor C, Thakur V, Tworetzky W, Wittlieb-Weber C, Woldu K, Donofrio MT, Peyvandi S; Fetal Heart Society Research Collaborative. **Associations between Maternal Sociodemographics and Hospital Mortality in Newborns with Prenatally Diagnosed Hypoplastic Left Heart Syndrome**. *Circulation*. 2023 Jul. 148(3):283-285. doi: 10.1161/CIRCULATIONAHA.123.064476. PMID: 37459407. PMCID: PMC10361626

Lubert AM, Cedars A, Almond CS, Amdani S, Conway J, Friedland-Little JM, Gajarski RJ, Kindel SJ, Lorts A, Morales DLS, O'Connor MJ, Peng DM, Rosenthal DN, Smyth L, Sutcliffe DL, Schumacher KR. **Considerations for Advanced Heart Failure Consultation in Individuals With Fontan Circulation: Recommendations From ACTION.** *Circ Heart Fail*. 2023 Feb. 16(2):e010123. doi: 10.1161/CIRCHEARTFAILURE.122.010123. PMID: 36786204

Lynch JM, Gaynor JW, Licht DJ. **Commentory on "Brain Injury during Transition in the Newborn with Congenital Heart Disease: Hazards of the Preoperative Period."** *Seminars in Pediatric Neurology*. 2023, Aug. 47:101075. doi:10.1016/j.spen.2023.101075. PMID: 37919030

Lynch A, Tatangelo M, Ahuja S, Steve Fan CP, Min S, Lafreniere-Roula M, Papaz T, Zhou V, Armstrong K, Aziz PF, Benson LN, Butts R, Dragulescu A, Gardin L, Godown J, Jeewa A, Kantor PF, Kaufman BD, Lal AK, Parent JJ, Richmond M, Russell MW, Balaji S, Stephenson EA, Villa C, Jefferies JL, Whitehill R, Conway J, Howard TS, Nakano SJ, Rossano J, Weintraub RG, Mital S. **Risk of Sudden Death in Patients With RASopathy Hypertrophic Cardiomyopathy**. *J Am Coll Cardiol*. 2023, Mar. 81(11):1035-1045. doi: 10.1016/j.jacc.2023.01.012. PMID: 36922089

Mahle WT, Keesari R, Trachtenberg F, Newburger JW, Lim H, Edelson J, Jeewa A, Lal A, Kindel SJ, Burns KM, Lang S, Bainton J, Carboni M, Villa CR, Richmond M, Henderson H, Menteer J, Pizarro C, Goldberg CS. **School-Age and Adolescent Heart Failure Following the Norwood Procedure**. *J Heart Lung Transplant*. 2023 Oct. S1053-2498(23)02077-6. doi: 10.1016/j.healun.2023.10.012. PMID: 37866470

Maleyeff L, Newburger JW, Wypij D, Thomas NH, Anagnoustou E, Brueckner M, Chung WK, Cleveland J, Cunningham S, Gelb BD, Goldmuntz E, Hagler DJ Jr, Huang H, King E, McQuillen P, Miller TA, Norris-Brilliant A, Porter GA Jr, Roberts AE, Grant PE, Im K, Morton SU. **Association of genetic and sulcal traits with executive function in congenital heart disease**. *Ann Clin Transl Neurol*. 2023 Nov. doi: 10.1002/acn3.51950. PMID: 38009418

PUBLICATIONS

Mavroudis CD, Grasty MA, *Restaino K, Montgomery CM, Pettit AN, O'Connor MJ, Wittlieb- Weber C, Edelson JB, Edwards J, *Berger J, Lin K, Rossano J, Maeda K. **A novel intracorporeal right ventricular assist device implantation technique in a young patient**. *JTCVS Techniques*. 2023, Nov. doi:10.1016/j.xjtc.2023.10.025

Mavroudis CD, O'Connor MJ, Wittlieb-Weber C, Edelson JB, *Berger JH, Lin KY, Rossano J, Katsuhide M. **Hybrid stage 1 palliation with simultaneous off-pump ventricular assist device placement in neonates with high-risk single ventricle anatomy: Initial experience.** ISSN 2666-2507. *JTCVS Techniques*. 10.1016/j.xjtc.2023.10.022

Miller TA, Hernandez EJ, Gaynor JW, Russell MW, Newburger JW, Chung W, Goldmuntz E, Cnota JF, Zyblewski SC, Mahle WT, Zak V, Ravishankar C, Kaltman JR, McCrindle BW, Clarke S, Votava-Smith JK, Graham EM, Seed M, Rudd N, Bernstein D, Lee TM, Yandell M, Tristani-Firouzi M. **Genetic and Clinical Variables Act Synergistically to Impact Neurodevelopmental Outcomes in Children with Single Ventricle Heart Disease**. *Commun Med (Lond)*. 2023, Sep. 3(1):127. doi: 10.1038/s43856-023-00361-2. PMID: 37758840; PMCID: PMC10533527

Marino BS, Cassedy A, Brown KL, Franklin R, Gaynor JW, Cvetkovic M, Laker S, Levinson K, MacGloin H, Mahony L, McQuillan A, Mussatto K, O'Shea D, Newburger J, Sykes M, Teele SA, Wernovsky G, Wray J. **Long-Term Quality of Life in Congenital Heart Disease Surgical Survivors: Multicenter Retrospective Study of Surgical and ICU Explanatory Factors.** *Pediatr Crit Care Med*. 2023, May. 24(5):391-398. doi: 10.1097/PCC.0000000000003190. PMID: 37140331

Marshall M, Malik A, Shah M, Fish FA, Etheridge SP, Aziz PF, Russell MW, Tisma S, Pflaumer A, Sreeram N, Kubus P, Law IH, Kantoch MJ, Kertesz NJ, Strieper M, Erickson CC, Moore JP, Nakano SJ, Singh HR, Chang P, Cohen M, Fournier A, Ilina MV, Zimmermann F, Horndasch M, Li W, Batra AS, Liberman L, Hamilton R, Janson CM, Sanatani S, Zeltser I, McDaniel G, Blaufox AD, Garnreiter JM, Balaji S. **Patterns of Electrocardiographic Abnormalities in Children with Hypertrophic Cardiomyopathy**. *Pediatr Cardiol*. 2023, Sep. doi: 10.1007/s00246-023-03252-4. PMID: 37684488

Massey SL, Weinerman B, Naim MY. **Perioperative Neuromonitoring in Children with Congenital Heart Disease.** *Neurocrit Care*. 2023, May. doi: 10.1007/s12028-023-01737-x. PMID: 37188884

*Masood IR, Edelson JB, **Exercise and Sports Participation with Cardiomyopathy: A Review**. *Curr Treat Options Cardio Med*. 2023, Sep. 25:543-559. doi.org/10.1007/s11936-023- 01006-2

McCormack SE, Wang Z, Wade KL, Dedio A, Cilenti N, Crowley J, Plessow F, Bamba V, Roizen JD, Jiang Y, Stylli J, Ramakrishnan A, Platt ML, Shekdar K, Fisher MJ, Vetter VL, Hocking M, Xiao R, Lawson EA. **A Pilot Randomized Clinical Trial of Intranasal Oxytocin to Promote Weight Loss in Individuals With Hypothalamic Obesity**. *J Endocr Soc*. 2023, Mar. 7(5):bvad037. doi: 10.1210/jendso/bvad037. PMID: 37153702; PMCID: PMC10154909

McCoy JA, Kim YY, Nyman A, Levine LD. **Prolonged labor and adverse cardiac outcomes in pregnant patients with congenital heart disease.** *Am J Obstet Gynecol*. 2022 Nov. 228(6): 728e1-728e8. doi: 10.1016/j.ajog.2022.11.1292.. PMID: 36427597

McDaniel CG, Adams DM, Steele KE, Hammill AM, Merrow AC, Crane JE, Smith CL, Kozakewich HPW, Le Cras TD. **Kaposiform lymphangiomatosis: Diagnosis, pathogenesis, and treatment.** *Pediatr Blood Cancer*. 2023, Jan. 70(4):e30219. doi: 10.1002/pbc.30219. PMID: 36683202

McSweeney J, Colgazier E, Becerra J, Leary B, Miller-Reed K, Walker S, Tilman K, Magness M, Ogawa M, Bannon W, Kivett T, Jackson EO, Davis A, Shepard C, Richards S, Whalen E, Engstrand S, DiPasquale Z, Connor JA. F**ailure to tolerate continuous subcutaneous treprostinil in pediatric pulmonary hypertension patients.** *Pulmonary Circulation*. 2023, Apr. 12(2) 212224. 10.1002/pul2.12224.

PUBLICATIONS

Medina Perez M, Lichtenberger JP, Huppmann AR, Gomez M, Ramirez Suarez KI, Foran A, *Vaiyani D, White AM, Biko DM. **Cardiac and Pericardial Neoplasms in Children: Radiologic-Pathologic Correlation**. *Radiographics*. 2023, Sep. 43(9):e230010. doi: 10.1148/rg.230010. PMID: 37561644

Mille F, Burstein D. **Diagnosis and Management of Pediatric Heart Failure**. *Indian J Pediatr*. 2023, Mar. 90(5):492. doi: 10.1007/s12098-022-04433-4. PMID: 36922473

Mitchell SE, Martin RP, Terry P, Drant SE, Valle D, Dietz H, Sobreira N. **Systemic artery to pulmonary artery aneurysm malformations associated with variants at MCF2L**. *Am J Med Genet A*. 2023, Feb. 191(5): 1250-1260. doi: 10.1002/ajmg.a.63141. PMID: 36760094

Morgan RW, Berg RA, Reeder RW, Carpenter TC, Franzon D, Frazier AH, Graham K, Meert KL, Nadkarni VM, Naim MY, Tilford B, Wolfe HA, Yates AR, Sutton RM; ICU-RESUS and the Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups. **The physiologic response to epinephrine and pediatric cardiopulmonary resuscitation outcomes.** *Crit Care*. 2023, Mar. 27(1):105. doi: 10.1186/s13054-023-04399-5. PMID: 36915182; PMCID: PMC10012560

Morgan RW, Reeder RW, Ahmed T, Bell MJ, Berger JT, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Dean JM, Diddle JW, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Hehir DA, Himebauch AS, Horvat CM, Huard LL, Maa T, Manga A, McQuillen PS, Meert KL, Mourani PM, Nadkarni VM, Naim MY, Notterman D, Page K, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tabbutt S, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Berg RA, Sutton RM. **Outcomes and Characteristics of Cardiac Arrest in Children with Pulmonary Hypertension: A Secondary Analysis of the ICU-RESUS Clinical Trial**. *Resuscitation*. 2023, Jul. 109897. doi: 10.1016/j.resuscitation.2023.109897. PMID: 37406760

Naik A, Forrest KM, Paul O, Issah Y, Valekunja UK, Tang SY, Reddy AB, Hennessy EJ, Brooks TG, Chaudhry F, Babu A, Morley M, Zepp JA, Grant GR, FitzGerald GA, Sehgal A, Worthen GS, Frank DB, Morrisey EE, Sengupta S. **Circadian Regulation of Lung Repair and Regeneration**. *JCI Insight*. 2023, Aug. 8(16):e164720. doi: 10.1172/jci.insight.164720. PMID: 37463053

Nam HH, Flynn M, Lasso A, Herz C, Sabin P, Wang Y, Cianciulli A, Vigil C, Huang J, Vicory J, Paniagua B, Allemang D, Goldberg DJ, Nuri M, Cohen MS, Fichtinger G, Jolley MA. **Modeling of the Tricuspid Valve and Right Ventricle in Hypoplastic Left Heart Syndrome with a Fontan Circulation**. *Circ Cardiovasc Imaging*. 2023, Mar. 16(3):e014671. doi: 10.1161/CIRCIMAGING.122.014671. PMID: 36866669; PMCID: PMC10026972 **

Nathan M, Gauvreau K, White O, Anderson BR, Bacha EA, Barron DJ, Cleveland J, Del Nido PJ, Eghtesady P, Galantowicz M, Kennedy A, Kohlsaat K, Ma M, Mattila C, Van Arsdell G, Gaynor JW. **Comparing Apples to Apples: Exploring public reporting of congenital cardiac surgery outcomes based on common congenital heart operations**. *J Thorac Cardiovasc Surg*. 2023, Sep. 5223(23)00767-5. doi: 10.1016/j.jtcvs.2023.08.052. PMID: 37689234

*Niccum M, *Gupta M, Rome JJ, O'Byrne ML. **Coil Embolization of a Ruptured Mycotic Coronary Artery Aneurysm in a Pediatric Patient**. *JACC: Case Reports.* 2023, Sep. doi: 10.1016/j.jaccas.2023.101967

Nicolson S. **Pediatric Cardiac Anesthesiologists: An Endangered Species. A Call to Action**. *World J Pediatr Congenit Heart Surg*. 2023, Nov. 15(1):139-141. doi: 10.1177/21501351231214756. PMID: 38018084

PUBLICATIONS

Nriagu BN, Adams DM, Srinivasan A, Krishnamurthy G, Smith C, Dori Y, Snyder K. **Multicompartment Dynamic Contrast Magnetic Resonance Lymphangiography in Diagnosis of Complicated Lymphatic Anomaly.** *Lymphat Res Biol*. 2023, Apr. 21(2):135-140. doi: 10.1089/lrb.2022.0012. PMID: 35984928

O'Byrne ML. **Commentary on: "Broad- Versus Narrow-Spectrum Perioperative Antibiotics and Outcomes in Pediatric Heart Disease Surgery: Analysis of the Vizient Clinical Data Base"**. *J Pediatric Infect Dis Soc*. 2023, Jun. 12(6):319-321. doi: 10.1093/jpids/piad034. PMID: 37389892

O'Byrne ML, Song L, Huang J, *Lemley B, Goldberg D, Gardner MM, Ravishankar C, Rome JJ, Glatz AC. **Attributable mortality benefit of digoxin treatment in hypoplastic left heart syndrome after the Norwood operation: An instrumental variable-based analysis using data from the Pediatric Health Information Systems Database.** *Am Heart J*. 2023, May. 263:35-45. doi: 10.1016/j.ahj.2023.05.005. PMID: 37169122 **

O'Byrne ML. **Patient-Reported Outcomes in Tetralogy of Fallot: The Potential of the CORRELATE Cohort**. *J Am Coll Cardiol*. 2023, May. 81(19):1951-1953. doi: 10.1016/j.jacc.2023.03.386. PMID: 37164528

O'Connor MJ. **Thirty years of pediatric heart transplantation-On the way to better outcomes for all patients**. *Pediatr Transplant*. 2023, Sep.27(8): e14604. doi: 10.1111/petr.14604. PMID: 37667419

O'Connor MJ, Shezad M, Ahmed H, Amdani S, Auerbach SR, Bearl DW, Butto A, Byrnes JW, Conway J, Dykes JC, Glass L, Lantz J, Law S, Mongé MC, Morales DLS, Parent JJ, Peng DM, Ploutz MS, Puri K, Shugh S, Shwaish NS, VanderPluym CJ, Wilkens S, Wright L, Zinn MD, Lorts A. **Expanding use of the HeartMate 3 ventricular assist device in pediatric and adult patients within the Advanced Cardiac Therapies Improving Outcomes Network (ACTION)**. *J Heart Lung Transplant*. 2023 Jul. 42(11):1546-1556. doi: 10.1016/j.healun.2023.06.015. PMID: 37419295

O'Connor AM, Cassedy A, Wray J, Brown KL, Cohen M, Franklin RCG, Gaynor JW, MacGloin H, Mahony L, Mussatto K, Newburger JW, Rosenthal DN, Teitel D, Ernst MM, Wernovsky G, Marino BS. **Differences in Quality of Life in Children across the Spectrum of Congenital Heart Disease**. *J Pediatr*. 2023 Aug. 263:113701. doi: 10.1016/j.jpeds.2023.113701. PMID: 37640230

Oh NA, Blitzer D, Chen L, Guariento A, Fuller S, Subramanyan RK, St Louis JD, Karamlou T; Members of The Society of Thoracic Surgeons Congenital Work Force. **The Impact of Congenital Cardiac Surgery Fellowship on Training and Practice.** *Ann Thorac Surg*. 2023 Jul. 116(6):1320-1327. doi: 10.1016/j.athoracsur.2023.06.018. PMID: 37419170

Omann C, Kristensen R, Tabor A, Gaynor JW, Hjortdal VE, Nyboe C. **School performance is impaired in children with both simple and complex congenital heart disease**. *Front Pediatr*. 2023, Feb. 11:1073046. doi: 10.3389/fped.2023.1073046. PMID: 36911031; PMCID: PMC9995927

Ortmann LA, Reeder RW, Raymond TT, Brunetti MA, Himebauch A, Bhakta R, Kempka J, di Bari S, Lasa JJ. **Epinephrine dosing strategies during pediatric extracorporeal cardiopulmonary resuscitation reveal novel impacts on survival: A multicenter study utilizing time-stamped epinephrine dosing records**. *Resuscitation*. 2023, May. 188:109855. doi: 10.1016/j.resuscitation.2023.109855. PMID: 37257678

PUBLICATIONS

Panigrahy A, Schmithorst V, Ceschin R, Lee V, Beluk N, Wallace J, Wheaton O, Chenevert T, Qiu D, Lee JN, Nencka A, Gagoski B, Berman JI, Yuan W, Macgowan C, Coatsworth J, Fleysher L, Cannistraci C, Sleeper LA, Hoskoppal A, Silversides C, Radhakrishnan R, Markham L, Rhodes JF, Dugan LM, Brown N, Ermis P, Fuller S, Cotts TB, Rodriguez FH, Lindsay I, Beers S, Aizenstein H, Bellinger DC, Newburger JW, Umfleet LG, Cohen S, Zaidi A, Gurvitz M; Pediatric Heart Network MINDS Neuroimaging Ancillary Study Investigators. **Design and Harmonization Approach for the Multi-Institutional Neurocognitive Discovery Study (MINDS) of Adult Congenital Heart Disease (ACHD) Neuroimaging Ancillary Study: A Technical Note**. *J Cardiovasc Dev Dis*. 2023 Sep. 10(9):381. doi: 10.3390/jcdd10090381. PMID: 37754810; PMCID: PMC10532244

Peng DM, Davies RR, Simpson KE, Shugh SB, Morales DLS, Jacobs JP, Butto A, Joong A, Conway J, Schindler K, Griffiths ER, Koehl D, Cantor R, Kirklin JK, Rossano JW, Adachi I; Pedimacs Investigators. **Seventh Annual Society of Thoracic Surgeons Pedimacs Report**. *Ann Thorac Surg*. 2023, Dec. 18:S0003-4975(23)01297-3. doi: 10.1016/j.athoracsur.2023.11.035. Epub ahead of print. PMID: 38123046

Peyvandi S, Xu D, Barkovich AJ, Gano D, Chau V, Reddy VM, Selvanathan T, Guo T, Gaynor JW, Seed M, Miller SP, McQuillen P. **Declining incidence of postoperative neonatal brain injury in congenital heart disease**. *J Am Coll Cardiol*. 2023 Jan. 81(3):253-266. doi: 10.1016/j.jacc.2022.10.029. PMID: 36653093

Pickard SS, Armstrong AK, Balasubramanian S, Buddhe S, Crum K, Kong G, Lang SM, Lee MV, Lopez L, Natarajan SS, Norris MD, Parra DA, Parthiban A, Powell AJ, Priromprintr B, Rogers LS, Sachdeva S, Shah SS, Smith CA, Stern KWD, Xiang Y, Young LT, Sachdeva R. **Appropriateness of cardiovascular computed tomography and magnetic resonance imaging in patients with conotruncal defects**. *J Cardiovasc Comput Tomogr*. 2023, Mar. 17(3): 211-219. doi: 10.1016/j.jcct.2023.01.044. PMID: 36868899

Reddy KP, *Jones AL, Naim MY, Mercer-Rosa L. **Association of race and ethnicity with resource utilisation among children with CHD: an evaluation of the National Health Interview Survey, 2010-2018**. *Cardiol Young*. 2023, Aug. 33(8):1471-1473. doi: 10.1017/S1047951123000033. Epub 2023 Jan 13. PMID: 36636921**

*Restaino K, Zhang X, Faerber JA, Rossano JW, Burstein D, Wittlieb-Weber CA, Lin KY, Edelson JB, Edwards JJ, O'Connor MJ. **Temporal trends in primary payers in pediatric heart transplant and association with long-term survival**. *Pediatr Transplant*. 2023, Feb. 27(3): e14484. doi: 10.1111/petr.14484. PMID: 36751006 **

Rippert AL, Trackman S, Burnstein D, Gaynor JW, Griffis H, Seymour C, Ahrens-Nicklas R. **Evaluating the Utility of a New Pathogenicity Predictor for Pediatric Cardiomyopathy**. *Human Mutation*. 2023, Oct. doi: 10.1155/2023/8892833 **

Rome JJ, O'Byrne ML. **Hybrid Palliation for Critical Left Heart Obstruction Is Versatile: Risk Factors Still Impede Optimal Outcome**. *J Am Coll Cardiol*. 2023, Oct. 2(14):1442-1444. doi: 10.1016/j.jacc.2023.08.023. PMID: 37758439

Ron HA, Crowley TB, Liu Y, Unolt M, Schindewolf E, Moldenhauer J, Rychik J, Goldmuntz E, Emanuel BS, Ryba D, Gaynor JW, Zackai EH, Hakonarson H, McDonald-McGinn DM. **Improved Outcomes in Patients with 22q11.2 Deletion Syndrome and Diagnosis of Interrupted Aortic Arch Prior to Birth Hospital Discharge, a Retrospective Study**. *Genes (Basel)*. 2022, Dec. 14(1):62. doi: 10.3390/genes14010062. PMID: 36672801; PMCID: PMC9859187

Ruppel H, Makeneni S, Faerber JA, Lane-Fall MB, Foglia EE, O'Byrne ML, Bonafide CP. **Evaluating the Accuracy of Pulse Oximetry in Children According to Race**. *JAMA Pediatr*. 2023, Mar. 177(5): 540-543. doi: 10.1001/jamapediatrics.2023.0071. PMID: 36939727; PMCID: PMC10028535 **

Ruppel H, O'Byrne ML, Foglia EE. **Mitigating Risks for Racial Bias in Pulse Oximetry on Children-Reply**. *JAMA Pediatr*. 2023 Jul 17.177(9): 982-983. doi: 10.1001/jamapediatrics.2023.2295. PMID: 37459108

PUBLICATIONS

*Saef J, Sundaravel S, Ortega-Legaspi J, Vaikunth S. **Safety and Treatment Experience with Sodium/glucose Cotransporter-2 Inhibitors in Adult Patients with Congenital Heart Disease**. *J Card Fail*. 2023, Mar. 29(6):974-975. doi: 10.1016/j.cardfail.2023.03.011. PMID: 37004868

Sadhwani A, Sood E, Van Bergen AH, Ilardi D, Sanz JH, Gaynor JW, Seed M, Ortinau CM, Marino BS, Miller TA, Gaies M, Cassidy AR, Donohue JE, Ardisana A, Wypij D, Goldberg CS. **Development of the data registry for the Cardiac Neurodevelopmental Outcome Collaborative**. *Cardiol Young*. 2023 May. 19:1-7. doi: 10.1017/S1047951123001208. PMID: 37203794

Sato T, Matsubara D, Wang Y, Agger P, Pedrizzetti G, Banerjee A. **Contraction Patterns of Post-Fontan Single Right Ventricle versus Normal Left and Right Ventricles in Children: Insights from Principal Strain Analysis**. *J Am Soc Echocardiogr*. 2023, Mar. S0894- 7317(23)00138-4. doi: 10.1016/j.echo.2023.03.004. PMID: 36931578

Schaft J, Füller S. **Supporting a Vibrant Entrepreneurial Ecosystem: High Density, Critical Mass, and Effective Strategies Underpin the Success of Innovative Life Science Ecosystems**. *EMBO Rep*. 2023, Aug. 24(9): e57798. doi: 10.15252/embr.202357798. PMID: 37530749

Schmithorst V, Ceschin R, Lee V, Wallace J, Sahel A, Chenevert TL, Parmar H, Berman JI, Vossough A, Qiu D, Kadom N, Grant PE, Gagoski B, LaViolette PS, Maheshwari M, Sleeper LA, Bellinger DC, Ilardi D, O'Neil S, Miller TA, Detterich J, Hill KD, Atz AM, Richmond ME, Cnota J, Mahle WT, Ghanayem NS, Gaynor JW, Goldberg CS, Newburger JW, Panigrahy A. **Single Ventricle Reconstruction III: Brain Connectome and Neurodevelopmental Outcomes: Design, Recruitment, and Technical Challenges of a Multicenter, Observational Neuroimaging Study**. *Diagnostics (Basel)*. 2023, Apr. 13(9):1604. doi: 10.3390/diagnostics13091604. PMID: 37174995; PMCID: PMC10178603

Shah MJ, Borquez AA, Cortez D, McCanta AC, De Filippo P, Whitehill RD, Imundo JR, Moore JP, Sherwin ED, Howard TS, Rosenthal E, Kertesz NJ, Chang PM, Madan N, Kutalek SP, Hammond BH, Janson CM, Ramesh Iyer V, Williams MR. **Transcatheter Leadless Pacing in Children: A PACES Collaborative Study in the Real-World Setting.** *Circ Arrhythm Electrophysiol*. 2023, Apr. 16(4):e011447. doi: 10.1161/CIRCEP.122.011447. PMID: 37039017

Shaw K, Mavroudis CD, Ko TS, Jahnavi J, Jacobwitz M, Ranieri N, Forti RM, Melchior RW, Baker WB, Yodh AG, Licht DJ, Nicolson SC, Lynch JM. **The Use of Novel Diffuse Eptical Spectroscopies for Improved Neuromonitoring during Neonatal Cardiac Surgery Requiring Antegrade Cerebral Perfusion**. *Front Pediatr*. 2023 Jun. 11:1125985. doi: 10.3389/fped.2023.1125985. PMID: 37425272; PMCID: PMC10327557

Shankar VR, Lodha R. **Advances in Pediatric Critical Care- II**. *Indian J Pediatr*. 2023, Apr. doi: 10.1007/s12098-023-04574-0. PMID: 37017926

Sheppard SE, March ME, Seiler C, Matsuoka LS, Kim SE, Kao C, Rubin AI, Battig MR, Khalek N, Schindewolf E, O'Connor N, Pinto E, Priestley JR, Sanders VR, Niazi R, Ganguly A, Hou C, Slater D, Frieden IJ, Huynh T, Shieh JT, Krantz ID, Guerrero JC, Surrey LF, Biko DM, Laje P, Castelo-Soccio L, Nakano TA, Snyder K, Smith CL, Li D, Dori Y, Hakonarson H. **Lymphatic disorders caused by mosaic, activating KRAS variants respond to MEK inhibition**. *JCI Insight*. 2023 May. 8(9):e155888. doi: 10.1172/jci.insight.155888. PMID: 37154160

Sherwin ED, Shaw MJ. **Leadless Pacemakers in Patients with Congenital Heart Disease**. *Cardiac Electrophysiology Clinics*. 2023, Aug. ISSN 1877-9182. doi: 10.1016/j.ccep.2023.06.002

PUBLICATIONS

*Shustak RJ, Faerber JA, Stagg A, Hehir DA, Natarajan SS, Preminger TJ, Szwast A, Rome JJ, Giglia TM, Ravishankar C, Mercer-Rosa L, Gardner MM. **Association of Home Monitoring and Unanticipated Interstage Readmissions in Infants With Hypoplastic Left Heart Syndrome**. *J Am Heart Assoc*. 2023, Apr. 12(8): e025686. doi: 10.1161/JAHA.122.025686. PMID: 37066818 **

*Shustak RJ, Huang J, Tam V, Stagg A, Giglia TM, Ravishankar C, Mercer-Rosa L, Guevara JP, Gardner MM. **Neighborhood Social Vulnerability and Interstage Weight Gain: Evaluating the Role of a Home Monitoring Program**. *J Am Heart Assoc*. 2023, Sep.12 (18): e030029. doi: 10.1161/JAHA.123.030029. PMID: 37702068 **

Silka MJ, Shah MJ, Silva JNA, Balaji S, Beach CM, Benjamin MN, Berul CI, Cannon B, Cecchin F, Cohen MI, Dalal AS, Dechert BE, Foster A, Gebauer R, Corcia MCG, Kannankeril PJ, Karpawich PP, Kim JJ, Krishna MR, Kubuš P, LaPage MJ, Mah DY, Malloy-Walton L, Miyazaki A, Motonaga KS, Niu MC, Olen M, Paul T, Rosenthal E, Saarel EV, Silvetti MS, Stephenson EA, Tan RB, Triedman J, Bergen NHV, Wackel PL. **2021 PACES Expert Consensus Statement on the Indications and Management of Cardiovascular Implantable Electronic Devices in Pediatric Patients: Executive Summary**. *Ann Pediatr Cardiol*. 2022 May-Jun; 15(3):323-346. doi: 10.4103/0974-2069.361245. 2022 Nov 16. PMID: 36589659; PMCID: PMC9802608

Simpao AF, Randazzo IR, Chittams JL, Burnham N, Gerdes M, Bernbaum JC, Walker T, Imsdahl S, DeWitt AG, Zackai EH, Gaynor JW, Loepke AW. **Anesthesia and sedation exposure and neurodevelopmental outcomes in infants undergoing congenital cardiac surgery: a retrospective cohort study**. *Anesthesiology*. 2023 Jul. 9(4):393-404. doi: 10.1097/ALN.0000000000004684. PMID: 37440275

Singh SK, Faridmoayer E, Vitale N, Woodard E, Xue Y, Abramov A, Levy RJ, Ferrari G. **Valved Conduits for Right Ventricular Outflow Tract Reconstruction: A Review of Current Technologies and Future Directions**. *Pediatr Cardiol*. 2023, Dec. doi: 10.1007/s00246-023-03346-z. PMID: 38041710

Sperotto F, Gutiérrez-Sacristán A, Makwana S, Li X, Rofeberg VN, Cai T, Bourgeois FT, Omenn GS, Hanauer DA, Sáez C, Bonzel CL, Bucholz E, Dionne A, Elias MD, García-Barrio N, González TG, Issitt RW, Kernan KF, Laird-Gion J, Maidlow SE, Mandl KD, Ahooyi TM, Moraleda C, Morris M, Moshal KL, Pedrera-Jiménez M, Shah MA, South AM, Spiridou A, Taylor DM, Verdy G, Visweswaran S, Wang X, Xia Z, Zachariasse JM; Consortium for Clinical Characterization of COVID-19 by EHR (4CE); Newburger JW, Avillach P. **Clinical phenotypes and outcomes in children with multisystem inflammatory syndrome across SARS-CoV-2 variant eras: a multinational study from the 4CE consortium.** *EClinicalMedicine.* 2023 Sep 14. 64:102212. doi: 10.1016/j.eclinm.2023.102212. PMID: 37745025; PMCID: PMC10511777

Srinivasan A, Smith C, Krishnamurthy G, Escobar F, Biko D, Dori Y. **Characterization and treatment of thoracic duct obstruction in patients with lymphatic flow disorders**. *Catheter Cardiovasc Interv.* 2023, Mar. 101(5): 853-862. doi: 10.1002/ccd.30613. PMID: 36877806

Stack KO, Schluger C, Roberts AL, Lawrence K, Balsara S, Hunt M, Kaplinski M, Gardner MM, Ravishankar C, Rossano J, Goldberg DJ, Mahle M, O'Connor MJ, Mascio CE, Gaynor JW, Burstein D. **Impact of Ventricular Dysfunction and Atrioventricular Valve Regurgitation on Pre-Fontan Attrition.** *Ann Thorac Surg.* 2023 Jul. 116(4): 778-785. doi: 10.1016/j.athoracsur.2023.05.046. PMID: 37429514 **

Stagg A, Giglia TM, Gardner MM, Shustak RJ*, Natarajan SS, Hehir DA, Szwast AL, Rome JJ, Ravishankar C, Preminger TJ. **Feasibility of Digital Stethoscopes in Telecardiology Visits for Interstage Monitoring in Infants with Palliated Congenital Heart Disease**. *Pediatr Cardiol*. 2023 Jun. 44(8): 1702-1709. doi: 10.1007/s00246-023-03198-7. PMID: 37285041; PMCID: PMC1024654

PUBLICATIONS

Steinberg ZL, Cabalka AK, Balzer DT, Asnes JD, Morray BH, Gillespie MJ, McElhinney DB. **Right ventricular outflow tract obstruction associated with neointimal tissue accumulation and distortion of the Harmony TPV25 stent frame: Potential mechanisms and treatment.** *Catheter Cardiovasc Interv*. 2023, Nov. 102(6):1078-1087. doi: 10.1002/ccd.30901. 2023 Nov 5. PMID: 37925624

Stephens EH, Egbe AC, Connolly HM, Vricella LA, Fuller S, Cameron D, Dearani JA. **Aortic Dilation and Risk in Patients with Conotruncal Anomalies**. *Ann Thorac Surg*. 2023, Dec. S0003-4975(23)01224-9. doi: 10.1016/j.athoracsur.2023.11.020. PMID: 38043849

Stephens EH, Romano JC, Carpenter AJ, Yang SC, LaPar DJ, Fuller S. **Workforce and Training Implications of the 2022 Congenital Heart Surgery Practice Survey**. *Ann Thorac Surg*. 2023, Oct. S0003-4975(23)01071-8. doi:10.1016/j.athoracsur.2023.10.013. PMID: 37866647

Stephens EH, Romano JC, Karamlou T, Hayes SN, Bontrager CE, Overman DM, Fuller SM. **Working Toward Solutions for Gender Disparity: Implications of the 2022 Congenital Workforce Survey**. *Ann Thorac Surg*. 2023, Dec 1:S0003-4975(23)01223-7. doi: 10.1016/j.athoracsur.2023.11.019. PMID: 38043850

Sulentic, A, *Gupta M, Amin, S, Wang, Y, *Vaiyani D, Sabin P, Partington SL, Gillespie MJ, Jolley MA. **3-Dimensional Modeling Guided Transcatheter Repair of Dehisced Pulmonary Venous Baffle with Gore ASD Device**. *JACC: Case Reports*. 2023, Sep. doi:10.1016/j.jaccas.2023.101968

Tedla BA, Kim YY, Vaikunth S. **Novel Approaches to the Failing Congenital Heart**. *Curr Cardiol Rep*. 2023, Oct. 25(11: 1633-1647. doi: 10.1007/s11886-023-01979-3. PMID: 37889420

Tomasulo CE, Dori Y, Smith CL. **Understanding the next circulation: lymphatics and what the future holds**. *Curr Opin Cardiol*. 2023, Jul. 38(4):369-374. doi: 10.1097/HCO.0000000000001064. 2023 May 9. PMID: 37195304

Vaikunth SS, Murphy DJ, Tremmel JA, Schnittger I, Mitchell RS, Maeda K, Rogers IS. **Symptomatic Myocardial Bridging in D-Transposition of the Great Arteries Post-Arterial Switch**. *J Am Coll Cardiol Case Rep*. 2023 Feb. 8:101730: doi: 10.1016/j.jaccas.2022.101730. PMID: 36860558

Vaikunth S, Sundaravel S, Saef J, Ortega-Legaspi J. **Novel Therapeutic Strategies in Heart Failure in Adult Congenital Heart Disease: of Medicines and Devices**. *Curr Heart Fail Rep*. 2023, Aug. 20(5): 401-416. doi: 10.1007/s11897-023-00621-1. PMID: 37582901

*Vaiyani D, Elias MD, Biko DM, Whitehead KK, Harris MA, Partington SL, Fogel MA. **Patients with Post-COVID-19 Vaccination Myocarditis Have More Favorable Strain in Cardiac Magnetic Resonance Than Those With Viral Myocarditis.** *Pediatr Cardiol*. 2023, Apr. 44(5): 1108-1117. doi: 10.1007/s00246-023-03150-9. PMID: 37004523; PMCID: PMC10067005

Vicory J, Herz C, Han Y, Allemang D, Flynn M, Cianciulli A, Nam HH, Sabin P, Lasso A, Jolley MA, Paniagua B. **Skeletal model-based analysis of the tricuspid valve in hypoplastic left heart syndrome**. *Stat Atlases Comput Models Heart*. 2023, Feb. 13593:258-268. doi: 10.1007/978-3-031-23443-9_24. PMID: 36848309; PMCID: PMC9949511

PUBLICATIONS

Vissing CR, Axelsson Raja A, Day SM, Russell MW, Zahka K, Lever HM, Pereira AC, Colan SD, Margossian R, Murphy AM, Canter C, Bach RG, Wheeler MT, Rossano JW, Owens AT, Benson L, Mestroni L, Taylor MRG, Patel AR, Wilmot I, Thrush P, Soslow JH, Becker JR, Seidman CE, Lakdawala NK, Cirino AL, McMurray JJV, MacRae CA, Solomon SD, Bundgaard H, Orav EJ, Ho CY; Valsartan for Attenuating Disease Evolution in Early Sarcomeric Hypertrophic Cardiomyopathy (VANISH) Investigators. **Cardiac Remodeling in Subclinical Hypertrophic Cardiomyopathy: The VANISH Randomized Clinical Trial.** *JAMA Cardiol*. 2023, Sep. 8(11): e232808. doi: 10.1001/jamacardio.2023.2808. PMID: 37672268; PMCID: PMC10483382

Walter JK, Feudtner C, Cetin A, DeWitt AG, Zhou M, Montoya-Williams D, Olsen R, Griffis H, Williams C, Costarino A. **Parental Communication Satisfaction with the Clinical Team in the Paediatric Cardiac ICU**. *Cardiol Young*. 2023 Jun. 26:1-9. doi: 10.1017/S1047951123001555. PMID: 37357911 **

Webber SA, Chin H, Wilkinson JD, Armstrong BD, Canter CE, Dipchand AI, Dodd DA, Feingold B, Lamour JM, Mahle WT, Singh TP, Zuckerman WA, Rossano JW, Morrison Y, Diop H, Demetris AJ, Bentlejewski C, Mohanakumar T, Odim J, Zeevi A; CTOTC-09 investigators. I**mpact of Donor Specific Anti-HLA Antibody on Cardiac Hemodynamics and Graft Function 3 years after Pediatric Heart Transplantation: First Results from the CTOTC-09 Multi-Institutional Study**. *Am J Transplant*. 2023, Aug. 23(12): 1893-1907. doi: 10.1016/j.ajt.2023.08.006. PMID: 37579817

Wei ZA, Fogel MA, Yoganathan AP. **Invited Commentary to 'Hemodynamic performance of 16-20mm extracardiac Goretex conduits in adolescent Fontan patients at rest and during simulated exercise'**. *Eur J Cardiothorac Surg*. 2022, Dec. 63(1):ezad015. doi: 10.1093/ejcts/ezad015. PMID: 36688694

*Weinreb S, Shah MJ. **A Not-So-Natural History of Nonsurgical Complete Atrioventricular Block in Children in the Current Era**. *JACC Clin Electrophysiol*. 2023, Aug. 9(8 Pt 1) 1390- 1392. doi: 10.1016/j.jacep.2023.04.027. PMID: 37354186

Weiss PF, Brandon TG, Lambert RG, Biko DM, Chauvin NA, Francavilla ML, Herregods N, Hendry AM, Maksymowych WP. **Consensus-Driven Definition for Unequivocal Sacroiliitis on Radiographs in Juvenile Spondyloarthritis**. *J Rheumatol*. 2023, Sep; 50(9):1173-1177. doi: 10.3899/jrheum.2022-0890. 2023, Apr 15. PMID: 37061228

White BR, Chan C, Vandekar S, Shinohara RT. **Statistical approaches to temporal and spatial autocorrelation in resting-state functional connectivity in mice measured with optical intrinsic signal imaging.** *Neurophotonics*. 2022 Oct; 9(4):041405. doi: 10.1117/1.NPh.9.4.041405. 2022 Mar 14. PMID: 35295407; PMCID: PMC8920489

Wiegman A, Greber-Platzer S, Ali S, Doortje Reijman M, Brinton EA, Charng MJ, Srinivasan S, Baker-Smith C, Baum S, Brothers JA, Hartz J, Moriarty PM, Mendell J, Bihorel S, Banerjee P, George RT, Hirshberg B, Pordy R. **Evinacumab for Pediatric Patients With Homozygous Familial Hypercholesterolemia**. *Circulation*. 2023, Oct. doi: 10.1161/CIRCULATIONAHA.123.065529. PMID: 37860863

*Williams TR, Cianciulli AR, Wang Y, Lasso A, Pinter C, Pouch AM, Biko DM, Nuri M, Quartermain MD, Rogers LS, Chen JM, Jolley MA. **Truncal Valve Repair: 3-Dimensional Imaging and Modeling to Enhance Preoperative Surgical Planning.** *Circ Cardiovasc Imaging*. 2022 Dec; 15(12):e014424. doi: 10.1161/CIRCIMAGING.122.014424. 2022 Sep 12. PMID: 36093770; PMCID: PMC9772078

Williamson BJ, Barnes-Davis ME, Vannest J, Anixt JS, Heydarian HC, Kuan L, Laue CS, Pratap J, Schapiro M, Tseng SY, Kadis DS. **Altered white matter connectivity in children with congenital heart disease with single ventricle physiology**. *Sci Rep*. 2023, Jan. 13(1):1318. doi: 10.1038/s41598-023-28634-9. PMID: 36693986; PMCID: PMC9873737

PUBLICATIONS

Wright LK, Rossano JW. **Reducing Pediatric Heart Failure Readmissions: The Time Is Now**. *JACC Heart Fail*. 2023, Nov. 12(1): 97-99. doi: 10.1016/j.jchf.2023.10.011. PMID: 37999663

Yeh MJ, Bergersen L, Gauvreau K, Barry OM, Batlivala SP, Bjornlund E, Boe B, Caneo LF, Croti UA, Doyle T, Furnaz S, Moraes RC, O'Byrne ML, de Oliveira Paes E, Palacios-Macedo A, Pechilkov D, Sandoval NF, Sen S, Stajevic M, Travessa MAF, Jenkins KJ. **COVID-19 international experience in paediatric patients with congenital heart disease.** *Heart*. 2023, Apr. 109(9):710-718. doi: 10.1136/heartjnl-2022-321208. PMID: 36598072

Jang MY, Patel PN, Pereira AC, Willcox JAL, Haghighi A, Tai AC, Ito K, Morton SU, Gorham JM, McKean DM, DePalma SR, Bernstein D, Brueckner M, Chung WK, Giardini A, Goldmuntz E, Kaltman JR, Kim R, Newburger JW, Shen Y, Srivastava D, Tristani-Firouzi M, Gelb BD, Porter GA Jr, Seidman CE, Seidman JG. **Contribution of Previously Unrecognized RNA Splice-Altering Variants to Congenital Heart Disease**. *Circ Genom Precis Med*. 2023, May. 16(3): 224-231. doi: 10.1161/CIRCGEN.122.003924. PMID: 37165897

Yu M, Aguirre M, Jia M, Gjoni K, Cordova-Palomera A, Munger C, Amgalan D, Rosa Ma X, Pereira A, Tcheandjieu C, Seidman C, Seidman J, Tristani-Firouzi M, Chung W, Goldmuntz E, Srivastava D, Loos RJF, Chami N, Cordell H, Dreßen M, Mueller-Myhsok B, Lahm H, Krane M, Pollard KS, Engreitz JM, Gagliano Taliun SA, Gelb BD, Priest JR. **Oligogenic Architecture of Rare Noncoding Variants Distinguishes 4 Congenital Heart Disease Phenotypes**. *Circ Genom Precis Med*. 2023, Apr. 16(3): 258-266. doi: 10.1161/CIRCGEN.122.003968. PMID: 37026454

Yuerek M, Kozyak BW, Shankar VR. **Advances in Extracorporeal Support Technologies in Critically Ill Children**. *Indian J Pediatr*. 2023, Mar. 90(5): 501-509. doi: 10.1007/s12098-023- 04545-5. PMID: 36988821; PMCID: PMC10049895

Yuerek M, Naim MY. **Communication Breakdown, it's always the same**. *Resuscitation*. 2023 Jun. 189:109878. doi: 10.1016/j.resuscitation.2023.109878. PMID: 37331562

Yurasek GK, Fortkiewicz J, Duelley C, Arold L, Pleau C, Park A, Greenberg I, Payne AS, Mass P, Bost JE, Herrera G, Diddle JW, Peer M, Yerebakan C. **Interprofessional Extracorporeal Membrane Oxygenation Cardiopulmonary Resuscitation Simulations Aimed at Decreasing Actual Cannulation Times: A Longitudinal Study**. *Simul Healthc*. 2023, Oct. 18(5):285-292. doi: 10.1097/SIH.0000000000000693. 2022 Nov 2. PMID: 36730866

Yver H, Habet V, DeWitt AG, Thomas NJ, Yehya N. **Stratifying Severity of Acute Respiratory Failure Severity in Cyanotic Congenital Heart Disease**. *Pediatr Cardiol*. 2023, Apr. 44(6): 1271-1276. doi: 10.1007/s00246-023-03160-7. PMID: 37060477

Zampi JD, Heinrich KP, Bergersen L, Goldstein BH, Batlivala SP, Fuller S, Glatz AC, O'Byrne ML, Marino B, Afton K, Lowery R, Yu S, Goldberg CS. **Neurocognitive function and health- related quality of life in adolescents and young adults with CHD with pulmonary valve dysfunction**. *Cardiol Young*. 2023 Nov. 30: 1-8. doi: 10.1017/S1047951123003979. PMID: 38031461

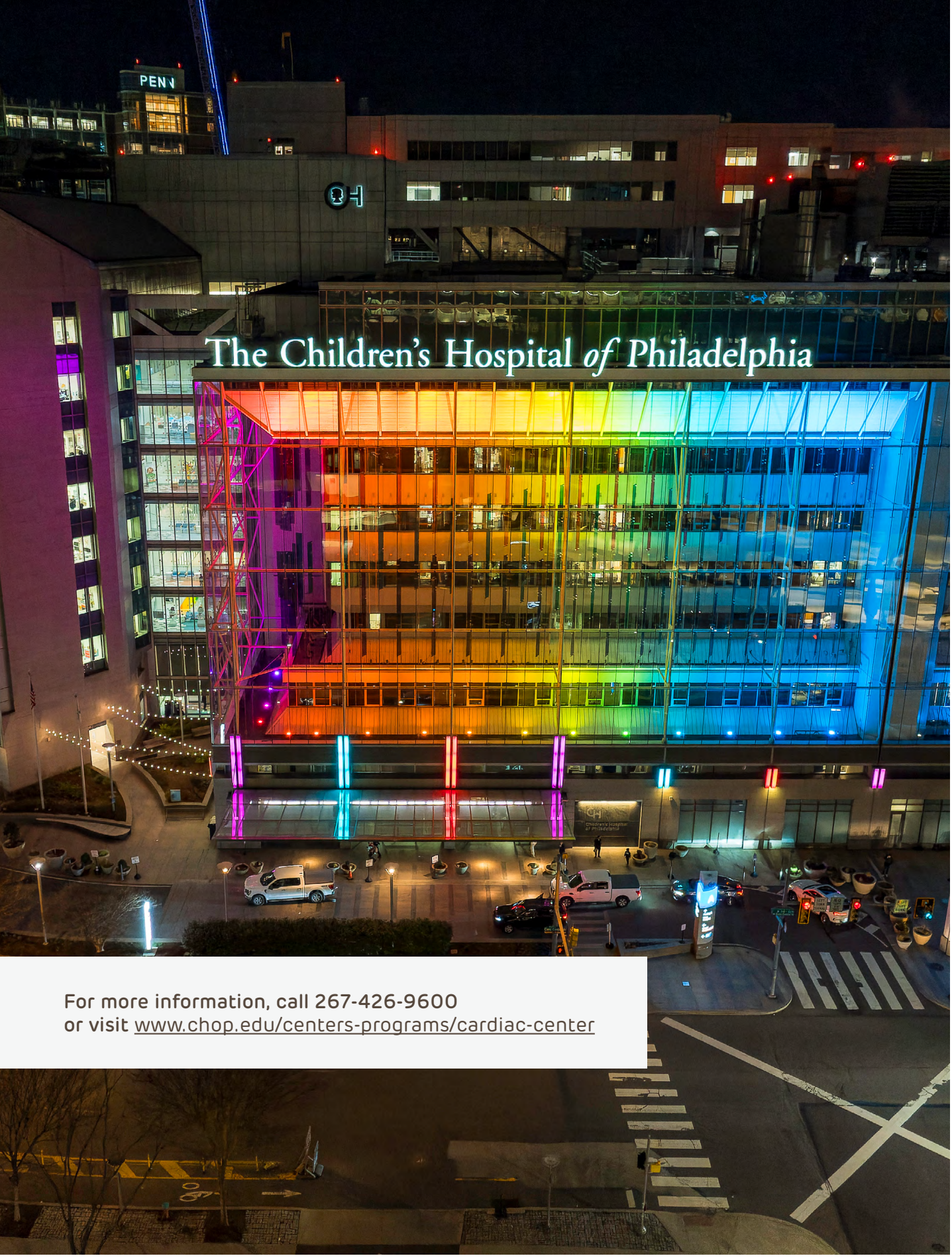
Zhao Y, Wang Y, Shi L, McDonald-McGinn DM, Crowley TB, McGinn DE, Tran OT, Miller D, Lin JR, Zackai E, Johnston HR, Chow EWC, Vorstman JAS, Vingerhoets C, van Amelsvoort T, Gothelf D, Swillen A, Breckpot J, Vermeesch JR, Eliez S, Schneider M, van den Bree MBM, Owen MJ, Kates WR, Repetto GM, Shashi V, Schoch K, Bearden CE, Digilio MC, Unolt M, Putotto C, Marino B, Pontillo M, Armando M, Vicari S, Angkustsiri K, Campbell L, Busa T, Heine-Suñer D, Murphy KC, Murphy D, García-Miñaúr S, Fernández L; International 22q11.2 Brain and Behavior Consortium (IBBC); Zhang ZD, Goldmuntz E, Gur RE, Emanuel BS, Zheng D, Marshall CR, Bassett AS, Wang T, Morrow BE. **Chromatin regulators in the TBX1 network confer risk for conotruncal heart defects in 22q11.2DS**. *NPJ Genom Med*. 2023, Jul. 8(1):17. doi: 10.1038/s41525-023-00363-y. PMID: 37463940; PMCID: PMC10354062

PUBLICATIONS

Zinna SS, Morgan RW, Reeder RW, Ahmed T, Bell MJ, Bishop R, Bochkoris M, Burns C, Carcillo JA, Carpenter TC, Cooper KK, Michael Dean J, Wesley Diddle J, Federman M, Fernandez R, Fink EL, Franzon D, Frazier AH, Friess SH, Graham K, Hall M, Harding ML, Hehir DA, Horvat CM, Huard LL, Landis WP, Maa T, Manga A, McQuillen PS, Meert KL, Mourani PM, Nadkarni VM, Naim MY, Notterman D, Pollack MM, Sapru A, Schneiter C, Sharron MP, Srivastava N, Tilford B, Viteri S, Wessel D, Wolfe HA, Yates AR, Zuppa AF, Berg RA, Sutton RM. **Chest compressions for pediatric organized rhythms: A hemodynamic and outcomes analysis**. *Resuscitation*. 2023, Dec. 194:110068. doi: 10.1016/j.resuscitation.2023.110068. Epub ahead of print. PMID: 38052273

Zuckerberg JC, Matsubara D, Kauffman HL, Chang JC, Calderon-Anyosa R, Patel C, Hogarty AN, Falkensammer CB, Mercer-Rosa LM, Quartermain MD, Wang Y, Banerjee A. **Left atrial stiffness and strain are novel indices of left ventricular diastolic function in children: validation followed by application in multisystem inflammatory syndrome in children due to COVID-19**. *Eur Heart J Cardiovasc Imaging*. 2023, May. 34(9): 1241-1251. doi: 10.1093/ehjci/jead087. PMID: 37159912

* Manuscripts involving cardiology fellows
** denotes publications supported by CCRC = 15
Total projects =223



For more information, call 267-426-9600
or visit www.chop.edu/centers-programs/cardiac-center

Publication acknowledgement: Mark Schwartz, Amanda Thaler, Sara Baumgarten, Jennifer Betit